UNITED STATES ARMY GARRISON HAWAII

STORM WATER MANAGEMENT PLAN

APPENDICIES

OCTOBER 2015

PREPARED BY:

DIRECTORATE OF PUBLIC WORKS

ENVIRONMENTAL DIVISION

PERMIT NO. HI S000090

STORM WATER MANAGEMENT PLAN
APPENDIX

United States Army Garrison Hawaii

PERMIT NO. HI S000090

FINAL

Prepared by

Directorate of Public Works

Environmental Division Clean Water Branch

October 2015

This page intentionally left blank.

TABLE OF CONTENTS

SECTION 1: Introduction

INTRO Appendix	Page
United States Army Garrison Hawaii (USAG-HI) Facility Maps	A
MS4 NPDES Permit Number HI S000090	B
Directorate of Public Works Organization Chart	C

SECTION 2: Public Education / Outreach / Involvement Program
(Permit Part D.1.a. and D.1.b.)

PUB Appendix	Page
Clean Water Program Brochure	A
Storm Drain Placard	B

SECTION 3: Illicit Discharge Detection and Elimination Program
(Permit Part D.1.c.)

IDDE Appendix	Page
Request to Discharge Form	A
Connection Application	B
Connection Permit	C
Policy Memo USAG-HI-59 Illicit Discharge Detection and Elimination	D
Outfall Reconnaissance Inventory (ORI)	E
Outfalls and Discharge Points	F
Outfall Inspection Checklist	G
Illicit Discharge Flow Chart	H

Spill Prevention Containment and Countermeasures	I
Wastewater Spill Standard Operating Procedures	J
Island Palm Communities (IPC) Legal Authority	K
U.S Army Corps of Engineers Legal Authority	L
Job Order Contract (JOC) Legal Authority	L
Environmental Compliance Officer (ECO) Training Documents	M

SECTION 4: Construction Site Runoff Control Program
(Permit Part D.1.d.)

CON Appendix	Page
City and County of Honolulu Storm Water Best Management Practice Manual	A
Hawaii State Department of Transportation Storm Water Best Management Practices Manual	B
USAG-HI Storm Water Pollution Prevention Plan Content Review Checklist	C
USAG-HI Letter Of Authorization SAMPLE	D
USAG-HI Initial BMP Site Inspection Checklist	E
USAG-HI Corrective Procedures for Construction Storm Water Inspections	F
USAG-HI Construction Oversight Field Inspection Checklist	G
USAG-HI Construction Site Runoff Control Enforcement Program Policy Memo - DRAFT	H
USAG-HI Construction Site Runoff Control Enforcement Response Plan	I
USAG-HI Construction Best Management Practice (BMP) Storm Water Training	J

SECTION 5: Post-Construction Storm Water Management Program
(Permit Part D.1.e.)

PR Appendix	Page

Army Stormwater Management Using Low Impact Development Memo A

Army Stormwater Management Using Low Impact Development B

DoD Unified Facilities Criteria: UFC 3-120-10 Low Impact Design C

Army Low Impcat Development Technical User Guide D

SECTION 6: Pollution Prevention / Good Housekeeping

Debris Control BMP Program
(Permit Part D.1.f.(1))

DCBP Appendix Page

Street Sweeping Routes and Schedules A

Action Plan for Retrofitting Structural BMPs B

Chemical Applications BMP Program
(Permit Part D.1.f.(2))

CABP Appendix Page

United States Army Garrison Hawaii (USAG-HI) Integrated Pest Management Plan A

Erosion Control BMP Program
(Permit Part D.1.f.(3))

ECBP Appendix Page

Erosion Control BMPs Program Plan A

Action Plan to Address Erosional Outfalls B

Maintenance Activities BMP Program
(Permit Part D.1.f.(4))

MABP Appendix Page

Maintenance Interim SOPs A

SECTION 7: Industrial and Commercial Activities Discharge Management Program
(Permit Part D.1.g.)

ICA Appendix	Page
Storm Water Pollution Control Plan Enforcement Program Memo	A
Industrial Facilities Inventory	B
Commercial Facilities Inventory	C
Prioritized List for Industrial and Commercial Facilities	D
Environmental Compliance Inspection Checklist	E
USAG-HI Storm Water Pollution Control Plan	F

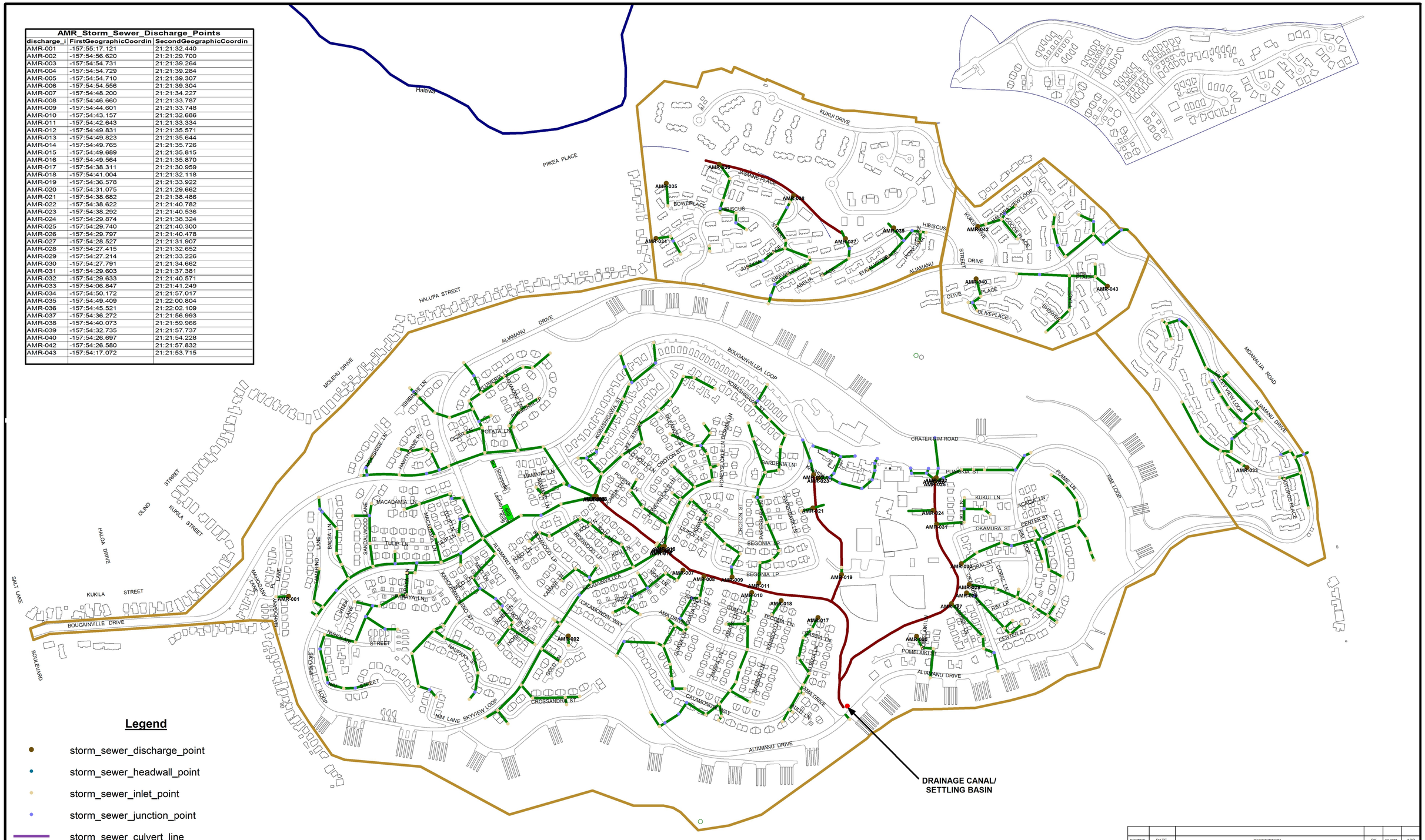
SECTION 1: Introduction
INTRO APPENDIX

This page intentionally left blank.

INTRO APPENDIX A
United States Army Garrison Hawaii (USAG-HI) Facility Maps

This page intentionally left blank.

AMR_Storm_Sewer_Discharge_Points		
discharge_i	FirstGeographicCoordin	SecondGeographicCoordin
AMR-001	-157:55:17.121	21:21:32.440
AMR-002	-157:54:56.620	21:21:29.700
AMR-003	-157:54:54.731	21:21:39.264
AMR-004	-157:54:54.729	21:21:39.284
AMR-005	-157:54:54.710	21:21:39.307
AMR-006	-157:54:54.556	21:21:39.304
AMR-007	-157:54:48.200	21:21:34.227
AMR-008	-157:54:46.660	21:21:33.787
AMR-009	-157:54:44.601	21:21:33.748
AMR-010	-157:54:43.157	21:21:32.686
AMR-011	-157:54:42.643	21:21:33.334
AMR-012	-157:54:49.831	21:21:35.571
AMR-013	-157:54:49.823	21:21:35.644
AMR-014	-157:54:49.765	21:21:35.726
AMR-015	-157:54:49.689	21:21:35.815
AMR-016	-157:54:49.564	21:21:35.870
AMR-017	-157:54:38.311	21:21:30.959
AMR-018	-157:54:41.004	21:21:32.118
AMR-019	-157:54:36.578	21:21:33.922
AMR-020	-157:54:31.075	21:21:29.662
AMR-021	-157:54:38.682	21:21:38.486
AMR-022	-157:54:38.622	21:21:40.782
AMR-023	-157:54:38.292	21:21:40.536
AMR-024	-157:54:29.874	21:21:38.324
AMR-025	-157:54:29.740	21:21:40.300
AMR-026	-157:54:29.797	21:21:40.478
AMR-027	-157:54:28.527	21:21:31.907
AMR-028	-157:54:27.415	21:21:32.652
AMR-029	-157:54:27.214	21:21:33.226
AMR-030	-157:54:27.791	21:21:34.662
AMR-031	-157:54:29.603	21:21:37.381
AMR-032	-157:54:29.633	21:21:40.571
AMR-033	-157:54:06.847	21:21:41.249
AMR-034	-157:54:50.172	21:21:57.017
AMR-035	-157:54:49.409	21:22:00.804
AMR-036	-157:54:45.521	21:22:02.109
AMR-037	-157:54:36.272	21:21:56.993
AMR-038	-157:54:40.073	21:21:59.966
AMR-039	-157:54:32.735	21:21:57.737
AMR-040	-157:54:26.697	21:21:54.228
AMR-042	-157:54:26.580	21:21:57.832
AMR-043	-157:54:17.072	21:21:53.715



Legend

- storm_sewer_discharge_point
- storm_sewer_headwall_point
- storm_sewer_inlet_point
- storm_sewer_junction_point
- storm_sewer_culvert_line
- storm_sewer_headwall_line
- storm_sewer_inlet
- storm_sewer_line
- storm_sewer_open_drainage_line/grass_swale
- streams
- storm_sewer_drainage_basin_area
- Industrial_Facilities

ALIAMANU MILITARY RESERVATION

N

0 250 500 750 1000
Feet

SYMBOL	DATE	DESCRIPTION	BY	CHK'D	APP
		REVISIONS			

DIRECTORATE OF PUBLIC WORKS
U. S. ARMY GARRISON, HAWAII

DESIGNED: DATE
DRAWN BY: DATE
SCALE:

STORM SEWER PLAN AND INDUSTRIAL FACILITIES
ALIAMANU MILITARY RESERVATION

PROJECT NO.

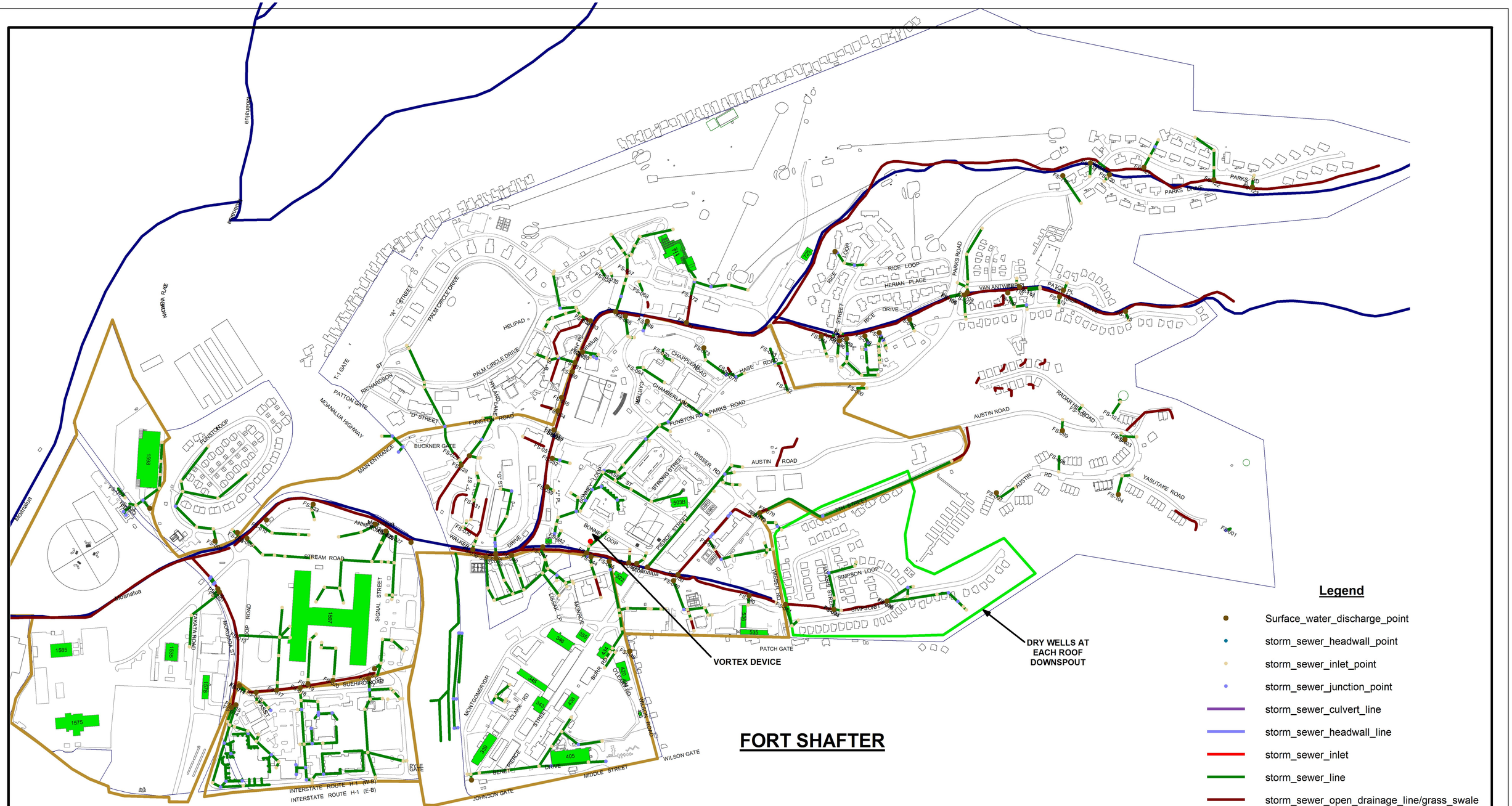
CHECKED: ARCH, CIVIL, MECH, ELEC, FIRE, ENVIRON, AREA ENGR

APPROVED: DATE
DIRECTOR

SUBMITTED BY: DATE
APPROVAL RECOMMENDED BY: DATE

SHT. OF SHTS DRAWING NO.

FEBRUARY 2011



FS_Storm_Sewer_Discharge_Points		
discharge_i	FirstGeographicCoordin	SecondGeographicCoordin
FS-001	-157:52:23.675	21:20:57.331
FS-002	-157:53:32.487	21:20:23.215
FS-003	-157:53:31.133	21:20:22.541
FS-004	-157:53:31.269	21:20:22.734
FS-005	-157:53:24.648	21:20:23.358
FS-006	-157:53:22.913	21:20:20.696
FS-007	-157:53:22.733	21:20:20.491
FS-008	-157:53:23.642	21:20:24.487
FS-009	-157:53:22.904	21:20:24.562
FS-010	-157:53:22.544	21:20:25.813
FS-011	-157:53:18.271	21:20:15.921
FS-012	-157:53:18.256	21:20:15.985
FS-013	-157:53:19.990	21:20:18.849
FS-014	-157:53:17.890	21:20:14.473
FS-015	-157:53:17.900	21:20:14.778
FS-016	-157:53:16.966	21:20:16.099
FS-017	-157:53:15.842	21:20:17.020
FS-018	-157:53:14.508	21:20:17.861
FS-019	-157:53:14.204	21:20:18.388
FS-020	-157:53:12.781	21:20:19.373
FS-021	-157:53:10.647	21:20:20.618
FS-022	-157:53:10.272	21:20:21.133
FS-023	-157:53:20.164	21:20:28.690
FS-024	-157:53:15.529	21:20:29.652
FS-025	-157:53:14.671	21:20:29.572
FS-026	-157:53:14.637	21:20:29.571
FS-027	-157:53:13.999	21:20:29.613
FS-028	-157:53:12.489	21:20:35.767
FS-029	-157:53:13.501	21:20:36.242
FS-030	-157:53:10.101	21:20:32.327
FS-031	-157:53:10.477	21:20:34.139
FS-032	-157:53:10.222	21:20:48.181
FS-033	-157:53:09.590	21:20:48.198
FS-034	-157:53:10.457	21:20:51.244
FS-035	-157:53:09.985	21:20:51.439

FS_Storm_Sewer_Discharge_Points		
discharge_i	FirstGeographicCoordin	SecondGeographicCoordin
FS-036	-157:53:08.899	21:20:31.303
FS-037	-157:53:07.779	21:20:31.359
FS-038	-157:53:07.329	21:20:31.885
FS-039	-157:53:07.137	21:20:31.642
FS-040	-157:53:06.308	21:20:32.302
FS-041	-157:53:04.681	21:20:33.538
FS-042	-157:53:04.151	21:20:34.946
FS-043	-157:53:01.861	21:20:35.077
FS-044	-157:53:01.409	21:20:34.768
FS-045	-157:53:00.246	21:20:35.151
FS-046	-157:52:58.933	21:20:35.721
FS-047	-157:52:58.438	21:20:35.912
FS-048	-157:52:55.840	21:20:30.696
FS-049	-157:52:55.621	21:20:36.147
FS-050	-157:52:55.590	21:20:36.654
FS-051	-157:53:08.168	21:20:39.543
FS-052	-157:53:07.285	21:20:39.139
FS-053	-157:53:08.106	21:20:40.814
FS-054	-157:53:08.483	21:20:42.063
FS-055	-157:53:08.701	21:20:42.910
FS-056	-157:53:08.069	21:20:40.662
FS-057	-157:53:07.806	21:20:40.664
FS-058	-157:53:07.833	21:20:40.769
FS-059	-157:53:06.566	21:20:37.340
FS-060	-157:53:09.133	21:20:44.719
FS-061	-157:53:09.214	21:20:45.325
FS-062	-157:53:09.275	21:20:46.111
FS-063	-157:53:09.074	21:20:46.200
FS-064	-157:53:05.263	21:20:47.069
FS-065	-157:53:08.512	21:20:49.645
FS-066	-157:53:07.756	21:20:49.568
FS-067	-157:53:09.337	21:20:52.426
FS-068	-157:53:07.640	21:20:51.630
FS-069	-157:53:06.298	21:20:50.056
FS-070	-157:53:04.316	21:20:48.936

FS_Storm_Sewer_Discharge_Points		
discharge_i	FirstGeographicCoordin	SecondGeographicCoordin
FS-071	-157:53:03.867	21:20:51.364
FS-072	-157:53:04.556	21:20:53.030
FS-073	-157:53:01.934	21:20:50.378
FS-074	-157:52:59.738	21:20:50.017
FS-075	-157:52:59.354	21:20:49.808
FS-076	-157:52:54.799	21:20:39.575
FS-077	-157:52:52.859	21:20:42.774
FS-078	-157:52:52.705	21:20:42.753
FS-079	-157:52:52.370	21:20:43.362
FS-080	-157:52:50.502	21:20:37.762
FS-081	-157:52:47.985	21:20:38.431
FS-082	-157:52:55.629	21:20:50.936
FS-083	-157:52:57.857	21:20:52.501
FS-084	-157:52:55.230	21:20:54.883
FS-085	-157:52:54.510	21:20:55.284
FS-086	-157:52:53.964	21:20:55.194
FS-087	-157:52:53.975	21:20:55.702
FS-088	-157:52:53.568	21:20:55.539
FS-089	-157:52:52.508	21:20:56.281
FS-090	-157:52:51.198	21:20:53.116
FS-091	-157:52:51.786	21:20:56.961
FS-092	-157:52:50.414	21:20:58.691
FS-093	-157:52:44.970	21:20:39.801
FS-094	-157:52:44.929	21:20:39.773
FS-095	-157:52:41.961	21:20:42.008
FS-096	-157:52:41.906	21:20:41.953
FS-097	-157:52:39.103	21:20:51.671
FS-098	-157:52:36.581	21:20:55.829
FS-099	-157:52:37.336	21:20:57.429
FS-100	-157:52:37.006	21:20:59.161
FS-101	-157:52:34.842	21:21:00.050
FS-102	-157:52:33.584	21:20:59.046
FS-103	-157:52:33.173	21:20:58.985
FS-104	-157:52:31.725	21:20:55.554
FS-105	-157:52:48.730	21:21:01.348

FS_Storm_Sewer_Discharge_Points		
discharge_i	FirstGeographicCoordin	SecondGeographicCoordin
FS-106	-157:52:48.754	21:21:01.397
FS-107	-157:52:47.854	21:21:01.776
FS-108	-157:52:47.799	21:21:02.047
FS-109	-157:52:45.122	21:21:03.215
FS-110	-157:52:45.036	21:21:04.068
FS-111	-157:52:44.263	21:21:04.290
FS-112	-157:52:44.323	21:21:04.365
FS-113	-157:52:42.139	21:21:04.878
FS-114	-157:52:42.102	21:21:05.453
FS-115	-157:52:37.524	21:21:06.143
FS-116	-157:52:46.195	21:21:11.883
FS-117	-157:52:44.929	21:21:13.549
FS-118	-157:52:44.426	21:21:13.815
FS-119	-157:52:43.951	21:21:13.757
FS-120	-157:52:43.406	21:21:13.426
FS-121	-157:52:41.552	21:21:15.045
FS-122	-157:52:36.891	21:21:16.646
FS-123	-157:52:34.305	21:21:17.467

SYMBOL	DATE	DESCRIPTION	BY	CHK'D	APP
		REVISIONS			

DIRECTORATE OF PUBLIC WORKS

U. S. ARMY GARRISON, HAWAII

DESIGNED: DATE

DRAWN BY: DATE

SCALE:

STORM SEWER PLAN AND INDUSTRIAL FACILITIES

FORT SHAFTER

PROJECT NO.

CHECKED: ARCH, CIVIL, MECH, ELEC, FIRE, ENVIRON, AREA ENGR

APPROVED: DATE

DIRECTOR

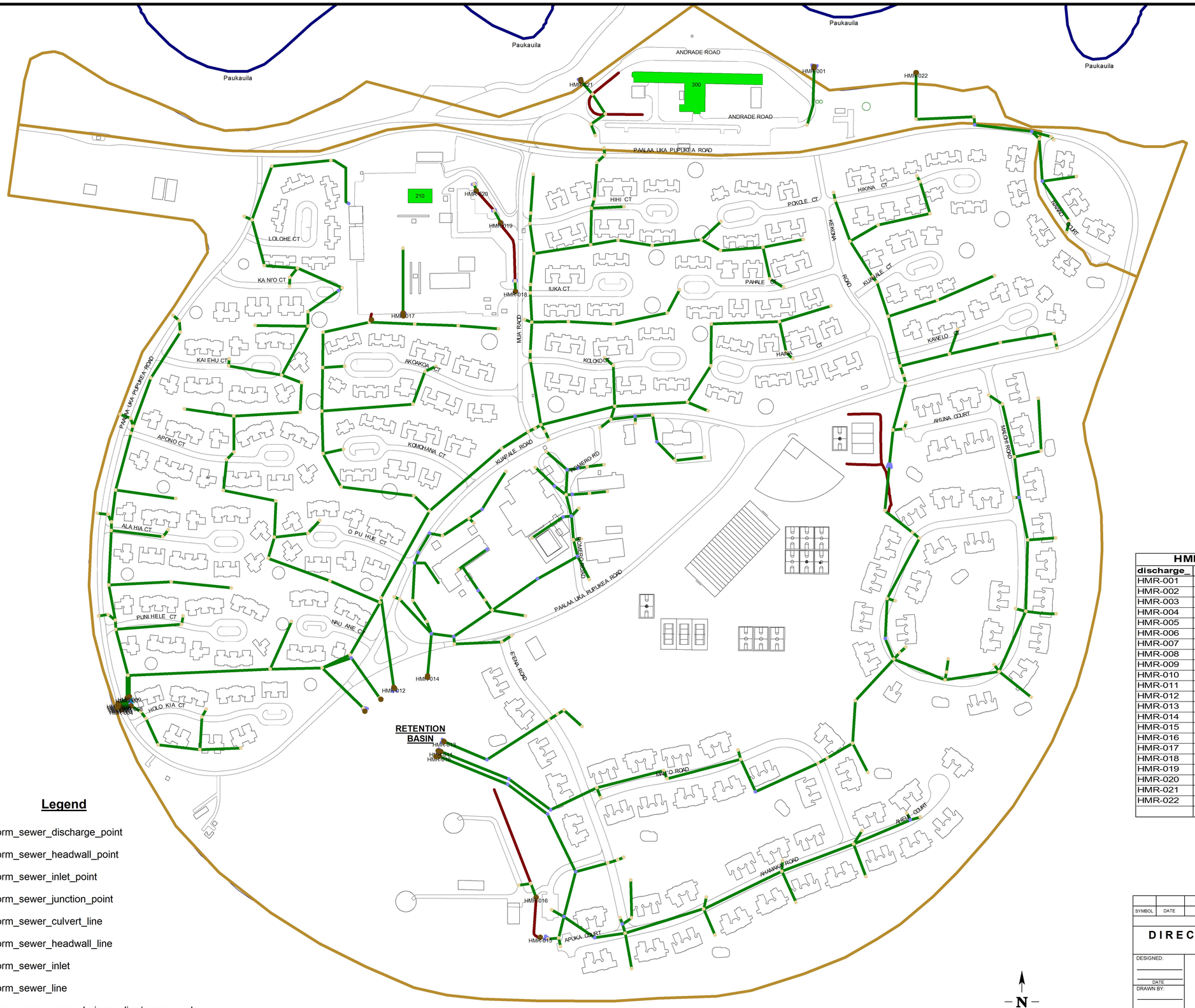
SUBMITTED BY: DATE

APPROVAL RECOMMENDED BY: DATE

SHT. OF SHTS

DRAWING NO.

FEBRUARY 2011



Legend

- storm_sewer_discharge_point
- storm_sewer_headwall_point
- storm_sewer_inlet_point
- storm_sewer_junction_point
- storm_sewer_culvert_line
- storm_sewer_headwall_line
- storm_sewer_inlet
- storm_sewer_line
- storm_sewer_open_drainage_line/grass_swale
- streams
- storm_sewer_drainage_basin_area
- Industrial_Facilities

HELEMANO MILITARY RESERVATION

0 150 300 450 600
Feet

HMR_Storm_Sewer_Discharge_Points

discharge_	FirstGeographicCoordi	SecondGeographicCoordi
HMR-001	-158:01:01.424	21:32:25.996
HMR-002	-158:01:29.651	21:32:01.703
HMR-003	-158:01:29.621	21:32:01.646
HMR-004	-158:01:29.587	21:32:01.583
HMR-005	-158:01:29.715	21:32:01.823
HMR-006	-158:01:29.684	21:32:01.766
HMR-007	-158:01:29.353	21:32:02.038
HMR-008	-158:01:29.189	21:32:01.729
HMR-009	-158:01:29.260	21:32:02.086
HMR-010	-158:01:16.670	21:31:59.818
HMR-011	-158:01:16.592	21:31:59.996
HMR-012	-158:01:18.511	21:32:02.437
HMR-013	-158:01:16.458	21:32:00.374
HMR-014	-158:01:17.138	21:32:02.882
HMR-015	-158:01:12.548	21:31:52.933
HMR-016	-158:01:12.719	21:31:54.449
HMR-017	-158:01:18.131	21:32:16.683
HMR-018	-158:01:13.563	21:32:17.499
HMR-019	-158:01:14.165	21:32:20.115
HMR-020	-158:01:15.158	21:32:21.331
HMR-021	-158:01:10.891	21:32:25.487
HMR-022	-158:00:57.274	21:32:25.826

SYMBOL	DATE	DESCRIPTION	BY	CHK'D	APP

REVISIONS

DIRECTORATE OF PUBLIC WORKS
U. S. ARMY GARRISON, HAWAII

DESIGNED: DATE
DRAWN BY: DATE
SCALE:

STORM SEWER PLAN AND INDUSTRIAL FACILITIES
HELEMANO MILITARY RESERVATION

PROJECT NO.

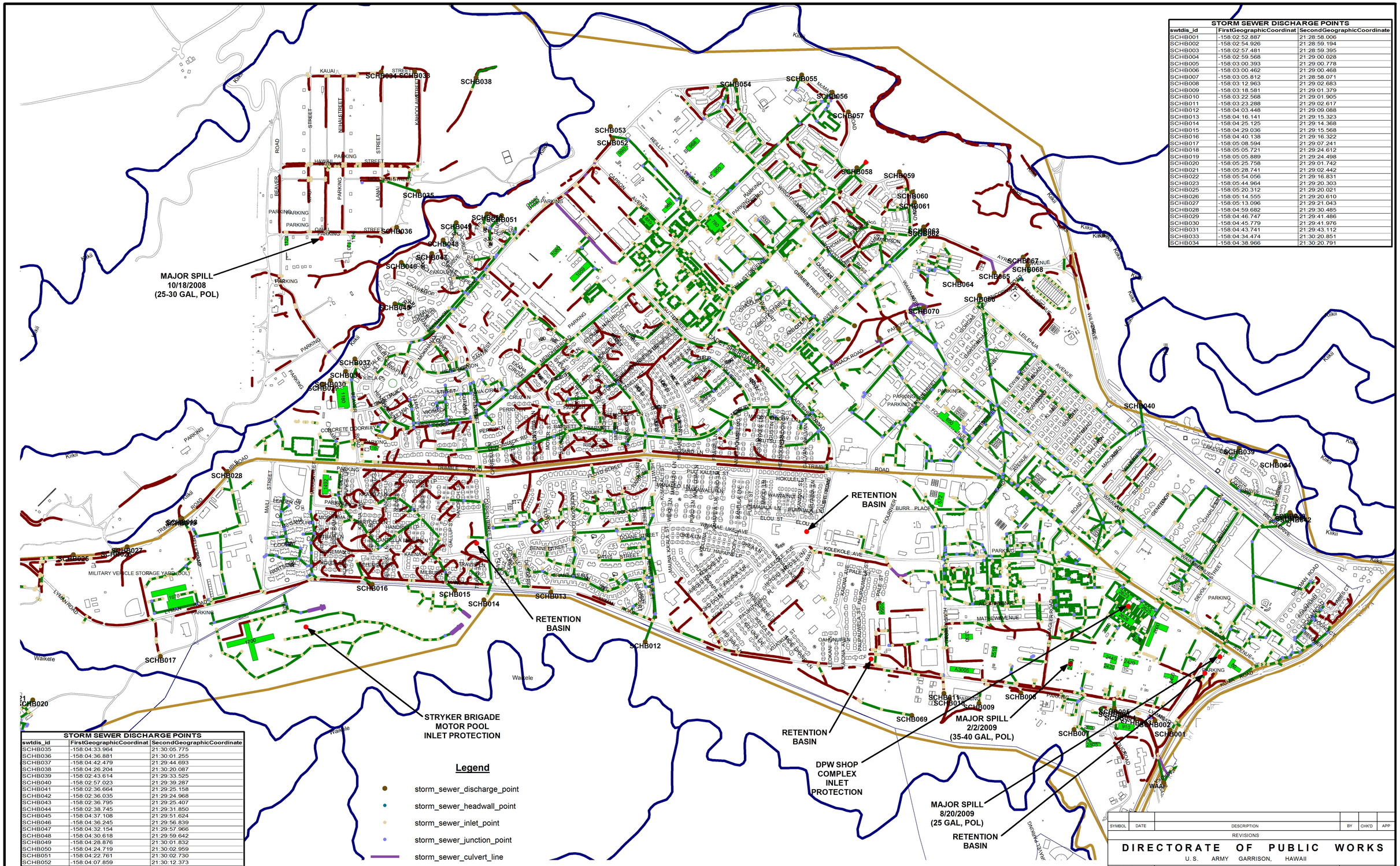
CHECKED: ARCH, CIVIL, MECH, ELEC, FIRE, ENVIRON, AREA ENGR

APPROVED: DATE
DIRECTOR

SUBMITTED BY: DATE
APPROVAL RECOMMENDED BY: DATE

SHT. OF SHTS DRAWING NO.

FEBRUARY 2011



STORM SEWER DISCHARGE POINTS		
swtdis_id	FirstGeographicCoordinat	SecondGeographicCoordinate
SCHB001	-158:02:52.887	21:28:58.006
SCHB002	-158:02:54.926	21:28:59.194
SCHB003	-158:02:57.481	21:28:59.395
SCHB004	-158:02:59.568	21:29:00.028
SCHB005	-158:03:00.393	21:29:00.778
SCHB006	-158:03:00.462	21:29:00.468
SCHB007	-158:03:05.812	21:28:58.071
SCHB008	-158:03:12.963	21:29:02.683
SCHB009	-158:03:18.581	21:29:01.379
SCHB010	-158:03:22.568	21:29:01.905
SCHB011	-158:03:23.288	21:29:02.617
SCHB012	-158:04:03.448	21:29:09.088
SCHB013	-158:04:16.141	21:29:15.323
SCHB014	-158:04:25.125	21:29:14.368
SCHB015	-158:04:29.036	21:29:15.568
SCHB016	-158:04:40.138	21:29:16.322
SCHB017	-158:05:08.594	21:29:07.241
SCHB018	-158:05:05.721	21:29:24.612
SCHB019	-158:05:05.889	21:29:24.498
SCHB020	-158:05:25.758	21:29:01.742
SCHB021	-158:05:28.741	21:29:02.442
SCHB022	-158:05:54.056	21:29:16.831
SCHB023	-158:05:44.964	21:29:20.303
SCHB025	-158:05:20.312	21:29:20.021
SCHB026	-158:05:14.555	21:29:20.610
SCHB027	-158:05:13.096	21:29:21.043
SCHB028	-158:04:59.682	21:29:30.485
SCHB029	-158:04:46.747	21:29:41.486
SCHB030	-158:04:45.779	21:29:41.976
SCHB031	-158:04:43.741	21:29:43.112
SCHB033	-158:04:34.474	21:30:20.851
SCHB034	-158:04:38.966	21:30:20.791

STORM SEWER DISCHARGE POINTS		
swtdis_id	FirstGeographicCoordinat	SecondGeographicCoordinate
SCHB035	-158:04:33.964	21:30:05.775
SCHB036	-158:04:36.881	21:30:01.255
SCHB037	-158:04:42.479	21:29:44.693
SCHB038	-158:04:26.204	21:30:20.087
SCHB039	-158:02:43.614	21:29:33.525
SCHB040	-158:02:57.023	21:29:39.287
SCHB041	-158:02:36.664	21:29:25.158
SCHB042	-158:02:36.035	21:29:24.968
SCHB043	-158:02:36.795	21:29:25.407
SCHB044	-158:02:38.745	21:29:31.850
SCHB045	-158:04:37.108	21:29:51.624
SCHB046	-158:04:36.245	21:29:56.839
SCHB047	-158:04:32.154	21:29:57.966
SCHB048	-158:04:30.618	21:29:59.642
SCHB049	-158:04:28.876	21:30:01.832
SCHB050	-158:04:24.719	21:30:02.959
SCHB051	-158:04:22.761	21:30:02.730
SCHB052	-158:04:07.859	21:30:12.373
SCHB053	-158:04:08.148	21:30:13.959
SCHB054	-158:03:51.344	21:30:19.768
SCHB055	-158:03:42.441	21:30:20.464
SCHB056	-158:03:38.338	21:30:18.266
SCHB057	-158:03:36.163	21:30:15.799
SCHB058	-158:03:35.013	21:30:08.771
SCHB059	-158:03:29.305	21:30:08.273
SCHB060	-158:03:27.529	21:30:05.715
SCHB061	-158:03:27.267	21:30:04.431
SCHB062	-158:03:26.036	21:30:00.993
SCHB063	-158:03:26.030	21:30:01.325
SCHB064	-158:03:21.425	21:29:54.588
SCHB065	-158:03:16.538	21:29:55.586
SCHB066	-158:03:18.516	21:29:52.707
SCHB067	-158:03:12.674	21:29:57.552
SCHB068	-158:03:12.051	21:29:56.461
SCHB069	-158:03:27.601	21:28:59.856
SCHB070	-158:03:26.019	21:29:51.190

Legend

- storm_sewer_discharge_point
- storm_sewer_headwall_point
- storm_sewer_inlet_point
- storm_sewer_junction_point
- storm_sewer_culvert_line
- storm_sewer_headwall_line
- storm_sewer_inlet
- storm_sewer_line
- storm_sewer_open_drainage_line/grass_swale
- streams
- storm_sewer_drainage_basin_area
- Industrial_Facilities

SCHOFIELD BARRACKS

N

0 400 800 1200 1600
Feet

SYMBOL	DATE	DESCRIPTION	BY	CHK'D	APP

REVISIONS

DIRECTORATE OF PUBLIC WORKS
U. S. ARMY GARRISON, HAWAII

DESIGNED: DATE
DRAWN BY: DATE
SCALE:

STORM SEWER PLAN AND INDUSTRIAL FACILITIES

SCHOFIELD BARRACKS

PROJECT NO.

CHECKED: ARCH, CIVIL, MECH, ELEC, FIRE, ENVIRON, AREA ENGR

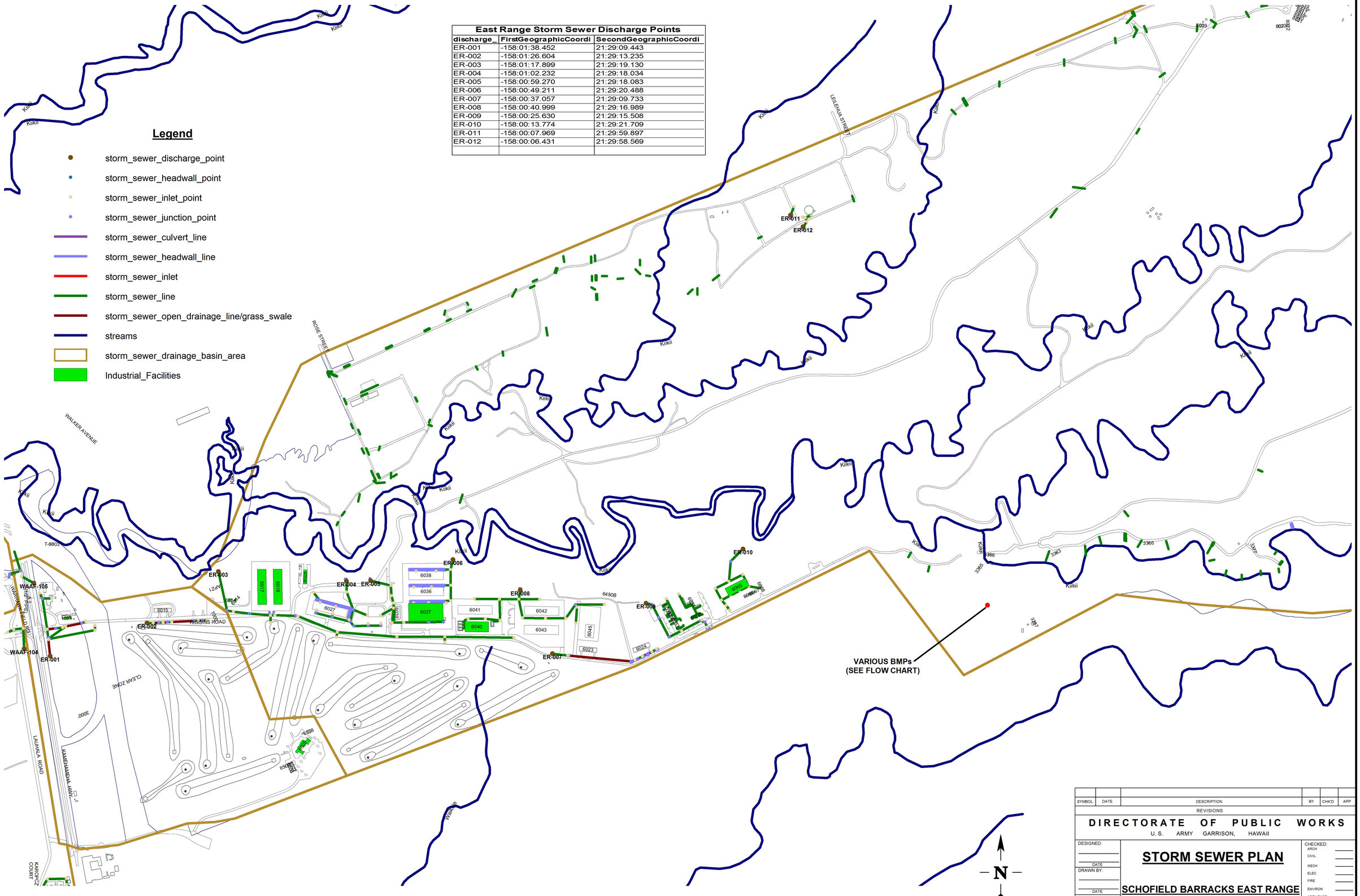
APPROVED: DATE
DIRECTOR

SUBMITTED BY: DATE
APPROVAL RECOMMENDED BY: DATE

SHT. OF SHTS DRAWING NO.

FEBRUARY 2011

East Range Storm Sewer Discharge Points		
discharge_	FirstGeographicCoordi	SecondGeographicCoordi
ER-001	-158:01:38.452	21:29:09.443
ER-002	-158:01:26.604	21:29:13.235
ER-003	-158:01:17.899	21:29:19.130
ER-004	-158:01:02.232	21:29:18.034
ER-005	-158:00:59.270	21:29:18.083
ER-006	-158:00:49.211	21:29:20.488
ER-007	-158:00:37.057	21:29:09.733
ER-008	-158:00:40.999	21:29:16.989
ER-009	-158:00:25.630	21:29:15.508
ER-010	-158:00:13.774	21:29:21.709
ER-011	-158:00:07.969	21:29:59.897
ER-012	-158:00:06.431	21:29:58.569



SCHOFIELD BARRACKS EAST RANGE

SYMBOL	DATE	DESCRIPTION	BY	CHK'D	APP

REVISIONS

DIRECTORATE OF PUBLIC WORKS
U. S. ARMY GARRISON, HAWAII

DESIGNED: DATE
DRAWN BY: DATE
SCALE:

STORM SEWER PLAN

SCHOFIELD BARRACKS EAST RANGE

PROJECT NO.

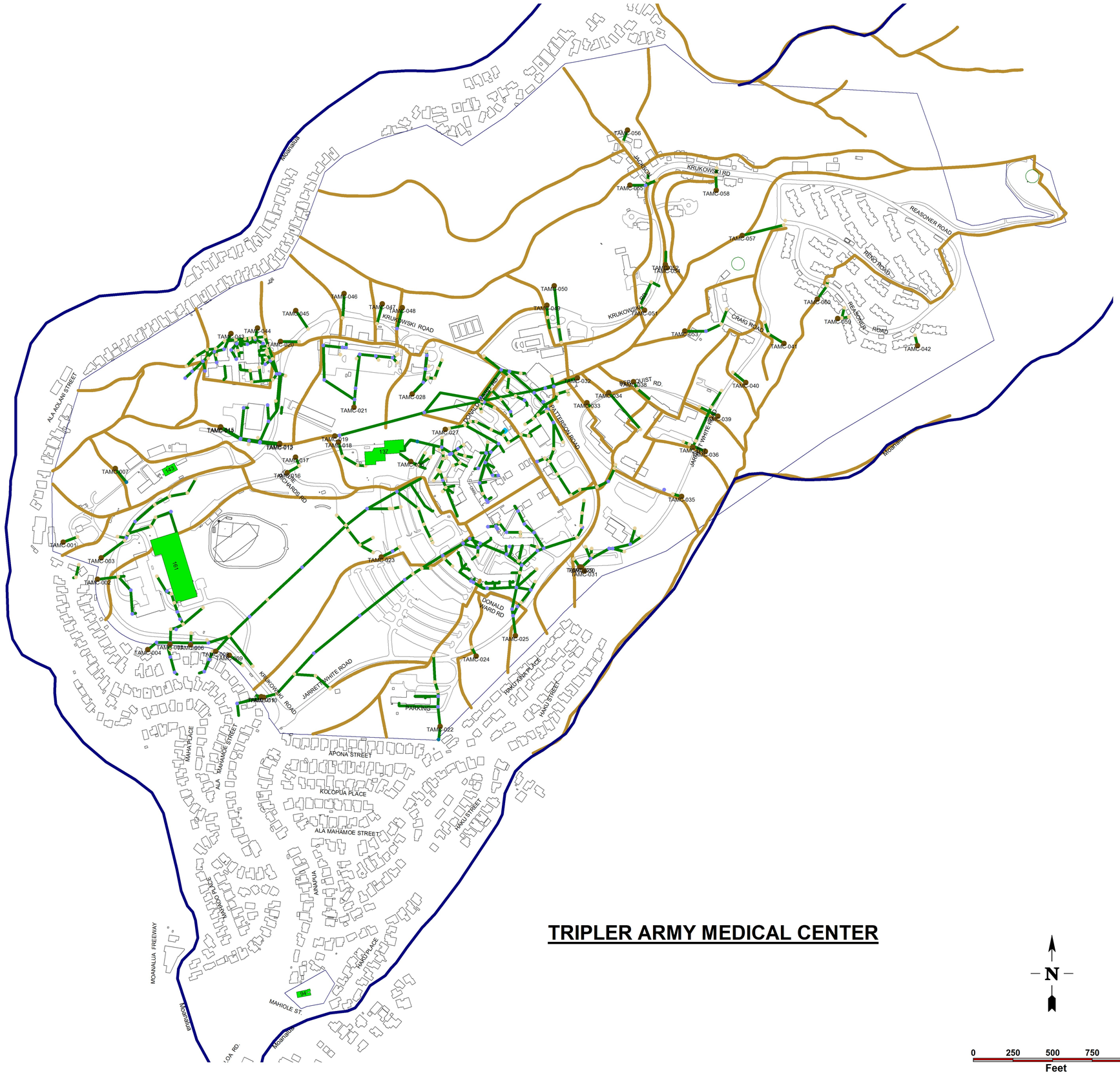
CHECKED: ARCH, CIVIL, MECH, ELEC, FIRE, ENVIRON, AREA ENGR

APPROVED: DATE
DIRECTOR

SUBMITTED BY: DATE
APPROVAL RECOMMENDED BY: DATE

SHT. OF SHTS DRAWING NO.

FEBRUARY 2011



TRIPLER ARMY MEDICAL CENTER

N

0 250 500 750 1000
Feet

TAMC_STORM_SEWER_DISCHARGE_POINTS		
discharge_i	FirstGeographicCoordin	SecondGeographicCoordina
TAMC-001	-157:53:52.604	21:21:33.109
TAMC-002	-157:53:50.324	21:21:30.786
TAMC-003	-157:53:50.072	21:21:32.124
TAMC-004	-157:53:46.958	21:21:26.390
TAMC-005	-157:53:45.486	21:21:26.721
TAMC-006	-157:53:44.111	21:21:26.687
TAMC-007	-157:53:49.130	21:21:37.710
TAMC-008	-157:53:42.425	21:21:26.277
TAMC-009	-157:53:41.512	21:21:26.033
TAMC-010	-157:53:39.235	21:21:23.402
TAMC-011	-157:53:39.384	21:21:23.434
TAMC-012	-157:53:38.156	21:21:39.201
TAMC-013	-157:53:38.146	21:21:39.265
TAMC-014	-157:53:42.106	21:21:40.265
TAMC-015	-157:53:42.087	21:21:40.314
TAMC-016	-157:53:37.644	21:21:37.450
TAMC-017	-157:53:37.087	21:21:38.414
TAMC-018	-157:53:34.221	21:21:39.348
TAMC-019	-157:53:34.471	21:21:39.732
TAMC-020	-157:53:38.084	21:21:45.649
TAMC-021	-157:53:33.191	21:21:41.531
TAMC-022	-157:53:27.452	21:21:21.574
TAMC-023	-157:53:31.368	21:21:32.170
TAMC-024	-157:53:25.044	21:21:25.962
TAMC-025	-157:53:22.414	21:21:27.238
TAMC-026	-157:53:29.393	21:21:38.140
TAMC-027	-157:53:27.092	21:21:40.144
TAMC-028	-157:53:29.302	21:21:42.364
TAMC-029	-157:53:18.122	21:21:31.534
TAMC-030	-157:53:18.004	21:21:31.515
TAMC-031	-157:53:17.818	21:21:31.274
TAMC-032	-157:53:18.268	21:21:43.359
TAMC-033	-157:53:17.637	21:21:41.807
TAMC-034	-157:53:16.173	21:21:42.436
TAMC-035	-157:53:11.318	21:21:35.940
TAMC-036	-157:53:09.726	21:21:38.750
TAMC-037	-157:53:10.564	21:21:39.011
TAMC-038	-157:53:14.525	21:21:43.118
TAMC-039	-157:53:08.891	21:21:40.961
TAMC-040	-157:53:07.031	21:21:43.058
TAMC-041	-157:53:04.475	21:21:45.508
TAMC-042	-157:52:55.559	21:21:45.357
TAMC-043	-157:53:41.391	21:21:46.147
TAMC-044	-157:53:39.627	21:21:46.496
TAMC-045	-157:53:37.065	21:21:47.585
TAMC-046	-157:53:33.837	21:21:48.643
TAMC-047	-157:53:31.292	21:21:47.994
TAMC-048	-157:53:29.949	21:21:47.758
TAMC-049	-157:53:20.304	21:21:47.905
TAMC-050	-157:53:19.807	21:21:49.123
TAMC-051	-157:53:13.785	21:21:47.585
TAMC-052	-157:53:12.388	21:21:50.437
TAMC-053	-157:53:11.101	21:21:46.284
TAMC-054	-157:53:12.288	21:21:50.234
TAMC-055	-157:53:14.751	21:21:55.412
TAMC-056	-157:53:14.904	21:21:58.855
TAMC-057	-157:53:07.251	21:21:52.262
TAMC-058	-157:53:08.985	21:21:55.077
TAMC-059	-157:53:00.882	21:21:47.060
TAMC-060	-157:53:02.243	21:21:48.278

Legend

- tamc_storm_sewer_discharge_point
- storm_sewer_headwall_point
- storm_sewer_inlet_point
- storm_sewer_junction_point
- storm_sewer_culvert_line
- storm_sewer_headwall_line
- storm_sewer_inlet
- storm_sewer_line
- storm_sewer_open_drainage_line/grass_swale
- streams
- storm_sewer_drainage_basin_area
- Industrial_Facilities

SYMBOL	DATE	DESCRIPTION	BY	CHK'D	APP

REVISIONS

DIRECTORATE OF PUBLIC WORKS
U. S. ARMY GARRISON, HAWAII

DESIGNED: DATE
DRAWN BY: DATE
SCALE:

STORM SEWER PLAN AND INDUSTRIAL FACILITIES

TRIPLER ARMY MEDICAL CENTER

PROJECT NO.

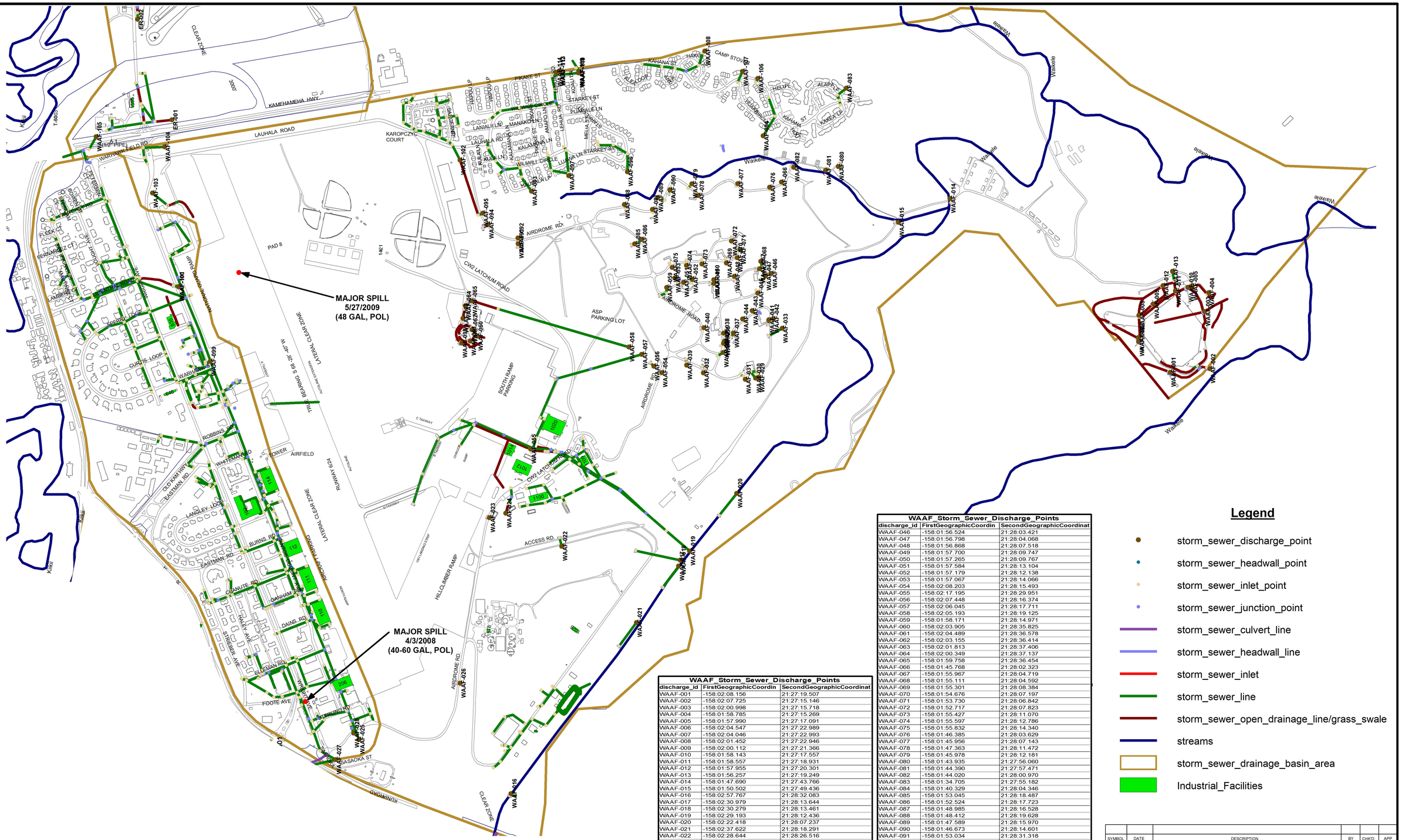
CHECKED: ARCH, CIVIL, MECH, ELEC, FIRE, ENVIRON, AREA ENGR

APPROVED: DATE
DIRECTOR

SUBMITTED BY: DATE
APPROVAL RECOMMENDED BY: DATE

SHT. OF SHTS DRAWING NO.

FEBRUARY 2011



WHEELER ARMY AIRFIELD

N

0 400 800 1200 1600
Feet

WAAF_Storm_Sewer_Discharge_Points		
discharge_id	FirstGeographicCoordin	SecondGeographicCoordinat
WAAF-001	-158:02:08.156	21:27:19.507
WAAF-002	-158:02:07.725	21:27:15.146
WAAF-003	-158:02:00.998	21:27:15.718
WAAF-004	-158:01:58.785	21:27:15.269
WAAF-005	-158:01:57.990	21:27:17.091
WAAF-006	-158:02:04.547	21:27:22.989
WAAF-007	-158:02:04.046	21:27:22.993
WAAF-008	-158:02:01.452	21:27:22.946
WAAF-009	-158:02:00.112	21:27:21.366
WAAF-010	-158:01:58.143	21:27:17.557
WAAF-011	-158:01:58.557	21:27:18.931
WAAF-012	-158:01:57.955	21:27:20.301
WAAF-013	-158:01:56.257	21:27:19.249
WAAF-014	-158:01:47.690	21:27:43.766
WAAF-015	-158:01:50.502	21:27:49.436
WAAF-016	-158:02:57.767	21:28:32.083
WAAF-017	-158:02:30.979	21:28:13.644
WAAF-018	-158:02:30.279	21:28:13.461
WAAF-019	-158:02:29.193	21:28:12.436
WAAF-020	-158:02:22.418	21:28:07.237
WAAF-021	-158:02:37.622	21:28:18.291
WAAF-022	-158:02:28.644	21:28:26.516
WAAF-023	-158:02:25.291	21:28:34.473
WAAF-024	-158:02:24.745	21:28:32.670
WAAF-025	-158:02:51.408	21:28:48.829
WAAF-026	-158:02:44.769	21:28:37.705
WAAF-027	-158:02:53.762	21:28:51.412
WAAF-028	-158:02:50.643	21:28:49.421
WAAF-029	-158:02:08.803	21:28:04.805
WAAF-030	-158:02:08.848	21:28:05.176
WAAF-031	-158:02:08.991	21:28:06.308
WAAF-032	-158:02:08.242	21:28:10.918
WAAF-033	-158:02:02.983	21:28:02.238
WAAF-034	-158:02:05.841	21:28:08.754
WAAF-035	-158:02:04.740	21:28:08.700
WAAF-036	-158:02:04.502	21:28:08.589
WAAF-037	-158:02:03.551	21:28:07.603
WAAF-038	-158:02:03.555	21:28:08.671
WAAF-039	-158:02:07.321	21:28:12.768
WAAF-040	-158:02:02.915	21:28:10.857
WAAF-041	-158:02:02.009	21:28:03.713
WAAF-042	-158:02:01.862	21:28:03.217
WAAF-043	-158:02:00.909	21:28:05.547
WAAF-044	-158:02:01.876	21:28:06.592
WAAF-045	-158:01:58.860	21:28:04.929

WAAF_Storm_Sewer_Discharge_Points		
discharge_id	FirstGeographicCoordin	SecondGeographicCoordinat
WAAF-046	-158:01:56.524	21:28:03.421
WAAF-047	-158:01:56.798	21:28:04.068
WAAF-048	-158:01:56.868	21:28:07.518
WAAF-049	-158:01:57.700	21:28:09.747
WAAF-050	-158:01:57.265	21:28:09.767
WAAF-051	-158:01:57.584	21:28:13.104
WAAF-052	-158:01:57.179	21:28:12.138
WAAF-053	-158:01:57.067	21:28:14.066
WAAF-054	-158:02:08.203	21:28:15.493
WAAF-055	-158:02:17.195	21:28:29.951
WAAF-056	-158:02:07.448	21:28:16.374
WAAF-057	-158:02:06.045	21:28:17.711
WAAF-058	-158:02:05.193	21:28:19.125
WAAF-059	-158:01:58.171	21:28:14.971
WAAF-060	-158:02:03.905	21:28:35.825
WAAF-061	-158:02:04.489	21:28:36.578
WAAF-062	-158:02:03.155	21:28:36.414
WAAF-063	-158:02:01.813	21:28:37.406
WAAF-064	-158:02:00.349	21:28:37.137
WAAF-065	-158:01:59.758	21:28:36.454
WAAF-066	-158:01:45.768	21:28:02.323
WAAF-067	-158:01:55.967	21:28:04.719
WAAF-068	-158:01:55.111	21:28:04.592
WAAF-069	-158:01:55.301	21:28:08.384
WAAF-070	-158:01:54.676	21:28:07.197
WAAF-071	-158:01:53.730	21:28:06.842
WAAF-072	-158:01:52.717	21:28:07.823
WAAF-073	-158:01:55.427	21:28:11.070
WAAF-074	-158:01:55.597	21:28:12.786
WAAF-075	-158:01:55.832	21:28:14.340
WAAF-076	-158:01:46.385	21:28:03.629
WAAF-077	-158:01:45.956	21:28:07.143
WAAF-078	-158:01:47.363	21:28:11.472
WAAF-079	-158:01:45.978	21:28:12.181
WAAF-080	-158:01:43.935	21:27:56.060
WAAF-081	-158:01:44.390	21:27:57.471
WAAF-082	-158:01:44.020	21:28:00.970
WAAF-083	-158:01:34.705	21:27:55.182
WAAF-084	-158:01:40.329	21:28:04.346
WAAF-085	-158:01:53.045	21:28:18.487
WAAF-086	-158:01:52.524	21:28:17.723
WAAF-087	-158:01:48.985	21:28:16.528
WAAF-088	-158:01:48.412	21:28:19.628
WAAF-089	-158:01:47.589	21:28:15.970
WAAF-090	-158:01:46.673	21:28:14.601
WAAF-091	-158:01:53.034	21:28:31.318
WAAF-092	-158:01:52.350	21:28:31.332
WAAF-093	-158:01:46.843	21:28:29.853
WAAF-094	-158:01:50.738	21:28:34.631
WAAF-095	-158:01:49.442	21:28:35.224
WAAF-096	-158:01:44.553	21:28:19.291
WAAF-097	-158:01:45.025	21:28:25.752
WAAF-098	-158:02:04.733	21:28:37.546
WAAF-099	-158:02:06.898	21:29:05.223
WAAF-100	-158:01:58.111	21:29:08.727
WAAF-101	-158:01:58.080	21:29:08.723
WAAF-102	-158:01:43.188	21:28:37.728
WAAF-103	-158:01:47.071	21:29:11.600
WAAF-104	-158:01:41.630	21:29:10.271
WAAF-105	-158:01:40.444	21:29:17.799
WAAF-106	-158:01:33.573	21:28:04.932
WAAF-107	-158:01:32.737	21:28:06.617
WAAF-108	-158:01:30.360	21:28:10.775
WAAF-109	-158:01:32.925	21:28:24.669
WAAF-110	-158:01:32.846	21:28:24.593
WAAF-111	-158:01:32.851	21:28:24.620
WAAF-112	-158:01:32.762	21:28:26.760
WAAF-113	-158:01:32.688	21:28:26.773
WAAF-114	-158:01:32.847	21:28:27.136

Legend

- storm_sewer_discharge_point
- storm_sewer_headwall_point
- storm_sewer_inlet_point
- storm_sewer_junction_point
- storm_sewer_culvert_line
- storm_sewer_headwall_line
- storm_sewer_inlet
- storm_sewer_line
- storm_sewer_open_drainage_line/grass_swale
- streams
- storm_sewer_drainage_basin_area
- Industrial_Facilities

SYMBOL	DATE	DESCRIPTION	BY	CHK'D	APP

REVISIONS

DIRECTORATE OF PUBLIC WORKS
U. S. ARMY GARRISON, HAWAII

DESIGNED: DATE
DRAWN BY: DATE
SCALE:

STORM SEWER PLAN AND INDUSTRIAL FACILITIES

WHEELER ARMY AIRFIELD

PROJECT NO.

CHECKED: ARCH, CIVIL, MECH, ELEC, FIRE, ENVIRON, AREA ENGR

APPROVED: DATE
DIRECTOR

SUBMITTED BY: DATE
APPROVAL RECOMMENDED BY: DATE

SHT. OF SHTS DRAWING NO.

FEBRUARY 2011

This page intentionally left blank.

INTRO APPENDIX B
MS4 NPDES Permit Number HI S000090

This page intentionally left blank.

PERMIT NO. HI S000090

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, as amended, (33 U.S.C. §1251 et. seq.; the "Act"); Hawaii Revised Statutes, Chapter 342D; and Hawaii Administrative Rules (HAR), Department of Health (DOH), State of Hawaii, Chapters 11-54 and 11-55;

U.S. ARMY GARRISON HAWAII

(hereinafter PERMITTEE)

is authorized to discharge storm water runoff and certain non-storm water discharges as identified in Part B.2. of this permit from the U.S. Army Garrison Hawaii Municipal Separate Storm Sewer System (MS4), Oahu Hawaii from storm sewer outfalls identified in the Permittee's NPDES permit application dated February 28, 2011, and additional storm sewer outfalls that may be identified from time to time by the Permittee,

into State Waters in and around the Island of Oahu, Hawaii,

in accordance with the general requirements, discharge monitoring requirements, and other conditions set forth herein, and in the attached DOH "Standard NPDES Permit Conditions," that is available on the DOH, Clean Water Branch (CWB) website at http://health.hawaii.gov/cwb/site-map/home/standard-npdes-permit-conditions.

All references to Title 40 of the Code of Federal Regulations (CFR) are to regulations that are in effect on July 1, 2013, except as otherwise specified. Unless otherwise specified herein, all terms are defined as provided in the applicable regulations in Title 40 of the CFR.

This permit will become effective on April 7, 2014.

This permit and the authorization to discharge will expire at midnight, **March 6, 2019**.

Signed this 7th day of March, 2014.

(For) Director of Health

FINAL PERMIT
March 7, 2014

TABLE OF CONTENTS

Part	Description	Page
Part A.	**GENERAL REQUIREMENTS**	3
Part B.	**DISCHARGE LIMITATIONS**	5
Part C.	**RECEIVING WATER LIMITATIONS, INSPECTIONS, AND CORRECTIVE ACTIONS**	7
Part D.	**STORM WATER MANAGEMENT PLAN (SWMP)**	9
Part E.	**INDUSTRIAL FACILITIES**	34
Part F.	**MONITORING REQUIREMENTS**	36
Part G.	**REPORTING REQUIREMENTS**	41
Part H.	**SUMMARY OF DEADLINES**	44
Part I.	**Maps**	48

ATTACHMENT: STANDARD NPDES PERMIT CONDITIONS (VERSION 14). In case of conflict between the conditions stated in this permit and those specified in the Standard NPDES Permit Conditions, the more stringent conditions shall apply.

Part A. GENERAL REQUIREMENTS

The Permittee shall:

Part A.1. Comply with the existing Storm Water Management Plan (SWMP) until submittal of the revised SWMP to DOH; and future activities as identified in its last submitted Annual Report. The revised SWMP shall be implemented upon submittal to DOH.

Part A.2. Retain a copy of this permit and all other related materials and the SWMP, with all subsequent revisions, at designated location as identified in the SWMP.

Part A.3. Ensure that anyone working under this permit complies with the terms and conditions of this permit.

Part A.4. Include the permit number, **HI S000090**, and the following certification with all information required under this permit:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Part A.5. All “Plans” (e.g., SWMP Plan, Enforcement Response Plan, Trash Reduction Plan, Plan for Requiring LID in its Standards; etc.) shall be available (e.g., on Permittee’s website or other means) for a minimum of 30 calendar days for public review and comment. The Permittee shall notify DOH by email at cleanwaterbranch@doh.hawaii.gov of the availability of the plan five (5) calendar days of the plan being available. The Permittee shall address all comments received within the 30 calendar day period and provide both comments and responses to DOH with its submittal of the Plan in accordance with the deadline as specified in Part H. All Plans shall be implemented upon submittal regardless of DOH’s review and acceptance. If any deficiencies are found by DOH after submittal, the Permittee shall correct the deficiencies to DOH’s satisfaction

within 30 calendar days or such other time as agreed to in writing and resubmit the plan. In addition to the Plans being available for public comment, the current/existing plans shall also be accessible for public viewing.

Part A.6. All information and reports required under this permit and updates to information on file shall be submitted through the CWB Compliance Submittal Form for Individual NPDES Permits and Notice of General Permit Coverages (NGPCs). This form is accessible through the e-Permitting Portal website at: https://eha-cloud.doh.hawaii.gov/epermit/View/home.aspx. If not already registered, you will be asked to do a one-time registration to obtain your login and password. After you register, click on the Application Finder tool to locate the form. Follow the instructions to complete and submit this form. All submissions shall include a CD or DVD containing the downloaded e-Permitting submission and a completed Transmittal Requirements and Certification Statement for e-Permitting NPDES/NGPC Compliance Submissions Form, with original signature and date.

Part A.7. The Permittee shall submit annual reports to EPA at the following address:

U.S. Environmental Protection Agency, Region 9
Attention: WTR-5
75 Hawthorne Street
San Francisco, CA 94105-3901

Part B. DISCHARGE LIMITATIONS

Part B.1. The Permittee shall effectively prohibit non-storm water discharges through its separate storm sewer system into State Waters and from its facilities discharging directly to State Waters or through a non-Permittee-owned MS4. National Pollutant Discharge Elimination System (NPDES) permitted discharges and non-storm water discharges identified in Part B.2 of this permit are exempt from this prohibition.

Part B.2. The following non-storm water discharges may be discharged into the Permittee's MS4 provided that the discharge is identified below, and meets all conditions when specified by the Permittee. In the event that any of the non-storm water discharges listed below are determined to be a source of pollution by the Permittee, the discharge will no longer be allowed.

- Water line flushing;
- Landscape irrigation;
- Diverted stream flows;
- Rising ground waters;
- Uncontaminated ground water infiltration (as defined in 40 CFR §35.2005(20));
- Uncontaminated pumped ground water;
- Discharges from potable water sources and foundation drains;
- Air conditioning condensate;
- Irrigation water;
- Springs;
- Water from crawl space pumps and footing drains;
- Lawn watering runoff;
- Water from individual residential car washing;
- Water from charity car washes;
- Flows from riparian habitats and wetlands;
- Dechlorinated swimming pool discharges;
- Exterior building wash water (water only);
- Residual street wash water (water only), including wash water from sidewalks, plazas, and driveways, but excluding parking lots; and
- Discharges or flows from firefighting activities.

The Permittee may also develop a list of other similar occasional incidental non-storm water discharges (e.g., non-commercial car washes, etc.) that will not be addressed as illicit discharges. These non-storm water discharges must not be reasonably expected (based on the information available to the Permittee) to be significant sources of pollutants to the MS4, because of either the nature of the discharges or conditions the Permittee has established for allowing these discharges to the MS4 (e.g., non-commercial car wash with appropriate controls on frequency, proximity to sensitive water bodies, Best Management Practices (BMPs) for the wash water, etc.). The Permittee shall document in the SWMP any local controls or conditions placed on the discharges, and include a provision prohibiting any individual non-storm water discharge that is determined to be contributing pollutants to the MS4.

Part B.3. The discharge of pollutants from the Permittee's MS4 shall be reduced to the Maximum Extent Practicable (MEP), consistent with Section 402(p)(3)(B) of the CWA. The intent of this permit, and the provisions herein, is for the Permittee to develop, achieve, and implement a timely, comprehensive, cost-effective SWMP to reduce the discharge of pollutants to the MEP from the Permittee’s MS4 to waters of the State. MEP is a dynamic performance standard and evolves as knowledge of urban runoff control measures increases.

Part B.4. The discharge of pollutants from the Permittee's facilities classified as Industrial in accordance with 40 CFR §122.26(b)(14) shall be reduced to the appropriate discharge limitations subject to the Best Available Technology currently available (BAT)/ Best Conventional Pollutant Control Technology (BCT) discharge requirement, consistent with the CWA and other respective federal and state requirements for such facilities.

Part C. RECEIVING WATER LIMITATIONS, INSPECTIONS, AND CORRECTIVE ACTIONS

Part C.1. The discharge shall comply with the basic water quality criteria which states:

"All waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants, including:

Part C.1.a. Materials that will settle to form objectionable sludge or bottom deposits;

Part C.1.b. Floating debris, oil, grease, scum, or other floating materials;

Part C.1.c. Substances in amounts sufficient to produce taste in the water or detectable off flavor in the flesh of fish, or in amounts sufficient to produce objectionable color, turbidity or other conditions in receiving waters;

Part C.1.d. High or low temperatures; biocides; pathogenic organisms; toxic, radioactive, corrosive, or other deleterious substances at levels or in combinations sufficient to be toxic or harmful to human, animal, plant, or aquatic life, or in amounts sufficient to interfere with any beneficial use of the water;

Part C.1.e. Substances or conditions or combinations thereof in concentrations which produce undesirable aquatic life; and

Part C.1.f. Soil particles resulting from erosion on land involved in earthwork, such as the construction of public works; highways; subdivisions; recreational, commercial, or industrial developments; or the cultivation and management of agricultural lands."

Part C.2. The discharge shall not cause or contribute to a violation of any of the applicable beneficial uses or water quality objectives contained HAR, Chapter 11-54, titled "Water Quality Standards."

Part C.3. During inspections/screenings as required by this permit, the Permittee shall also visually inspect the receiving state waters, effluent, control measures and BMPs to detect violations of, and conditions which may cause violations of, the basic water quality criteria as specified in HAR, Section 11-54-4. (e.g., the Permittee shall look at effluent and receiving state waters for turbidity, color, floating oil and grease, floating debris and scum, materials that will settle, substances that will produce taste in the

water or detectable off-flavor in fish, and inspect for items that may be toxic or harmful to human or other life).

Part C.4. The Permittee shall immediately take action to stop, reduce, or modify the discharge of pollutants as needed to stop or prevent a violation of the basic water quality criteria as specified in HAR, Section 11-54-4.

Part D. STORM WATER MANAGEMENT PLAN (SWMP)

Part D.1. Development, Improvement, Implementation and Enforcement of SWMP

The Permittee shall further develop and improve, implement, and enforce a SWMP designed to address the requirements of this permit and reduce, to the MEP, the discharge of pollutants to and from its MS4 to protect water quality and to satisfy the appropriate water quality requirements of the Act. The SWMP shall include the following information for each of the SWMP components described in Part D.1.a to Part D.1.g below:

- The BMPs, including the underlying rationale, that will be implemented for each of the program components.
- The measurable standards and milestones for each of the BMPs, including the underlying rationale and interim measures to aid in determining the level of effort and effectiveness of each program component.
- The name or position title of the person or persons responsible for implementation or coordination of each program component.
- A monitoring program to determine effectiveness of the controls and the overall storm water program.

Submittal Date. The SWMP shall be: updated and modified per the requirements of this permit; consistent with the format of this permit; submitted to DOH in accordance with Part A.6. within 18 months after the effective date of this permit, or as otherwise specified; and fully implemented upon submittal. The Permittee shall implement the existing SWMP until submittal of the revision. The SWMP and any of its revisions, additions, or modifications are enforceable components of this permit.

Part D.1.a. Public Education and Outreach

The Permittee shall further develop and implement a comprehensive education and involvement program to distribute educational materials to the community or conduct equivalent outreach activities about the impacts of storm water as well as enabling the public to identify and report a pollution-causing activity (i.e., spotting an illicit discharge) and the steps that the public can take to reduce pollutants in storm water runoff. The program should create: positive changes in attitude, knowledge, and

awareness; BMP implementation; pollutant load reduction; and an improvement in discharge and receiving water quality. The SWMP shall include a written public education plan for how the Permittee will reach all targeted audiences and implement the permit requirements described below. The Permittee may fulfill portions of this requirement by cooperating with other MS4 storm water public education programs.

Part D.1.a.(1) *Targeted Groups* - The Permittee shall address the following targeted groups in the public education plan with appropriate messages, and describe outreach activities and anticipated frequencies that each activity will be conducted over the permit term:

- Entities responsible for illicit discharges.
- Housing residents, school children, and the general public.
- Enlisted Army personnel and their dependents.
- Civilian Army personnel.
- Army consultants.
- Construction industry.
- Industrial facilities covered by the NPDES permit program.
- Commercial businesses such as landscape service and maintenance (e.g., to prevent the use of leaf blowers from blowing material into the drainage structures), automobile detailing, automobile repair and maintenance, retail gasoline outlets, and restaurants, including those types of businesses highly ranked, according to relative risk of discharge of contaminated runoff to the Permittee's MS4. Refer to Part D.1.g.(5).
- Any other source that the Permittee determines may contribute a significant pollutant load to its MS4.

Part D.1.a.(2) *General Public* - The Permittee shall include in the public education plan the following activities and subjects, with anticipated frequencies that each activity will be conducted over the permit term:

- Public Service Announcements (PSAs).
- School programs.
- Distribution of brochures.
- Participation in special events and exhibits.
- Web site.
- Pesticides, herbicides, and fertilizer use.
- Water conservation.
- Proper disposal of grass clippings, leaves, and other green waste.

- Proper disposal of household hazardous waste.

Part D.1.a.(3) *Evaluation Methods* - The Permittee shall evaluate the progress of the public education program based on the following:

- Annual survey of Army housing residents to measure both behavior and knowledge relating to storm water. The surveys can be conducted in person at events, on the phone, or using Web-based survey tools. The results of the survey shall be compared to past surveys.
- Number of brochures distributed.
- Participation in events.
- Volunteer hours.
- Any other methods that the Permittee determines to be effective.

The results of the evaluation shall be summarized in the Annual Report.

Part D.1.b. Public Involvement/Participation

The Permittee shall include the public in developing, reviewing, and implementing the SWMP. The draft and final SWMP shall be made available to the public (e.g., on Permittee's website) and at local offices. An informational meeting shall be scheduled and announced prior to finalizing the SWMP to solicit comments and answer questions from the public. Other activities to involve the public may include providing volunteer opportunities that improve water quality, organizing a citizen advisory group to solicit ongoing input from the public about changes to the SWMP and specific SWMP-related projects, or organizing clean-up events to educate the public about impacts of storm water.

Part D.1.c. Illicit Discharge Detection and Elimination

The Permittee shall implement the ongoing SWMP to detect and eliminate illicit connections and illegal discharges into its MS4 and shall include an improved program in the revised SWMP Plan. The program shall include:

Part D.1.c.(1) *Connection Permits for private drain connections* - Within one (1) year after the effective date of this permit the Permittee shall establish requirements for issuing connection permits and require obtaining the permit prior to allowing the drain connections. A database shall be

maintained of all permitted connections to its MS4. Prior to issuing a connection permit, the Permittee shall ensure the following are met:

- the project has provided proof of filing a Notice of Intent (NOI) or NPDES application, if applicable; and
- control measures comply with its requirements to minimize pollutant discharge into its MS4.

Part D.1.c.(2) *Field Screening* - The Permittee shall implement an Outfall Field Screening Plan for observing major and minor outfalls to screen for improper discharges. The plan shall designate priority areas for screening, specify the frequency for screening, and identify the procedures to be followed if a discharge is observed. At a minimum, outfalls in priority areas shall be screened once per permit term.

Part D.1.c.(3) *Tracking* - The Permittee shall maintain a database of complaints, illicit connections, illegal discharges, and spills which tracks the location of the discharge by Tax Map Key (TMK), type of discharge, responsible party, the Permittee's investigation and response of the discharge, follow-up activities, and the resolution of each discharge to the MS4.

Part D.1.c.(4) *Complaint Investigation* - The Permittee shall promptly investigate observed, suspected, or reported illicit flows and pursue enforcement actions, as appropriate. Complaints made to the CWB, which discharge to the Permittee’s MS4 will be forwarded to the Permittee for action. The Permittee shall:

(i) Develop and implement a database to identify illicit discharge activities by TMK. The database shall include information about each suspected improper discharge, the Permittee's investigation of that discharge, follow-up activities, and the resolution of each discharge as required in Part D.1.c.(3) above;

(ii) Implement a program to facilitate public reporting of illicit discharges (i.e., environmental hotline and/or website for reporting), including providing at least one contact that the public can reach (including phone number and/or email address) that is clearly posted on the website; and

(iii) Develop a response plan for the investigation of illicit discharges to be consistent with the requirements in this permit.

Part D.1.c.(5) *Enforcement* - Within one (1) year after the effective date of this permit the *Permittee* shall:

(i) Establish policies for enforcement and penalties for entities found to be in noncompliance with requirements developed in accordance with Part D.1.c.(1), including for persons illegally discharging pollutants to its MS4, and

(ii) Pursue enforcement actions against entities in non-compliance with its requirements, with illegal drain connections, and illegally discharging pollutants to its MS4 without direct connections.

Part D.1.c.(6) *Spill Prevention and Response* - The Permittee shall implement its ongoing SWMP to prevent, respond to, contain, and clean up all wastewater and other spills that may enter into its MS4 from any source (including private laterals and failing cesspools). This program shall be included in the SWMP. Spill response teams, which may consist of local, state, and/or federal agencies, shall prevent entry of spills into the Permittee's MS4 and contamination of surface water, ground water, and soil to the MEP.

The Permittee shall coordinate spill prevention, containment, and response activities throughout all appropriate departments, programs, and agencies to ensure maximum water quality protection at all times.

The Permittee shall notify DOH of all wastewater spills or overflows from private laterals and failing septic systems into its MS4. The Permittee shall prevent, respond to, contain, and clean up wastewater from any such notification.

Part D.1.c.(7) *Used Oil and Toxic Materials Disposal* - The Permittee shall implement its ongoing SWMP to facilitate the proper management and disposal or recycling of used oil, vehicle fluids, toxic materials, and other *household* hazardous wastes. Such a program shall include educational activities, public information activities, and identification of collection sites or methods.

Part D.1.c.(8) *Training* - The Permittee shall provide annual training to staff on identifying and eliminating illicit connections, illegal discharges, and spills to its MS4. This training shall be specific to the Permittee's activities, policies, rules, and procedures.

Part D.1.d. Construction Site Runoff Control

The Permittee shall implement a construction site management program to reduce to the MEP the discharge of pollutants from both private and public construction projects (i.e., contract, in-house, maintenance, and encroachment). The construction site management program shall include the following minimum elements:

Part D.1.d.(1) *Requirement to develop BMPs Manuals* - Within two (2) years from the effective date of this permit the Permittee shall develop and submit to the Director the following types of manuals for construction projects :

- Construction Best Management Practices Field Manual.
- Maintenance Activities Best Management Practices Field Manual.
- Storm Water Permanent Best Management Practices Manual.

The Permittee shall review these standards annually and, as necessary, revise to include descriptions of new or modified BMPs, including permanent BMPs and LID practices. All revisions made during a calendar year shall be discussed in its corresponding Annual Reports and all documents included in the SWMP Plan. All documents shall be made available to the Permittee's staff, contractors, and consultants, as appropriate.

Part D.1.d.(2) *Requirement to implement BMPs* - Within three (3) years from the effective date of this permit the Permittee shall establish policies to require proposed construction projects to implement BMPs and standards described in the following:

- Construction Best Management Practices Field Manual.
- Maintenance Activities Best Management Practices Field Manual.
- Storm Water Permanent Best Management Practices Manual.

Part D.1.d.(3) *Inventory of construction sites* - Within six (6) months from the effective date of this permit, the Permittee shall, implement a system to track both private and public construction projects (i.e., contract, in-house, maintenance, and encroachment). This system shall track information on the project (including permit or file number, if available), status of plan review and approval, inspection dates, and if applicable, enforcement actions, and whether the project has applied for coverage under HAR, Chapter 11-55, Appendix C, NPDES General Permit Authorizing the Discharge of Storm Water Associated with

Construction Activity (a.k.a. General Construction Activity Storm Water permit) (unless the project will disturb less than one acre of land) and satisfied any other applicable requirements of the NPDES permit program (i.e., an individual NPDES permit).

Part D.1.d.(4) *Plan Review and Approval* - The Permittee shall:

(i) Review the appropriate Storm Water Pollution Prevention Plan (SWPPP) and other pollution prevention measures (e.g., for Erosion and Sediment Control, Grading, Post-construction BMP and Landscaping) or similar plans/documents prior to approval of the construction plans and specifications. The Permittee shall verify that the SWPPP meets the following requirements:

- HAR, Chapter 11-55, Appendix C, and any other requirements under the NPDES permit program, as applicable;
- Construction Best Management Practices Field Manual (after developed);
- Maintenance Activities Best Management Practices Field Manual (after developed);
- Storm Water Permanent Best Management Practices Manual (after developed); and
- Implementation of measures to ensure that the discharge of pollutants from the site will be reduced to the appropriate discharge limitations subject to the Best Available Technology currently available (BAT)/ Best Conventional Pollutant Control Technology (BCT) discharge requirement, consistent with the CWA and other respective federal and state requirements for such facilities and will not cause or contribute to an exceedance of water quality standards.

(ii) Require a permit or written equivalent approval for drainage connections to its MS4, discharge of surface storm water runoff of storm water associated with construction (i.e., from both private and public projects) or discharge permit (i.e., hydrotesting and dewatering effluent or other non-storm water, except those allowed under this permit) into their MS4 and maintain a database of the permits/approvals. Prior to issuing a drainage connection, discharge of surface runoff permit/approval, discharge permit, or encroachment permit the Permittee shall ensure that the following are met:

- The project owner has provided proof of filing an NOI Form C or NPDES application for the discharge of storm water associated with construction activities that disturb one (1) acre or more;
- The project owner has provided proof of filing a NOI Form F and/or G or NPDES application for the discharge, if applicable; and
- A SWPPP or other documents (e.g., Erosion and Sediment Control, Grading, Post-construction BMP and Landscaping Plans, Dewatering Plan, and Hydrotesting Plan) relating to pollution prevention or similar document(s) have been reviewed and accepted by the Permittee;

(iii) Prohibit the commencement of construction on any private or public construction project (i.e., contract, in-house, maintenance, and encroachment) unless and until it has verified that the project has received from DOH a Notice of General Permit Coverage (NGPC) under HAR, Chapter 11-55, Appendix C, NPDES General Permit Authorizing the Discharge of Storm Water Associated with Construction Activity (General Construction Activity Storm Water permit) (unless the project will disturb less than one (1) acre of land) and satisfied any other applicable requirements of the NPDES permit program (i.e., an individual NPDES permit);

(iv) Update and submit for review and acceptance, a plan review checklist that its reviewers shall use in evaluating the plans and BMPs or other similar document(s) which have been implemented pursuant to this Part [i.e., Part D.1.d.] within 90 calendar days from the effective date of this permit. Copies of this plan review checklist shall be provided to applicants for connection, discharge, and encroachment permits; and to consultants and contractors for their use in developing the Plans or other similar document(s) for Permittee-contracted construction projects. The plan review checklist shall include, at a minimum, but not be limited to comments on any deficiencies and the date when comments were addressed to the satisfaction of the Permittee. A system shall be implemented to ensure all comments, identified during the review process has been properly addressed.

Part D.1.d.(5) Inspections – The Permittee shall:

(i) Prior to the initiation of ground-disturbing activities at any site, except for activities associated with the installation of BMPs at a site, an engineer or qualified inspector employed or retained by the Permittee who reviews and becomes familiar with the project's SWPPP and/or other equivalent document(s), shall inspect the site to verify BMPs as required by the BMP Plan and/or other documents have been installed correctly and in the correct locations prior to the commencement of ground-disturbing activity. Inspections shall include a review of site Erosion and Sediment Controls, good housekeeping practices, and compliance with Permittee-accepted erosion and sediment control plans, construction BMPs Plans, or other similar documents and Permittee-approved permits. The inspector shall also identify and remedy any site conditions having the potential for erosion and sediment runoff, including other pollutant discharges which may occur as a result of the project's construction activities.

(ii) In addition to inspections required by the NPDES permit program, all contract, in-house and maintenance construction projects shall be inspected at least monthly by a qualified construction inspector who is independent (i.e., not involved in the day-to-day planning, design, or implementation) of the construction projects to be inspected. The Permittee may use more than one (1) qualified construction inspector for these inspections. The reporting procedures shall include, at a minimum, notification of any critical deficiencies to the DOH. Upon three (3) successive monthly inspections that indicate, in total, no critical or major deficiencies or less than six (6) minor deficiencies with no more than three (3) minor deficiencies in one (1) month in a project's BMPs or other storm water management activities, the Permittee may decrease the inspection frequency for such project to quarterly. However, if while under a quarterly inspection frequency, an inspection of a project conducted pursuant to this paragraph indicates at least one critical or major deficiency or a total of three (3) or more minor deficiencies in the project's BMPs or other storm water management activities, the inspections frequency shall immediately return to no less than monthly. This reduced inspection frequencies option is contingent upon the Permittee having defined each type (i.e., critical, major, or minor) of deficiency. The Permittee shall further develop and implement

written procedures for appropriate corrective actions and follow-up inspections when deficiencies had been identified at an inspected project. The corrective action procedures shall at a minimum require that 1) all critical deficiencies shall be corrected or addressed before the close of business on the day of the inspection at which the deficiency is identified, and 2) all major deficiencies shall be corrected or addressed as soon as possible, but in no event later than five (5) calendar days after the inspection at which the deficiency is identified or before the next forecasted precipitation, whichever is sooner.

(iii) All construction projects with a connection permit, encroachment permit, or discharge of surface runoff permit/approval shall be inspected at least once annually or once during the life of the project, whichever comes first, by a qualified construction inspector who is independent (i.e., not involved in the day-to-day planning, design, or implementation) of the construction projects to be inspected. The Permittee may use more than one (1) qualified construction inspector for these inspections. If the project has a SWPPP or other equivalent document(s), the inspection shall also verify that the BMPs were properly installed and at the locations specified in the Plan. The reporting procedures shall include, at a minimum, notification of any critical deficiencies to the DOH.

(iv) The Permittee shall develop and implement a standard inspection form(s); reporting and corrective procedures for inspections, including use of an inspection checklist, or equivalent; and a database or equivalent system to track inspection results. The inspection checklist shall include, at a minimum, but not be limited to, identifying any deficiencies and the date of the corrective actions. Photos shall accompany the inspection checklist to document the deficiencies. The inspection form(s), inspection checklist, and reporting and corrective procedures shall be submitted to DOH for review and acceptance within 90 calendar days the effective date of this permit.

Part D.1.d.(6) Enforcement – Within one (1) year from the effective date of this permit, the Permittee shall:

(i) Establish policies for enforcement and penalties for those in non-compliance with Part D.1.d.(2) requiring the implementation of standards, and

(ii) Develop and implement an Enforcement Response Plan to include written procedures for appropriate corrective and enforcement actions, and follow-up inspections when an inspected project is not in full compliance with its requirements, other permits, and any other applicable requirements under the NPDES permit program.

Part D.1.d.(7) Process *to refer noncompliance and non-filers to DOH* - In the event the Permittee has exhausted its use of sanctions and cannot bring a construction site or construction operator into compliance with its policies, standards, or this permit, or otherwise deems the site poses an immediate and significant threat to water quality, the Permittee shall provide an e-mail notification to cleanwaterbranch@doh.hawaii.gov, Attn: Enforcement Section Supervisor within one (1) week of such determination. E-mail notifications shall be followed by written notification in accordance with Part A.6. and include a copy of all inspection checklists, notes, and related correspondence in pdf format (300 minimum dpi) within two (2) weeks of the determination. In instances where an inspector identifies a site that has not applied for permit coverage under the NPDES permit program, the Permittee shall provide written notification in accordance with Part A.6. to DOH within two (2) weeks of the discovery.

Part D.1.d.(8) Training - The Permittee shall provide annual training on the Construction BMPs Program Plan to all staff with construction storm water responsibilities, including construction engineers, construction and maintenance inspectors, and plan reviewers. This training shall be specific to the Permittee's activities (including the proper installation and maintenance of accepted BMPs), policies, rules and procedures.

Part D.1.d.(9) *Education* - The Permittee shall implement an education program as part of its ongoing SWMP to ensure that project applicants, contractors, developers, property owners, and other responsible parties have an understanding of the storm water requirements they need to implement.

Part D.1.e. Post-Construction Storm Water Management in New Development and Redevelopment

The Permittee shall further develop, implement, and enforce a program to address storm water runoff from all (i.e., both private and public) new development and redevelopment projects that result in a land disturbance of one (1) acre of more and smaller projects that have the potential to discharge pollutants to the Permittee's MS4. The Permittee's program must ensure that permanent controls are in place to prevent or minimize water quality impacts to the MEP. The Permittee shall review and update as necessary the criteria defining when, and the types of, permanent post-construction BMPs, including, among other measures, Low Impact Development (LID) techniques, must be included in a project design to address storm water impacts and pollutants of concern. For State waters on the State CWA Section 303(d) list or State established and EPA approved TMDLs, the pollutants of concern to be targeted shall include the parameters causing impairment. The Permittee shall consider trash reduction techniques to comply with short and long term plans as required in Part D.1.f(1)(v). The program shall include, at a minimum, the following elements:

Part D.1.e.(1) *Standards Revision* – The Permittee shall revise its standards for addressing post-construction BMPs to LID requirements. Within six (6) months of the effective date of this permit, the Permittee shall submit to DOH a plan for requiring LID in the standards to the MEP, including revisions to the plan review and inspection checklist to include LID. LID refers to storm water management practices which seek to mimic a site's predevelopment hydrology by minimizing disturbed areas and impervious cover and then infiltrating, storing, detaining, evapotranspiring, and/or biotreating storm water runoff close to its source. The standards shall ensure that the management practices are prioritized to favor infiltration, evapotranspiration, or harvesting/reuse of storm water followed by other practices that treat and release storm water. The standards shall be applicable to all construction projects disturbing at least one (1) acre and smaller projects that have the potential to discharge pollutants to the Permittee's MS4. LID employs principles such as preserving and recreating natural landscape features and minimizing imperviousness to create functional and appealing site drainage that treats storm water as a resource, rather than a waste product. LID treatment measures include harvesting and use, infiltration, evapotranspiration, or

biotreatment. The plan for the implementation of LID provisions shall include at a minimum the following:

- Criteria for requiring implementation.
- Investigation into the development of quantitative criteria for a specific design storm to be managed by LID techniques. Examples of design storm requirements include: 24-hour, 85% storm through infiltration; on-site management of the first inch of rainfall within a 24-hour period; retention of the 100-year, 2-hour storm; or on-site management of the 24-hour, 95% storm.
- Feasibility criteria for circumstances in which a waiver could be granted for the LID requirements.
- When a LID waiver is granted, alternatives such as offsite mitigation and/or non-LID treatment control BMPs could be required.

A draft of the revised standards shall be submitted to the DOH in accordance with Part A.6. for review and acceptance within 12 months from the effective date of this permit and include at a minimum the above. Within 18 months after the effective date of this permit, subject to adoption by rulemaking or other equivalent process, the revised standards shall be submitted to the DOH in accordance with Part A.6. To the extent that the revised Standards have not been adopted, the Permittee shall submit a compliance schedule for adoption, which shall not exceed 24 months after the effective date of this permit.

Part D.1.e.(2) *Review of Plans for Post-Construction BMPs* – For design-bid-build projects, the Permittee shall not advertise any construction project nor award any construction contract until the project design has been reviewed and accepted to ensure that appropriate permanent post-construction BMPs, which include LID practices upon adoption into its standards, have been included in the project design and are included in the bid package to ensure compliance with this part of the permit. For design-build projects, the Permittee shall review and approve the project design the same as for design-bid-build projects prior to implementation. No project shall proceed without the inclusion of appropriate permanent post-construction BMPs unless a waiver is granted by the Permittee based on specific documentation demonstrating that such post-construction BMPs are not feasible. Project documents for projects that will include installation of permanent post-construction BMPs shall also include appropriate requirements for their future continued maintenance.

Part D.1.e.(3) *BMP, Operation and Maintenance, and Inspection Database* - The Permittee shall implement its Asset Management System to track the frequency of inspections and maintenance of the Permanent BMPs. In addition to the standard information collected for all projects (e.g., project name, owner, location, start/end date, etc.), the database shall also include, at a minimum:

- Type and number of LID practices.
- Type and number of Source Control BMPs.
- Type and number of Treatment Control BMPs.
- Latitude/Longitude coordinates of controls using Global Positioning Systems (GPS) and NAD83 or other Datum as long as the datum remains consistent.
- Photographs of controls.
- Operation and maintenance requirements.
- Frequency of inspections.
- Frequency of maintenance.

All storm water treatment and LID BMPs shall be inspected at least once a year for proper operation; maintenance shall be performed as necessary to ensure proper operation.

Part D.1.e.(4) *Education* and *Training*

(i) *Project Proponents* - The Permittee shall provide education and outreach material for those parties who apply for permits (i.e., developers, engineers, architects, consultants, construction contractors, excavators, and property owners) on the selection, design, installation, operation and maintenance of storm water BMPs, structural controls, post construction BMPs, and LID practices. The outreach material may include a simplified flowchart for thresholds triggering permits and requirements, a list of required permits, implementing agencies, fees, overviews, timelines and a brief discussion of potential environmental impacts associated with storm water runoff.

(ii) Inspectors - All Permittee staff and contractors responsible for inspecting permanent *post-construction* BMPs and LID practices shall receive annual training.

Part D.1.f. Pollution Prevention/Good Housekeeping

The Permittee shall further develop and implement a system maintenance program to reduce to the MEP the discharge of pollutants from all Permittee-owned facilities, roads, parking lots, maintenance facilities, and the Permittee's MS4. The program shall include:

Part D.1.f.(1) Debris Control BMPs Program Plan

(i) *Asset Management System and Mapping* - The Permittee shall implement a comprehensive asset management system and map of its MS4, including structural and vegetative BMPs and an inventory of related appurtenances, including maintenance equipment, to ensure appropriate debris removal and system maintenance. The asset management system shall, at a minimum, assign an identification number for each drain inlet, outfall, and BMP, and map their location on the Geographic Information System (GIS). The Permittee shall use this asset management system to establish priorities and to schedule and track efforts of appropriate system maintenance and debris removal program activities such as street sweeping, catch basin cleaning, and green waste and accumulated soil removal. The SWMP shall include justification of its priorities applied to the asset management system on the basis of potential impacts to water quality.

(ii) *Inspection/Maintenance Schedule* - The Permittee shall include in its SWMP procedures and a schedule for inspections of:

a) All roadways for the purpose of identifying if sweeping of roadways, shoulders, and/or medians is needed; and

b) All storm drainage system catch basins, gutters and open ditches, trenches, and BMPs for the purpose of identifying if maintenance/cleaning of such structures are needed.

In both cases, the need for sweeping and/or maintenance/cleaning shall, at a minimum, be determined based upon material accumulation rates and/or potential threat of discharge to State waters that may have an effect on water quality. The schedule shall provide that each roadway mile, storm drainage feature, and BMP is inspected at least once during the

term of this permit (maintenance/cleaning may be conducted in lieu of inspections to satisfy this requirement). The adopted procedures shall provide for the identification of roadway segments and their associated storm drainage features and BMPs that may require more frequent sweeping and/or structure cleaning based upon material accumulation rates and potential threat of discharge to State waters that may have an effect on water quality. The procedures shall establish debris accumulation thresholds above which sweeping and/or structure cleaning must occur. The priority-based schedule shall be annually reviewed; updated as necessary; and the changes, along with explanations of the changes submitted within the Annual Report.

(iii) *Storm Drain Placards* - The Permittee shall install placards on its drainage inlets; evaluate the effectiveness of the placards; and revise as necessary to meet its purpose. The purpose of the placards shall be discussed within the SWMP. A minimum of 50 new placards shall be installed per year. Priority shall be given to the Permittee's industrial and commercial areas and areas with pedestrian traffic. The Permittee shall implement its system to track placement of placards and procedures for maintenance staff to inspect and replace, as necessary, placards during routine maintenance activities.

(iv) *Action Plan for Retrofitting Structural BMPs* – The Permittee shall provide the DOH with an Action *Plan* for Retrofitting Structural BMPs within one (1) year from the effective date of this permit, which shall identify retrofits to be implemented, and include an explanation of the basis for their selection and an implementation schedule. The implementation schedule shall cover a five (5) year period and be updated annually to include additional retrofit projects with water quality protection measures. The annual updates to the implementation schedule shall be included in the Annual Report with a description of the projects status. The Action Plan may include, but not be limited to projects in compliance with any TMDL implementation and monitoring plan.

(v) *Trash Reduction Plan* - Within three (3) years from the effective date of this permit, the Permittee shall develop and submit to DOH for review and acceptance, a trash reduction plan which assesses the issue; identifies and implements control measures; and monitors the control measures to *reduce* trash loads from the

MS4. The plan shall include, at a minimum and be formatted consistent with the following:

- Quantitative estimate of the debris currently being discharged (baseline load) from the MS4, including methodology used to determine the load.
- Description of control measures currently being implemented as well as those needed to reduce debris discharges from the MS4 consistent with short-term and long-term reduction targets.
- A short-term plan and proposed compliance deadline for reducing debris discharges from the MS4 by 50% from the baseline load.
- A long-term plan and proposed compliance deadline for reducing debris discharges from the MS4 to zero.
- Geographical targets for trash reduction activities with priority on waterbodies listed as impaired for trash on the State's CWA Section 303(d) list.
- Trash reduction-related education activities as a component of Part D.1.a.
- Integration of control measures, education and monitoring to measure progress toward reducing trash discharges.
- An implementation schedule.
- Monitoring plan to aid with source identification and loading patterns as well as measuring progress in reducing the debris discharges from the MS4.
- The Annual Report shall include a summary of its trash load reduction actions (control measures and best management practices) including the types of actions and levels of implementation, the total trash loads and dominant types of trash removed by its actions, and the total trash loads and dominant types of trash for each type of action.

The plan shall provide for compliance with the above short-term and long-term discharge limits in the shortest practicable timeframe.

Part D.1.f.(2) Chemical Applications BMPs Program Plan

(i) *Training* - The Permittee shall develop an Authorized Use List of chemicals used and implement a specific training program for all potential appliers (bulk and hand-held) of the chemicals (e.g., fertilizers, pesticides, and herbicides) on the proper application of the chemicals. The Permittee shall not permit the application of fertilizers, pesticides, or herbicides unless the applier has first received this training.

(ii) *Implement appropriate requirements for pesticide, herbicide, and fertilizer applications* - The Permittee shall implement BMPs to reduce the contribution of pollutants associated with the application, storage, and disposal of pesticides, herbicides, and fertilizers from Permittee-owned areas and activities to its MS4. Permittee-owned areas and activities include, at a minimum, federal facilities, right-of-ways, and landscaped areas.

Such BMPs shall include, at a minimum: (1) educational activities, permits, certifications and other measures for applicators; (2) integrated pest management measures that rely on non-chemical solutions; (3) the use of native vegetation; (4) chemical application, as needed; and (5) the collection and proper disposal of unused pesticides, herbicides, and fertilizers.

The Permittee shall ensure that their employees or contractors or employees of contractors applying registered pesticides, herbicides, and fertilizers work under the direction of a certified applicator, follow the pesticide label, and comply with any other State, City, or Federal regulations for pesticides, herbicides, and fertilizers. All Permittee employees or contractors applying pesticides, herbicides or fertilizers shall receive training on the BMPs annually.

Part D.1.f.(3) Erosion Control BMPs Program Plan - The Permittee shall:

(i) Implement permanent erosion control improvements, ensuring that erosion-prone areas with the potential for significant water quality impact, but with limited public safety concerns, are also considered a high priority for remediation. Identification of erosion-prone areas with the potential for significant water quality impact shall include areas where there is evidence of rilling, gullying, and/or other evidence of significant sediment transport,

and areas in close proximity to receiving waters listed as impaired by either sediment, siltation and/or turbidity. The Permittee shall include procedures to identify and implement erosion control projects based on water quality concerns while continuing to address high profile public safety projects.

(ii) Require the implementation of temporary erosion control measures (e.g., erosion control blankets and/or fabrics, gravel bag placement and silt fencing/fiber rolls) on erosion-prone areas with the potential for significant water quality impact if a permanent solution is not immediately possible. Notwithstanding any other implementation provisions, the SWMP shall require the implementation of such temporary erosion control measures on all applicable areas within 18 months from the effective date of this permit. For projects which require a CWA Section 401 Water Quality Certification (WQC), the WQC application shall be submitted to DOH within one (1) year from the effective date of this permit and be implemented with six (6) months of the WQC or other regulatory permit(s) issuance date.

(iii) Develop a maintenance plan for vegetated portions of the drainage system used for erosion and sediment control, and LID features; including controlling any excessive clearing/removal, cutting of vegetation, and application of herbicide which affects its usefulness.

(iv) Provide the DOH with an Action Plan to address erosion at its storm drain system outlets with significant potential for water quality impacts within one (1) year from the effective date of this permit. The Action Plan shall also identify outfalls to be addressed and include an explanation on the basis of their selection and an implementation schedule. The implementation schedule shall cover a five (5) year period. A status report on implementation of the plan shall be included in the Annual Report. The Permittee shall install velocity dissipators or other BMPs to reduce erosion at locations identified by periodic required inspections.

(v) Submit a list of projects and an implementation schedule for permanent erosion control improvements as described in Part D.1.f.(3)(i) of this permit to DOH within one (1) year from the effective date of this permit.

Part D.1.f.(4) Maintenance Activities BMPs Program Plan

(i) *Maintenance Activities Best Management Practices Field Manual* - The Permittee shall develop and implement a BMPs Field Manual for Maintenance Activities for all Army maintenance activities within three (3) years from the effective date of this permit. Examples of such activities include, but are not limited to: paving and road repairs, street cleaning, saw cutting, concrete work, curb and gutter replacement, buried utility repairs and installation, vegetation removal, painting and paving, debris and trash removal, spill cleanup, etc. The Field Manual shall be updated as necessary or at least once per permit term and include written procedures to minimize pollutant discharge for maintenance activities which have the potential to discharge pollutants to its MS4.

(ii) *Training* - The Permittee shall further develop and provide annual training to staff on proper maintenance activities to prevent storm water pollution. The training shall cover the BMPs Field Manual, identify potential sources of pollution, general BMPs that can be used to reduce and/or eliminate such sources, and specific BMPs for their activities. The training shall incorporate components of the public education campaign and educate staff that they serve a role in protecting water quality. Staff shall be made aware of the NPDES permit, the overall SWMP, and the applicable BMPs Program(s).

Part D.1.g Industrial and Commercial Activities Discharge Management Program

The Permittee shall develop and implement an industrial and commercial discharge management program to reduce to the MEP the discharge of pollutants from all industrial and commercial facilities and activities which initially discharge into the Permittee's MS4. At a minimum, the program shall include:

Part D.1.g.(1) *Requirement to Implement BMPs* - Require a permit or written equivalent approval for drainage connections and discharge of surface runoff into the MS4 and maintain a database of the permits/approvals. The permit/approval shall obligate the facility to implement BMPs.

Part D.1.g.(2) *Inventory and Map of Industrial Facilities and Activities* - The *Permittee* shall update and submit, in electronic portable document format (pdf - minimum 300 dpi), the industrial facilities and activities inventory (industrial i*n*ventory), sorted by TMK, and map of such facilities and activities discharging, directly or indirectly, to its MS4.

The industrial inventory shall include the facility name, street address, TMK, nature of business or activity, Standard Industrial Classification (SIC) code(s) that best reflect the facility product or service, principal storm water contact, receiving State water, and whether an NGPC under HAR, Chapter 11-55, Appendix B, NPDES General Permit Authorizing the Discharge of Storm Water Associated with Industrial Activities (General Industrial Storm Water permit) or any other applicable NPDES permit has been obtained, including a permit or file number and issuance date.

At a minimum, the industrial inventory shall include facilities and activities such as:

- Municipal Landfills (open and closed).
- Hazardous waste recovery, treatment, storage and disposal facilities.
- Facilities subject to Section 313 of the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. 11023.
- Findings from follow-up investigations of the industrial facilities identified in the Questionnaire Survey.
- Facilities subject to NPDES permit coverage that are adjacent to the Permittee's facilities or discharge to the MS4.
- And any other industrial facility that either the Permittee or DOH determines is contributing a substantial pollutant loading to the MS4.

Part D.1.g.(3) *Inventory and Map of Commercial Facilities and Activities* - The Permittee shall update and submit, in pdf format (minimum 300 dpi), the commercial facilities and activities inventory (commercial inventory), sorted by priority areas, and map of such facilities and activities discharging, directly or indirectly, to its MS4 within its Annual Report. The commercial inventory update may be based on the Collection of new information obtained during field activities or through other readily available intra-agency informational databases (e.g., business licenses, pretreatment permits, sanitary sewer hook-up permits).

The commercial inventory shall include, by priority area, the facility name, street address, TMK, nature of business or activity, SIC code(s) that best reflect the facility product(s) or service(s), principal storm water contact, and receiving State water.

At a minimum, the commercial inventory shall include facilities and activities such as:

- Findings from investigations of the commercial facilities identified in the Questionnaire Survey.
- Retail Gasoline Outlets.
- Retail Automotive Services, including Repair Facilities.
- Restaurants.
- Any other commercial facility that either the Permittee or DOH determines is contributing pollutants to the MS4 that may cause or contribute to an exceedance of State water quality standards.

Part D.1.g.(4) *Prioritized Areas for Industrial and Commercial Facility and Activity Inspections* - The Permittee shall implement the Prioritized Areas for Industrial and Commercial Facility and Activity Plan (refer to the SWMP Plan, Appendix L.2). Under that Plan, the Permittee is to designate priority areas for industrial and commercial facility and activity inspections, based on the relative risk that any discharge might be contaminated with pollutants.

Within 60 calendar days from the effective date of this permit, the Permittee shall submit a status report to DOH. The status report shall identify the numbers of industrial and commercial facilities discharging into the Permittee's MS4 and the number of inspections that have been completed during the prior permit term. The status report shall be organized by priority area. On an annual basis, the Permittee shall modify the Plan based on updated information from its industrial and commercial inventory, findings from previous inspections, the number of industrial and commercial facilities in the area, the density of these facilities, previous storm water violations in the area, and water quality impairments in the area. The modified Plan shall set a schedule that ensures inspections will be completed in accordance with the schedule in Part D.1.g.(6). This Plan shall be submitted with the Permittee's annual report.

Part D.1.g.(5) *Inspection of Industrial and Commercial Facilities and Activities* -

The industrial/commercial inspection program shall be implemented and updated as appropriate to reflect the outcomes of the investigations.

The Permittee shall ensure industrial and commercial facilities and activities identified in the industrial and commercial inventories required under Parts D.1.g.(2) and D.1.g.(3) are inspected and re-inspected as often as necessary based on its findings to ensure corrective action was taken and the deficiency was resolved.

At a minimum, the Permittee shall inspect each industrial facility that does not have NPDES permit coverage under the NPDES permit program at least twice every five (5) years, and each industrial facility that does have such NPDES permit coverage at least once every five (5) years. Any industrial facility discharging Industrial Storm Water (as defined by 40 C.F.R. Part 122.26(b)(14)) that does not have NPDES Permit coverage shall be reported to DOH within 30 calendar days of the inspection. Commercial dischargers are to be ranked according to relative risk of discharge of contaminated runoff to the MS4. The highly ranked commercial facilities shall be inspected at least once every five (5) years.

All inspections shall be in accordance with the applicable portions (e.g., Chapter 11 – Storm Water) of the "NPDES Compliance Inspection Manual" (EPA 305-X-04-001), dated July 2004. Inspectors shall be trained to identify deficiencies, assess potential impacts to receiving waters, evaluate the appropriateness and effectiveness of deployed BMPs, and require controls to minimize the discharge of pollutants to the MS4. The inspectors shall use an inspection checklist, or equivalent, and photographs to document site conditions and BMP conditions. Records of all inspections shall be maintained for a minimum of five (5) years, or as otherwise indicated.

The Permittee shall submit semi-annual inspection report(s) to the DOH by October 31st and April 30th for inspections done within the previous period.

Part D.1.g.(6) *Storm Water Pollution Control Plan (SWPCP) Review and Acceptance for Industrial Facilities* - The Permittee shall:

(i) Verify the facility owner has received NPDES permit coverage for the discharge of storm water associated with industrial activity or provided proof of filing an NOI, or NPDES application; and

(ii) Review and accept a SWPCP or other plans relating to pollution prevention or similar document(s).

Part D.1.g.(7) *Enforcement Policy for Industrial and Commercial Facilities and Activities* - Within one (1) year of the effective date of this permit, the Permittee shall establish and implement its own polices for enforcement and penalties for industrial and commercial facilities which have failed to comply. The policy shall be part of an overall escalating enforcement policy and must consist of the following:

- Conducting inspections.
- Issuance of written documentation to a facility representative within 30 calendar days of storm water deficiencies identified during inspection. Documentation must include copies of all field notes, correspondence, photographs, and sampling results if applicable.
- A timeline for correction of the deficiencies.
- Provisions for re-inspection and pursuing enforcement actions, if necessary.

In the event the Permittee has exhausted all available sanctions and cannot bring a facility or activity into compliance with its policies and this permit, or otherwise deems the facility or activity an immediate and significant threat to water quality, the Permittee shall provide e-mail notification to cleanwaterbranch@doh.hawaii.gov, Attn: Enforcement Section Supervisor within one (1) week of such determination. E-mail notification shall be followed by written notification and include a copy of all inspection checklists, notes, photographs, and related correspondence in pdf format (300 minimum dpi) in accordance with Part A.6. within two (2) weeks of the determination. In instances where an inspector identifies a facility that has not applied for the General Industrial Storm Water permit coverage or any other applicable NPDES permit, the Permittee shall provide email notification to DOH within one (1) week of such determination.

Part D.1.g.(8) *Training* - The Permittee shall provide training to staff on how to conduct industrial and commercial inspections, the types of facilities requiring NPDES permit coverage for storm water permit associated with industrial activity or any other applicable NPDES permit,

components in a SWPCP for industrial facilities, BMPs and source control measures for industrial and commercial facilities, and inspection and enforcement techniques. This training shall be specific to the Permittee's activities, policies, rules, and procedures. Any updates to the training shall be submitted to DOH for review within 90 calendar days of the change. Permittee inspectors shall receive annual training.

Part D.2. SWMP Modifications

The Permittee shall modify the SWMP as required when any of the following occur:

- Exceedance of any discharge limitation or water quality standard established in HAR, Section 11-54-4. The revisions shall include BMPs and/or other measures to reduce the amount of pollutants found to be in exceedance from entering State Waters.
- Change in conditions and incorporation of more effective approaches to pollutant control.
- System modifications, including any planned physical alterations or additions to the permitted MS4 and any existing outfalls newly identified over the term of the permit.

The Permittee shall properly address all modifications, concerns, requests, and/or comments to the satisfaction of the DOH and/or EPA. Minor changes may be proposed by the Permittee or requested by DOH or the EPA. Proposed changes that imply a major reduction in the overall scope and/or level of effort of the SWMP must be made for cause and in compliance with 40 CFR §122.62 and Part 124. A written report shall be submitted to the DOH for acceptance at least 30 calendar days prior to the initiation date of the major modification. The Permittee shall report and justify all other modifications made to the SWMP in its Annual Report for the year in which the modification was made.

Part E. INDUSTRIAL FACILITIES

Part E.1. The industrial facilities covered under this permit shall comply with the requirements in HAR, Chapter 11-55, Appendix B.

The industrial facilities covered under this permit include the Department of Public Works Building 2624, Schofield Barracks; Motorpool Building 2600, Schofield Barracks; and Hot POL Refueling Pad, Schofield Barracks.

Part E.2. An individual at each facility (e.g., yard foreman) shall be charged with ensuring implementation of the SWPCP. This individual shall be trained to implement the SWPCP, including but not limited to, collecting storm water samples and analyzing samples for temperature and pH, conducting inspections, identifying deficiencies and performing corrective actions.

Part E.3. This permit may cover new or currently existing industrial facilities not currently identified in the Permittee's application upon submission of the "MS4 NPDES Individual Permit - Industrial Storm Water Discharge Notification Form" by the Permittee using the "CWB Compliance Submittal Form for Individual NPDES Permits and NGPCs" through the DOH's e-Permitting Portal. Along with the submission of the form, the Permittee shall submit a SWPCP for the industrial facility, and other attachments to the DOH for review and comment, including updating its SWMP Plan. Upon acceptance of the information, the DOH will acknowledge by letter NPDES permit coverage under this permit for the added facility. The SWPCP must be implemented upon the start-up of the facility or for an existing industrial facility; the SWPCP must be implemented upon submittal of the written request.

To request coverage of a facility's industrial storm water discharges under this NPDES permit:

- Open the e-Permitting Portal website at: https://eha-cloud.doh.hawaii.gov/epermit. Enter your login and password. If you do not have a login and password you will be asked to do a one-time registration.

- Click on the e-Permitting Application Finder tool and locate the "CWB Compliance Submittal Form for Individual NPDES Permits and NGPCs."

- Under Additional Links, download the “MS4 NPDES Individual Permit – Industrial Storm Water Discharge Notification Form.”

- You are required to complete the “MS4 NPDES Individual Permit -Industrial Storm Water Discharge Notification Form” for each facility that discharges industrial storm water. All sections of this form MUST be completed for NPDES Permit compliance.

- Follow the instructions to complete and submit this form.

- Attach the completed “MS4 NPDES Individual Permit – Industrial Storm Water Discharge Notification Form” in Section 7 of the “CWB Compliance Submittal Form for Individual NPDES Permits and NGPCs.”

Part E.4. The SWPCP shall contain all information required under HAR, Chapter 11-55, Appendix B, Section 6.

Part F. MONITORING REQUIREMENTS

Part F.1. Annual Monitoring Plan

Part F.1.a. The Permittee shall submit the Annual Monitoring Plan to the DOH by June 1st of each year for review and acceptance. The Annual Monitoring Plan shall be implemented over the coming fiscal year.

The monitoring program must be designed and implemented to meet the following objectives:

Part F.1.a.(1) Assess compliance with this permit (including TMDL I&M Plans and demonstrating consistency with WLAs, if required);

Part F.1.a.(2) Measure the effectiveness of the Permittee's SWMP;

Part F.1.a.(3) Assess the overall health based on the chemical, physical, and biological impacts to receiving waters resulting from storm water discharges and an evaluation of the long term trends;

Part F.1.a.(4) Characterize storm water discharges;

Part F.1.a.(5) Identify sources of specific pollutants;

Part F.1.a.(6) Detect and eliminate illicit discharges and illegal connections to the MS4; and

Part F.1.a.(7) Assess the water quality issues in watershed resulting from storm water discharges to receiving waters.

Part F.1.b. The plan shall, at a minimum, include the following items:

Part F.1.b.(1.) Written narrative of the proposed monitoring plan's objectives, including but not limited to the objectives identified in Part F.1.a., and description of activities;

Part F.1.b.(2.) For each activity, a description of how the results will be used to determine compliance with this permit.

Part F.1.b.(3.) Identification of management measures proven to be effective and/or ineffective at reducing pollutants and flow.

Part F.1.b.(4.) Written documentation of the following:

(i) Characteristics (timing, duration, intensity, total rainfall) of the storm event(s);

(ii) Parameters for measured pollutant loads; and

(iii) Range of discharge volumes to be monitored, as well as the timing, frequency, and duration at which they are identified;

Part F.1.b.(5.) Written documentation of the analytical methods to be used;

Part F.1.b.(6.) Written documentation of the Quality Assurance/Quality Control procedures to be used; and

Part F.1.b.(7.) Estimated budget to be implemented over the coming fiscal year.

Part F.2. Storm Water Associated with Industrial Activities

The Permittee shall annually monitor the storm water runoff for the parameters specified below, for each of the Permittee's industrial facilities, including any additional parameters which the Permittee also believes to be present in the storm water runoff.

Effluent Parameter (units)	**Effluent Limitation {1}**	**Type of Sample {2}**
Flow (gallons)	{4}	Calculated or Estimated
Biochemical Oxygen Demand (5-Day) (mg/l)	{4}	Composite {3}
Chemical Oxygen Demand (mg/l)	{4}	Composite {3}
Total Suspended Solids (mg/l)	{4}	Composite {3}
Total Phosphorus (mg/l)	{4}	Composite {3}
Total Nitrogen (mg/l) {5}	{4}	Composite {3}
Nitrate + Nitrite Nitrogen (mg/l)	{4}	Composite {3}
Oil and Grease (mg/l)	15	Grab {6}
pH Range (Standard Units)	5.5-8.0	Grab {7}

Effluent Parameter (units)	Effluent Limitation {1}	Type of Sample {2}
Ammonia Nitrogen (mg/l)	{4}	Composite
Turbidity (0.1 NTU)	{4}	Grab
Dissolved Oxygen (0.1 mg/l)	{4}	Grab
Oxygen Saturation (1%)	{4}	Grab
Temperature (0.1 ºC)	{4}	Grab
Salinity (0.1 ppt)	{4}	Grab
Benzene (µg/l)	1,800	Grab
Toluene (µg/l)	5,800	Grab
Ethylbenzene(µg/l)	11,000	Grab
Cadmium(µg/l) {8}	3+	Composite {3}
Chromium (IV) (µg/l) {8}	16	Composite {3}
Copper {8}	6+	Composite {3}
Lead (µg/l) {8}	29+	Composite {3}

mg/l = milligrams per liter = 1000 micrograms per liter (µg/l)
+ = The value listed is the minimum standard. Depending upon the receiving water $CaCO_3$ hardness, higher standards may be calculated using the respective formula in the U.S. Environmental Protection Agency publication Quality Criteria for Water (EPA 440/5-86-001, Revised May 1, 1987).

NOTES:

{1} Pollutant concentration levels shall not exceed the storm water discharge limits or be outside the ranges indicated in the table. Actual or measured levels which exceed those storm water discharge limits or are outside those ranges shall be reported to the CWB required in HAR, Chapter 11-55, Appendix B, Section 10(c).

{2} The Permittee shall collect samples for analysis from a discharge resulting from a representative storm. A representative storm means a rainfall that accumulates more than 0.1 inch of rain and occurs at least 72 hours after the previous measurable (greater than 0.1 inch) rainfall event.

"Grab sample" means a sample collected during the first 15 minutes of the discharge.

"Composite sample" means a combination of at least two (2) sample aliquots, collected at periodic intervals. The composite shall be flow proportional; either the time interval between each aliquot or the volume of each aliquot must be proportional to the total flow of storm water discharge flow since the collection of the previous aliquot. The Permittee may collect aliquots manually or automatically.

Samples for analysis shall be collected during the first 15 minutes of the discharge and at 15-minute intervals thereafter for the duration of the discharge, as applicable. If the discharge lasts for over an hour, sample collection may cease.

{3} If the duration of the discharge event is less than 30 minutes, the sample collected during the first 15 minutes of the discharge shall be analyzed as a grab sample and reported toward the fulfillment of this composite sample specification. If the duration of the discharge event is greater than 30 minutes, the Permittee shall analyze two (2) or more sample aliquots as a composite sample.

{4} Monitor and Report. The value shall not exceed the applicable limit as specified in Chapter 11-54 for the applicable classification of the receiving state waters. If no limitation is specified in Chapter 11-54, then the Permittee shall monitor and report the analytical result. The Department may include discharge limitations specified in Section 11-55-19 and discharge limitations based on Federal Register, Vol. 73, No. 189, Pages 56572–56578, dated September 29, 2008.

{5} The Total Nitrogen parameter is a measure of all nitrogen compounds in the sample (nitrate, nitrite, ammonia, dissolved organic nitrogen, and organic matter present as particulates).

{6} The Permittee shall measure Oil and Grease using EPA Method 1664, Revision A.

{7} The Permittee shall measure pH within 15 minutes of obtaining the grab sample.

{8} The Permittee shall test for the total recoverable portion of all metals.

Part F.2.a The sampling locations shall be representative of storm water discharging from the industrial facility and consist of storm water runoff from industrial activities.

Part F.3. Other TMDLs

As TMDLs are adopted by DOH and approved by the EPA that identify the Permittee as a source, the Permittee shall develop Implementation and Management (I&M) Plans for a minimum of one (1) additional TMDL per year within one (1) year of the approval date. The Permittee shall include within each I&M Plan a compliance schedule with a final deadline to demonstrate consistency with the WLAs consistent with the assumption of the associated TMDL document. The schedule shall provide for the implementation of the BMPs, monitoring to evaluate its performance, and time to make adjustments necessary to demonstrate consistency with the WLAs consistent with the assumption of the associated TMDL document at the earliest possible time. If the schedule extends beyond a year, interim dates and milestones shall be included in the schedule with the time between interim dates not to exceed one (1) year.

Part F.4. Re-opener

In accordance with 40 CFR Parts 122 and 124, this permit may be modified (i.e., to include compliance schedules, permit conditions, etc.) to address additional or revised TMDLs as adopted by DOH and approved by the EPA.

Part G. REPORTING REQUIREMENTS

All submittals to DOH shall be in a format consistent with first satisfying the requirements of this permit.

Part G.1. Annual Report

PartG.1.a. The Permittee shall submit the Annual Report by December 31st of each year in pdf format (minimum 300 dpi) in accordance with Part A.6. The Annual Report shall cover the past fiscal year. The Annual Report for the fiscal year prior to the expiration date of the permit shall serve as the permit's renewal application. Submittal of the renewal application shall include a $1,000 filing fee.

PartG.1.b. The Permittee shall revise its SWMP to include a description of reporting procedures and activities, including schedules and proposed content of the Annual Reports such that, at a minimum, the following is reported for each storm water program component in each Annual Report:

Part G.1.b.(1) *Requirements* - Describe what the Permittee was required to do (describe status of compliance with conditions of this permit and other commitments set forth in the SWMP).

Part G.1.b.(2) *Past Year Activities* - Describe activities over the reporting period in comparison to the requirements, including, where applicable, progress accomplished toward meeting specific measurable goals, standards and milestones or other specific performance requirements. When requirements were not fully met, include a detailed explanation as to why the Permittee did not meet its commitments for the reporting period. Also describe an assessment of the SWMP, including progress towards implementing each of the SWMP program components.

Part G.1.b.(3) *Future Activities* - Describe planned activities, including, *where* applicable, specific activities to be undertaken during the next reporting period toward accomplishing specific measurable goals, standards and milestones or other specific performance requirements.

Part G.1.b.(4) *Resources* - Report on the status of the Permittee's resource base for implementing this NPDES permit during the applicable *reporting* period and an estimate of the resources over and above those required in the current reporting period that will be required in the next reporting period.

PartG.1.c. *Modifications* - In each Annual Report, the Permittee shall describe any modifications made to the SWMP and implementation schedule during the past year, including justifications. The Permittee shall also describe major modifications made to the Permittee's MS4, including, but not limited to, addition and removal of outfalls, drainage lines, and facilities.

PartG.1.d. *Program Effectiveness Reporting* - Within one (1) year from the effective date of the permit, the Permittee shall submit to DOH a written strategy for determining effectiveness of its SWMP. The strategy shall include water quality monitoring efforts as well as program implementation information and other indicators. The Permittee shall include an assessment of program effectiveness and identification of water quality improvements or degradation beginning with the 2nd Annual Report.

Part G.2. Annual Monitoring Report

Part G.2.a. The Permittee shall submit the Annual Monitoring Report by December 31st of each year in pdf format (minimum 300 dpi) in accordance with Part A.6. The Annual Monitoring Report shall cover the past fiscal year.

Part G.2.b. The monitoring report shall at a minimum, include the following items:

Part G.2.b.(1) Discussion on the activities/work implemented to meet each objective, as outlined in Part F.1.a., including any additional objectives identified by the Permittee, and the results [e.g., assessment of the water quality issues in each watershed resulting from storm water discharges, refer to Part F.1.a.(7)] and conclusions.

Part G.2.b.(2) Written narrative of the past fiscal year's activities, including those coordinated with other agencies, objectives of activities, results and conclusions.

Part G.2.b.(3) Data gathered on levels of pollutants in non-storm water discharges to the Permittee’s MS4; and

Part G.2.b.(4) Using rainfall data collected by the Permittee and other agencies, the Permittee shall relate rainfall events, measured pollutant loads, and discharge volumes from the watershed and other watersheds that may be identified from time to time by the DOH or Permittee.

Part G.2.b.(5) Dates when monitoring occurred for each industrial facility covered under this permit. The monitoring event shall be of a representative storm event, where results were available for all required parameters following the QA/QC measures as described in the Annual Monitoring Plan.

Part G.2.b.(6) Discharge Monitoring Reports (DMRs) for industrial facilities shall be included in the Annual Monitoring Report and be submitted via NetDMR once established by the DOH. NetDMR is a Web-based tool that allows NPDES permittees to electronically sign and submit their DMRs to EPA's Integrated Compliance Information System (ICIS-NPDES) via the Environmental Information Exchange Network. A DMR must be submitted for the facility which is scheduled to be monitored even if sampling was not conducted. An explanation as to why sampling was not conducted shall be explained with the submittal.

Part H. SUMMARY OF DEADLINES

Deadline	Description	Part	Submit to DOH
18 months after the Effective Date of Permit (EDOP)	Revised SWMP Plan.	D.1.	Yes
1 year after EDOP	Establish requirements for issuing connection permits and require obtaining the permit prior to allowing the drain connection.	D.1.c.(1)	No
1 year after EDOP	Establish policies for enforcement and penalties for non-compliance with Part D.1.c.(1) and for persons illegally discharging pollutants to its MS4; and pursue enforcement actions.	D.1.c.(5)	No
2 year after EDOP	Establish BMP Manuals.	D.1.d.(1)	Yes
3 year after EDOP	Establish policies to require construction projects to implement BMPs and standards.	D.1.d.(2)	No
6 months after EDOP	Implement a system to track both private and public construction projects.	D.1.d.(3)	No
90 calendar days after EDOP	Plan review checklist.	D.1.d.(4)(iv)	Yes
90 calendar days after EDOP	Inspection form(s), inspection checklist, and reporting and corrective procedures.	D.1.d.(5)(iv)	Yes
1 year after EDOP	Establish policies for enforcement and penalties for non-compliance with Part D.1.d.(2); and develop and implement an Enforcement Response Plan.	D.1.d.(6)	No
6 months after EDOP	Plan for requiring LID in its Standards.	D.1.e.(1)	Yes

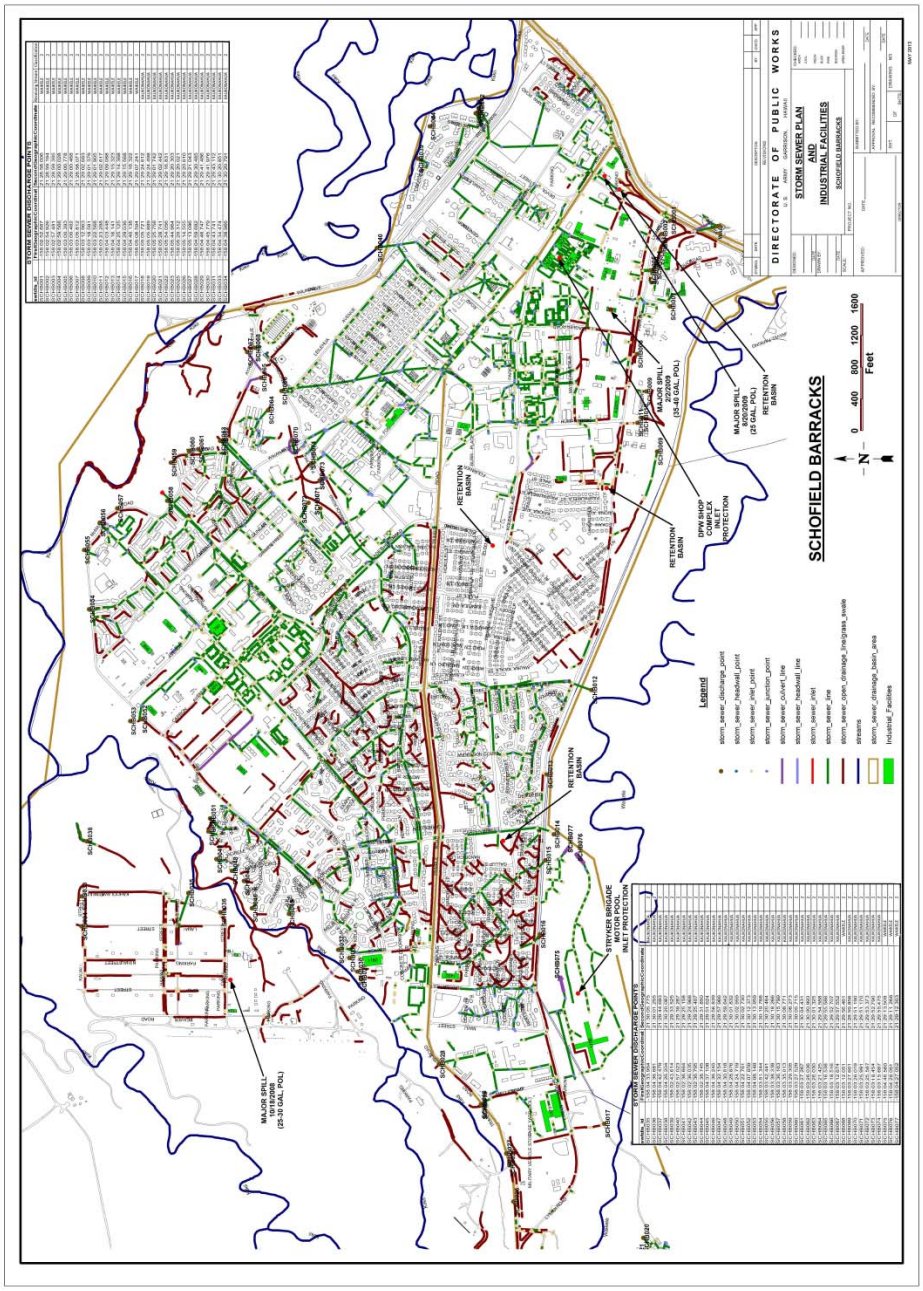
Deadline	Description	Part	Submit to DOH
12 months after EDOP	Draft of the revised Standards.	D.1.e.(1)	Yes
18 to 24 months after EDOP dependent on adoption by rulemaking	Final of the revised Standards.	D.1.e.(1)	Yes
1 year after EDOP	Action Plan for Retrofitting Structural BMPs	D.1.f.(1)(iv)	Yes
1 year after EDOP	Trash Reduction Plan	D.1.f.(1)(v)	Yes
18 months after EDOP	Require the implementation of temporary erosion control measures on erosional areas within the right-of-ways.	D.1.f.(3)(ii)	No
1 year after EDOP	WQC application(s) for temporary erosion control measures.	D.1.f.(3)(ii)	Yes
1 year after EDOP	Action Plan to address erosion at its storm drain system outlets.	D.1.f.(3)(iv)	Yes
1 year after EDOP	List of projects and implementation schedule for permanent erosion control improvements.	D.1.f.(3)(v)	Yes
4th Year Annual Report	Industrial facilities and activities inventory information.	D.1.g.(2)	Yes
4th Year Annual Report	Commercial facilities and activities inventory information	D.1.g.(3)	Yes
60 calendar days after EDOP	Prioritized areas for industrial and commercial facility and activity inspection status report.	D.1.g.(4)	Yes
October 31st and April 30th of each	Semi-Annual Industrial and Commercial	D.1.g.(5)	Yes

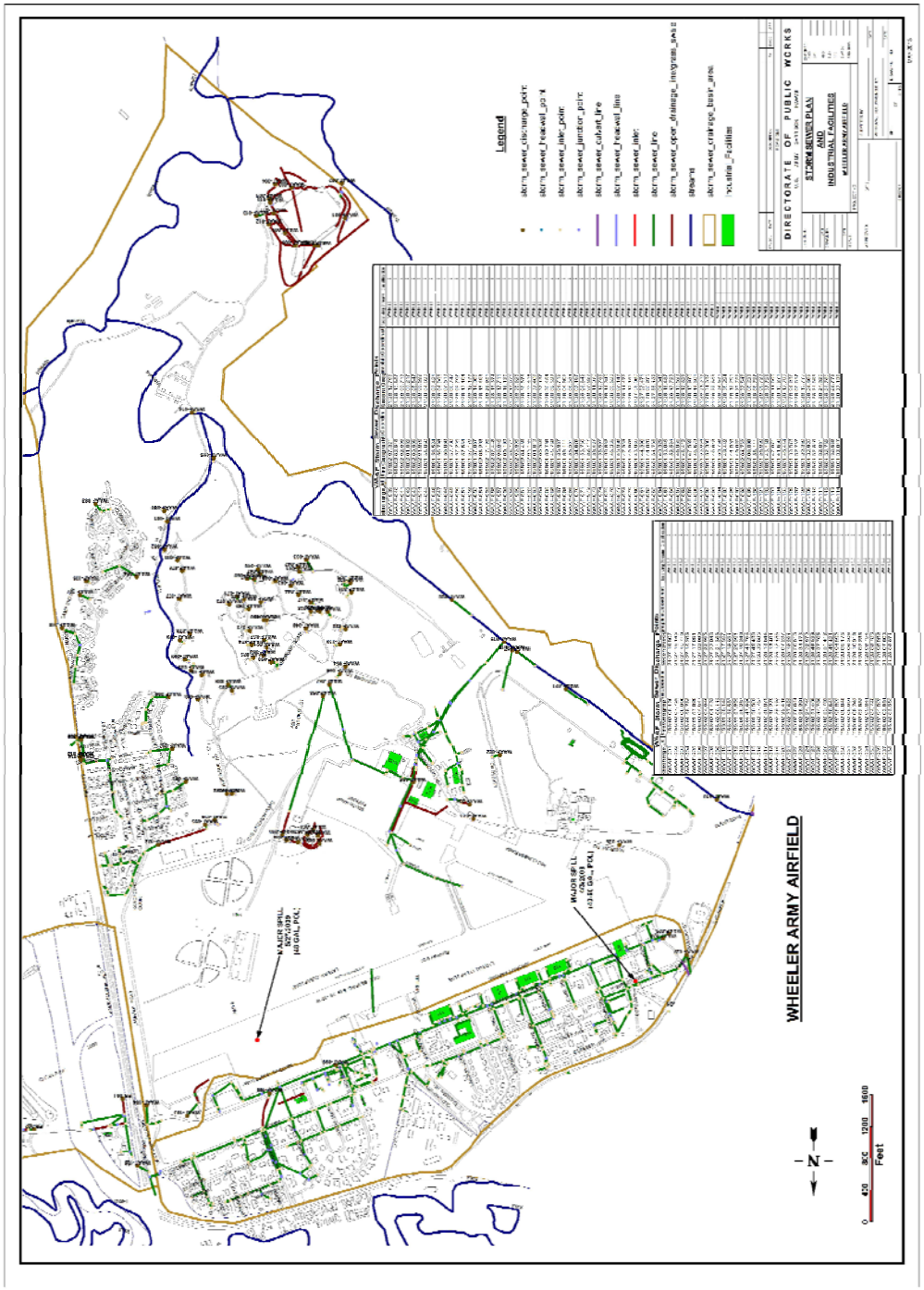
Deadline	Description	Part	Submit to DOH
year	Inspection Reports.		
1 year after EDOP	For Industrial and Commercial Facilities, establish and implement policies for enforcement and penalties.	D.1.g.(7)	No
90 calendar days of the change	Updates to the industrial and commercial inspection training	D.1.g.(8)	Yes
30 calendar days prior to the initiation date of the major modification	SWMP Modification Report	D.3.a.	Yes
As needed	MS4 NPDES Individual Permit - Industrial Storm Water Discharge Notification Form and SWPCP for each industrial activity. (For those that have not yet been submitted.)	E.3.	Yes
June 1st of each year	Annual Monitoring Plan	F.1.a.	Yes
Various	TMDL Compliance, refer to Schedules of Compliance	F.3.c.	Yes
December 31st of each year	Annual Report, to include but not limited to: • Progress evaluation results of the public education program [Part D.1.a.(3)], • Description and reason for any revision to its Standards and copy of the revised Standards [Part D.1.d.(2)], • Updates to its inspection/maintenance schedule,	G.1.	Yes

Deadline	Description	Part	Submit to DOH
	including explanation of the changes [Part D.1.f.(1)(ii)], • Updates to its implementation schedule for retrofitting structural BMPs [Part D.1.f.(1)(iv)], • Summary of its trash load reduction actions [Part D.1.f.(1)(v), • Status report on implementation of erosion control measures at its storm drain system outlets [Part D.1.f.(3)(iv)], • Updated industrial inventory information (4th Annual Report)[Part D.1.g.(2)] • Updated commercial inventory information (4th Annual Report)[Part D.1.g.(3)] • Modified Prioritized Areas for Industrial and Commercial Facility and Activity Plan [Part D.1.g.(4)], • SWMP Modifications [Part D.1.a.] • System Modifications [Part D.3.b.], • Annual Report requirements [Part G.1.], and • Amendments to MOUs [Parts G.3.a. and G.3.b.].		
1 year after EDOP	Written strategy for determining effectiveness of its SWMP	G.1.d.	Yes
December 31st of each year	Annual Monitoring Report with Discharge Monitoring Reports	G.2.	Yes

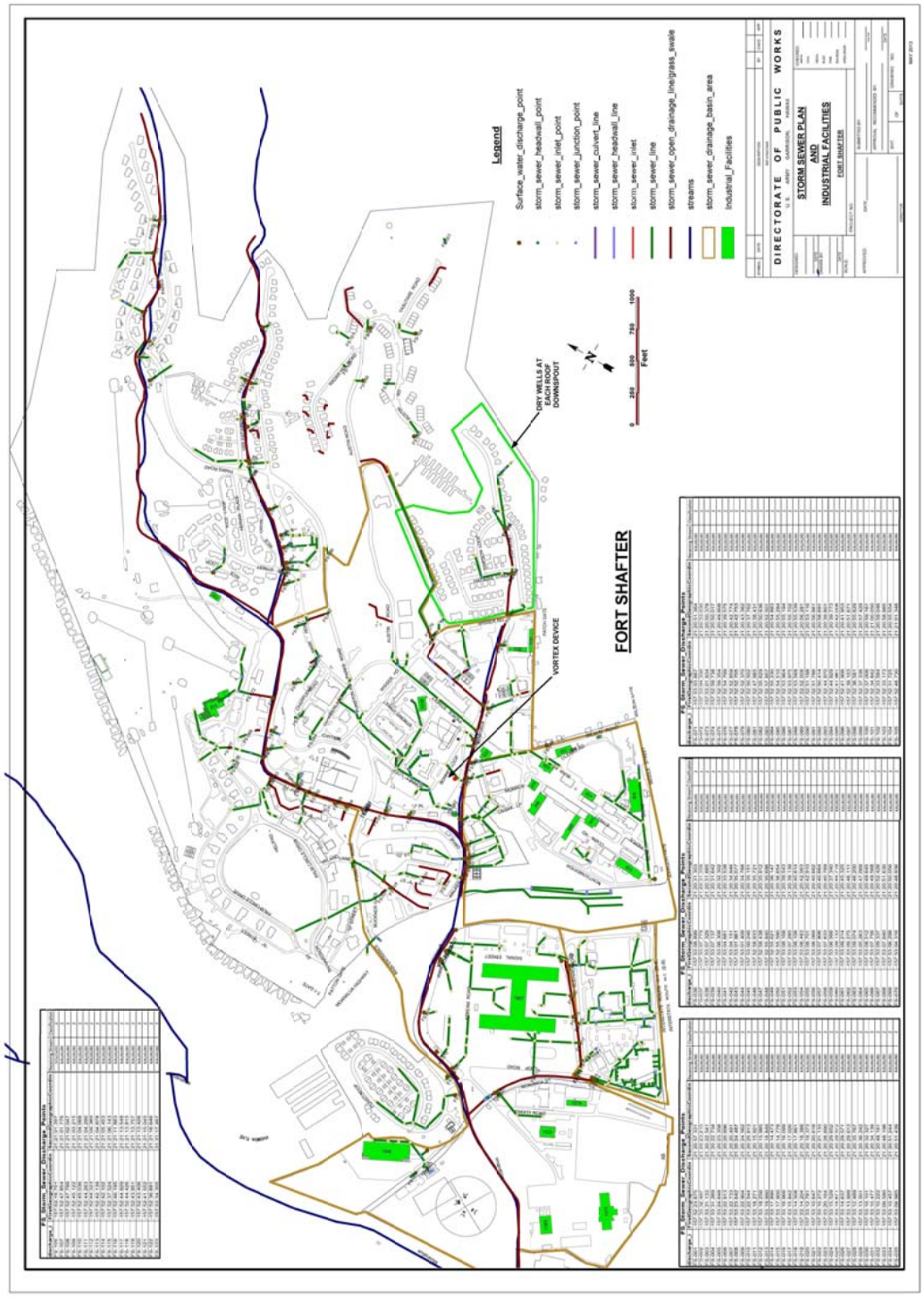
Part I. Maps

1. Schofield Barracks, Wahiawa, Oahu, Hawaii

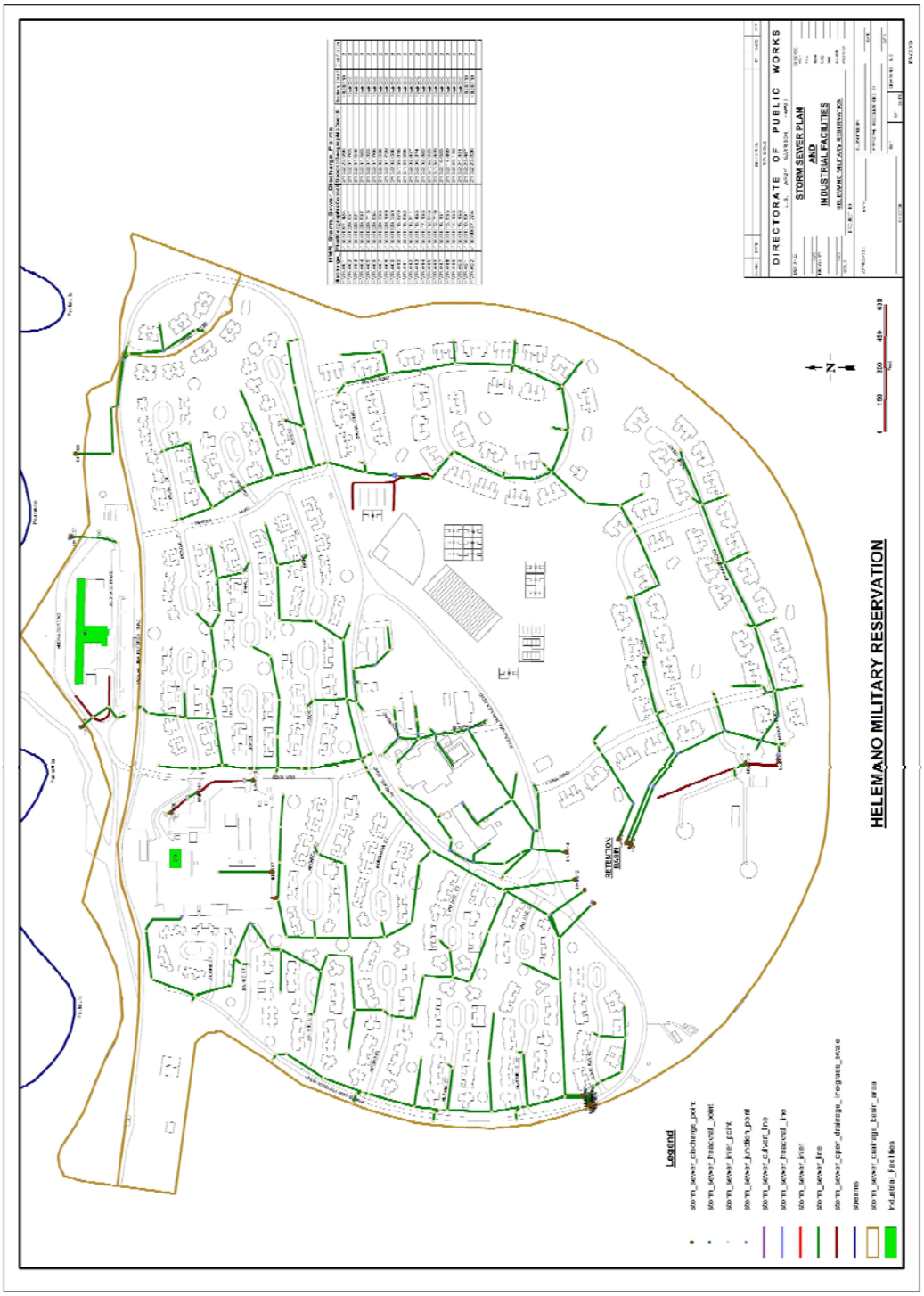



Legend
DIRECTORATE OF PUBLIC WORKS
STORM SEWER PLAN
INDUSTRIAL AREA
WHEELER ARMY AIRFIELD
N
0 400 800 1200 1600
Feet

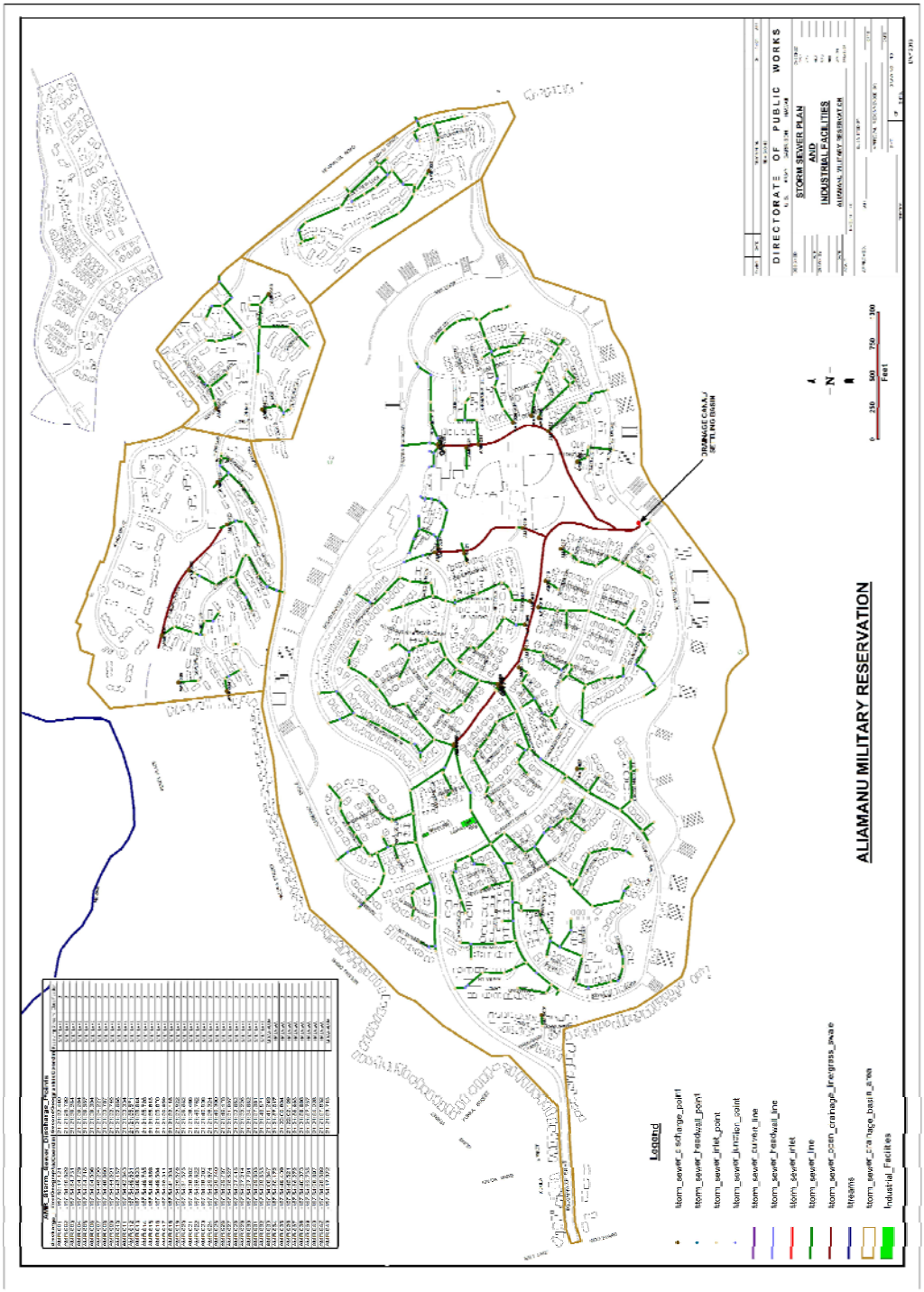
3. Fort Shafter, Honolulu, Oahu, Hawaii



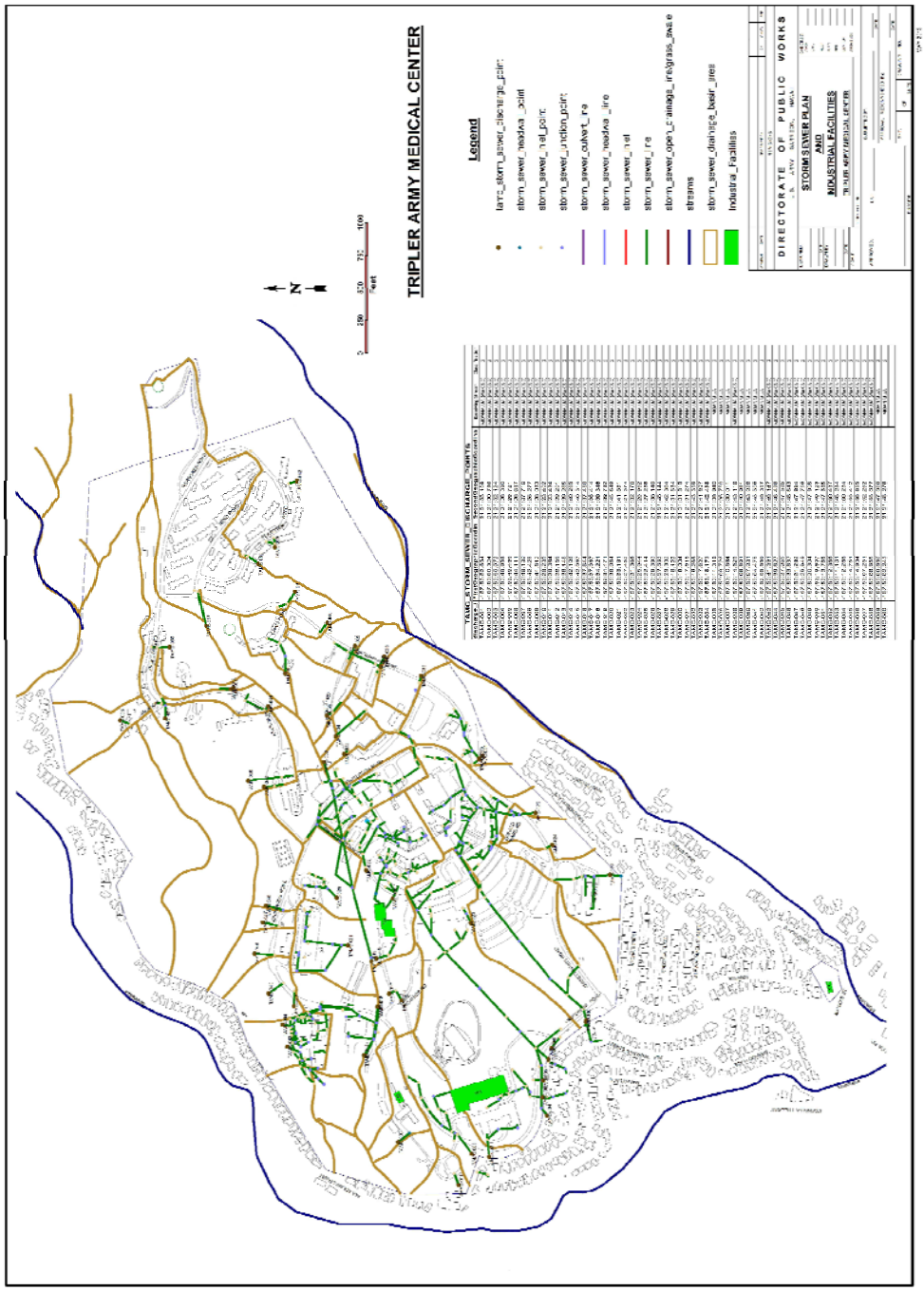
4. Helemano Military Reservation, Wahiawa, Oahu, Hawaii



5. Aliamanu Military Reservation, Honolulu, Oahu, Hawaii



6. Tripler Army Medical Center



This page intentionally left blank.

INTRO APPENDIX C
Directorate of Public Works Organization Chart

This page intentionally left blank.

Facilities Management Overview

DIRECTORATE OF PUBLIC WORKS (DPW)

Environmental

- Conservation
- Partner with ITAM
- Environmental Restoration
- Compliance Programs
- Pollution Prevention Program
- Recycling policy & reuse program mgmt
- Environmental audits
- INRMP & ICRMP
- Forestry Mgmt
- Agriculture Lease
- Hunting & Fishing Program
- Training programs
- Law & regulation implementation

8,308 Total Employees

Operations & Maintenance

Buildings and Grounds

- Facility Maintenance & Minor Repairs
- Surfaced and Unsurfaced areas, bridges, dams, roads, ports, and utility plants and system maintenance
- Railroad maintenance
- Custodial Services
- Facility service contracts

Utilities/Energy

- Water/ waste water operations
- Utility rates management
- Utility Usage and Payments
- Utilities Privatization Mgmt
- Energy Management
- UEMCS management

Municipal Services

- Grounds maintenance
- Snow, ice, and sand removal
- Pest Control services
- Refuse / recycling operations
- Sustainment Management Systems

Housing

AFH/RCI

- AFH Management
- Maint and Repair
- Long/short range planning
- Conversions/diversions
- GFOQ 6 year plans
- AFH Budget
- Leasing
- RCI Oversight

UPH

- BUR/4I Report
- CAN
- Furnishings
- FSBP
- PAL
- Warrior Transition

Housing Services Office

- Soldier advocacy
- Housing Market Analysis
- BAH surveys
- Homeowners assistance program
- AHRN

Engineering

Project Management

- Project acquisition strategy
- Facilities Engineer Services
- Project Prioritization System
- Statutory and regulatory requirements
- Work classification
- Minor construction
- AT/FP Engineering
- Engineering Procurement

Design Services

- Project Designs
- A-E Services
- JOC
- CADD

QAE/QC

- Construction contracts oversight
- Contract Quality Assurance Evaluation

MILCON/ Master Planning

MILCON Programming/execution

- MILCON POM Build
- MILCON Management
- UMMCA/ Congressional adds
- HQDA MILCON RFIs

Master Planning / GIS

- RPLANS
- Installation GIS
- Develop and maintain all components of the installation Master Plan
- Installation Planning Board
- Space utilization

Real Property / Real Estate Management

- Real Property Accountability
- Space Assignment
- Real Estate support and coordination

Business Operations / Integration

Work Management

- Annual Work Planning, prioritization, & Execution
- Reimbursable work planning, integration and execution.
- Management of sustainment funding and organization codes
- Work Order / Service Order reception
- Job Estimating
- Work Order/ Service Order scheduling
- Supply Operations
- Self-help store
- DPW Training coordination
- CP-18 career management

Engineering Systems

- Integrated Facilities System (IFS) and General Fund Enterprise Business System (GFEBS) operations and support
- DPW performance management and reporting
- ISR oversight
- Business Engineering

This page intentionally left blank.

SECTION 2: Public Education / Outreach / Involvement Program
PUB APPENDIX

This page intentionally left blank.

PUB APPENDIX A
Clean Water Program Brochure

This page intentionally left blank.

Make a Difference...

Best Management Practices

- Never dump anything down the storm drains or in the streams.
- Throw trash in trash cans and keep trash cans covered.
- Pick up pet waste and dispose of properly.
- Check cars, boats, motorcycles, and other machinery for leaks and spills and fix leaks immediately.
- Clean up spills immediately using absorbent materials and dispose of materials properly to prevent spills from entering storm drains.
- Recycle used oil and automotive fluids.
- Use, store, and dispose of chemicals properly.
- Only apply recommended amounts of fertilizer and do not fertilize when rain is forecasted.
- Use low- or no-phosphate detergents sparingly to wash cars.
- Keep sidewalks, curbs, and gutters clean by sweeping debris and dispose of properly.

For more information contact:
Clean Water Program
656-3105/3086

To report spills or dumping, day or night, call: 656-1111

Recycle by sharing with a friend or dispose of in the proper recycling bin

Clean Water Program

DPW Environmental Division

U.S. ARMY
Garrison-Hawaii

Mission

The Clean Water Program supports the mission to sustain the evironment by protecting water quality.

We all live in a watershed. A watershed is an area of land that drains downward through a series of streams into a common body of water, which in Hawai'i is the ocean. What we do on the land affects the quality and quantity of water, our natural resources, and aquatic ecosystems.

You have an important duty to help keep the watershed, streams, and ocean clean for all of us to enjoy. By preventing pollution and practicing simple best management practices, you show pride in the installation and respect for the environment.

Prevent Polluted Runoff

Rainwater that falls on impervious surfaces, such as buildings, roads, and parking lots, and is not soaked into the ground results in runoff. Runoff can also be caused by car washing, hosing down sidewalks, and watering our yards. All runoff enters the storm drain system that flows into the streams and ocean.

Any rubbish, dirt, chemicals, and pollutants that may be in the environment can be transported by the runoff into the storm drain system, eventually reaching the waterbodies we use for swimming and fishing.

Clean Water Program

The DPW Environmental Division Clean Water Program oversees compliance with the Army's National Pollutant Discharge Elimination System permit. The permit, issued by the state in accordance with the federal Clean Water Act, authorizes the discharge of storm water runoff and requires the use of best management practices to reduce pollutants from entering the storm drain system to the maximum extent practicable. As required by the permit, the Clean Water Program implements the following control measures:

Public Education and Outreach
The program provides educational materials on the impacts of storm water runoff on waterbodies and the hazards associated with illicit discharges.

Public Involvement
The program collaborates with the USAG-HI community on water quality demonstration projects and environmental education. The program enlists community participation in labeling storm drains with markers that read: "Dump No Waste, Flows to the Ocean."

Illicit Discharge Detection and Elimination
The program establishes installation-wide enforcement procedures and actions that prohibit non-storm water discharges into the storm sewer system.

Construction Site Runoff Control
The program establishes installation-wide enforcement procedures and actions that require erosion and sediment control best management practices. The program performs review of erosion and sediment control plans for potential water quality impacts and performs construction site inspections to ensure proper installation and functioning of erosion and sediment control best management practices.

Post-Construction Storm Water Management in New Development and Redevelopment
The program establishes installation-wide enforcement procedures and actions to reduce pollutants in storm water runoff from new development and redevelopment projects.

Pollution Prevention
The program provides Storm Water Pollution Control Plans with site-specific best management practices to reduce pollutant runoff for industrial facilities. The program ensures training on spill prevention and response procedures. The program monitors the use of pesticides and fertilizers and the frequency of street cleaning.

PUB APPENDIX B
Storm Drain Placard

This page intentionally left blank.

DUMP NO WASTE
CALL 656-1111
TO REPORT SPILLS
OR DUMPING
U.S. ARMY
GARRISON
HAWAII
HELP PROTECT OUR WATERS . . . FOR LIFE.
FLOWS TO OCEAN

This page intentionally left blank.

SECTION 3: Illicit Discharge Detection and Elimination Program
IDDE APPENDIX

This page intentionally left blank.

IDDE APPENDIX A
Request to Discharge Form

This page intentionally left blank.

REQUEST TO DISCHARGE

General Information (Please fill out for your exercise):

Name of Exercise _____
Location of Exercise (Installation) _____
Military Grid Reference System (MGRS) _____
Date(s) of Exercise _____ Total No. of Days _____
Point of Contact (Rank, Name, Phone, Email) _____

General Requirements (Please check off after reviewing each requirement):

- ❑ Greywater discharge shall not enter any stream, natural water body, drainage ditch or feature, drain inlet, or storm sewer system.
- ❑ Greywater run through a Multi-functional Modular Fluid Filtration System (MMFFS) or greywater ***as approved by DPW Environmental Clean Water Program*** may be discharged to an approved vegetated area where it is able to infiltrate and evaporate. Limit discharging during rain events to prevent runoff.
- ❑ If greywater is heated, e.g. for LADS or field kitchen use, it shall be held until cooled to a temperature of 105° F or less before being discharged to an approved vegetated area.

- ❑ Greywater NOT approved to be discharged to a vegetated area shall be:
  - ❍ ***Coordinated with the DPW Environmental Clean Water Program*** to be discharged into the sanitary sewer as approved by Aqua Engineers, owner of the Schofield Barracks Wastewater Treatment Plant.
    OR
  - ❍ ***Coordinated with the DPW Environmental Hazardous Waste Program*** for proper disposal. See Note under Decontamination Operations.

Exercise Information:

- **Place a checkmark next to each type of operation being performed**
- **Fill out the corresponding information**
- **Check off that a location map showing proposed discharge point(s) is attached**

❑ **Laundry Advanced System (LADS)**:
Volume of discharge (gallons, or gallons/day if multiple days) _____
Detergent to be used, attach MSDS _____
Concentration of detergent (amount per gallon) _____
Temperature of water to be discharged _____
Cooling time of greywater (how long is it held before release) _____
❍ Location map showing proposed discharge point(s) is attached.

❑ **Field Shower**:
Volume of discharge (gallons, or gallons/day if multiple days) _____
Temperature of water to be discharged _____
❍ Location map showing proposed discharge point(s) is attached.

REQUEST TO DISCHARGE

- ❑ **Field Kitchen**:
  Volume of discharge (gallons or gallons/day if multiple days) _____
  Kitchen greywater shall be free of solid matter and grease (Yes or No, see Note below) _____
  Note: Soakage pits are generally not necessary. If the Unit determines that a soakage pit is required based on Field or Technical Manual directives, the Unit must complete a Record of Environmental Consideration (REC) before proceeding and obtain an excavation permit from DPW. Contact the Clean Water Program (656-3105 / 656-3317) for more information.
  - ❍ Location map showing proposed discharge point(s) is attached.

- ❑ **Decontamination Operations**:
  Volume of discharge (gallons or gallons/day if multiple days) _____
  Only soap and water will be used (Yes or No, see Note below) _____
  Note: If only soap and water is used for the training, the greywater may be discharged to an approved vegetated area where it is able to infiltrate and evaporate.
  If the training involves chemical agents, contact the Hazardous Waste Program Manager (Gary Akasaki, 656-7001) for a review of the products. Pending review, the waste stream may need to be containerized for proper disposal.
  - ❍ Location map showing proposed discharge point(s) is attached.

APPROVED BY (To be signed by DPW Environmental):

_____	_____	_____	_____
Print Name	Signature	Date	Phone

IDDE APPENDIX B
Connection Application

This page intentionally left blank.

Application for a New/Existing/ Temporary Storm Drain Connection(s) to the US Army Garrison Hawaii Municipal Separate Storm Sewer System (MS4)

In accordance with section D.1.c.(1) of the US Army Garrison Hawaii Municipal Separate Storm Sewer System Permit# HI S000090 the US Army must issue a permit for all private facilities connected to the USAG-HI MS4 system.

I. Project Information:

Project Title: _____
Location: _____
Tax Map Key: _____

Project Start: _____ Project Finish: _____

II. Brief Description of Connection(s)

For each connection, provide size, inflow type, flow rate, and location. (Attach a copies of the drainage plan/map showing the location of the drain connection(s)

III. Storm Water Quality

A. Does your property/facility discharge runoff associated with "industrial activity"? If yes, submit analysis of a runoff sample performed by a laboratory acceptable by the City within one (1) year after the date of the connection

B. Is your property/facility presently covered by a National Pollutant Discharge Elimination System (NPDES) permit? If yes, attach a copy of the NPDES permit including effluent limitation

C. Is your property/facility requires NPDES permit coverage, Install permanent best management practices (BMPs) and provide written documentation for future maintenance of the permanent BMPs. If permanent BMPs are not included, ten submit specific documentation demonstrating that they are

IV. Contact Information

Name: _____
Title: _____
Company: _____
Address: _____
_____

Email: _____ Phone: _____

Signature: _____ Date: _____

This page intentionally left blank.

IDDE APPENDIX C
Connection Permit

This page intentionally left blank.

Permit for Connection(s) to the US Army Garrison Hawaii Municipal Separate Storm Sewer System (MS4)

In accordance with section D.1.c.(1) of the US Army Garrison Hawaii Municipal Separate Storm Sewer System Permit# HI S000090 the US Army must issue a permit for all private facilities connected to the USAG-HI MS4 system.

I. Permittee Information:

Name:
Title:
Company:
Address:
NPDES Permit#

The fore mentioned permittee is authorized to connect to the USAG-HI MS4 drainage system ONLY at the location(s) specified below and no other location

II. Connection Location and Description:

Discharge/Connection Point #: _____

III. Permitte Responsibility

A. The permittee shall bear the cost of engineering, construction, maintenance and upkeep of the drainage system.

B. No additions or alterations will be made without the prior written consent of the USAG-HI DPW Staff and the event that any portion of the USAG-HI system is damaged or destroyed during the construction or modification to the private connection, the permittee shall bear all costs associated repair or replacement of USAG-HI property.

C. At Any time should the private drainage system discharge pollutants or other objectionable material into the USAH-HI drainage system which exceeds applicable water quality standards of the State of Hawaii as identified in Section 11-54-04, HAR, or otherwise misuse the system, or cause a violation of any provisions of the NPDES permit, the USAG-HI may terminate this permit and have the system removed at the permittees expense.

D. That discharges into the USAG-HI drainage system shall be composed entirely of storm water. In the event the discharge into USAG-HI system includes stormwater associated with an industrial activity as defined in federal regulations the permittee shall obtain NPDES permit coverage and shall provide the USAG-HI a copy of the permit and all sampling analysis that may be associated with the permit.

E. The USAG-HI DPW staff may inspect, investigate or sample the drainage area during normal work hours and with advanced notification.

IV. Approval

Name: _____
Title: _____
Company: _____
Address: _____
_____

Email: _____ Phone: _____

Signature: _____ Date: _____

This page intentionally left blank.

IDDE APPENDIX D
Policy Memo USAG-HI-59 Illicit Discharge Detection and Elimination

This page intentionally left blank.

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND, PACIFIC REGION
HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
745 WRIGHT AVENUE, BUILDING 107, WHEELER ARMY AIRFIELD
SCHOFIELD BARRACKS, HAWAII 96857-5000

REPLY TO ATTENTION OF:

IMHW-ZA

MEMORANDUM FOR ALL Military Personnel and Department of Defense Civilian Employees within United States Army Garrison, Hawaii (USAG-HI) Installations

SUBJECT: Policy Memorandum USAG-HI-59, Illicit Discharge Detection and Elimination Enforcement Program

1. References.

a. Army Regulation (AR) 200-1, Environmental Protection and Enhancement, 13 Dec 07.

b. USAG-HI National Pollutant Discharge Elimination System Permit Number HI S000090, 7 Apr 14.

c. Hawaii Administrative Rules, Title 11 Department of Health, Chapter 54 Water Quality Standards (HAR 11-54) and Chapter 55 Water Pollution Control (HAR 11-55), 15 Nov 14.

2. Purpose. To provide a formal, written Illicit Discharge Detection and Elimination Program enforcement policy statement to ensure that garrison facilities and activities are in compliance with the requirements of the USAG-HI National Pollutant Discharge Elimination System (NPDES) permit.

3. Background. The State Department of Health (SDOH), Clean Water Branch (CWB) issued USAG-HI an NPDES Municipal Separate Storm Sewer System (MS4) permit effective 7 Apr 14. This policy is prepared in compliance with Part D.1.c.(5) of the permit which requires USAG-HI to perform the following:

"*Establish policies for enforcement and penalties for entities found to be in non-compliance with requirements developed in accordance with Part D.1.c.(1), including for persons illegally discharging pollutants to its MS4, and pursue enforcement actions against entities in non-compliance with its requirements, with illegal drain connections, and illegally discharging pollutants to its MS4 without direct connections*."

4. Applicability. This policy applies to all Soldiers, Civilians, Family members, contractors, and other personnel who work on, reside on, or visit any US Army installation, facility, or work site in the State of Hawaii.

5. General. The USAG-HI holds an NPDES permit issued by the SDOH CWB. The permit requires the USAG-HI to develop and implement a Storm Water Management Plan and procedures to reduce the discharge of pollutants to the Maximum Extent Practicable from its MS4 to waters of the State.

An illicit discharge is any discharge of pollutants to the storm sewer system that is not specifically listed as an allowable non-storm water discharge in Part B.2 of the USAG-HI NPDES permit. Common examples of illicit discharges that enter the storm sewer system are wastewater spills from sewage systems, Petroleum Oil and Lubricants (POL) fluids from automobiles or equipment, and wash or rinse water from painting and other construction activities. No person shall illegally dump or discard materials into the storm sewer, drainage ditch, stream, or any other water of the State. No person shall illegally connect to the storm sewer, drainage ditch, stream, or any other water of the State.

a. Notification. Any Directorate of Public Works (DPW) employee, Environmental Compliance Officer, Soldier, Contractor, Civilian or any other person who witnesses or receives a report of a violation of the USAG-HI NDPES permit, specifically the discharge of a non-authorized substance, shall communicate the finding to the DPW Clean Water Program Manager at 656-2878 or 656-1111 within 24 hours of discovery.

b. Enforcement. The DPW Clean Water Program will investigate the suspected illegal dumping or connection by conducting a site visit to the facility or area. If it is determined that an illicit discharge or connection has occurred or is occurring the following enforcement procedure will be initiated:

(1) The tenant will be notified of the deficiency on the spot, and the tenant shall immediately correct the deficiency.

(2) If the deficiency cannot be corrected immediately, the DPW Clean Water Program will issue a written finding including copies of the field notes, correspondence, photographs, and sampling results, if applicable, to the tenant point of contact within five (5) working days. The tenant shall correct the deficiency and provide a written response to the DPW Environmental Division within ten (10) calendar days from the date of notification. The response should address what actions were taken to correct the deficiency and when they were completed. The tenant is responsible for all cost, fines, and penalties associated with the illicit discharge.

(3) As needed, the DPW Clean Water Program will conduct a re-inspection to ensure that the deficiency has been corrected.

(4) In the event all options have been exhausted and a facility or tenant cannot be brought into compliance with this policy and permit, or it is deemed that the facility or activity poses an immediate and significant threat to water quality, an email notification will be submitted to the SDOH CWB in accordance with Part D.1.g.(7) of the USAG-HI NPDES permit.

(5) Military Law Enforcement has the ability to enforce Hawaii state laws through the Assimilative Crimes Act (ACA). The ACA is a federal statute (18 U.S. Code § 13) which provides adoption by Congress of state criminal laws for areas of exclusive or concurrent federal jurisdiction if the crime is not punishable under federal law. In short, when a criminal offense has been committed on land or buildings that have been reserved or acquired by the federal government, and the offense is not a federal offense, state law will apply to the offense under the ACA. The military police can enforce Hawaii Revised Statute (HRS) Chapter 342D, Water Pollution and HRS § 708-829, Criminal Littering.

c. Record Keeping. Findings and inspection reports shall be kept on file with the DPW Environmental Division. Records shall be kept for five (5) years in accordance with the permit.

6. The Illicit Discharge Detection and Elimination Enforcement Program policy shall be given widest dissemination. This policy memorandum will be available for download at: www.garrison.hawaii.army.mil/sites/policies/policies.asp and available to the public upon request.

7. This policy supersedes Policy Memorandum USAG-HI-59, SAB, dated 4 Jun 14 and remains in effect until superseded or cancelled in writing.

8. Proponent. The proponent for administration of the USAG-HI Illicit Discharge Detection and Elimination Enforcement Program policy is the DPW Environmental Division, at 656-5790.

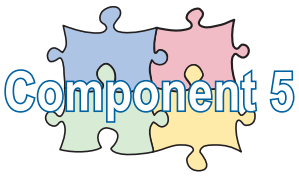
RICHARD A. FROMM
COL, AD
Commanding

DISTRIBUTION
Electronic Media

This page intentionally left blank.

IDDE APPENDIX E
Outfall Reconnaissance Inventory (ORI)

This page intentionally left blank.



Chapter 7: Searching for Illicit Discharge Problems in the Field

Purpose: This program component consists of detective work, and involves rapid field screening of outfalls in priority subwatersheds followed by indicator monitoring at suspect outfalls to characterize flow types and trace sources.

Method(s): The primary field screening tool is the Outfall Reconnaissance Inventory (ORI), which is used to find illicit discharge problems and develop a systematic outfall inventory and map of the MS4. The ORI is frequently supplemented with more intensive indicator monitoring methods to test suspect outfalls. A wide range of monitoring methods can be used; this chapter describes a framework for choosing the safest, most accurate and repeatable methods for a community.

Desired Product or Outcome(s): The search for illicit discharge problems yields several important management products, including:

- An updated map of the locations of all outfalls within the MS4
- Incorporation of ORI data into the outfall inventory/tracking system
- Design and implementation of an indicator monitoring strategy to test suspect outfalls
- Creation of a local chemical "fingerprint" library of pollutant concentrations for various discharge flow types
- Data reports that evaluate the significance and distribution of illicit discharge problems in the community

Budget and/or Staff Resources Required: Field screening and indicator monitoring can consume substantial staff and budget resources. Monitoring costs are closely related to the number of outfalls screened and the complexity of illicit discharge problems discovered. An MS4 that screens 10 stream miles and analyzes 80 indicator samples each year can expect to spend about $15,000 to $35,000. Consequently, choosing which indicator(s) to use in a community (and when and where to use them) ranks as one of the most important budget decisions for any project manager.

Integration with Other Programs: Program managers should explore two strategies to integrate field screening and indicator monitoring with other programs to achieve cost savings. The first strategy links outfall screening to broader stream corridor assessments that support local watershed restoration efforts. Often, watershed organizations and "stream waders" can be enlisted and trained to conduct outfall screening. The second strategy is to find a local agency partner to conduct laboratory analysis (such as a drinking water or wastewater treatment plant).

7.1 Overview of Searching for Illicit Discharge Problems in the Field

This chapter provides basic information about the field and laboratory strategies needed to detect illicit discharges, beginning with a field screening technique designed to gather basic information and identify highly suspect outfalls or obvious discharges. Next, it provides a basic framework for using the data from this screening to address obvious discharges, develop a chemical monitoring program, and make future program decisions. Finally, it summarizes the basic options for conducting an ongoing chemical monitoring program. The approaches outlined here are only summarized briefly, and primarily in the context of overall program management. Much more detailed and "hands-on" information is provided in Chapters 11 and 12 that provide specific methods and technical guidance for field crew and laboratory staff.

7.2 The Outfall Reconnaissance Inventory (ORI)

The field screening technique recommended for an IDDE program is the Outfall Reconnaissance Inventory or ORI. The ORI is a stream walk designed to inventory and measure storm drain outfalls, and find and correct continuous and intermittent discharges without in-depth laboratory analysis (Figure 10). The ORI should be completed for every stream mile or open channel within the community during the first permit cycle, starting with priority subwatersheds identified in the desktop analysis. Outfall screening requires relatively little expertise, and can be incorporated into other stream assessments such as the Unified Stream Assessment (Kitchell and Schueler, 2004).

The ORI can discover obvious discharges that are indicated by flowing outfalls with very high turbidity, strong odors and colors, or an "off the chart" value on a simple field test strip. When obvious discharges are found, field crews should immediately track down and remove the source (see Chapters 8 and 13). In other instances, ORI crews may encounter a transitory discharge, such as a liquid or oil spill that should be immediately referred to the appropriate agency for cleanup (Figure 11).

Figure 10: Measuring an outfall as part of the ORI

Figure 11: Some discharges are immediately obvious

The ORI is not meant to be a "one size fits all" method, and should be adapted to suit the unique needs of each community. Program managers should also modify the ORI over time to reflect field observations, crew experience, new or modified indicators, and any other innovations that make fieldwork easier or faster. Table 20 summarizes the four basic steps to conduct an ORI, and more detail on ORI protocols is provided in Chapter 11.

7.3 Interpreting ORI Data

Once the first few ORI surveys are conducted, data can be analyzed to confirm and update the desktop analysis originally used for targeting subwatersheds. The ORI data analysis follows four basic steps, which are described in Table 21. Ideally, ORI data should be stored within a continuously-updated geospatial tracking system.

Table 20: Field Screening for an IDDE Program

Step	Strategies
Step 1. Acquire necessary mapping, equipment and staff	• Use basic street maps or detailed maps from initial assessment • Minimal field equipment required; use a portable spectrophotometer if desired • Two staff per crew with basic field training required; more specialized staff or training is optional
Step 2. Determine when to conduct field screening	• During dry season and leaf off conditions • After a dry period of at least 48 hours • Low groundwater levels
Step 3. Identify where to conduct field screening (based on desktop assessment)	• Minimal: integrate field screening with broader watershed or stream assessments • Clustered: screen drainage areas ranking High and Medium first for illicit discharge potential • Severe: screen all outfalls systematically
Step 4. Conduct field screening	• Mark and photograph all outfalls • Record outfall characteristics • Simple monitoring at flowing outfalls • Take flow sample at outfalls with likely problems • Deal with major problems immediately

Table 21: Field Data Analysis for an IDDE Program	
Step	**Considerations**
Step 1. Compile data from the ORI	• Compile GPS data and photographs of outfall locations • Enter ORI data into database • Send any samples for lab analysis
Step 2. Develop ORI designation for outfalls	• Use ORI data to designate outfalls as having obvious, suspect, potential, or unlikely discharge potential
Step 3. Characterize the extent of illicit discharge problems	• Use data from initial assessment • Use outfall designation data • Update initial assessment of illicit discharge problems as minimal, clustered, severe
Step 4. Develop a monitoring strategy	• At a minimum, sample 10% of flowing outfalls per year • Repeat field screening in second permit cycle • Use various monitoring methods depending on outfall designation and subwatershed characteristics

7.4 Design and Implementation of an Indicator Monitoring Strategy

The next step is to design an indicator monitoring program to test suspect or problem outfalls to confirm whether they are actually an illicit discharge, and determine the type of flow. From a program management standpoint, six core issues need to be considered during the design of the monitoring strategy, as shown in Table 22.

The indicator monitoring strategy should be concentrated primarily on continuous and intermittent discharges, and can be adapted to isolate the specific flow type found in a discharge. Figure 12 presents an overall monitoring design framework that organizes some of the key indicators and monitoring techniques that may be needed. In general, different indicators and monitoring methods are used depending on whether flow is present at an outfall or not. The details of the discharge monitoring framework are described in Chapter 12. The basic framework should be adapted to reflect the unique discharge problems and analytical capabilities of individual communities.

Some of the recommended monitoring strategies are discussed below. The preferred method to test flowing outfalls is the **flow chart method** that uses a small set of indicator parameters to determine whether a discharge is clean or dirty, and predicts its or flow type (Pitt, 2004). The flow chart method is particularly suited to distinguish sewage and washwater flow types. Industrial sites may require special testing, and the **benchmark concentrations method** includes several supplemental indicators to distinguish industrial sources.

Table 22: Indicator Monitoring Considerations
• Use ORI data to prioritize problem outfalls or drainage areas • Select the type of indicators needed for your discharge problems • Decide whether to use in-house or contract lab analytical services • Consider the techniques to detect intermittent discharges • Develop a chemical library of concentrations for various flow types • Estimate staff time, and costs for equipment and disposable supplies

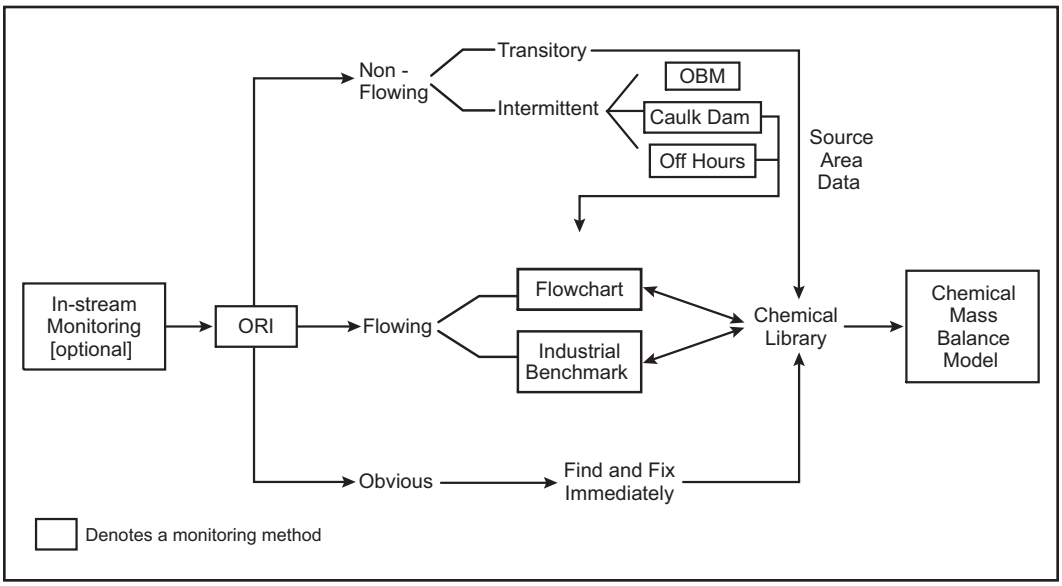


Figure 12: IDDE Monitoring Framework

Non-flowing outfalls are more challenging to diagnose. Intermittent flows can be diagnosed using specialized monitoring techniques such as:

- Off hours monitoring
- Caulk dams
- Optical brightener monitoring traps

When intermittent discharges are captured by these specialized techniques, samples are normally diagnosed using the flow chart method.

Transitory discharges are extremely difficult to detect with routine indicator monitoring, and are frequently identified from hotline reports. Transitory discharges are usually diagnosed by inspection, although water quality samples may be collected to support enforcement measures.

As communities acquire more monitoring data, they should consider creating a **chemical "fingerprint" library**, which is a database of the chemical make-up of the many different flow types in the community. Chemical libraries should include sewage, septage, washwater, and common industrial flows. Default values for the chemical library can initially be established based on existing research and literature values. Data are then updated based on local monitoring to develop more accurate decision points in the flow chart or benchmark methods. Clean water sources such as tap water, groundwater, spring water, and irrigation water are also important entries in the chemical library. The chemical library should also characterize the water quality of known or unknown transitory discharges sampled in the field. Over time, chemical library data should help a community better understand the potential pollutant loads delivered to receiving waters from various generating activities.

These library data can be used to support more advanced strategies such as the **Chemical Mass Balance Model** (CMBM) method. This method, developed by the University of Alabama as part of this project (Karri, 2004), is particularly useful in identifying flow types in blended discharges, where groundwater or tap water is diluted or commingled with sewage and other illicit discharges. The CMBM requires substantial upfront work to develop an accurate chemical library for local flow types. Specifically, the library requires 10-12 samples for each flow type (for industrial flow types, samples can be obtained in association with NPDES pre-treatment programs). A user's guide for the CMBM can be found in Appendix I.

Section 7.5 Field and Lab Safety Considerations

Program managers should take into account and fully plan for all necessary field and laboratory safety precautions. Most communities already have well established standard operating procedures they follow when conducting field and lab work, and these typically provide an excellent starting point for IDDE programs. Chapters 11, 12, and 13 along with Appendices F and G provide guidance on specific considerations associated with IDDE programs. Of particular note is that program managers may want to consider requiring/recommending field crews be vaccinated against Hepatitis B, particularly if the crews will be accessing waters known to be contaminated with illicit sewage discharges. Program managers should contact local health department officials to explore this issue in more detail prior to making a decision.

IDDE APPENDIX F
Outfalls and Discharge Points

This page intentionally left blank.

Outfall Name	Installation	Outfall Type	Outfall Priority	Last Inspected	Contributing Facilities	Discharges to:	Notes
AMR	AMR	Major	High	Jul-14	Housing	Salt Lake	
AMR-2X	AMR	Major	High	Jul-14	Housing	Halawa Stream	This storm channel is not in GIS.
Icarus - AMR	AMR	Major	High	Jul-14	Housing	City storm sewer	Manhole
C00-00	AMR	Major	High		Housing	Unknown	New storm lines are not available in GIS, old lines are suspect.
D-1500-200 (15	Fort Shafter	Major	High	Jul-14	Motor pool	Moanalua Stream	GIS of storm lines is non-existent in this area (i.e. Army Reserve).
D-1500-3	Fort Shafter	Major	High	Jul-14	Vehicle maintenance	Moanalua Stream	
D-1500-5	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-1500-50	Fort Shafter	Major	High	Jul-14	Bldg 1507 Maintenance F	Ditch upstream from Moanalua	
D-1500-55	Fort Shafter	Major	High	Jul-14	Bldg 1507 Maintenance F	Ditch upstream from Moanalua	
D-1500-57/160/	Fort Shafter	Major	High	Jul-14	Parking lots	Moanalua Stream	
D-1500-59	Fort Shafter	Major	High	Jul-14	Upstream outfalls	Moanalua Stream	
D-1500-7	Fort Shafter	Major	High	Jul-14	1585 Motorpool parking	Moanalua Stream	End of long parking lot.
D-200-001	Fort Shafter	Major	High	Jul-14	Fort Shafter	Moanalua Stream	Field Created to account for Fort Shafter storm channel discharge.
D-200-20	Fort Shafter	Major	High	Jul-14	Bldg 223	Moanalua Stream	
D-200-223	Fort Shafter	Major	High	Jul-14	Multiple	Moanalua Stream	Field Created. In storm channel west of Bldg 223 running along highway.
D-200-26A	Fort Shafter	Major	High	Jul-14	School	Moanalua Stream	
D-200-28A	Fort Shafter	Major	High	Jul-14	School	Moanalua Stream	
D-200-30A	Fort Shafter	Major	High	Jul-14	School	Moanalua Stream	
D-200-7	Fort Shafter	Major	High	Jul-14	Bldg 230	Moanalua Stream	
D-300-12/12B	Fort Shafter	Major	High	Jul-14	Multiple	Moanalua Stream	
D-300-14	Fort Shafter	Major	High	Jul-14	Bldg 320	Moanalua Stream	
D-300-18	Fort Shafter	Major	High	Jul-14	Bldg 420 Motorpool	City storm sewer	Manhole near Johnson Gate
D-300-8A	Fort Shafter	Major	High	Jul-14	Multiple	Moanalua Stream	May receive some contribution from DPW
D-500-18	Fort Shafter	Major	High	Jul-14	Area near bowling alley	Moanalua Stream	From up hill near bowling alley
D-500-18A	Fort Shafter	Major	High	Jul-14	Multiple	Moanalua Stream	Near Water treatment plant (downstream from D-500-18)
D-500-20	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-500-23	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-500-25	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-500-28	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-500-30	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-500-30A	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-500-33	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-500-47	Fort Shafter	Major	High	Jul-14	Roads around PX	Moanalua Stream	
D-500-56e	Fort Shafter	Major	High	Jul-14	Multiple facilities	Moanalua Stream	
D-500-59A	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-500-59B	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-500-59X	Fort Shafter	Major	High	Jul-14	Unknown	Moanalua Stream	
D-500-61	Fort Shafter	Major	High	Jul-14	Gas Station	Moanalua Stream	
Fort Shafter	Fort Shafter	Major	High	Jul-14	Fort Shafter	Moanalua Stream	
Fort Shafter Flat	Fort Shafter	Major	High	Jul-14	Fort Shafter Flats	Moanalua Stream	
D-100-250	Fort Shafter	Major	High	Jul-14	Near bldg 145	Moanalua Stream	
D-100-23	Fort Shafter	Major	High	Jul-14	Parking Lot	Moanalua Stream	
D-100-27	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-100-31B	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-100-36	Fort Shafter	Major	High	Jul-14	Roads around Bldg 101	Moanalua Stream	
D-100-38	Fort Shafter	Major	High	Jul-14	Road near bldg 104	Moanalua Stream	
D-100-40	Fort Shafter	Major	High	Jul-14	Road near bldg 104	Moanalua Stream	
D-100-42	Fort Shafter	Major	High	Jul-14	Road near bldg 102	Moanalua Stream	
D-100-44	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-100-45	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-100-46	Fort Shafter	Major	High	Jul-14	Road	Moanalua Stream	
D-1500-105	Fort Shafter	Major	High	Jul-14	Parking lot near bldg 1507	Ditch upstream from Moanalua	
D-1500-105 B/C	Fort Shafter	Major	High	Jul-14	Unknown	Ditch upstream from Moanalua	These outfalls, adjacent to D-1500-105 do not show up on GIS or any maps.
D-1500-110	Fort Shafter	Major	High	Jul-14	Roads	Ditch upstream from Moanalua	
D-1500-13	Fort Shafter	Major	High	Jul-14	Motor pool parking	Moanalua Stream	
D-1500-46	Fort Shafter	Major	High	Jul-14	Motor pool	Ditch upstream from Moanalua	
D-1500-17	Fort Shafter	Major	High	Jul-14	Parking lot	Moanalua Stream	
D-1500-20	Fort Shafter	Major	High	Jul-14	Parking Lot	Moanalua Stream	
D-1500-23	Fort Shafter	Major	High	Jul-14	Parking lot	Moanalua Stream	
D-1500-25	Fort Shafter	Major	High	Jul-14	Motor pool parking	Moanalua Stream	
D-1500-39	Fort Shafter	Major	High	Jul-14	Motor pool	Moanalua Stream	
D-1500-56X	Fort Shafter	Major	High	Jul-14	Bldg 1507 parking	Ditch upstream from Moanalua	New line. Not in GIS or on maps.
D-1600-9	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-600-36	Fort Shafter	Major	High	Jul-14			
D-700-5a/5b	Fort Shafter	Major	High	Jul-14			
D-700-8	Fort Shafter	Major	High	Jul-14			
D-800-16	Fort Shafter	Major	High	Jul-14			
D-800-20	Fort Shafter	Major	High	Jul-14			
D-900-10	Fort Shafter	Major	High	Jul-14			
D-1000-10	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-1000-16	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-1000-17	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-1000-20	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-1000-21	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-1000-6	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-1100-9	Fort Shafter	Major	High	Jul-14	Housing	Off installation	
D-1200-16	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-1200-18	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-1200-20	Fort Shafter	Major	High	Jul-14	Housing	Moanalua Stream	
D-500-53 / 55	Fort Shafter	Major	High	Jul-14			
D-500-62	Fort Shafter	Major	High	Jul-14			
D-800-7	Fort Shafter	Major	High		Road	Moanalua Stream	
D-800-13	Fort Shafter	Major	High		Road	Moanalua Stream	
D-800-18	Fort Shafter	Major	High		Road	Moanalua Stream	
D-800-22	Fort Shafter	Major	High		Road	Moanalua Stream	
D-800-25A	Fort Shafter	Major	High		Road / Child Development	Moanalua Stream	
D-800-32A	Fort Shafter	Major	High		Child Development Cente	Moanalua Stream	
D-900-6	Fort Shafter	Major	High		Road	Moanalua Stream	
D-900-13	Fort Shafter	Major	High		Road	Moanalua Stream	
D-1100-15	Fort Shafter	Major	High		Housing	Off Installation	
D-1100-20	Fort Shafter	Major	High		Housing	To be determined	
D-1100-18	Fort Shafter	Major	High		Housing	To be determined	
D-1100-04	Fort Shafter	Major	High		Housing	To be determined	
D-1100-11	Fort Shafter	Major	High		Housing	To be determined	
D-1100-14	Fort Shafter	Major	High		Housing	To be determined	
D-1100-02	Fort Shafter	Major	High		Housing	To be determined	
D-1200-5	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1200-9	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1200-12	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1200-16	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1200-18	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1200-20	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1200-26	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1300-2	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1300-4	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1300-8	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1300-12	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1300-16	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1300-19	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1300-20	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1300-21	Fort Shafter	Major	High		Housing	Moanalua Stream	
D-1500-32	Fort Shafter	Major	High		Parking lot	Moanalua Stream	Maps show multiple (4) lines. Found one outfall in the area that was identified as D-1500-25
D-1500-43	Fort Shafter	Major	High		Multiple motor pools	Moanalua Stream	This outfall has never been found. Attempted to locate for 3 years.
D-1500-153	Fort Shafter	Major	High		Parking lot	Ditch upstream from Moanalua	
D-1500-159	Fort Shafter	Major	High		Parking lot	Ditch upstream from Moanalua	
D-1600-11	Fort Shafter	Major	High		Road near Flats gate	Moanalua Stream	This does not show up on most maps. May have been removed.
D-1600-26	Fort Shafter	Major	High	Jul-14	Warehouse/admin	Off Installation	Not accessible. Inspected upstream contributors D-1600-21/24
D-2-221 (D-409)	HMR	Major	High	Jul-14	Housing	Paukauila	
D-410	HMR	Major	High	Jul-14	Housing	Paukauila	
D-412	HMR	Major	High	Jul-14	Housing	Paukauila	
D-404	HMR	Major	High	Jul-14	Housing	Off Installation	
D-A-77	Schofield	Major	High		Housing	Kiikii Stream	Cannot find. Suspect this is tied into D-A-14 or D-A-11
D-CC-8	Schofield	Major	High		Range Area (MOUT site)	Waikele Stream	Restricted access
D-CC-9A	Schofield	Major	High		Range Area (MOUT site)	Waikele Stream	Restricted access
D-D-51	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream	Private property. Inspected via D-C-9 and D-D-49

D-DD-2A	Schofield	Major	High	Jul-14	Stryker Brigade	Waikele Stream		Downstream from D-DD-2
D-DD-4	Schofield	Major	High	Jul-14	Stryker Brigade	Waikele Stream		Downstream from D-DD-2
D-DD-85	Schofield	Major	High	Jul-14	Stryker Brigade	Waikele Stream		Downstream from D-DD-3
D-DD-86	Schofield	Major	High		Housing	Waikele Stream		
D-G-28A	Schofield	Major	High			D-G-47		Downstream from D-G-115
D-G-47	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		See D-G-46
D-GG-18	Schofield	Major	High		Housing	Kiikii Stream		
D-GG-19	Schofield	Major	High		Housing	Kiikii Stream		
D-GG-4	Schofield	Major	High		Housing	Kiikii Stream		GIS shows this point in the stream without attached storm lines.
D-I1-49	Schofield	Major	High		Housing	Kiikii Stream		Believe this line was abandoned whtn D-I1-146 was installed.
D-I1-90	Schofield	Major	High		Unknown	Kiikii Stream		GIS does not show any upstream lines. Was not found on survey.
D-I-55	Schofield	Major	High		Bldg 750	D-G-47		
D-I-55B	Schofield	Major	High		Bldg 750	D-G-47		
D-J-85-70	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		Assume this is from both D-J-85 and D-J-70 recommend deletion.
D-N-3	Schofield	Major	High		Housing	D-N-10?		Discharges off the installation. May flow to D-N-10.
D-N-32	Schofield	Major	High		Multiple	Waikele Stream		From multiple upstream culverts.
D-N-48	Schofield	Major	High		Road by bldg 3004	Waikele Stream		
D-N-93	Schofield	Major	High		Around bldg 3004	Waikele Stream		
D-Q-10	Schofield	Major	High		Bldg 2800	D-4-219 (Wheeler)		
D-Q-11A	Schofield	Major	High		Auto Craft	D-4-219 (Wheeler)		
D-Q-17	Schofield	Major	High		Multiple facilities	D-4-219 (Wheeler)		
D-Q-55	Schofield	Major	High		Bldg 910 OWS	D-4-219 (Wheeler)		Have never been able to find.
D-Q-62	Schofield	Major	High		Lyman Road	D-4-219 (Wheeler)		
D-S-23	Schofield	Major	High		Multiple facilities	Kiikii Stream		
D-S-26	Schofield	Major	High		Housing	Kiikii Stream		
D-S-29	Schofield	Major	High		Housing	Kiikii Stream		
D-S-31A	Schofield	Major	High		Housing	Kiikii Stream		D-S-32 or D-S-31A likely does not exist.
D-S-32	Schofield	Major	High		Housing	Kiikii Stream		D-S-32 or D-S-31A likely does not exist.
D-S-34	Schofield	Major	High		Housing	Kiikii Stream		
D-S-37	Schofield	Major	High		Housing	Kiikii Stream		
D-S-42	Schofield	Major	High		Housing	Kiikii Stream		
D-W1-2	Schofield	Major	High		1180 Motorpool	Kiikii Stream		
D-W1-32	Schofield	Major	High		1503 parking lot	Kiikii Stream		
D-W1-4	Schofield	Major	High		1180 Motorpool	Kiikii Stream		
D-W-41	Schofield	Major	High	Jul-14	Housing	Waikele Stream		Hard to access, visited upstream manhole along Carpenter.
D-W-45	Schofield	Major	High		Housing	Off post (Waikele)		
D-X-12A	Schofield	Major	High		Range	Kiikii Stream		Ditch combining D-X-10 and D-X-12
D-X-14	Schofield	Major	High		Range	Kiikii Stream		Culvert
D-X-2	Schofield	Major	High		Range	Kiikii Stream		
D-X-37D	Schofield	Major	High		Range	Kiikii Stream		
D-X-38C	Schofield	Major	High		Range	Kiikii Stream		
D-X-46	Schofield	Major	High		Range	Kiikii Stream		
D-X-52	Schofield	Major	High		Range	Kiikii Stream		
D-X-54A	Schofield	Major	High		Range	Kiikii Stream		
D-X-62	Schofield	Major	High		Range	Kiikii Stream		
D-X-65B	Schofield	Major	High		Range	Kiikii Stream		May receive contribution from D-X-37D/D-X-54A
D-Z-11	Schofield	Major	High		Road	Waikele Stream		Culvert under Lyman.
D-Z-13	Schofield	Major	High		Road	Kiikii Stream		
D-Z-15	Schofield	Major	High		Road near bldg 1650	Kiikii Stream		Culvert
D-Z-27	Schofield	Major	High		Multiple facilities	Waikele Stream		Last in a series of culverts / storm ditches
D-Z-40	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		With D-Z-17
D-Z-7	Schofield	Major	High		Road	Waikele Stream		
D-Z-9	Schofield	Major	High		Road	Waikele Stream		Culvert under Lyman.
D-A-11	Schofield	Major	High	Jul-14	Housing	Kiikii Stream		
D-A-14	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		
D-C-9	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		Representative of D-D-51
D-D-49	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		Representative of D-D-51
D-DD-1	Schofield	Major	High	Jul-14	Stryker Brigade	Waikele Stream		
D-DD2	Schofield	Major	High	Jul-14	Stryker Brigade	Waikele Stream		
D-DD-3	Schofield	Major	High	Jul-14	Stryker Brigade	Waikele Stream		
D-G-115	Schofield	Major	High	Jul-14	Multiple facilities	D-G-47		
D-G-15A	Schofield	Major	High	Jul-14		D-G-47		Three outfalls within close proximity. Only one in GIS/on maps.
D-G-15B	Schofield	Major	High	Jul-14		D-G-47		Three outfalls within close proximity. Only one in GIS/on maps.
D-G-15C	Schofield	Major	High	Jul-14		D-G-47		Three outfalls within close proximity. Only one in GIS/on maps.
D-G-28	Schofield	Major	High	Jul-14		D-G-47		
D-G-35	Schofield	Major	High	Jul-14		D-G-47		
D-G-35X	Schofield	Major	High	Jul-14		D-G-47		
D-G-36	Schofield	Major	High	Jul-14		D-G-47		
D-G-39	Schofield	Major	High	Jul-14		D-G-47		
D-G-41	Schofield	Major	High	Jul-14	Multiple facilities	D-G-47		
D-G-42	Schofield	Major	High	Jul-14		D-G-47		
D-G-43	Schofield	Major	High	Jul-14		D-G-47		
D-G-44	Schofield	Major	High	Jul-14		D-G-47		
D-G-46	Schofield	Major	High	Jul-14	Multiple facilities	D-G-47		Immediately upstream from D-G-47
D-G-4B	Schofield	Major	High	Jul-14		D-G-47		
D-G-5A	Schofield	Major	High	Jul-14		D-G-47		
D-G-70A	Schofield	Major	High	Jul-14		D-G-47		
D-I1-146	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		
D-I1-16	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		
D-I1-18	Schofield	Major	High	Jul-14	Community center	Kiikii Stream		
D-I1-24	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		
D-I1-130A	Schofield	Major	High	Jul-14	Housing	Kiikii Stream		
D-I1-145	Schofield	Major	High	Jul-14	School	Kiikii Stream		
D-I1-86A	Schofield	Major	High	Jul-14	Housing	Kiikii Stream		
D-I1-88	Schofield	Major	High	Jul-14	Housing	Kiikii Stream		
D-I1-92	Schofield	Major	High	Jul-14	Road	Kiikii Stream		
D-I1-94	Schofield	Major	High	Jul-14	Road	Kiikii Stream		
D-J-70	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		
D-J-85	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		
D-N-10	Schofield	Major	High	Jul-14	Housing	Off post (Waikele)		
D-Q-12	Schofield	Major	High	Jul-14	Motor pools	D-4-219 (Wheeler)		From motor pool row to natural area (to Waikele)
D-Q-51	Schofield	Major	High	Jul-14	Multiple facilities	Waikele Stream		
D-T1-6	Schofield	Major	High	Jul-14	Multiple facilities	Kiikii Stream		
D-V-19/30	Schofield	Major	High	Jul-14	Housing	Waikele Stream		
D-W-23	Schofield	Major	High	Jul-14	Housing	Waikele Stream		
D-W-26	Schofield	Major	High	Jul-14	Housing	Waikele Stream		
D-W-26?	Schofield	Major	High	Jul-14	Housing	Waikele Stream		
D-W-40	Schofield	Major	High	Jul-14				
D-Y-3/4	Schofield	Major	High	Jul-14	Motor pools	Kiikii Stream		
D-Z-17	Schofield	Major	High	Jul-14	Motor pools	Kiikii Stream		
New motorpool	Schofield	Major	High	Jul-14	Motor pool	Waikele Stream		
D-11	Schofield, East Range	Major	High	Jul-14				
D-16	Schofield, East Range	Major	High	Jul-14				
D-3	Schofield, East Range	Major	High	Jul-14				
D-33	Schofield, East Range	Major	High	Jul-14				
D-43	Schofield, East Range	Major	High	Jul-14				
D-60	Schofield, East Range	Major	High	Jul-14				
D-82	Schofield, East Range	Major	High	Jul-14				
D-000-17	TAMC	Major	High	Jul-14				Upstream from DO-000-12
DI-000-10	TAMC	Major	High	Jul-14				Upstream from DO-000-02
DI-100-38	TAMC	Major	High	Jul-14				
DO-000-10	TAMC	Major	High	Jul-14	Multiple areas around the	Off installation		
DO-100-14	TAMC	Major	High	Jul-14				
DO-100-5A/B	TAMC	Major	High	Jul-14		DO-TAMC-1		
DO-TAMC-1	TAMC	Major	High	Jul-14	Most of TAMC	Off installation		End of landfill on TAMC
DO-200-14	TAMC	Major	High	Jul-14				
DO-200-13	TAMC	Major	High	Jul-14		DO-100-14		
DO-200-12	TAMC	Major	High	Jul-14				
DO-200-11	TAMC	Major	High	Jul-14				
DO-200-10	TAMC	Major	High	Jul-14				
DO-200-06	TAMC	Major	High	Jul-14				
DO-200-3	TAMC	Major	High	Jul-14				
DO-200-2	TAMC	Major	High	Jul-14				
DO-200-1	TAMC	Major	High	Jul-14				
DO-000-9	TAMC	Major	High	Jul-14		Off installation		
DO-000-8	TAMC	Major	High	Jul-14		City storm sewer		Inaccessible July 2014 due to overgrown vegetation.

DO-000-6	TAMC	Major	High	Jul-14				
DO-100-16	TAMC	Major	High	Jul-14				
DO-100-13	TAMC	Major	High	Jul-14				
DO-100-9	TAMC	Major	High	Jul-14				
DO-100-10	TAMC	Major	High	Jul-14				
DO-100-11	TAMC	Major	High	Jul-14				
DO-100-12	TAMC	Major	High	Jul-14				
DO-000-4A	TAMC	Major	High	Jul-14				
D-100-23 upstre	TAMC	Major	High	Jul-14				
DI-100-1 upstre	TAMC	Major	High	Jul-14				
DI-100-5 upstre	TAMC	Major	High	Jul-14				
DO-100-8	TAMC	Major	High	Jul-14				
DO-100-6	TAMC	Major	High	Jul-14				
DO-100-7	TAMC	Major	High	Jul-14				
DO-100-01	TAMC	Major	High	Jul-14	Road near bldg 161	City storm sewer	Not accessible. Inspected nearest available upstream inlet	
DO-100-01B	TAMC	Major	High	Jul-14	Around bldg 160	City storm sewer	Not accessible. Inspected nearest available upstream inlet	
DO-100-02	TAMC	Major	High		Around bldg 153	City storm sewer		
DO-300-01	TAMC	Major	High		Gymnasium	Off Installation		
DO-300-02	TAMC	Major	High		Gymnasium	Off Installation	This outfall has never been found. Attempted 5 consecutive years.	
DO-300-05	TAMC	Major	High		Housing	Off Installation	Inaccessible July 2014 due to construction	
DO-300-06	TAMC	Major	High		Housing	Off Installation	Inaccessible July 2014 due to construction	
DO-300-09	TAMC	Major	High		Housing	Off Installation	Inaccessible July 2014 due to construction	
DO-300-10	TAMC	Major	High		Housing	Off Installation	Inaccessible July 2014 due to construction	
DO-300-11	TAMC	Major	High		Housing	Off Installation	Inaccessible July 2014 due to construction	
DO-200-04	TAMC	Major	High		Parking Lot	Off Installation		
DO-000-12	TAMC	Major	High	Jul-14	Multiple	City storm sewer	Inspected at D-000-17	
DO-000-03	TAMC	Major	High	Jul-14	Road	City storm sewer	Inspected at DI-000-10	
DO-000-05A/B/	TAMC	Major	High	Jul-14	Multiple	City storm sewer	Inspected at D-100-23	
D-18	WAAF	Major	High	Jul-14				
D-2-188? near D	WAAF	Major	High	Jul-14				
D-2-221	WAAF	Major	High	Jul-14	Roads around bldg 300 &:	Natural area leading to Waikele Stream		
D-4-219 (142)	WAAF	Major	High	Jul-14	Schofield Barracks	Natural area leading to Waikele Stream		
D-4-220 (143)	WAAF	Major	High	Jul-14	Roads around bldg 300 &:	Natural area leading to Waikele Stream		
D-4-221	WAAF	Major	High	Jul-14	Airfield hangars	Natural area leading to Waikele Stream		
D-5-296	WAAF	Major	High	Jul-14	Airfield hangars	Waikele Stream		
D-8-17	WAAF	Major	High	Jul-14	Airfield	Natural area leading to Waikele Stream		
D-8-18	WAAF	Major	High	Jul-14	Airfield	Natural area leading to Waikele Stream		
D-2-273	WAAF	Major	High	Jul-14	Road/area aound wastew	Waikele Stream		
D-3-460	WAAF	Major	High	Jul-14	Schofield Barracks	Waikele Stream		
D-2-243	Wheeler	Major	High		Housing	Waikele Stream		
D-2-269	Wheeler	Major	High		Housing	Storm ditch to culverts to Waikele Stream		
D-2-244	Wheeler	Major	High		Housing	Waikele Stream		
D-2-252	Wheeler	Major	High		Housing	Waikele Stream		
D-2-246	Wheeler	Major	High		Roads in housing	Natural area to Waikele Stream		
D-2-396	Wheeler	Major	High		From off-post	Natural area to Waikele Stream	Same as below? Duplicate outfall number	
D-2-428	Wheeler	Major	High		From off-post	Natural area to Waikele Stream	Same as above?	
D-2-250	Wheeler	Major	High		Housing	Waikele Stream		
D-2-247	Wheeler	Major	High		Housing	Waikele Stream		
D-2-248	Wheeler	Major	High		Housing	Waikele Stream		
D-2-249	Wheeler	Major	High		Housing	Waikele Stream		
D-2-251	Wheeler	Major	High		Housing	Waikele Stream		
D-2-233	Wheeler	Major	High		Flightline	D-2-188? Along road to stables or Waike	Could not locate outfall.	
D-2-241	Wheeler	Major	High		Flightline	D-2-188? Along road to stables or Waike	Could not locate outfall or upstream inlet.	
D-1-383	Wheeler	Major	High		Near Gate	Unknown		
D-4-384	Wheeler	Major	High		Around bldg 232	Natural area leading to Waikele Stream	Buried or removed during wastewater line installation.	

This page intentionally left blank.

IDDE APPENDIX G
Outfall Inspection Checklist

This page intentionally left blank.

OUTFALL RECONNAISSANCE INVENTORY/ SAMPLE COLLECTION FIELD SHEET

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today's date:		Time (Military):	
Investigators:		Form completed by:	
Temperature (°F):	Rainfall (in.): Last 24 hours:	Last 48 hours:	
Latitude:	Longitude:	GPS Unit:	GPS LMK #:
Camera:		Photo #s:	

Land Use in Drainage Area (Check all that apply):

- ☐ Industrial
- ☐ Ultra-Urban Residential
- ☐ Suburban Residential
- ☐ Commercial
- ☐ Open Space
- ☐ Institutional
- Other: _____
- Known Industries: _____

Notes (e.g., origin of outfall, if known):

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ **Closed Pipe**	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other: _____	☐ Circular ☐ Eliptical ☐ Box ☐ Other: _____	☐ Single ☐ Double ☐ Triple ☐ Other: _____	Diameter/Dimensions: _____	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ **Open drainage**	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: _____	☐ Trapezoid ☐ Parabolic ☐ Other: _____		Depth: _____ Top Width: _____ Bottom Width: _____	
☐ **In-Stream**	**(applicable when collecting samples)**				
Flow Present?	☐ Yes ☐ No	***If No, Skip to Section 5***			
Flow Description (If present)	☐ Trickle ☐ Moderate ☐ Substantial				

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		**RESULT**	**UNIT**	**EQUIPMENT**
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	_____' _____"	Ft, In	Tape measure
	Measured length	_____' _____"	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer
pH			pH Units	Test strip/Probe
Ammonia			mg/L	Test strip

Outfall Reconnaissance Inventory Field Sheet

Section 4: Physical Indicators for Flowing Outfalls Only

Are Any Physical Indicators Present in the flow? ☐Yes ☐No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	☐	☐ Sewage ☐ Rancid/sour ☐ Petroleum/gas ☐ Sulfide ☐ Other:	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐Clear ☐ Brown ☐ Gray ☐ Yellow ☐Green ☐ Orange ☐Red ☐Other:	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐Suds ☐ Petroleum (oil sheen) ☐ Other:	☐ 1 – Few/slight; origin not obvious	☐ 2 – Some; indications of origin (e.g., possible suds or oil sheen)	☐ 3 - Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls

Are physical indicators that are not related to flow present? ☐ Yes ☐ No *(If No, Skip to Section 6)*

INDICATOR	CHECK if Present	DESCRIPTION	COMMENTS
Outfall Damage	☐	☐ Spalling, Cracking or Chipping ☐ Peeling Paint ☐ Corrosion	
Deposits/Stains	☐	☐Oily ☐ Flow Line ☐Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	
Poor pool quality	☐	☐ Odors ☐ Colors ☐Floatables ☐ Oil Sheen ☐Suds ☐ Excessive Algae ☐ Other:	
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	

Section 6: Overall Outfall Characterization

☐ Unlikely ☐ Potential (presence of two or more indicators) ☐ Suspect (one or more indicators with a severity of 3) ☐ Obvious

Section 7: Data Collection

1. Sample for the lab?	☐ Yes	☐No	
2. If yes, collected from:	☐ Flow	☐ Pool	
3. Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type: ☐OBM ☐ Caulk dam

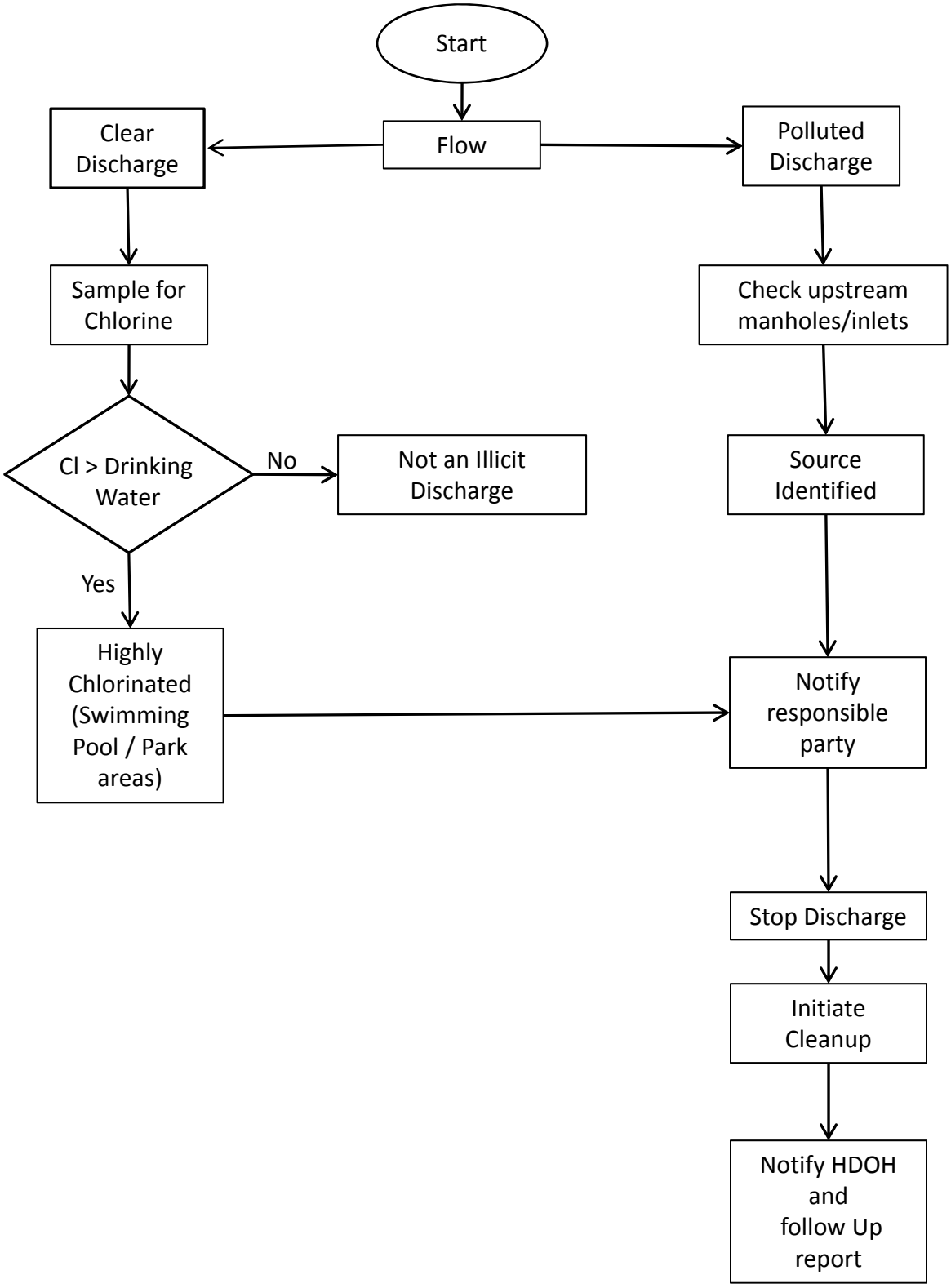
Section 8: Any Non-Illicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?

IDDE APPENDIX H
Illicit Discharge Flow Chart

This page intentionally left blank.

IDENTIFY AN ILLICIT DISCHARGE OR ILLEGAL DUMPING

(Dry Weather Inspection or Notification from Soldier/Citizen)



This page intentionally left blank.

IDDE APPENDIX I
Spill Prevention Containment and Countermeasures

This page intentionally left blank.

U.S. ARMY GARRISON - HAWAII
(USAG -HI)

SPILL PREVENTION, CONTROL and COUNTERMEASURES (SPCC) PLAN

Date: October 9, 2009

Prepared for:
Mr. Steven Raymond, Director, Directorate of Public Works, USAG-Hawaii

c/o Ms. Rhonda Suzuki, Chief, Compliance/P2/Restoration Branch, Environmental Division, Directorate of Public Works, USAG-Hawaii

Prepared by:
U.S. Army Center for Health Promotion and Preventive Medicine–Pacific
Environmental Health Engineering Division
Camp Zama, Japan 96343-5006
Telephone: (81) 46-407-8447, DSN 315-263-8447

USACHPPM
Readiness thru Health
Pacific

For Official Use Only. Distribution limited to U.S. Government agencies only; protection of privileged information evaluating another command. Requests for this document must be referred to Director, Directorate of Public Works, USAG-Hawaii.

CERTIFICATION

I have completed review and evaluation of the U.S. Army Garrison – Hawaii Spill Prevention, Control and Countermeasures Plan in October 2009, and have amended the Plan as a result. A summary of the changes to the plan is provided on the following page.

Signature of Project Manager

David Brixius
Printed Name of Project Manager

REVIEWED BY:

16 Oct 09

Signature of USACHPPM-PAC Reviewer

Prakash Temkar, Ph.D., P.E.
Printed Name of USACHPPM-PAC Reviewer

APPROVED BY:

for 16 Oct 09

Signature of USACHPPM-PAC Approval Authority

Virginia De Swarte, LTC

Printed Name of USACHPPM-PAC Approval Authority

RECORD OF CHANGES

Date of Change	Page # of Change	Description of Change	Recertification Required?	Date of Recertification
May 2008	Various	• Update of facility inventories, maps, controls, and recommendations • Addition of facilities storing animal and vegetable fats and oils • Addition of general spill prevention procedures for dining facilities • Update of contact information, inspection forms	Yes	May 8, 2008
October 2009	p. vii p. 14 p. 16-17	• Added bldg. 1700 and bldg 1700 ASTs to the SPCC database • Added the abbreviation "PMCS" • Changed written reporting requirement to exempt small spills occurring on concrete and cleaned up immediately • Changed requirement for fuel tanker secondary containment waivers	Yes	

TABLE OF CONTENTS

LIST OF ABBREVIATIONS VI

1.0 INTRODUCTION 1

1.1 PURPOSE AND SCOPE 1
1.2 APPLICABLE LAWS 3
1.2.1 Department of the Army 3
1.2.2 Federal Regulations 3
1.2.3 United States Environmental Protection Agency (USEPA) Facility Response Rules (FRP) 4
1.2.4 Hawaii Department of Health (HDOH) Regulations 4
1.3 ORGANIZATION OF THIS SPCCP 5
1.3.1 Section 1: Introduction 5
1.3.2 Section 2: Spill Prevention 5
1.3.3 Section 3: Control and Response 5
1.3.4 Section 4: Employee Training 5
1.3.5 Section 5: Plan Amendments 6
1.3.6 Appendices 6
1.3.7 Cross Reference 6
1.4 RESPONSIBILITIES 8
1.4.1 Commander, U.S. Army Garrison Hawaii 8
1.4.2 Director of Public Works (DPW) 8
1.4.3 DPW SPCC Coordinator 9
1.4.4 Commanders at Remote Installations: Pohakuloa Training Area, Kilauea Military Camp 11
1.4.5 Military Police 11
1.4.6 Fire Department 11
1.4.7 Staff Judge Advocate (SJA) 12
1.4.8 Public Affairs Office (PAO) 12
1.4.9 Installation Safety Office 12
1.4.10 All Other Units and Activities on USAG-HI Facilities 13
1.4.11 Housing Office and On-Post Residents 14

2.0 SPILL PREVENTION 15

2.1 MISSION 15
2.2 SPCC PLAN PROVISIONS 15
2.2.1 General Provisions 15
2.2.1.1 Planning Thresholds 15
2.2.1.2 De Minimis Containers 15
2.2.2 Definition of Facility 16
2.2.3 Guidelines 16
2.2.3.1 Secondary Containment 16
2.2.3.2 Regular Inspections 17
2.2.3.3 Personnel Training 17
2.3 GENERAL SPILL PREVENTION PROCEDURES FOR SELECTED ACTIVITIES 18

2.3.1 Introduction ... 18
2.3.2 Spill Containment, Security and Operational Procedures ... 18
2.3.2.1 Underground Storage Tanks (UST) ... 18
2.3.2.2 Aboveground Storage Tanks (AST) ... 18
2.3.2.3 Drum Storage ... 19
2.3.2.4 Filling and Handling Procedures ... 20
2.3.2.5 Motor Pool Complexes and Maintenance Facilities ... 21
2.3.2.6 Maintenance Bays ... 22
2.3.2.7 Recyclable Material Shop Storage Points ... 22
2.3.2.8 POL Storage Points and Flammable Lockers ... 23
2.3.2.9 Hazardous Waste Shop Storage Points (HWSSP) ... 23
2.3.2.10 Lube Pits, Lube Racks, and Maintenance Platforms ... 24
2.3.2.11 Mobile Refuelers and Transportable Fuel Storage Tanks/Bladders ... 24
2.3.2.12 Compressed Gas Cylinders ... 25
2.3.2.13 Gas Cans ... 26
2.3.2.14 Wash Racks, Sediment Basins, and Oil Water Separators ... 26
2.3.2.15 Oil Filled Electrical Transformers ... 26
2.3.2.16 Convoys of Military Vehicles ... 27

3.0 CONTROL AND RESPONSE, INSTALLATION SPILL CONTINGENCY PLAN ... 29

3.1 MISSION ... 29
3.2 RESPONSIBILITIES FOR SPILL RESPONSE ... 30
3.2.1 Introduction ... 30
3.2.2 Categorizing and Classifying Spills ... 30
3.2.3 Minor Spills ... 31
3.2.3.1 What Are Minor Spills? ... 31
3.2.3.2 Who Cleans Up Minor Spills? ... 31
3.2.3.3 How Are Minor Spills Cleaned Up? ... 33
3.2.4 Major Spills ... 33
3.2.4.1 What Are Major Spills? ... 33
3.2.4.2 Who Cleans Up Major Spills? ... 36
3.2.4.3 How to Activate the IRT In the Event of a Major Spill? ... 36
3.2.5 Installation Response Team (IRT) ... 36
3.2.5.1 Installation On-Scene Coordinator (IOSC) ... 37
3.2.5.2 Responders at Remote Installations ... 39
3.2.5.3 DPW Unit ... 39
3.2.5.4 Fire Department ... 39
3.2.5.5 Military Police ... 40
3.2.5.6 Commanders Engineering Battalions ... 40
3.2.5.7 Other Units and Activities on USAG-HI Installations ... 40
3.2.5.8 Support Staff to the IRT ... 41
3.2.5.8.1 Staff Judge Advocate ... 41
3.2.5.8.2 Public Affairs Office ... 41
3.2.5.8.3 Director, Installation Safety Office ... 41
3.2.5.8.4 Director of Health Services ... 41
3.3 SPILL DISCOVERY AND INITIAL NOTIFICATION PROCEDURES. 42

3.3.1 Initial Defensive Actions 42
3.3.2 Initial Notification Procedures 43
3.3.2.1 Notification for Major Spills 43
3.3.2.2 Information to Be Provided 43
3.4 SPILL RESPONSE ACTIONS 44
3.4.1 IOSC/IRT Response 44
3.4.1.1 Activation of the IRT 44
3.4.1.2 Identification of the Spilled Material 45
3.4.1.3 Evaluation of the Severity of the Spill 45
3.4.1.4 Protection of Personnel 45
3.4.1.5 Determination of the Responsible Party (RP) 46
3.4.1.6 Determination of the Nature and Cause of the Spill 46
3.4.1.7 Implementation of Spill Containment Procedures 46
3.4.1.8 Initiation of Clean up Actions 47
3.4.1.9 Additional Internal Notification 47
3.4.2 Incident Log 48
3.4.3 Reporting 49
3.4.3.1 Hazardous Substances/Hazardous Waste Releases 49
3.4.3.2 Releases of Oil to Navigable Waters 50
3.4.3.3 Underground Tank Releases 51
3.4.4 Restoration of Spill Sites 51
3.5 SPILL RESPONSE SUPPLIES 52
3.5.1 Response Kit for Minor Spills 52
3.5.2 IRT Spill Supplies 54

4.0 EMPLOYEE TRAINING AND BRIEFINGS 54

4.1 INITIAL TRAINING 55
4.2 FOLLOW-UP TRAINING 56
4.3 INSTALLATION RESPONSE TEAM (IRT) TRAINING 57

5.0 RECOMMENDATIONS 58

5.1 INTRODUCTION 58
5.2 RECOMMENDED CORRECTIVE ACTIONS 58
5.2.1 Aboveground Storage Tanks (ASTs) 58
5.2.2 Field Fueling Operations 59
5.2.3 GIS Map Layer Revisions 59
5.2.4 Dining Facilities 59
6.0 PLAN REVIEW AND AMENDMENT PROCEDURES 59
6.1 INTRODUCTION 59
6.1.1 Plan Review and Amendments 59
6.2 USEPA REQUIRED SPCC PLAN REVIEW AND AMENDMENTS 60
6.3 FACILITY MODIFICATION REVIEW AND AMENDMENTS 62
6.4 DEPARTMENT OF THE ARMY REQUIRED REVIEW AND AMENDMENTS 62
6.5 INSTALLATION SPILL CONTINGENCY PLAN REVIEW AND AMENDMENTS 62
6.6 PLAN CERTIFICATION 63

TABLES

Table 1-1	Cross Reference Table for SPCC Requirements……	7
Table 3-1.	Point of Contacts to Activate IRT ……	32
Table 3-2.	Installation Response Team (IRT) Members …….	33
Table 3-3.	Other DoD Organizations with Spill Response Capabilities ……..	38
Table 3-4.	List of Persons/Agencies to be Notified of Spills …….	50
Table 3-5.	Tier 1 Action Levels for Soil and Groundwater ……	52

APPENDICES

Appendix A Access Database
Site-Specific Information, ASTs, USTs, Transformers and HFLP Pipeline:

- Aliamanu Military Reservation
- Schofield Barracks
- Wheeler Army Airfield
- East Range
- Fort Shafter
- Tripler Army Medical Center
- Helemano Military Reservation
- Fort DeRussy
- Pohakuloa Training Area
- Kilauea Military Camp

Installation Descriptions
Installation Topographic Maps

Appendix B Forms and Checklists

- Spill Notification Form
- AST Inspection Checklist
- Transformer Inspection Checklist
- ECO Inspection Form
- Secondary Containment Discharge Log Sheet

Appendix C Reportable Quantities for Oil and Hazardous Materials
Appendix D Spill Recovery Guidelines
Appendix E Army Assistance for Clean Up of Non-Department of Army Spills
Appendix F Spill Exercises
Appendix G Substantial Harm Checklist
Appendix H Public Affairs Office Notification
Appendix I Inventories

Mobile Fuel Tanks/Fuel Vehicles
USTs/Oil/Water Separators
Grease Traps
Appendix J 40 CFR 112 Oil Pollution Prevention Regulation

LIST OF ABBREVIATIONS

AAFES	Army and Air Force Exchange Service
AMR	Aliamanu Military Reservation
AR	Army Regulation
AST	Aboveground Storage Tank
AUL	Authorized Usage List
BMP	Best Management Practice
BN	Battalion
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act
CFR	Code of Federal Regulations
CHRIS	Chemical Hazard Response Information System
DAAF	Dillingham Army Air Field
DA	Department of the Army
DA PAM	Department of the Army Pamphlet
DHS	Director of Health Services
DoD	Department of Defense
DOT	Department of Transportation
DPW	Directorate of Public Works
EAS	Emergency Alert System
ECO	Environmental Compliance Officer
EO	Executive Order
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EQCC	Environmental Quality Control Committee
ER	East Range
FEMA	Federal Emergency Management Agency
FDR	Fort DeRussey
FIBC	Flexible Intermediate Bulk Container
FRP	Facility Response Plan
FS	Fort Shafter
HDOH	Hawaii Department of Health
HAR	Hawaii Administrative Rules
HAZCOM	Hazard Communication
HazMat	Hazardous Materials
HEMTT	Heavy Expanded Mobility Tactical Truck
HMR	Helemano Military Reservation
HSPD	Homeland Security Presidential Directive
HW	Hazardous Waste
HWSSP	Hazardous Waste Shop Storage Point
H&SP	Health and Safety Plan
IAG	Inter-Agency Agreement
ICS	Incident Command System
IHMWP	Installation Hazardous Waste Management Plan
ISCP	Installation Spill Contingency Plan

ISPC	Installation Spill Prevention Coordinator
IOSC	Installation On-Scene Coordinator
IRT	Installation Response Team
LEPC	Local Emergency Planning Committee
KTA	Kahuku Training Area
KMR	Kawaihae Military Reservation
KMC	Kilauea Training Camp
KMR	Kilauea Military Reservation
LEPC	Local Emergency Planning Committee
MPC	Motor Pool Complex
MSDS	Material Safety Data Sheets
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NRC	National Response Center
OHS	Oil and Hazardous Substances
OPA	Oil Pollution Act
OSHA	Occupational Safety and Health Administration
OWS	Oil Water Separator
PAO	Public Affairs Office
PE	Registered Professional Engineer
PCB	Polychlorinated Biphenyls
PMCS	Preventive Maintenance Checks and Services
POL	Petroleum Oil and Lubricants
PTA	Pohakuloa Training Area
RCRA	Resource Conservation and Recovery Act
RMSSP	Recyclable Materials Shop Storage Point
RP	Responsible Party
RQ	Reportable Quantities
RRT	Regional Response Team
SARA	Superfund Amendments and Reauthorization Act
SB	Schofield Barracks
SERC	State Emergency Response Commission
SJA	Staff Judge Advocate
SOP	Standard Operating Procedure
SPCCP	Spill Prevention Control and Countermeasures Plan
TAMC	Tripler Army Medical Center
TAP	Temporary Accumulation Point (Hazardous Wastes)
TGM	Technical Guidance Manual
TSDF	Treatment Storage and Disposal Facility
USAG-HI	United States Army Garrison-Hawaii
USARHAW	U.S. Army Hawaii
USDHS	U.S. Department of Homeland Security
USEPA	U.S. Environmental Protection Agency
UST	Underground Storage Tank
WAAF	Wheeler Army Air Field

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this Spill Prevention, Control and Countermeasures Plan (SPCCP) is to fulfill the Federal requirement to have an SPCCP for facilities that: (a) have a minimum of 1,320 gallons total capacity of petroleum products in the total number of above ground storage tanks (ASTs) on their property or a total completely buried oil storage capacity (UST) greater than 42,000 gallons. This update to the SPCCP also addresses provisions of the Final Rule amending requirements of the Oil Pollution Prevention regulation at 40 CFR 112 dated 26 December 2006. The Oil Pollution Act of 1990, Facility Response Rule [40 CFR 112] dated 30 June 2000 and the Resource Conservation and Recovery Act (RCRA) of 1976 required facilities to develop Facility Response Plans (FRP), which evolved into Oil and Hazardous Substance Plans. DA PAM 200-1, Chapter 3, directs that the FRP be integrated into an installation's SPCCP. Since the USAG-HI facility is not classified as a substantial harm facility according to 40 CFR 112.20(f) (See checklist in Appendix G), submittal of an FRP is not required. However, preparation of an Oil Spill Contingency Plan in accordance with 40 CFR 109 is required and is included in this plan.

The requirements for the SPCCP are outlined as follows:

1) To identify locations and activities where the potential exists for harmful discharges to the environment of animal fat/vegetable oil, or petroleum, oil, and lubricants (POL). The definition of oil includes animal fats and vegetable oils as well as petroleum products as specified in the Final Revised SPCC Rule dated 17 July 2003.

2) To establish a general spill prevention program and specific guidelines for facilities identified below.

3) To outline spill response procedures for personnel in identified facilities.

This plan meets regulatory requirements and is applicable to units and activities required to have a SPCCP under 40 CFR 112 .1(d)(2)(ii) on the following United States Army Garrison - Hawaii (USAG-HI) Installations:

Aliamanu Military Reservation (AMR)
Dillingham Army Air Field (DAAF)[Note 1]
East Range (ER)
Fort DeRussy (FDR)
Fort Shafter (FS)
Helemano Military Reservation (HMR)
Kahuku Training Area (KTA)[Note 1]
Kawaihae Military Reservation (KMR)[Note 2]
Kilauea Military Camp (KMC)
Makua Military Reservation (MMR)[Note 1]
Pohakuloa Training Area (PTA)
Schofield Barracks (SB)

Tripler Army Medical Center (TAMC)
Wheeler Army Air Field (WAAF)

Note 1: Does not exceed aboveground storage tank (AST) 1,320 gallon capacity except during training exercises if a Heavy Expanded Mobility Tactical Truck (a) is used to refuel vehicles. SPCCP not required.
Note 2: Does not exceed AST 1,320 gallon capacity except when vehicles are unloaded at dock and fueled for trip to PTA.

Specific information on each installation and how the SPCCP applies to the above installations is provided in Appendix A. Site specific information on facilities that use and store POL, animal or vegetable fats or oils in containers that exceed the "de-minimis" container size of 55 gallons, ASTs that exceed the "de minimis" container size of 55 gallons, along with related pollution prevention and control recommendations, facility maps, and potential spill receptors are addressed in an Access database titled "Hawaii SPCCP". A DVD containing the database is provided in Appendix A.

Contractors and tenants working on the USAG-HI installations listed above that do not provide direct support to the Army or USAG-HI organizations are not covered under this SPCCP. A requirement of their contract or Support Agreement is that they develop their own SPCCP and provide a copy to DPW, Environmental Division (DPW-ED) and the Contracting Office. Facilities and units are not required to have an SPCCP if they have less than 1,320 gallons total storage capacity in the total number of above ground storage tanks (ASTs) or more than 42,000 UST total storage capacity on their facility.

The Final Rule amendments to the SPCCP of the Oil Pollution Prevention Regulation allows facilities with a total oil storage capacity of 10,000 gallons or less total storage capacity to self certify their SPCCP in lieu of a review and certification by a Professional Engineer. The SPCCP should clearly address the following three areas:

- Operating procedures that prevent oil spills;
- Control measures installed to prevent a spill from reaching navigable waters; and
- Countermeasures to contain, clean up, and mitigate the effects of an oil spill that reaches navigable waters.

The Oil Pollution Prevention and Response; Non-Transportation-Related Onshore and Offshore Facilities; Final Rule, dated 17 July 2002, revised the specified elements and sequence format of the SPCCP. If the Plan does not follow the revised sequence, it must supplement it with a section cross-referencing the location of requirements listed in the revised rule and the equivalent requirements in the Plan. In Section 1.3 there is a table that lists each requirement in the revised rule, provides the corresponding paragraph of the current rule, and shows the location of the provision in the Plan.

1.2 APPLICABLE LAWS

1.2.1 Department of the Army

Army Regulation (AR) 200-1, Environmental Protection and Enhancement, requires Army Installations and Facilities to implement the provisions and requirements of the Clean Water Act, including the preparation of a Spill Prevention Control and Countermeasures Plan (SPCCP).

Department of the Army Pamphlet (DA PAM), 200-1, Environmental Protection and Enhancement, explains how the Army will execute the "U.S. Army Environmental Strategy into the 21st Century" and provides detailed guidance to support implementation of AR 200-1 to include: water resources management, oil and hazardous substances spills, hazardous materials management, hazardous and solid waste management, air pollution, environmental noise management, asbestos management, radon reduction, pollution prevention, environmental restoration, environmental quality technology, automated environmental management systems, the Army environmental program in foreign countries, and other miscellaneous topics.

1.2.2 Federal Regulations

Section 311 of the **Clean Water Act** addresses prevention of pollution resulting from oil and hazardous substance release and directs the Environmental Protection Agency (EPA) to promulgate regulation regarding harmful discharges of oil and hazardous materials to the environment.

The **Oil Pollution Act of 1990** addresses contingency planning requirements for facilities to prevent and respond to harmful discharges of oil and hazardous materials.

The **Oil Pollution Prevention Regulation, 40 CFR 112,** addresses specific requirements and provisions for the preparation of SPCC Plans.

Discharge of Oil, 40 CFR 110, defines reporting requirements and responsibilities for discharges of oil into or on bodies of water.

Designation, Reportable Quantities, and Notification, 40 CFR 302 defines Reportable quantities (RQs) of hazardous substances. A RQ is the threshold amount of any substance that must be reported to the National Response Center (NRC) when a release equal to or greater than the threshold occurs.

The EPA's regulations on the maintenance and operations of underground storage tanks are contained in **40 CFR 280**.

The Occupational Safety and Health Administration (OSHA) regulations contained in **29 CFR 1910.120** describe training requirements for personnel handling or responding to oil spills and/or other hazardous substances.

The Comprehensive Environmental Response, Compensation, & Liability Act (CERCLA), also known as Superfund, contains a list of hazardous substances and the RQs that trigger reporting and cleanup.

Resource Conservation and Recovery Act (RCRA) of 1976 describes hazardous waste management requirements for generators and treatment, storage and disposal facilities. The State of Hawaii has been given primacy to manage and enforce the federal regulations. See Hawaii Administrative Rules.

Emergency Planning & Community Right-to-Know Act (EPCRA) of 1986 requires specified facilities to collect and report information on storage, manufacture, process, and use of chemicals in excess of designated "threshold planning quantities." Federal facilities are required to comply with this act through Presidential Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, . Required reports are provided to the EPA, the State of Hawaii Department of Health (HDOH), the City and County, and local fire departments for use in emergency planning and response.

Homeland Security Presidential Directive-5 (HSPD-5) directed the Secretary of the U.S. Department of Homeland Security (USDHS) to develop and administer a National Incident Management System (NIMS). This system provides a consistent nationwide template to enable Federal, State, local, and tribal governments and private-sector and nongovernmental organizations to work together effectively and efficiently to prepare for, prevent, respond to, and recover from domestic incidents, regardless of cause, size, or complexity, including acts of catastrophic terrorism. USDHS has developed a National Response Plan which forms the basis for how the federal government will coordinate with state, local and tribal governments and the private sector during the response to a national incident.

1.2.3 United States Environmental Protection Agency (USEPA) Facility Response Rules (FRP)

The USEPA established requirements for a Facility Response Plan (FRP) that was published as a Final Rule on 1 July 1994. AR 200-1 (par 3-3b) requires facilities to include the FRP as part of the Facility SPCCP. However, since the total oil storage capacity at USAG-HI facilities does not exceed the specified threshold, this plan does not incorporate the FRP. (See Appendix H, Substantial Harm Checklist).

1.2.4 Hawaii Department of Health (HDOH) Regulations

The HDOH administers state regulations reflecting federal regulations with regard to the management of Underground Storage Tanks (USTs), and response to oil and hazardous substance spills.

Title 11-451 Hawaii Administrative Rules (HAR) "The State Contingency Plan" describes State requirements for response and notification for spills of oil and hazardous substances.

Title 11-260-268 HAR "Hazardous Waste Management" governs the storage, handling, transportation, and disposal of hazardous waste.

Title 11-279 HAR "Hazardous Waste Management Standards for the Management of Used Oil" describes State of Hawaii requirements for handling, storing and disposing of used oil.

Title 11-281 HAR "Underground Storage Tanks" describes State of Hawaii requirements for operating and maintaining USTs. These requirements are described in a state document:

> The "**Technical Guidance Manual for Underground Storage Tank Closure and Release Response**" dated March 2000 describes release response and notification requirements for discharges associated with USTs. Hawaii state guidelines for corrective action at UST release sites use risk-based decision-making which is a process that utilizes risk and exposure assessment methodology to help UST implementing agencies make determinations about the extent and urgency of corrective action and about the scope and intensity of their oversight of corrective action by UST owners and operators.

1.3 ORGANIZATION OF THIS SPCCP

The Oil Pollution Prevention and Response; Non-Transportation-Related Onshore and Offshore Facilities; Final Rule, dated 17 July 2002, specifies the elements and sequence format of the SPCCP. The plan is organized as follows:

1.3.1 Section 1: Introduction

Outlines the scope and applicability of this plan and provides an overview of applicable regulations and laws and the broad responsibilities of the principal parties involved in enforcing, maintaining, and implementing this SPCCP.

1.3.2 Section 2: Spill Prevention

Outlines general prevention measures, requirements, and provides a general discussion of facilities subject to SPCCP requirements.

1.3.3 Section 3: Control and Response

Addresses spill response procedures, the composition and operation of the Installation Response Teams, reporting, and follow up actions.

1.3.4 Section 4: Employee Training

Addresses training requirements for personnel handling oil and hazardous materials and personnel involved in spill response.

1.3.5 Section 5: Plan Amendments

Addresses the process for reviewing and amending this plan.

1.3.6 Appendices

Appendix A: Contains the following inventories: (a) facilities by installation that store and manage POL or animal or vegetable fats or oils in containers with capacity equal to or exceeding 55 gallons; (b) all major components of the pipeline on Wheeler AAF; (c) all aboveground and non-regulated underground storage tanks under U.S. Army control by installation; and (d) a listing of all transformers by installation. The Access database also contains site photos and facility maps and identifies pollution prevention controls, spill receptors and recommendations for corrective actions. (Note: An inventory of the pad-mounted transformers located on USAG-HI facilities is maintained by the SPCC Coordinator and is included by incorporation.)

Appendices B through I: Contain inspection checklists for USAG-HI installations, forms for reporting spills, tables of reportable quantities of oil and hazardous substances, UST/oil/water separator and grease trap inventories, the Substantial Harm Criteria Checklist, and guidelines for spill response activities.

Appendix J: Contains a copy of 40 CFR 112, Oil Pollution Prevention regulation, all applicable aspects of which will be complied with regardless of if explicitly stated within the contents of this SPCCP.

1.3.7 Cross Reference

Since this plan deviates from the specified sequence for different requirements of the SPCCP as specified the Oil Pollution Prevention and Response; Non-Transportation-Related Onshore and Offshore Facilities; Final Rule, dated 17 July 2002, Table 1-1 lists each requirement in the revised rule and shows the location of the provision in the Plan.

Table 1-1 Cross Reference Table for SPCC Requirements

Revised Rule	Description of Rule	Section(s)
§112.7	General requirements for SPCC Plans for all facilities and all oil types.	1.0
§112.7(a)	General requirements; discussion of facility's conformance with rule requirements; deviations from Plan requirements; facility characteristics that must be described in the Plan; emergency procedures.	2.1, 2.2, 2.3, 3.3, 3.4, Appendix A (Access Database)
§112.7(a)(3)(i)	Type of oil, storage capacity	Appendix A (Access Database)
§112.7(a)(3)(ii)	Discharge prevention procedures	2.3.2.4

§112.7(a)(3)(iii)	Discharge or drainage controls	Appendix A (Access Database), 2.2.3.2, 3.4, 3.5
§112.7(a)(3)(iv)	Countermeasures	3.3, 3.4
§112.7(a)(3)(v)	Disposal of recovered materials	3.4.1.8
§112.7(a)(3)(vi)	Contact list, phone numbers	3.2
§112.7(a)(vi)(4)	Spill reporting procedures	3.3.2.1, 3.3.2.2, 3.4.3
§112.7(a)(vi)(5)	Spill procedures	3.2, 3.3.3.4, Appendix D
§ 112.7(b)	Potential for equipment failures	Appendix A (Access Database)
§ 112.7(c)	Secondary containment	2.2.3.1, Appendix A (Access Database)
§ 112.7(d)	Secondary containment not practicable, contingency planning	2.3.2.15, 3.0 – 3.5
§ 112.7(e)	Inspections, tests, and records	2.2.3.2, Appendix B
§112.7(f)	Employee training and discharge prevention procedures	1.4.10, 2.2.3.4, 4.0
§112.7(g)(1) – (g)(5)	Security – fencing, flow and drain valves, pump starter controls, not in service or standby loading/unloading connections, lighting	2.3.1, 2.3.2.2, Appendix A (Access Database)
§112.7(h)	Loading/unloading (excluding offshore facilities)	2.3.2.4
§112.7(i)	Brittle fracture evaluation requirements	n/a
§112.7(j)	Conformance with State requirements	1.2, 2.3
§112.7(k)	Qualified oil-filled operational equipment	2.3.2.15
§112.8(b) §112.12(b)	Facility drainage systems	2.2.3.1, Appendix A, Appendix B
§112.8(c) §112.12(c)	Bulk storage containers – compatibility, secondary containment, secondary containment drainage, aboveground container integrity testing, discharge controls, visible discharges, mobile or portable oil storage containers	2.2.3.1, 2.2.3.2, 2.3.2.2, 2.3.2.11, Appendix A, B
§112.8(d) §112.12(d)	Facility transfer operations, pumping, and facility process	2.3.2.2, 2.3.2.4, Appendix A

1.4 RESPONSIBILITIES

1.4.1 Commander, U.S. Army Garrison Hawaii

Spill Planning

1) Review and approve the Plan.

Spill Prevention

1) Designate the Director of Public Works (DPW), USAG-HI as responsible for training and enforcement of spill prevention and maintenance requirements contained in this plan.

2) Allocate resources, as available, to implement the provisions of this plan.

Spill Response

1) Direct the DPW to designate qualified DPW Environmental Compliance Program Managers as the Installation On-Scene Coordinators, responsible for coordinating spill response and cleanup operations.

2) Direct units and activities to comply with spill clean-up requirements of this plan, under the direction of the Installation On-Scene Coordinator (IOSC).

1.4.2 Director of Public Works (DPW)

Spill Planning

1) Maintain and enforce the provisions of this plan.

2) Conduct periodic review of facilities and provisions for changes and updates to this plan.

Spill Prevention

1) Director or his designated representative will serve as the Installation Spill Prevention Coordinator (ISPC) who will direct training and inspection of units and facilities to comply with spill prevention procedures in this plan.

2) Ensure all units and organizations participate in the Environmental Compliance Officer (ECO) program.

3) Ensure secondary containment and spill prevention provisions are maintained at existing facilities and incorporated into new or temporary facilities activities.

4) Designate in writing an individual as the SPCC Coordinator.

Spill Response

1) Designate in writing qualified DPW Environmental Compliance Program Managers as the Installation On-Scene Coordinators (IOSCs) who will notify and coordinate the Installation Response Team (IRT) as detailed in Section 3.2.4. This includes supervision and use within their capability of DPW in-house workers, contractors, troops, other supporting staff and other Department of Defense (DoD) organizations and civilian agencies with whom a spill response support agreement has been signed.

2) Provide DPW construction equipment, with trained and qualified operators, for SPCCP and ISCP activities, as necessary.

3) Ensure the construction or installation of new storage tanks or facilities for the storage and handling of oil and hazardous materials/substances are in compliance with the provisions of this plan.

4) Notify the DPW SPCC Coordinator of any changes to the SPCCP and spill response procedures and responsibilities.

1.4.3 DPW SPCC Coordinator

1) The DPW SPCC Coordinator will be designated by the Director of Public Works.

2) Maintain and update administrative aspects of the SPCCP such as alert rosters, internal DPW Standard Operating Procedures (SOP), and point of contact lists.

3) Make recommendations and advise the professional engineer overseeing the SPCCP review and re-certification.

4) Assist ISPC by reviewing records of training, assist in scheduling training to ensure all personnel working with materials identified in the SPCCP are properly trained, and correct deficiencies in IRT member skills.

5) Maintain inventory database and records of releases of oil for installations covered by this plan.

6) Establish procedures with DPW Engineering to ensure that all maps are kept up to date with new facilities and major changes to existing facilities that may impact the spill receptor(s), response routes and/or quantities of materials used and stored at these facilities.

7) Respond to spills as required based on the facility information in the SPCCP Appendix A, Access Database and the information provided by the facility or unit and provide technical support for units recovering minor spills, as needed.

8) Respond or coordinate response to major spills. A spill is classified as a "major spill" based on the material, quantity and potential receptors. Any spill that goes off the installation will be treated as a major spill until determined otherwise.

9) Ensure spills are reported, when required, to appropriate outside agencies.

10) Periodically review and audit components of this plan to ensure that inspections and maintenance are performed on storage tanks, electrical transformers, and other locations where oil is stored or handled.

11) Ensure new construction or installation of facilities for the storage and handling of oil incorporate the provisions of this plan.

12) Provide continuity and consistency to spill response within USAG-HI.

13) Initiate technical changes and amendments to this plan when required in accordance with Section 6 of this plan and require a review, evaluation and certification by a registered professional engineer. In accordance with 40 CFR 112.5(b), recertification of the SPCCP is required at least once every five (5) years, and as necessary due to major changes in the use and storage of oil.

14) Participate in the activities of the Local Emergency Planning Committee (LEPC), and comply with requests for information from the committee or other parties through the Public Affairs Office (if available under the Freedom of Information Act). See LEPC contact information in Table 3-4.

15) Coordinate Installation Response Team (IRT) training. Ensure DPW members with responsibilities under the SPCCP receive adequate training for carrying out the provisions of this Plan.

16) Develop and maintain emergency spill response contracts as deemed necessary. Include contracted spill responders in spill drills and in the planning of exercises.

17) Maintain an inventory of spill supplies and response equipment available for use by the IRT. Update the inventory at least annually.

18) Maintain internal DPW IRT mobilization procedures for major spills. The procedures and this plan must be available to personnel designated in writing by the Director, DPW, as IOSCs at all times.

19) Provide SPCC training for all personnel assigned duties under the plan, as needed.

1.4.4 Commanders at Remote Installations: Pohakuloa Training Area, Kilauea Military Camp

1) Ensure that all units, including tenants and contractors, notify the DPW Environmental Office immediately of any substantial changes in fuel storage facilities or operational methods that will require modification of this plan.

2) Immediately report all spills to the facility DPW Environmental Office, (808) 656-1111. For major spills, notify Fire Departments and Medical Facilities immediately. At KMC the Directorate of Public Works Engineering Office is (808) 967-8379. At PTA the Directorate of Public Works DPW Team Supervisors phone number is (808) 969-2436. Submit follow-up Spill Notification Form at Appendix B to DPW-ED.

3) Maintain copies of this SPCCP.

1.4.5 Military Police

1) Immediately report all spill calls received to the USAG-HI DPW-ED Office, 656-1111.

2) Respond to spills. Isolate the spill area and control traffic. Ensure that the Fire Department and Medical Facility have been notified.

3) Maintain a copy of this SPCCP.

4) Designate personnel to attend and receive SPCC-related training.

1.4.6 Fire Department

1) Immediately report all spill calls received to the DPW Environmental office, 656-1111.

2) The U.S. Army Fire Chief coordinates with the U.S. Navy Fire Chief for support. The Army Fire Chief is assigned to the Safety Office and can be reached at 656-9540 or 656-1715. Fire station personnel function as first responders, operations level, containing spills/releases of hazardous, oil or unknown substances from a distance to keep from spreading and to protect and minimize exposure to nearby persons, property, and the environment. The Station Chief on duty will serve as IOSC until the spill has been controlled and on-site control has been turned over to the DPW IOSC.

3) Respond to hazardous material or oil spills that cannot be handled locally by the installation tenant, contractor, or IRT until relieved by private spill response.

3) The Fire Station at KMC is manned by Hawaii County personnel. The fire response vehicle is on loan from the National Park Service. The fire station is on National Park Service property leased by the U.S. Army as part of the KMC Recreational Area. Initial spill response is handled by the KMC Fire Department which can only provide limited response. The KMC Directorate of

Public Works KMC Team Supervisor must ensure that all spills are documented and immediately reported to the USAG-HI DPW–ED Office, (808) 656-1111. Because of the distance involved the only U.S. Army personnel that could respond within a reasonable time period are the PTA Fire Department. The USAG-HI DPW-ED Office can only provide limited response initially. Therefore, additional initial response assistance will have to be obtained from local municipalities or qualified contractors.

4) The PTA Fire Station is manned by U.S. Army civilian personnel. They have minimal response capability and materials. USAG-HI DPW-ED Office can only provide limited response initially. Therefore, additional initial response assistance will have to be handled by the PTA DPW Team and may be augmented by local municipalities or qualified contractors.

5) Provide Fire Department personnel with training and equipment necessary to comply with the OSHA standards for response to hazardous substance spills. All Fire Station personnel assigned to Army facilities on Oahu are U.S. Navy employees and are provided training through the Navy Training Coordinator. Spill response supplies are provided through DPW on USAG-HI installations.

6) Maintain agreements and request support from the County Fire Department hazardous materials (HazMat) spill response team(s) if necessary.

1.4.7 Staff Judge Advocate (SJA)

1) Submit and update, as necessary, the names and phone numbers of primary and alternate SJA IRT personnel to the DPW-ED Office

2) Respond to spills at the request of the IOSC.

3) Provide legal assistance as required.

1.4.8 Public Affairs Office (PAO)

1) Submit and update the names and 24 hour emergency phone numbers of primary and alternate PAO IRT personnel to the DPW-ED Office, as necessary.

2) Respond to spills at the request of the IOSC. Provide news releases for the media as detailed in Section 3 and Appendix H.

3) Participate in spill exercises conducted by DPW or other agencies as required under Inter-Agency Agreements (IAG).

1.4.9 Installation Safety Office

1) Submit and update the names and 24 hour emergency phone numbers of primary and alternate Safety personnel and the U.S. Army Fire Chief assigned to the DPW-ED Office, as necessary.

2) Respond to spills at the request of the IOSC.

3) Participate in spill exercises conducted by DPW, DES, or other agencies as required under Inter-Agency Agreements (IAG).

1.4.10 All Other Units and Activities on USAG-HI Facilities

Spill Planning

1) Notify the DPW-ED SPCC Coordinator immediately of any substantial changes in fuel or hazardous substances storage facilities or operational methods that will require modification of this plan, including addition/removal of aboveground storage tanks (ASTs), relocation of motorpools/shops, etc.

2) Participate in the Environmental Compliance Officer (ECO) program administered by the DPW-ED Office. Names of personnel assigned as ECOs must be submitted to DPW. ECOs are required to attend the basic ECO course within 30 days of appointment, and attend annual refresher training thereafter. Information pertaining to policies, training, certification and other guidance documents are available on the DPW website at https://dpwhawaii.army.mil/ECO.

3) Unit ECOs are responsible for ensuring all assigned personnel are familiar with this plan. Each unit must maintain a copy of this plan on site, and develop and maintain site-specific spill SOPs. Units on deployment with equipment that exceeds the total 1,320 gallon storage capacity or hazardous materials must have a qualified ECO as part of the deployment team. The ECO must have all the necessary hazard and cleanup information and adequate spill response supplies when deployed. Should the ECO Certification of a deployed unit ECO expire, the unit commander can submit a waiver request to allow the ECO to attend the 8 hour ECO Refresher Course to the Instructor, Environmental Compliance Training Program, DPW. Refer to the following website for the form: https://dpwhawaii.army.mil/ECO (File Name: ECO Deploy Recert Waiver).

Spill Prevention

1) Operate fuel, oil, and hazardous substance and waste storage and handling facilities in accordance with established spill prevention, control, and countermeasure procedures, as set forth in this plan.

2) Implement all spill prevention operations and maintenance requirements as recommended in this plan.

3) Submit to DPW job requests for repair of containment structures and storage facilities for the storage of oil as required to meet the requirements of this plan.

4) Request guidance from the DPW-ED Office for operating procedures for temporary non-routine handling and storage of oil.

5) Conduct spill response training IAW site-specific spill SOPs, and place emphasis on recent spills.

6) Contractors and tenants working on the USAG-HI installations listed above that do not provide direct support to the Army or USAG-HI are responsible for conducting spill response training IAW with their site-specific SPCCPs.

Spill Response

1) Maintain inventory records to establish the quantity of oil lost in the event of an accidental spill or underground tank/line leak.

2) Purchase and store appropriate sorbent materials, containers, and other spill response equipment for containing spills at the Unit/Activity. Supplies shall be determined based on the type and amount of oils and hazardous substance used/stored, and the type of operations being conducted.

3) Designate a person (usually the ECO) responsible for reporting spills and directing responses to small spills.

4) Report all spills immediately to the DPW Environmental Hotline at 656-1111, and submit written follow-up notification on the USAG-HI Spill Notification Form in Appendix B. The form is also available at the DPW website at https://dpwhawaii.army.mil/ECO (File Name: Spill Report Form). POL spills of less than one gallon, entirely on a concrete surface and immediately cleaned up, are exempt from the written reporting requirement.

5) Tenants, contractors, or other activities not under or directly supporting the Army or USAG-HI are responsible for accomplishing cleanup and regulatory reporting of all spills/releases caused by their operations. Cleanup shall be accomplished in a timely manner and comply with State of Hawaii cleanup guidelines. Tenants/contractors shall obtain contractor support to accomplish cleanup outside their capabilities. Tenants/Contractors shall be responsible for any fines/penalties levied by regulatory agencies resulting from the incident, and shall reimburse USAG-HI for any costs incurred should spills/releases not be cleaned up in a timely manner or to the satisfaction of the DPW-ED.

1.4.11 Housing Office and On-Post Residents

1) Ensure that all accompanied and unaccompanied personnel assigned on-post quarters are instructed on storage and disposal of hazardous materials and how and to whom they will report a release or spill.

2) All on-post residents are responsible for disposing of all hazardous materials prior to vacating government furnished housing. Refer to the DPW website: http://www.25idl.army.mil/dpw/. Click on “Customer Handbook” located on the left side of the page for guidance on household hazardous waste disposal.

2.0 SPILL PREVENTION

2.1 MISSION

Army installations having certain non-transportation related on-shore storage facilities are required by Army Regulation 200-1 to prepare a SPCCP. Sections 112.1 through 112.7 of Chapter 40 CFR provide guidelines for the preparation and implementation of a SPCCP.

The purpose of this plan is to minimize the discharge of oil or hazardous materials to air, land, or water of the United States by United States Army Hawaii Facilities. In the event of a discharge the plan describes the actions to be taken to reduce and mitigate a release of oil or hazardous substances. The locations of the installations addressed in this plan are shown in Appendix A.

This plan identifies engineering controls, operational procedures, and response guidelines to prevent accidental discharges, and to contain and resolve those that occur. Emphasis is placed on prevention through engineering design, periodic inspection, preventative maintenance, and operator training. The plan identifies potential sources of spills and their likely direction of flow and pathway to bodies of water or drainage.

Detailed site-specific data has been collected for facilities storing and using large quantities of petroleum products. The site-specific information is located in an Access database described in Appendix A of this Plan and is organized by installation and building number. The facilities consist of motor pools, maintenance facilities, aviation facilities, bulk storage tanks and fuel distribution points, warehouses, and dining facilities. Data on tenants and contractors on USAG-HI facilities are also included in the database.

2.2 SPCC PLAN PROVISIONS

This section details certain requirements, concepts, and applicability of USAG-Hawaii SPCCPs. Facility specific information, however, will not be presented in this section, but is presented in Appendix A.

2.2.1 General Provisions

2.2.1.1 Planning Thresholds

All units, tenants and contractors on U.S. Army Facilities are subject to SPCC planning and implementation requirements unless the completely buried storage capacity of the facility for POL substances is 42,000 gallons or less of oil and the aggregate aboveground storage capacity of the facility is 1,320 gallons or less of oil.

2.2.1.2 De Minimis Containers

For purposes of threshold calculation, only POL and animal fat/vegetable oil containers that are 55 gallons or greater in size that are available for use or storage, even if they contain only small volumes of POL or animal fat/vegetable oil, must be counted when determining storage capacity.

Containers with storage capacity of less than 55 gallons are exempt from SPCC requirements. However, all activities under the Army and USAG-HI are committed to the safe handling and storing all quantities of POL, animal fat/vegetable oil, as well as hazardous substances, and therefore will provide secondary containment for containers whenever possible. Any request for exception to the secondary containment must be submitted to the DPW SPCC Coordinator. An exception is only temporary and will not be approved if there is a high potential for a release into surface waters.

2.2.2 Definition of Facility

By definition, a "**facility**" can be as small as a single storage tank or as large as a military installation [40 CFR 112.2]. For the purposes of this Plan each separate USAG-HI installation will be treated as a facility.

2.2.3 Guidelines

2.2.3.1 Secondary Containment

Federal regulations require regulated containers (55 gallons or greater) for the storage of oil and hazardous materials be equipped with secondary containment, or equivalent protection as in the case of double walled aboveground storage tanks. When secondary containment is not possible, a contingency plan to prevent a discharge and a strong commitment and an allocation of resources and personnel to prevent a discharge will be made (40 CFR 112.7). USAG-HI policy is that all containers of POL and hazardous substances will be provided secondary containment, capable of containing the entire contents of the largest container or 10% of the total volume of all containers, whichever is greater, and, for outdoor storage, sufficient freeboard to contain precipitation. Any exceptions to this policy must be approved by the DPW SPCC Coordinator in writing.

Drainage valves for secondary containment shall be manual, open-and-closed design; flapper-type drain valves are not authorized.

A release that is contained within the secondary containment (including drip pans) or within the outer shell of a double walled storage tank does not meet the definition of "a release to the environment" and therefore does not have to be reported to DPW-ED or other regulatory agencies. The release shall be immediately cleaned up to prevent overflow and discharge into the environment

Although the Final Rule amending requirements of the Oil Pollution Prevention regulation at 40 CFR 112 exempts mobile refuelers from the sized secondary containment requirements for bulk storage containers, it is USAG-HI policy that mobile refuelers have secondary containment capable of containing 110% of the storage capacity of the tank whenever possible. Any exceptions to this policy must be approved by the DPW SPCC Coordinator. Written request must be submitted, including strong justification for the exception and a copy of the site-specific SOP addressing spill prevention and response procedures to be implemented. Exceptions are not

required for minimum quantities stored in mobile refuelers necessary to maintain and PMCS the vehicle and its components.

Accumulated rainwater in secondary containment will be checked **prior to release of the rainwater**. [40 CFR 112.8(c)(3)] **Only rainwater should be released into the environment and only designated trained personnel shall be authorized to release the rainwater.** Should there be an oil sheen or evidence of possible oil contamination in the water, hydrocarbon (absorbs oil-only) absorbent materials (e.g., pads, pillows, socks) may be used to absorb the oil or oil sheen. Contamination of gasoline or products other than petroleum may be a hazardous waste, and shall be drained/transferred into an approved container. Contact DPW-ED for testing, as needed, and disposal. Secondary containment discharges should be documented on a log sheet similar to the sample provided in Appendix B.

2.2.3.2 Regular Inspections

Containers for the storage of oil will be regularly inspected for wear and corrosion. Although federal requirements do not stipulate a specific inspection schedule, they do state inspections will be conducted in accordance with good industry practice. Inspection guidelines and checklists are presented in Appendix B. Use manufacturer recommendations to set schedules for equipment inspections. Inspection frequency should be adequate to prevent mechanical or material failure due to corrosion or wear from use. Maintain inspection records for 3 years.

2.2.3.3 Personnel Training

General Training: USAG-HI personnel will only perform tasks involving the handling of oil and hazardous materials for which they are properly trained, and are adequately supervised. USAG-HI administers an Environmental Compliance Officer (ECO) training and inspection program, which includes training down to unit level, combined with regular periodic inspections and review at all Army and USAG-HI activities. ECOs are required to provide initial assignment and quarterly spill response training to personnel assigned to their unit/activity. For ECO training schedule, see the following website: https://dpwhawaii.army.mil/ECO (File Name: ECO Training Class).

Installation On-Scene Coordinator (IOSC) Training: Personnel assigned as IOSCs are required to receive the initial 40 hour OSHA Hazardous Waste Operations and Emergency Response Training and a yearly eight hour refresher training.

HazMat Team: The U.S. Navy has assigned HazMat Response Teams to respond to U.S. Army Installations on Oahu. All HazMat Team members meet the requirements of Hazardous Waste Operations and Emergency response. – 29 CFR 1910.120. Installations on the island of Hawaii are supported by County HazMat Teams. Training for these teams is provided by their employers.

Discharge Prevention Procedures [112.7(f)]: Individual units and activities are also responsible to ensure that all oil-handling personnel are trained in the operation and maintenance of equipment available to prevent discharges, discharge procedure protocols, applicable pollution

prevention laws, rules and regulations, general facility operations, and the contents of this SPCCP.

In addition, individual units will:

- Designate one person who will be responsible for discharge prevention efforts (typically the unit ECO).
- Schedule, conduct and document refresher training for oil-handling personnel at least once a year including review and evaluation of any known discharges or failures, malfunctioning components, and/or any new precautionary procedures or measures.

2.3 GENERAL SPILL PREVENTION PROCEDURES FOR SELECTED ACTIVITIES

2.3.1 Introduction

This section addresses spill prevention, control, and countermeasure state and Federal guidelines for all USAG-HI facilities storing or handling fuel, oil, or hazardous substances or wastes. The provisions of this plan must be implemented and enforced at all activities with a potential for discharge into the environment.

In general, Access to the USAG-HI installations covered by this plan is controlled by the installation security and fencing. Access to the installations is generally limited to individuals with military or Department of Defense civilian identification or other civilians on official business.

2.3.2 Spill Containment, Security and Operational Procedures

2.3.2.1 Underground Storage Tanks (UST)

USEPA underground storage tank regulations (40 CFR 280) have specific requirements for the operation and maintenance of underground storage tanks containing petroleum or hazardous substances. The State of Hawaii Title 11-281 HAR “Underground Storage Tanks” describes State of Hawaii requirements for operating and maintaining USTs. In general, 11-281 HAR reflects or exceeds the requirements of the USEPA. Facilities with less than 42,000 total UST storage capacities are not required to have an SPCCP. The AST total storage capacity must still be considered.

USTs will be located inside secure locations (fenced areas, restricted areas and walled enclosures). All tank fill points will be locked except during refilling operations. The keys will be maintained by the Facility Managers and/or the ECOs. USTs shall be inspected daily when in operational use.

2.3.2.2 Aboveground Storage Tanks (AST)

All aboveground storage tanks will have either 1) secondary containment capable of holding the entire contents of the largest tank within the containment area plus an additional ten percent to allow for rain; or 2) dual wall construction providing equivalent protection. Mobile tankers are exempt from this requirement under the Final Rule amending requirements of the Oil Pollution Prevention regulation; however, as a best management practice, it is USAG-HI policy that mobile tankers and fuel pods will comply with the 110% containment requirement.

Materials stored in tanks must be compatible with their construction and intended use. Tanks should be equipped with some form of leak detection. ASTs, including their associated fittings, piping, transfer lines and valves shall be periodically inspected for corrosion, material defects, overfill protection and tested to ensure they are functioning properly. **All piping and appurtenances without secondary containment shall be inspected for leakage prior to, during and after being used.** Leak and integrity testing of buried piping will be conducted at the time of installation or modification. All procedures specified in section 2.2.3.1 of this plan for discharging rainwater accumulated in secondary containment shall be followed.

The DPW AST Program Manager will ensure stationary ASTs storing oil are inspected on an annual basis using the checklist in Appendix B. As part of the annual inspection, above ground piping, valves, and appurtenances will also be inspected. A written record of inspections will be maintained for each AST for at least three (3) years, and shall be available from the DPW-ED Office upon request. DPW will schedule integrity testing for USAG-HI-owned ASTs whenever significant repair or modification of function is required.

In general, all ASTs are equipped either a high liquid level alarm, high liquid level shut off valve, or computerized inventory system. See the Access database for specific tank information.

ASTs will be located inside secure locations (fenced areas, restricted areas and walled enclosures). All tank fill points, flow and drain valves will be locked except during refilling operations. Fuel pump starter controls will be locked in the off position during non-working hours. The keys will be maintained by the Facility Managers and/or the ECOs.

2.3.2.3 Drum Storage

New and used products and wastes are stored in 55 gallon and smaller drums throughout installations. Generally only containers of 55 gallons or greater are required to have secondary containment; however, it is USAG-HI policy to store single wall containers in secondary containment or on containment pallets where possible. Typically, new petroleum products are issued to units in containers of 5 gallons or less; however, some maintenance bays also have a few 55 gallon drums of new material. The most common locations of 55 gallon drums are in Recyclable Material Shop Storage Points (RMSSPs) attached to motor pools and maintenance facilities. RMSSPs are constructed to provide secondary containment and are the best locations for storing drums. Dining facilities are also likely to have 55 gallon drums of used cooking oil. **Since animal, vegetable, and fish oils are now regulated under 40 CFR 112, these drums are also subject to the provisions of this plan**. For drums stored outdoors, strict adherence to the drainage requirements of 2.2.3.1 of this plan shall be followed.

All drums must be stored in secure areas (fenced areas, secure walled enclosures or buildings). ECOs shall inspect all drum storage areas on at least a monthly basis, ensuring tops of drums, secondary containment, and surrounding storage areas are free of oil residue. Dry absorbent shall be used to remove oils from surfaces; pressure washing is not authorized. Granular absorbent is an effective means of removing residual oil from asphalt and concrete surfaces.

All drums must be clearly marked with their contents. Empty drums must be labeled as "empty." Drums shall be in good material condition, and inspected regularly, at least monthly, for defects and corrosion using applicable checklists in the Installation Hazardous Waste Management Plan, or for tenants and contractors using comparable checklists. Worn or damaged drums will be replaced immediately. Material shall be stored only in drums compatible with the material being stored. For storage of new or used petroleum products, only drums with top mounted bungs shall be used. Non-sparking tools shall be used to open and close drums. For used petroleum drums, a log shall be maintained indicating when material begins to accumulate in the drum, and every subsequent addition of material to the drum.

2.3.2.4 Filling and Handling Procedures

Caution shall be exercised at all times while handling petroleum, used oil, cooking oil and hazardous materials or wastes to prevent a harmful discharge to the environment. Personnel should pay particular attention when handling or transferring products near bodies of water or drainage systems. Only personnel who are trained in properly handling POL, or specific hazardous materials, and have had the appropriate Hazard Communication (HAZCOM) briefing in accordance with OSHA guidelines, shall handle the specific material.

Any loading/unloading connections are to be securely capped or blank-flanged when not in service or when in standby service for an extended time. All loading/unloading vehicles are to be inspected prior to filling and departure in order to prevent discharges while in transit.

When significant quantities of POL (greater than 55 gallons), in single or multiple transfers will occur, block all down gradient storm or drainage openings within a 50-foot radius, prior to beginning the transfer. Before beginning transfer operations, have adequate supplies of absorbent materials such as socks, pillows, booms, and pads readily available. These are the best products to use because they are reusable. Drains and openings may be blocked by attaching a cover or by dikes of absorbent booms.

The following procedures should also be followed during tank filling operations:

- Inspect tank truck compartment(s) and hose(s) to ensure that there are is no potential for leaks.
- Ensure that the tank secondary containment valve is in the closed position.
- Place drip pans under connection points and other points with the potential for leakage to occur.
- Use wheel chocks or other system to prevent tank trucks from moving prior to disconnection of transfer lines.
- All tank filling operations should be observed by a trained employee.

If a discharge does occur, stop the transfer and source of the leak so it does not enter a waterway or drain.

2.3.2.5 Motor Pool Complexes and Maintenance Facilities

The Motor Pool Complexes (MPCs) provide storage and maintenance for tactical, construction, and utility vehicles as well as associated equipment such as trailers used by Army and USAG-HI activities. Other field maintenance facilities maintain associated equipment such as fuel bladders and power generators or perform tasks such as jet engine testing and painting that are outside the scope of MPC maintenance. Contractors and tenants also have maintenance facilities. POL and other chemical products used to maintain the vehicles and other equipment are stored at these maintenance shops. Maintenance at various levels includes fluid changes, component replacement, and technical inspections. Used POL and chemical products are stored on site and collected for disposal at regular intervals.

Personnel who normally work in the maintenance shops are selected and trained as Environmental Compliance Officers (ECOs). After receiving training, ECOs are responsible for ensuring compliance with environmental guidelines for maintenance facilities in accordance with U.S. Army, Federal and Hawaii regulations, including complying with best management practices (BMPs) and guidance issued by the DPW Environmental Division (DPW-ED). Units are inspected on a quarterly basis by a DPW-ED representative, given a numerical rating and a pass/fail score, with recommendations to bring them into compliance.

Tactical and military vehicles as well as associated equipment that contain hydraulic fluid and other POL fluids are parked at the MPCs. Standard Preventive Maintenance (PM) checks shall be conducted on all vehicles and equipment daily prior to use to ensure the vehicles/equipment are in good condition and are not leaking. The standard operating procedure (SOP) when parking a vehicle at the motor pool is to place a drip pan underneath the vehicle where small leaks of oil or fluids are likely to occur. Drip pans containing free-flowing oil are regulated as used oil containers and shall be marked “Used Oil”. Oil-only (hydrophobic) absorbent pads lined with an impervious material (such as plastic) may be strategically placed under vehicles/operational equipment likely to leak, especially those containing hydraulic fluid, reducing/eliminating the likelihood of free-flowing oil and possible overflowing into the environment.

All facilities with potential for oil runoff (especially at motorpools and maintenance facilities) are recommended to install hydrophobic oil-absorbing drain inserts which can be positioned inside stormwater inlets to absorb residual oil runoff.

For MPCs and other maintenance facilities where HEMTTs or other refueling vehicles/bladders/trailers are parked, secondary containment as required in section 2.2.3.1 shall be complied with, unless the tanks/containers are empty Additionally, all procedures for discharging rainwater accumulated in the secondary containment shall be followed.

2.3.2.6 Maintenance Bays

Maintenance on vehicles, aircraft and associated equipment can be performed in a maintenance shop or an open area inside an aviation hangar, motor pool maintenance building or other buildings with open areas. DPW, tenants and contractors also have shops that use or perform maintenance tasks on equipment that uses POL and other chemical products. The open areas used for maintenance are referred to as maintenance bays. Maintenance involving fluid transfers is usually performed in maintenance bays. The floor of a maintenance bay should be constructed of an impervious surface. Maintenance bays are required to have fire extinguishers, spill kits, and the necessary tools to safely perform the assigned tasks. Maintenance areas (bays and shops) are generally maintained in a neat manner and are cleaned regularly. Current cleaning standard operating procedures (SOPs) prohibit washing down maintenance bays or shops using water. Spills and stains of POL products and other chemicals shall be removed by placing absorbent materials over the spill and by dry sweeping. These absorbent material can be reused. Every maintenance bay and shop shall be equipped with a broom and have ready Access to spill recovery materials, including absorbent materials and protective clothing.

All facilities with potential for oil runoff (especially at motorpools and maintenance facilities) are recommended to install hydrophobic oil-absorbing drain inserts which can be positioned inside stormwater inlets to absorb residual oil runoff.

On a typical work day maintenance personnel will use various POL and other chemical products and generate similar waste products. These products are stored inside the maintenance bay/shop or in a secure outside area with some form of containment such as a flammable storage locker or a poly containment pallet. All procedures specified in section 2.2.3.1 of this plan for discharging rainwater accumulated in secondary containment shall be followed.

Open new product containers, when not in use, are regularly stored in lockers as or on pallets, as are used POL, chemicals and items such as batteries that contain chemicals (battery acid). Throughout the day the ECO or alternate will supervise the transfer of used products to the RMSSP.

2.3.2.7 Recyclable Material Shop Storage Points

Used POL products, used absorbents and other recyclable chemical products are temporarily stored in RMSSPs for collection. Generally, RMSSPs are constructed on a concrete foundation, with overhead cover, surrounded by a chain link style fence for security. Trench sumps are built into the floor and are typically 6-8 inches deep and 6-8 inches wide and form a storage platform on the center of the floor. Poly containment pallets with a 66 gallon capacity are commonly used as secondary containment and the trench sump serves as tertiary containment for releases that may occur. Used POL products may be stored is various sized containers up to 55 gallon drums. Only 55-gallon drums with top mounted bungs should be used to contain liquids. In some maintenance facilities, polypacks or other containment devices may be designated as an RMSSP; however, they must be clearly marked as an RMSSP. Hazardous Waste shall not be stored in an RMSSP.

DPW-ED has company(ies) under contract to remove all used/recyclable products monthly, or as requested for locations with small accumulation rates. Generally, product pickup should be done no less than once every 90 days. ECOs are required to check the containers monthly for deterioration, corrosion, or other damage.

RMSSPs shall be clearly marked with "Flammable" signs, the names of the points of contact and telephone numbers for the unit primary and alternate ECOs. A fire extinguisher and spill recovery materials shall be positioned in close proximity to the RMSSP, and should be readily Accessible to personnel. Spill materials should not be stored on top of the containers or in a location where spills may contaminate them. The RMSSP shall be kept as clean as practicable at all times. Trench sumps shall be kept free of oil residue, standing water and debris.

2.3.2.8 POL Storage Points and Flammable Lockers

POL storage points are often constructed similar to RMSSPs with trench sumps built into the foundation. Containment pallets are commonly used to store large containers; however container sizes are generally less than 55 gallons. Small size container use is encouraged. All procedures specified in section 2.2.3.1 of this plan for discharging rainwater accumulated in secondary containment shall be followed.

Units are limited in the types and quantities of any given product they may have on hand by their approved Authorized Use List (AUL). DPW-ED's Compliance section maintains the AUL. Refer to the following DPW website for information on your AUL: https://dpwhawaii.army.mil/ECO (File Name: AUL forms). Unit ECOs shall maintain copies of Material Safety Data Sheets (MSDS) for all products stored in the POL storage points. All materials shall be stored neatly, and segregation storage requirements for incompatible and flammable products shall be followed. ECOs should contact the installation Safety Office or DPW-ED for any questions about storage incompatibilities.

Only National Fire Protection Association (NFPA) approved flammable storage lockers should be used to store products such as flammable materials including small quantities of fuel, paints, and other fluids. These lockers are commonly collocated within the POL storage area. Flammable storage lockers are readily identifiable by their bright red or yellow color and by a "Flammable Storage" marking on the front doors of the cabinet. All products shall be stored neatly, and segregation storage requirements for incompatible and flammable products shall be followed. ECOs should contact the installation Safety Office or DPW-ED for any questions about storage incompatibilities. A list of contents may be posted at each locker. MSDSs for the locker contents may be located in a separate documented location.

2.3.2.9 Hazardous Waste Shop Storage Points (HWSSP)

Facilities generating hazardous wastes store them in an area/facility identified as a HWSSP. A HWSSP can be a covered fenced concrete slab, a building or a covered storage container. Most facilities within USAG-HI have HWSSPs that are readily identifiable as bright yellow plastic polypacks (clamshell hutches) approximately five (5) feet wide, three (3) feet deep, and four (4)

feet tall, with built in secondary containment. The polypacks have a clamshell opening and are secured with a padlock. Regardless of the type of HWSSP in use the following apply:

1) A list of materials inside the HWSSPs shall be maintained in the storage unit and at a separate designated location.

2) The HWSSPs are designed for and shall be used only for temporary storage until the waste can be transported to the appropriate Transfer and Accumulation Point (TAP). The maximum aggregate amount of HW that can be stored at a HWSSP is 55 gallons. Any amount in excess of the 55 gallons must be transferred to the TAP within 72 hours. Refer to the IHWMP for information on hazardous waste management. The IHWMP and other guidance documents are Accessible on the DPW website at: https://dpwhawaii.army.mil/ECO.

3)Typical hazardous wastes often stored in the units include used/damaged lithium batteries, products that have passed their shelf-life, products in damaged/deteriorated containers, and various solvents and adhesives that are no longer usable for their intended purpose. All waste products shall be stored neatly, and segregation storage requirements for incompatible and flammable products shall be followed. ECOs should contact the installation Safety Office or DPW-ED for any questions about storage incompatibilities

4) Containers in HWSSPs are generally 15 gallons or less in size; however, the only size requirement is that the container be 55 gallons or less.

5) HWSSPs shall be inspected at least weekly by the unit ECO.

6) All procedures specified in section 2.2.3.1 of this plan for discharging rainwater accumulated in secondary containment shall be followed.

2.3.2.10 Lube Pits, Lube Racks, and Maintenance Platforms

Originally designed for maintenance activities including lubrication of vehicles and oil changes, these structures are typically either raised platforms or pits to provide personnel Access to the underside of vehicles. Generally the platforms are connected to an oil-water separator and storage tank to collect oily runoff or releases from maintenance activities. The existing SOP limits use of these structures to visual inspection only. Above ground storage tanks associated with these platforms shall no longer be used, as their originally intended use is no longer an allowable work practice. All used POL is stored in RMSSPs until collected. It should be noted that many maintenance platforms and lube pits located in motorpools are no longer used for that purpose. The waste storage tanks have been removed or disconnected.

2.3.2.11 Mobile Refuelers and Transportable Fuel Storage Tanks/Bladders

Several facilities maintain mobile refuelers and fuel storage tank trucks/bladders (with more than 55 gallon capacity) used for refueling military vehicles and aircraft, and for establishing fuel points during tactical operations and exercises. **When in garrison and not in active use, it is USAG-HI policy that tanker trucks and bladders shall be stored empty.** HEMTTs are

considered empty when they contain 300 gallons or less fuel in their storage compartment. All refueling operations on USAG-HI installations using mobile refuelers and fuel storage tanks/bladders must be approved by DPW-ED. Requests for waivers to this policy must be submitted to the DPW SPCCP Coordinator, including strong justification for the waiver and an SOP including a map and a checklist to ensure all proper spill prevention and response measures are followed, and fueling personnel are properly trained in spill notification and unit response protocols prior to establishing a fueling point.

Vehicles and fuel storage tanks that contain fuel shall be parked/placed within a secondary containment. Tanker trucks and fuel storage tanks/bladders that carry fuel only when operating as tactical fuel points shall be emptied of fuel prior to returning to garrison. Spill response and recovery equipment and supplies shall be located on each vehicle or by each storage tank/bladder and be readily available to refueling personnel. When establishing a tactical refueling point, tanker trucks and fuel storage tanks/bladders shall be parked/placed inside secondary containment units. Secondary containment can be one of three types. They are:

1) An imperious cover placed inside a soil berm. The cover must be made of a material that is compatible with fuel and strong enough so that it will not tear when the vehicle drives on or off. This is the least desirable containment and should only be used under emergency situations and must be approved by DPW-ED.

2) A collapsible containment berm. The berm must be made of a material that is compatible with fuel and strong enough so that it will not tear from rocks and sharp objects stuck in treads when the vehicle drives on or off. It is recommended that ground mats be used to cushion and protect truck berm on rough terrain. A fuel drain filter should be attached for draining the containment unit of water and fuel.

3) Secondary containment unit made of metal. Metal containment berms are useful for long term parking of refueling vehicles/tanks. They are expensive and are made of large units which must be bolted together. A fuel drain filter should be attached for draining the containment unit of water and fuel.

All procedures specified in section 2.2.3.1 of this plan for discharging rainwater accumulated in secondary containment shall be followed.

Drivers and other personnel operating tanker trucks are required to have Fuel Handlers Certification . Each organization is responsible for certification of their fuel handlers. Standard training consists of the 40-Hour Fuel Handler Certification Course which encompasses safe fuel handling and spill response training

2.3.2.12 Compressed Gas Cylinders

Some MPCs and maintenance shops currently store compressed gases such as oxygen, acetylene, propane, and refrigerant cylinders. Cylinders come in different sizes and shapes. All cylinders shall be stored safely in accordance with OSHA requirements; protected from the weather, stored and secured upright, be capped and clearly marked as to the cylinder's contents. Empty

cylinders should be clearly identifiable as empty. Chains or other holding devices must be strong enough so as to break should the cylinder tilt, be placed approximately two thirds from the bottom of the cylinder to prevent it from falling over the device and will not be placed around the cylinder valve. Small cylinders stored inside cabinets will not be placed on a shelf with other chemical or POL products. Units no longer using cylinders should take appropriate steps to have the cylinders removed from their inventories. Contact DPW-ED for current guidance.

2.3.2.13 Gas Cans

Five (5) gallon metal containers (jerry cans) used for temporary storage of diesel, and gasoline for field operations have mostly been phased out and replaced by plastic cans. Current SOPs require that only empty fuel cans be returned to the MPC after field operations. It is recommended that unused fuel be used to top off vehicle fuel tanks. Cans containing fuel shall be stored in a secure, marked storage point with adequate secondary containment. The unit ECO shall inspect fuel cans regularly to ensure they are secure and empty. All procedures specified in section 2.2.3.1 of this plan for discharging rainwater accumulated in secondary containment shall be followed.

2.3.2.14 Wash Racks, Sediment Basins, and Oil Water Separators

MPCs are equipped with wash racks for washing military vehicles and other organizational equipment. Typically, the wash rack is a concrete pad sloped or channeled to drain into a sediment or settling basin. Military vehicles and equipment are washed with cold water and detergents and soaps listed on an approved list of cleaners. The list of approved cleaners is posted on the ECO link of the DPW website at http://dpw/hawaii.army.mil/ECO. Some oil-water separators (OWSs) are connected to a holding tank or underground storage tank which collects the fuel/oil. In some cases the OWS may be connected directly to the sanitary sewer system. Generally the OWS are set to discharge to the sanitary sewer when the washing spigots are turned on. In cases where the valves cannot be adjusted to discharge to the sanitary sewer, outflow is permanently set to flow to the sanitary sewer. Contractors perform routine oil-water separator maintenance. The contractor removes product collected in the holding tank on a scheduled maintenance period: twice a year all sediment is removed from the settling basin and drains. The OWSs at Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation, and East Range have been transferred to a contractor, who is responsible for properly maintaining and operating the OWSs in accordance with their NPDES permit. The servicing Wastewater Treatment Plant at Wheeler Army Airfield, operated by Aqua Engineers, is responsible for contracting this service. The OWSs at Fort Shafter and TAMC are under DPW maintenance contract. An inventory of OWSs serviced by Aqua Engineers is provided as Appendix I.

2.3.2.15 Oil Filled Electrical Transformers

Oil cooled pad-mounted electrical transformers are in use throughout the installations of USAG-HI. Pad-mounted transformers typically have a coolant capacity ranging from 55 to several hundred gallons. Transformers are cooled with a non-PCB (polychlorinated biphenyls) mineral oil solution.

Typically, USAG-HI discharges from pad-mounted transformers have been small quantities, resulting from slow corrosion of transformer components from weather exposure. Slow discharges tend to be absorbed rapidly into the soil surrounding the transformer pad, and have minimal potential of entering waterways or storm drainage systems. Catastrophic failure and release of the full contents of a transformer is likely only in the event of a vehicular collision; however most transformers are located away from roadways or are protected by collision obstacles or curbing.

Most leaks result from corrosion underneath the oil holding tanks and are only detectable by visible staining on the exterior of the tanks. Over time the oil will migrate to the transformer pad and into the soil surrounding the pad. The oil may also leak from corrosion of the transformer cooling fins.

Aside from a few exceptions, transformers are not equipped with secondary containment structures, dikes, or berms. Based on consultations with facility engineering personnel, other military installations, and commercial electrical contractors, the installation of secondary containment was determined to be unwarranted and impractical. USAG-HI has over 700 oil-filled pad-mounted transformers. Any structure designed to retain spills would also retain rainwater; continual and immediate drainage would be required to prevent the health hazards of standing water and the potential for overflow. Continual draining of hundreds of transformers, especially during the rainy season, would require several full time personnel whose sole function would be to drain containments. In general, installing a containment system would involve removing and replacing the transformer and pad. Moreover, the engineering section expressed concerns that retaining systems would cause water to back up and damage the electrical systems. Since early detection is the key to minimizing potential environmental pollution caused by leaking transformers, USAG-HI is committed to conducting regular inspections of all pad-mounted transformers. As a minimum, exterior inspections for leakage, corrosion, damage, and defects shall be conducted at least annually by the servicing High Voltage Shops using the checklist in Appendix B. Inspectors shall sign the inspection checklists. Maintenance shall be performed when noted during inspections, and as recommended by the transformer manufacturer. Inspection records shall be maintained for at least three years.

When a leak is discovered at a transformer site, DPW-ED shall be immediately notified. Before responding to leaks associated with transformers or electrical equipment, work shall be coordinated with the responsible High Voltage Shop. No untrained personnel shall make any assumptions or take any actions at electrical facilities without the direct supervision of authorized electrical personnel.

When a leak is discovered, responsible personnel shall identify the source and stop the leak whenever possible. If unable to stop the release, the transformer will be replaced immediately if a suitable replacement is in stock. If not in stock, steps shall be taken to minimize oil release into the environment, and procurement of a replacement will be initiated pending funding availability.

2.3.2.16 Convoys of Military Vehicles

Tactical military vehicle convoys traveling off USAG-HI installations shall be equipped with spill recovery equipment and supplies to respond to small oil, radiator, or hydraulic fluid leaks. At a minimum, supplies shall include drip pans, absorbent pads, socks/booms, and granular or other loose absorbent, durable plastic bags, broom, shovel, and container for the used absorbent. Absorbent material can be reused at the unit's MPC/maintenance bay. Leaks and spills are likely to be small and non-reportable but should be recovered on the spot and in a timely fashion. Cleanup for spills outside USAG-HI installations are the sole responsibility of the unit.

If a spill occurs, care shall be exercised to prevent/minimize release onto soil or into drainage systems by taking the following steps:

1) Park the leaking vehicle/equipment over concrete or asphalt surface whenever possible and safe to do so.

2) Place drip pan under the leak. Alternatively, place absorbent pads over impervious surface (e.g., plastic bags) to absorb the leak.

3) Immediately block off pathways to soil and drainage systems with socks/booms.

3) Clean up the spill with absorbent material.

All transportation-related spills of Army and USAG-HI units and activities shall be reported to the Installation Transportation Officer (ITO) at 656-4963.

2.3.2.17 Dining Facilities

Due to the inclusion of animal, vegetable, and fish oils in the 40 CFR 112 regulation, dining facilities handling and storing cooking oils are also subject to the requirements of this plan. Used cooking oil at dining facilities is typically stored in appropriate containers with capacities of 55 gallons or less. Private contractors are used to pick up and transport the used cooking oil to designated off-post disposal sites. Cooking oil disposal records are maintained at the dining facilities. All containers shall be clearly labeled with the contents of the container and shall be stored in a secured area. For containers stored outdoors, facilities will adhere to the requirements for secondary containment and drainage stated in section 2.2.3.1 of this plan.

The dining facilities are also required to participate in the ECO program. ECOs will schedule and conduct appropriate training for dining facility personnel on handling and storing oil and spill prevention and response. In addition, the dining facility ECOs will be responsible for conducting regular inspections of all cooking oil storage containers for defects, damage or oily residue. Inspection records shall be maintained at the dining facilities.

Most of the dining facilities are equipped with grease traps for removing grease and oil before entering the sanitary sewer system. Grease traps at Schofield Barracks, Helemano Military Reservation, Wheeler Army Airfield, and East Range are maintained by a contractor. An inventory of contractor-maintained grease traps is provided as Appendix I.

3.0 CONTROL AND RESPONSE, INSTALLATION SPILL CONTINGENCY PLAN

3.1 MISSION

The Installation Spill Contingency Plan (ISCP) establishes responsibilities, duties, procedures, and resources to be employed to contain, mitigate, and clean up petroleum product and hazardous substance spills on United States Army installations in Hawaii. It has been developed and implemented in order to minimize hazards to human health and the environment in the event of fires, explosion, or releases of petroleum, oil, or lubricant (POL) products to the environment.

Federal Regulations require activities that use petroleum products or hazardous substances, or generate hazardous wastes, to develop contingency plans to respond to spills of these materials. The U.S. Department of Homeland Security (USDHS) has developed and administers a National Incident Management System (NIMS). NIMS provides a consistent nationwide template to enable all government, private-sector, and nongovernmental organizations to work together during domestic incidents. Information about NIMS can be found at http://www.fema.gov/nims/. DHS has developed a National Response Plan which forms the basis for how the federal government will coordinate with state, local and tribal governments and the private sector during the response to a national incident. These programs are administered under the Federal Emergency Management Agency (FEMA). The Director of FEMA reports directly to the Secretary of Homeland Security. The FEMA Regional NIMS Coordinator for Hawaii is located in Oakland, CA.

The following statutes, Presidential Directives and regulations address contingency planning and reporting requirements:

- Army Regulation 200-1, Environmental Protection and Enhancement, 21 Feb 1997
- Title 40, Code of Federal Regulations, Part 300, National Oil and Hazardous Substance Pollution Contingency Plan
- Homeland Security Presidential Directive-5: The National Incident Management System (NIMS), 28 February 2003
- Homeland Security Presidential Directive-5: The National Response Plan, updated May 25, 2006
- Public Law 96-510, CERCLA of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986
- RCRA Regulations, Title 40 Code of Federal Regulations Part 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities; Part 262, Standards Applicable to Generators of Hazardous Wastes; Part 280, Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks
- Title 40 Code of Federal Regulations Part 110, Discharge of Oil

- State of Hawaii Emergency Alert System (EAS) Plan
- Title 11-451 Hawaii Administrative Rules (HAR), The State Contingency Plan

3.2 RESPONSIBILITIES FOR SPILL RESPONSE

3.2.1 Introduction

All units and activities on USAG-HI installations handling oil in their daily operations shall be familiar with the information contained in this plan for its successful execution. Furthermore, these organizations shall provide basic spill prevention and response training to their personnel on an annual basis.

For discharges that enter navigable waters, the The National Response Center (NRC) must be immediately notified. The NRC is the sole federal point of contact for reporting oil and chemical spills under the National Oil and Hazardous Substances Pollution Contingency Plan. The NRC can be contacted at 1-800- 424-8802 or (202) 267-2675. The NRC website is: www.nrc.uscg.mil/

Under NIMS, the State Emergency Response Committee (SERC) and the Local Emergency Planning Committee (LEPC) must be notified of all reportable spills. The State SERC is the Department of Health; on the island of Oahu, the Honolulu LEPC is the Department of Emergency Management. Phone numbers for these organizations are provided in Table 3-4. There are two HazMat units on the island. HazMat 2 is located in the Kapolei area near the entrance to Campbell Industrial Park and serves the western half of the island. HazMat serves downtown Honolulu and the other half of Oahu.

For spills caused by the Army or USAG-HI on USAG-HI installations, reporting will be accomplished by the DPW-ED Office. Tenants/contractors are responsible for reporting spills caused by their operations.

The provisions of this plan are to be carried out immediately in the event of an emergency or other situation that threatens human health or the environment.

3.2.2 Categorizing and Classifying Spills

WARNING: When a spill or leak of an unknown material or fluid is discovered, immediately contact the installation Fire Department. If there is any reason to suspect the discharge may have been deliberate or the result of an act of sabotage or terrorist activity, inform the Fire Department when reporting the spill; the Fire Department will notify the Installation Operations Center (IOC) at 655-8763/4/5 as needed. Do not attempt to recover the spill. Leave the area immediately, request further guidance from the Fire Department, and report the spill to DPW-ED.

The most common causes for spills are operator error and equipment failure. ALL PERSONNEL ARE RESPONSIBLE FOR PREVENTING SPILLS/RELEASES. Performing routine inspections and maintenance, training personnel to follow existing work procedures, implementing best management practices, and fostering an atmosphere of attention to detail will greatly reduce the likelihood of spills from occurring. All spills **shall be** immediately reported upon discovery to the DPW-ED Office at 656-1111.

When notified of a discharge or spill, the designated unit/activity Spill Coordinator shall determine the appropriate level of response and dispatch or request the necessary resources. Successful resolution of a spill event largely depends on prompt appropriate action. This plan discusses minor and major spills: minor spills typically being handled by the unit, tenant, or contractor; major spills requiring assistance from IRT, contractor support or other emergency response personnel.

3.2.3 Minor Spills

3.2.3.1 What Are Minor Spills?

1) For the purposes of this plan and as a general guideline, minor spills are those releases of oil, paints and other substances that are 1) stored and used at facilities, 2) that can be readily cleaned up by unit personnel with available equipment, and 3) that do not require specialized recovery techniques or advanced personal protective equipment. Report all spills immediately to the DPW-ED Office.

2) Minor spills involve small quantities of petroleum or cooking oil (less than 25 gallons), or paints and hazardous substances that do not require advanced personnel protective equipment, released indoors, to the ground, or to paved areas. Minor spills also include spills less than the reportable quantities (see Appendix C).

3) If there is any question regarding if the spill is a major or minor spill, assume the spill is a major spill.

4) All minor spills will be immediately cleaned up the same day the release is discovered whenever possible. A minor spill of POL not cleaned up within 72 hours becomes a major spill and must be reported to the State and the LEPC.

5) Releases of any amount of oil into water bodies or drainage systems, including storm drains and swales with the potential to empty into nearby streams, shall be considered as major spills due to their potential environmental impact and the need for reporting releases of certain oil and hazardous substances to regulatory agencies.

3.2.3.2 Who Cleans Up Minor Spills?

Minor spills are cleaned up by the unit/activity, tenant, or contractor that caused the spill.

Although in some instances DPW-ED may oversee the cleanup, cleanup of minor spills are not the responsibility of the USAG-HI IRT.

Prompt cleanup actions, including reporting and follow-through are essential. Any amount of oil released to the environment which is less than 25 gallons, but is not contained or cleaned up within 72 hours must be reported to the State and the Local Emergency Planning Committee (LEPC).

1) Each activity, tenant, or contractor using or storing petroleum, fuel, or cooking oil, hazardous substances, or hazardous wastes will designate a spill coordinator and an alternate that will be responsible for spill response and reporting. The spill coordinator, generally the ECO, will be identified to all personnel in the work area, and listed conspicuously on official bulletin boards.

2) The ECO will be responsible for coordinating and overseeing responses to minor spills, and calling the point of contact listed in Table 3-1. The ECO shall have a Memorandum of Appointment by the Unit Chain of Command, and attend the ECO training within 30 days of appointment. For a schedule of ECO courses, see https://dpwhawaii.army.mil/ECO (File Name: ECO Training Class). Contractors and tenant units should contact DPW-ED with questions regarding training requirements for their designated ECOs.

TABLE 3-1. Points of Contact to Activate IRT

For faster service, all spills will be called in to the Environmental Division Spill Response Line. Primary POCs will be contacted by Environmental Division personnel or Work Order desk clerk.

Title	Directorate/Activity	Location and Telephone Number
DPW Environmental Division Spill Response Line (M-F - 08:00 – 16:00)	DPW	**PH: 656-1111** 948 Santos Dumont Ave, 3rd Floor, WAAF
Alternate DPW Emergency Spill Response Line – Work Order Desk (After Duty Hours)	All spills	947 Wright Ave, 1st Floor, WAAF PH: 656-1275
PRIMARY POCS:		
Chief, Compliance/ Pollution Prevention Branch	DPW	948 Santos Dumont Ave, 3rd Floor, WAAF PH: 656-5301
Emergency Planning and Community Right-to-Know Act Program Manager	DPW	948 Santos Dumont Ave, 3rd Floor, WAAF PH: 656-5411
Hazardous Waste Program Manager	DPW	948 Santos Dumont Ave, 3rd Floor, WAAF PH: 656-7001

3.2.3.3 How Are Minor Spills Cleaned Up?

See Appendix D of this Plan.

3.2.4 Major Spills

3.2.4.1 What Are Major Spills?

1) For the purposes of this plan, major spills include any spill/release of petroleum oil, fuel oil, or cooking oil more than 25 gallons. It also includes any spill that exceeds the reportable quantities of items listed in Appendix C.

2) Any amount of an oil, fuel, hazardous substance, or hazardous waste that enters or has the potential to enter a stream, lake, river, canal, wetland, bay, ocean, storm drain, drainage ditch, or sewer manhole. An oil sheen on any body of water warrants investigation to determine if a release/spill has occurred.

3) Any amount of oil, fuel, cooking oil spilled/released in the environment not cleaned up within 72 hours.

4) Any spill considered by the IOSC to be beyond the cleanup capabilities of activity personnel or equipment due to the size or nature of the spill.

5) Suspected leaks from underground storage tanks or piping that are discovered from discrepancies in inventory record.

6) Any leak from a transformer that enters the soil is a major spill if the oil contains PCBs.

Table 3-2. Installation Response Team (IRT) Members

Title	Directorate/ Activity	Location and Telephone Number
INSTALLATION ON-SCENE COORDINATORS (IOSC)		
Chief, Compliance/ Pollution Prevention Branch	DPW	948 Santos Dumont Ave., 3rd Floor, WAAF PH: 656-5301
Hazardous Waste Program Manager	DPW	948 Santos Dumont Ave., 3rd Floor, WAAF PH: 656-7001
Emergency Planning and Community Right-to-Know Act Program Manager	DPW	948 Santos Dumont Ave., 3rd Floor, WAAF PH: 656-5411
Clean Water Program Manager	DPW	948 Santos Dumont Ave., 3rd Floor, WAAF

Title	Directorate/ Activity	Location and Telephone Number
		PH: 656-3105
Drinking Water, Air Pollutants Program Manager	DPW	948 Santos Dumont Ave., 3rd Floor, WAAF (Vacant)
Underground Storage Tanks Program Manager	DPW	948 Santos Dumont Ave., 3rd Floor, WAAF (Vacant)
Asbestos, Lead Paint, PCBs Program Manager	DPW	948 Santos Dumont Ave., 3rd Floor, WAAF (Vacant)
DPW POCs		
DPW Hazardous Waste Transfer and Accumulation Point (TAP) Manager	DPW	Bldg. 6040, Schofield Barracks, East Range PH: 656-0866
Environmental Support Section, Engineering Branch	DPW	Bldg. 2624, Schofield Barracks PH: 655-0584
Supervisor, Maintenance & Repair Branch	DPW	Bldg. 2624, Schofield Barracks PH: 655-0592/656-4321
Supervisor, Schofield Barracks Maintenance & Repair Section	DPW	Bldg. 2624, Schofield Barracks PH: 655-0580
Supervisor, Fort Shafter Maintenance & Repair Section	DPW	Bldg. 346, Fort Shafter PH: 438-1325
Chief, Engineering Plans & Services Division	DPW	572 Santos Dumont Ave, WAAF PH: 656-2419
Operations Officer	DPW	947 Wright Ave., WAAF PH: 656-1750
Lead, Contract Performance Evaluator, Contracts Branch	DPW	Bldg. 113, WAAF PH: 656-1410 ext. 2042
Cultural Resource Manager	DPW	572 Santos Dumont Ave, WAAF PH: 656-6790
Chief, Purchasing & Construction Div, Regional Contracting Office-HI	RCO-HI	Bldg. 520, Fort Shafter PH: 438-6535 ext. 136
ADDITIONAL ACTION OFFICERS		
Hazardous Waste Program Manager	DPW	656-7001
HMCC Contracting Officer Representative	DOL	656-2381
Range Officer, Range Control	G-3 25th ID	655-1404

Title	Directorate/ Activity	Location and Telephone Number
Assistant S-4	45th CSG	655-9089
Chief, Operations Division	TAMC	224-2350 Cellular
Logistics Management Officer	POD	438-8316
Environmental Manager	9th RSC	438-1600 ext. 3247
Safety & Security Officer, Hawaii Exchange	AAFES	423-8815
Battalion XO	65th Engineer BN	655-2881
Battalion XO Staff Duty	84th Engineer BN	655-6533 655-2895
FIRE DEPARTMENTS		
Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation, Fort Shafter, TAMC, Aliamanu Military Reservation, Fort DeRussy		471-7117 (Fort Shafter) 911
Pohakuloa Training Area		969-2441
Kilauea Military Camp		967-8377/8378
MILITARY POLICE		
Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation		655-7114 655-0911 (Schofield) 656-0911 (Wheeler)
Fort Shafter, Tripler Army Medical Center, Aliamanu Military Reservation		438-0911
Fort DeRussy		438-2650
Pohakuloa Training Area		969-2425
Kilauea Military Camp (Night Security)		967-8368
AMBULANCE		
Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation		911
Fort Shafter, Tripler Army Medical Center, Aliamanu Military Reservation		911
Fort DeRussy		911
Pohakuloa Training Area		969-2433
Kilauea Military Camp		911
SUPPORT STAFF:		
Staff Judge Advocate		438-2845/6722 655-4884
Installation Fire & Safety Officer		656-1331/0616 655-6755
Director of Health Services (Occupational Health Clinic)		433-8693 and 433-8390
Public Affairs Office		655-2918

Title	Directorate/ Activity	Location and Telephone Number
USAG COMMUNITY DIRECTOR'S OFFICE		
Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation		655-0497
Fort Shafter, Tripler Army Medical Center, Fort DeRussy		438-6996
Pohakuloa Training Area, Kilauea Military Camp		969-2400/2407

3.2.4.2 Who Cleans Up Major Spills?

1) Major spills will be managed and/or cleaned up by the USAG-HI IRT. However, common sense and prompt spill containment and emergency response in all situations should be practiced when it is safe to do so. A spill contractor will be used whenever the spill is outside the capabilities of in-house support. A copy of all spill response contracts will be maintained by the DPW SPCCP Coordinator.

2) In some instances of spills of large quantities of POL or where excavation is required, the responsible unit may still be able to perform recovery of the spill but shall be supervised by the DPW Environmental Office.
3) For major spills at Pohakuloa Training Area and Kilauea Military Camp, DPW IOSCs will provide guidance and support whenever possible and will make the necessary agency notifications. Assistance from a spill contractor will be used whenever the cleanup requirements exceed the capabilities of in-house support. A copy of all spill response contracts will be maintained by the DPW SPCCP Coordinator.

3.2.4.3 How to Activate the IRT In the Event of a Major Spill?

Refer to section 3.4.1 for notifying the IRT. The IOSC will activate the IRT if necessary upon receiving notification of a major spill.

3.2.5 Installation Response Team (IRT)

1) The IRT is tasked with spill containment, clean up, and site restoration, until a stable condition is reached for all spills that cannot be readily handled by the personnel and/or organization directly responsible for the spill.

2) The DPW IOSC supervises the IRT. Members of the IRT are listed in Table 3-2.

3) DPW Environmental has the responsibility under NIMS to contact the NRC for any oil or chemical spills in the U.S. and territorial waters. DPW and the IRT follow the guidelines for management of spills developed under the Incident Command System (ICS). The ICS is structured to facilitate activities in five major functional areas: **command, operations, planning logistics, and finance and administration.** The ICS is a standardized on-scene management concept designed to allow responders to adopt an integrated organizational (agencies other than

the U.S. Army) structure when the complexity of an incident exceeds in-house capabilities without being hindered by jurisdictional boundaries. The NRC website is: www.nrc.uscg.mil/

3) Units of the IRT are responsible for mobilizing and assembling promptly with the necessary materials and equipment at the location designated by the IOSC. The containment and clean up of the spill shall have priority over all DPW efforts.

4) The IRT shall participate in a simulated spill event training exercise on an annual basis. The IRT members shall receive formal training and refresher training as per 29 CFR 1910.120. Exercises using an integrated response force (U.S. Army, other DoD agencies. Federal, state and local agencies will be developed and conducted by the Directorate of Emergency Services (DES) to test the ICS and Support Agreements. Documentation of the training will be maintained by the SPCC Coordinator.

5) The IRT will conduct all emergency responses in accordance with OSHA regulations governing health and safety practices for emergency operations at hazardous waste sites except when dealing with non-hazardous materials. The Installation Fire and Safety Office will ensure that proper OSHA procedures are practiced by monitoring response activities.

6) Specific responsibilities for IRT members and support functions are described below.

3.2.5.1 Installation On-Scene Coordinator (IOSC)

The IOSC is responsible for managing the spill response effort. The designated IOSCs are listed in Table 3-2. The IOSC will:

1) Ensure that reportable spills are reported immediately to the USEPA, U.S. Coast Guard, the State Emergency Response Commission (SERC), the Local Emergency Planning Committee (LEPC), or the Pacific Region Office (PARO), as required by regulation. Contractors and tenants are responsible for reporting spills for which they are responsible. For spills suspected of being classified as a serious incident in accordance with AR 190-40, Serious Incident Report, immediately notify the DPW Operations Officer.

2) Maintain a current list of resources available for spill contingencies. Request construction equipment and vehicle support from military units, via the DPW Operations Officer. Resources of other non-Army agencies, along with telephone numbers, are included in Table 3-3.

Table 3-3. Other DoD Organizations with Spill Response Capabilities

Organization	Telephone No.
COMNAVBASE	471-8481
Base Civil Engineer Office, Hickam AFB	449-1660
NAVFAC (PWC) Cleanup Services	474-2446 471-9588 x321
Navy OSC	743-4689
SPILL HOTLINE NUMBERS	
National Response Center	800-424-8802
CHEMTREC	800-424-9300 800-262-8200
CERCLIS Hotline	703-538-7234
EPA Emergency Planning and Community Right-to-Know	800-424-9346
RCRA/UST Superfund	800-424-9346
TSCA	202-554-1404
CFC's (Ozone Protection Hotline)	800-296-1996
Air RISC Hotline	919-541-0888
Pesticides Information	800-858-7378
General Environmental Questions (Construction Engineering Research Lab, U.S. Army R&D Center, Environmental Processing Branch)	800-USA-CERL ext. 5424
Superfund Hotline	1-800-231-3075

3) Designate a location for an installation response operations center at each installation that will be used in the event of a major spill.

4) Identify available communications equipment that can be used during an emergency (such as Military Police radios, cellular telephones, etc.). Electronic communication and testing equipment must be intrinsically safe for use in explosive atmospheres.

5) Maintain a list of potential sources of spills at USAG-HI installations, including the capacity, type of substance stored, and remarks on relative risk of spills. Appendix A contains a list of current oil or hazardous substances/wastes that are potential sources of spills or leaks and complete inventory reports can be obtained from the DPW EPCRA program manager.

6) Identify water resources to be protected in the event of a significant spill. First priority resources include drinking water sources, which are presently all sub-surface. Second priority resources include sensitive streams and navigable waters.

7) Serve as a primary point-of-contact with other agencies to provide Army resources for assistance in Regional Response Plans for clean up or containment of non-Army spills. Initial request from outside agencies for Army assistance will be through the Director of Emergency Services, USAG-HI. Appendix E provides guidance when Army assistance is requested by the Regional Response Team, or when there is imminent danger to life and property requiring Army action to be taken for a non-Army spill.

8) Schedule/attend a simulated spill event annually. Appendix F establishes procedures for conducting the annual spill response exercise. The DES conducts annual large-scale anti-terrorism Chemical, Biological, Radiological, Nuclear exercises.

9) Maintain a library of reference materials pertinent to the ISCP. These materials should include Material Safety Data Sheets, emergency response resource information, general information on chemicals, etc.

10) Procure and maintain a supply of absorbent materials for absorbing spills and necessary equipment for spill response at IOSC installation.

11) Maintain records pertaining to major and minor spill events and response actions.

3.2.5.2 Responders at Remote Installations

1) For major spills at Pohakuloa Training Area, and Kilauea Military Camp, DPW IOSCs will provide guidance and support whenever possible and will make the necessary agency notifications. A spill contractor will be used whenever outside the capabilities of in-house support.

2) Spill responders will keep the DPW IOSC apprised of cleanup actions.

3.2.5.3 DPW Unit

1) The unit will respond to spills as directed by the DPW IOSC, within their capabilities.

2) Mobilization responsibilities and procedures are contained in DPW SOP Number IMPC-PWE-C No. 300, Notification and Initial Mobilization for Spills of POL, Hazardous Materials/Waste, or Air Pollutants and Wastewater.

3) The DPW Unit will only respond to spills where advanced Personal Protective Equipment is not required, and will respond to spills under the direction of the IOSC.

3.2.5.4 Fire Department

1) The Fire Department will respond to spills and releases of unknown substances. The responding Fire Chief will notify the Installation Operations Center (IOC) at 655-8763/4/5, as needed, based on the gravity of the incident, and if the incident may involve terrorist activity or CBRNE support is required,

2) Where there is a threat of fire, the Fire Department will immediately respond to an oil or hazardous substance spill in accordance with established procedures. The Fire Department will also respond at the first responder operations level to control a spill to keep it from spreading and to incidents where entry of oil or hazardous substance into a storm drain or waterway is imminent. The Fire Chief or his representative will assume the duties of the **Incident Commander**, directing the incident response operations and will activate the Incident Command System (ICS) as needed, based on the size and nature of the incident. The Fire Chief will coordinate operations with the Military Police to secure the area, if needed. After threats to life and property are eliminated and the spill in under control, command of the incident is transferred to the DPW IOSC. The Fire Chief will also provide technical assistance to the IOSC with respect to the response to and handling of combustible or flammable substances**.**

3) The Fire Department will also respond **to major spills that cannot be expeditiously handled by organizations that caused the spill or the IRT**. After arrival of a private spill contractor, the command of the incident is transferred to the IOSC.

4) The Fire Department will make available fire department personnel with protective clothing and equipment (e.g., SCBA) under its control. It will direct the emergency dispatch operator to obtain emergency medical services (if required) and call in the spill to the IOSC, if these actions have not already been accomplished. The US Army Fire Chief will develop and maintain agreements for support by the City and County Hazardous Material Team.

5) For spills at PTA and KMC, the Fire Department will respond at the first responder operations level, containing the spill from a distance to keep it from spreading and to protect and minimize exposure to nearby persons, property, and the environment.

3.2.5.5 Military Police

1) Request ambulance, fire department, and Installation On-Scene Coordinator (IOSC) support as appropriate. IOSC activation contacts are at Table 3-2.

2) Provide site security to prohibit entry of unauthorized persons to a spill site and to provide for safe flow of vehicular traffic in and around the spill site.

3) Evacuate military personnel within the Army installation and coordinate evacuation of civilian personnel with the Civil Defense and local police if necessary.

3.2.5.6 Commanders Engineering Battalions

Military Engineering units will provide available equipment and operators for response actions, when requested by the DPW Operations Officer. Available equipment includes small equipment excavators, backhoes, bulldozers, road graders, and scoop loaders.

3.2.5.7 Other Units and Activities on USAG-HI Installations

Units and activities are represented on the IRT by the action officers as indicated in Table 3-2. Action officers become members of the IRT on an ad-hoc basis, when a spill involving the IRT occurs at one of their facilities. In a spill situation, the ECO and the activity-specific emergency response coordinator and/or alternate will provide detailed information to the IRT on the nature of the spill and the steps already taken to control the spill. The ECO and coordinator will also assist the IRT, as appropriate. The ECO will also advise on the proper procedures for disposal of the spill residues.

3.2.5.8 Support Staff to the IRT

3.2.5.8.1 Staff Judge Advocate

1) The SJA will respond to oil and hazardous substance pollution spills at the request of the IC/IOSC and serve as an advisor to the IC/IOSC.

2) Provide guidance to ensure that information, records, and samples adequate for legal purposes are obtained and safeguarded for future use by appropriate responding agencies. The SJA will also advise the IC/IOSC on all the legal aspects of spill response.

3.2.5.8.2 Public Affairs Office

1) The PAO will provide an on-site PAO spokesperson for oil or hazardous substance spills when requested by the IC/IOSC and serve as an advisor to the IC/IOSC.

2) Upon notification of an oil or hazardous substance spill, or in response to media inquiry, the PAO will prepare and coordinate appropriate media releases. Detailed procedures, responsibilities, and methods for releasing information to the public are described in Appendix I.

3.2.5.8.3 Director, Installation Safety Office

1) The Director, Installation Safety, will respond to all major spills that present hazards to personnel and facilities and serve as an advisor to the IC/IOSC.

2) Provide technical assistance to the IC/IOSC with respect to the safety of personnel during response operations and ensure compliance with applicable OSHA regulations.

3.2.5.8.4 Director of Health Services

1) Upon request from the IOSC, the Director of Health Services (DHS) will provide medical support consistent with the emergency and serve as an advisor to the IC/IOSC. For Schofield Barracks, the Occupational Health Clinic is the primary medical point of contact for spills. For PTA, the Independent Duty Medical Technician is the medical point of contact.

2) On-site care will normally be limited to emergency medical treatment necessary to preserve life and limb. Although patient evacuation by military ambulance may be desired, use of on-site transportation assets may provide a more expedient means. If on-site transportation is used, consideration must be given to the additional potential spread of hazardous substances.

3) The on-site medical responder will also advise the IC/IOSC regarding the potential threat to personnel and civilians in the surrounding area and the need for evacuation to protect human health.

4) The on-site medical responder will also assist the Director, Installation Safety Office, with respirator fit testing, as needed, for response personnel. DHS may also provide guidance to identify chemical hazards and protective equipment.

3.3 SPILL DISCOVERY AND INITIAL NOTIFICATION PROCEDURES

These procedures are summarized in quick reference tables in Appendix D for various types of chemicals typically found at USAG-HI facilities.

3.3.1 Initial Defensive Actions

The following initial defensive actions shall be implemented as necessary **if safe to do so,** upon discovery of a spill:

1) Evacuate the area of non-essential personnel, restrict access to the area and direct personnel to notify the Fire Department and the Military Police as soon as possible. DPW Environmental or the DPW Work Order desk clerk (during non-duty hours) will be notified immediately (within 10 minutes whenever possible).

2) Summon emergency medical services if personnel are injured.

3) Remove all potential ignition sources (cigarettes, torches, etc.) and determine if electric power should be turned off in the case of a flammable spill to minimize fire hazards. Turning power off is critical if there flammable material vapors present.

4) If indoors, ventilate the area in the case of the presence of volatile materials or dense vapors spilled inside a building.

5) Stop the flow of material, **if it is safe to do so**, by plugging the leak, activating any emergency shut-off valves, reorienting the container, placing the container in a drip pan, placing the container in an over-pack container, or using any other expedient method available.

6) Contain spilled material and **prevent spill from spreading and flowing into drainage systems, swales, and soil**, by using plugs, mats, absorbents, spill booms, or any other expedient method available**. Position drip pans or similar containment device under the leak until the leak is stopped. For emergency situations, or where containment area is larger than a drip pan, absorbent pads or other absorbent media placed on or inside impervious thick plastic bags can form an effective temporary catchment device for small leaks under vehicles/equipment, keeping the oil from leaking onto soil, asphalt, or other surfaces which may be labor-intensive to clean up.** NOTE: The goal is to keep the contaminant from spreading; in the absence of normal absorbent material, be innovative (examples: a painting canvas was used to block a storm drain; a disposable diaper was used to absorb an oil leak).

7) As the spill area is isolated, the “hot zone” should be expanded in a DOWNWIND DIRECTION, paying particular attention to sensitive populations (e.g. schools, child-care center, medical facilities, etc.) if spilled materials are volatile, or there is a short-term danger if material is inhaled.

3.3.2 Initial Notification Procedures

The person discovering the spill shall report it immediately to the organization's designated spill response coordinator, who will immediately (within 10 minutes) notify DPW Environmental. The Fire Department and the Military Police shall be contacted for any spill release if: 1) if there is a threat of fire; 2) danger to public health; and/or 3) it could affect a sensitive environmental area (such as entering a water body).

All spills shall be immediately reported to DPW Environmental (Table 3-2) by the organization spill response coordinator, Military Police, Fire Department or anyone with knowledge of a spill.

3.3.2.1 Notification for Major Spills

1) The Military Police are to be notified of spills immediately by the person discovering the spill. Any instructions provided by the Military Police regarding evacuation procedures shall be followed. The Military Police will notify the Environmental Division if not already done (Table 3-2).

2) The Fire Department will be notified either by the person discovering the spill or by the Military Police when the threat of fire is present. The Fire Department will notify DPW Environmental if not already done (Table 3-2).

3) Medical/ambulance support will be requested either by the person discovering the spill or by the Fire Department or Military Police, if needed.

3.3.2.2 Information to Be Provided

At a minimum the following information shall be provided prior to activation of the IRT whenever possible (Use the Spill Notification Form in Appendix B of this plan if available):

- Name and organization of individual reporting spill
- Location of spill
- Number of injured personnel and the nature of their injuries (if applicable)
- Substance spilled (if known)
- Date and time spill occurred (if known)
- Amount of material spilled (if known)
- Source of spill (if known)
- Surface on which spill occurred (soil, pavement, concrete, storm drain etc.)
- Description of all affected media

- Rate of material spill (estimated)
- Direction and extent to which the spill has traveled
- Cause of spill
- Actions taken to stop, remove, and/or control spill
- Any damages of injuries caused by the spill
- Names of person(s) and/or organizations who have also been contacted

3.4 SPILL RESPONSE ACTIONS

The Fire Department will immediately respond as necessary to protect life and property with due respect for the environment. Oil or hazardous substances shall not be flushed into drains except as an emergency measure to prevent imminent danger to life or property. When time permits, the decision to flush a spill shall be coordinated with the DPW Environmental IOSC.

For major spills or where deemed necessary, the DPW IOSC or designee will immediately proceed to the spill site and evaluate the severity of the spill and determine the response necessary for containment and recovery. All effort will be made to expeditiously control the spill. As needed, the IOSC will:

- Activate the IRT and/or involve a private contractor.
- Mobilize the DPW response team.
- Direct the DPW/Tenant Activity Response Units in accordance with this plan.
- Report reportable spills to the National Response Center, U.S. Coast Guard, SERC, LEPC, PARO, and DPW Operations Officer as described in Section 3.4.3. Contractors and tenant organizations that do not provide direct support to the Army and USAG-HI mission shall be responsible for accomplishing all spill reporting. DPW Environmental will be notified of the spill and who the contractor or tenant notified.

3.4.1 IOSC/IRT Response

The response actions of the IOSC and IRT will include the following:

3.4.1.1 Activation of the IRT

The IOSC will activate and authorize action of appropriate members of the IRT based on information relayed during initial notification. If insufficient information is available to activate the IRT, the IOSC will immediately investigate and evaluate the reported spill.

3.4.1.2 Identification of the Spilled Material

The IOSC will determine the source, type, and appropriate quantity of spilled substance if not already determined. For releases of unknown substances, the Fire Department will conduct initial field tests to identify the substance. Samples will be collected for laboratory analysis as necessary. For hazardous chemical spills it is imperative that it be determined if the chemical or mixture falls under the reportable quantity category (refer to Appendix C).

3.4.1.3 Evaluation of the Severity of the Spill

The IOSC will evaluate the magnitude and severity of the threat to public health, welfare, and natural resources. Response organization expertise such as that possessed by the Fire Department, along with technical references, such as the "NIOSH Pocket Guide to Chemical Hazards," the "Chemical Hazard Response Information System (CHRIS) Manual," and the "DOT Hazardous Materials Emergency Response Guidelines" will be used as required. In addition, computer programs can be used as resources. Available programs include the EPA's "CAMEO" and "ALOHA" programs and the Federal Emergency Management Agency's "ARCHIE" program.

The CAMEO (Computer-Aided Management of Emergency Operations) program is an integrated set of software modules jointly developed by the National Oceanic and Atmospheric Administration (NOAA) and EPA. It's designed to help first responders and emergency planners plan for and quickly respond to chemical accidents. Rapid actions by firefighters, police, and other emergency personnel are often hampered by a lack of accurate information about the substances spilled and the safe actions to be taken to protect responders and the public. CAMEO is intended to be a solution to this problem. A free copy of CAMEO can be downloaded from the following USEPA website: http://www.epa.gov/ceppo/cameo/cam_down.htm

The ALOHA air dispersion model predicts the downwind dispersion of a chemical cloud. Graphical outputs include estimates of the cloud footprint (representing the area where hazardous gas concentrations may reach a level of concern), the rate and duration of release of the chemical to the atmosphere, and chemical concentration over time at locations of particular concern. A free copy of ALOHA can be downloaded from the following USEPA website: http://www.epa.gov/ceppo/cameo/aloha.htm

3.4.1.4 Protection of Personnel

The IRT, in consultation with the DHS and the Director, Installation Safety Office, and DPW IOSC will ensure that appropriate safety precautions are implemented to protect response personnel and any additional personnel located in close proximity to the probable spill vulnerability zone. Safety precautions will be site-specific, but will include generic actions as restricting Access to the area, use of personal protective equipment, and evacuation.

WARNING

It is the responsibility of the IOSC to ensure only trained and qualified personnel perform spill response activities involving major releases of oil and hazardous substances. Aggressive response, such as to a fire in conjunction with an oil tank, shall only be performed by trained first responders such as the fire department. The IOSC must keep a current record of IRT member training and qualifications, and only use the members of the IRT within the limits of their technical capability. The IOSC shall clearly determine the specific hazards before employing non-first responder trained personnel in responding to a spill.

3.4.1.5 Determination of the Responsible Party (RP)

If the responsible party (RP) for the spill is other than the U.S. Army (e.g., tenant, contractor, etc.), the RP shall be informed of the spill, and is responsible for cleaning up the spill and accomplishing all regulatory spill notifications. The RP's subsequent response actions will be evaluated by the IOSC. In cases involving Army contractors, the IOSC shall immediately notify the appropriate contracting office of the spill. If the contractor's response action is inadequate or not completed in a timely fashion in the judgment of the IOSC, the IOSC shall inform the Contracting Officer. The Contracting Officer shall direct the contractor to provide adequate response action or face the termination of the contract. In all cases, if the RP's response action is inadequate or not completed in a timely fashion in the judgment of the IOSC, the IOSC shall assume control of the spill response, and the RP shall make reimbursement as directed by the IOSC.

3.4.1.6 Determination of the Nature and Cause of the Spill

The IOSC will document the cause of the spill and take samples as required to determine the chemical identity, concentration, and extent of the spill for response actions and documentation for possible future legal action.

3.4.1.7 Implementation of Spill Containment Procedures

Spill containment procedures, as directed by the IOSC, are to be implemented in order to confine the spill as close to the source as practicable and, if at all possible, prevent spills from exiting the property limits of the installation, or from entering storm drains, sewer line, or navigable waters. Whenever safe to do so, these procedures include, but are not limited to:

- Plugging or patching leaking drums or containers
- Repositioning the container to stop or reduce the leak
- Placing the leaking container in an appropriate overpack
- Using of mats, absorbents, spill booms, or containment vessels to control the spill
- Preventing/diverting the flow path of the spill from entering storm drains or sewer lines

- Building earth dikes, or using sandbags in the case of large spills

If the spill cannot be contained, the IOSC will determine if highly vulnerable areas, water supplies, wastewater treatment plants, or recreational waters might be adversely affected. Appropriate personnel or organizations will be notified by the IOSC if such conditions exist (e.g. the U.S. Coast Guard if navigable waters are threatened, the wastewater treatment plant if spills could enter the sewer system, etc.).

3.4.1.8 Initiation of Clean up Actions

Once the spill has been contained, clean up actions will be initiated using Army resources, if possible. Troop support from Engineering Battalions, if needed, shall be coordinated through the DPW Operations Officer. In those cases where the IRT alone cannot meet the required needs for clean up and disposal, the IOSC will request additional resources. NAVFAC (PWC) Cleanup Services is another military organization that can be contacted for cleanup assistance. Their phone number is provided in Table 3-3. The services of commercial clean up contractors will be used when their expertise and services are warranted under emergency service contracts obtained and maintained by DPW Environmental. All pollutants will be collected and disposed of in accordance with hazardous waste regulations. Cleanup will be in accordance with State of Hawaii Department of Health (DOH) guidelines. Cleanup will be conducted using the level of manpower, equipment and materials required to remove harmful pollutants in an expeditious manner. Hawaii DOH Office of Hazard Evaluation and Emergency Response is responsible for overseeing the cleanup of contaminated sites. Their website is: http://www.hawaii.gov/health/environmental/hazard/index.html.

3.4.1.9 Additional Internal Notification

Cultural Resource Manager. Whenever excavation is required to clean up a spill, the DPW Cultural Resources Manager will be consulted prior to excavation to ensure proper management of areas which may contain historical artifacts.

Wastewater Treatment Plant. Because of the potential damage that can be caused to a sewage treatment plant, in the event of a release to a sanitary sewer system, the IOSC shall notify the appropriate sewage treatment plant as soon as possible after a spill has occurred. The wastewater treatment plant phone numbers are provided in Table 3-4.

Community Commander. The IOSC will also notify the appropriate Community Commander, if deemed necessary (e.g. road or facility closure requirements), as soon as practical, of the spill and the steps taken to control the spill.

Public Affairs Office (PAO). The IOSC will advise the PAO if deemed necessary, as soon as practical, of the nature of the spill and any response actions taken. Notification procedures are described in Appendix I.

Organizational Action Officers. Organizational Action Officers shall be notified, as soon as practical, of spills relating to waste oil, fuel or hazardous wastes at their respective sites.

3.4.2 Incident Log

The IOSC or designee will maintain an Incident Log detailing all actions taken during the course of the spill response. The log will satisfy the written notice requirements of SARA Title III. The log will include, but is not limited to:

- Identification of the substance(s) and approximate quantity (volume) of substances released. The name (trade and chemical) and chemical abstract service registry number if available
- Location of the spill, cause of spill, time of day, and duration of the release.
- Where the release occurred, sensitive environmental areas affected, and the extent of any environmental damage, if any
- Actions taken to recover the substance(s) and restore the environment
- Personnel involved in the response
- Health and safety precautions and measures employed
- Injuries or exposures that occurred and medical attention received by injured/exposed persons
- Known or anticipated acute or chronic health risks
- Internal notifications performed
- A brief description of the spill/release including the medium or media into which the release occurred
- Regulatory status of the release and agencies notified. Notification threshold (state and Federal) should be determined (see Section 3.4.3).
- Name, official office address and phone number of person notifying any state or Federal agency
- Under the Hawaii Contingency Plan the DOH requires a list of all external agencies that were notified
- Samples collected and analyzed
- Property damage, if any
- Disposal of spill residuals

- Decontamination procedures used

The PAO should be involved in the notification process if there is a potential public health threat. This information can only be released by the PAO or his representative.

3.4.3 Reporting

3.4.3.1 Hazardous Substances/Hazardous Waste Releases

Once it has been determined that a reportable hazardous substance release has occurred in accordance with 40 CFR 302: EPA Designation, Reportable Quantities and Notification Requirements for Hazardous Substances Under CERCLA it is the responsibility of the IOSC to ensure the spill is reported to Federal Agencies (refer to Section 3.2.4.1). Chemicals, used on USAG-HI installations, with reportable quantities (RQs) are identified in Appendix C. For mixtures, if the quantity of one or more of the hazardous constituent(s) of the mixture or solution is unknown, notification is required where the total amount of the mixture or solution released equals or exceeds the RQ for the hazardous constituent with the lowest RQ. Spills of hazardous substances as defined in this regulation must be reported immediately to the National Response Center or the U.S., Coast Guard. Telephone numbers are provided in Table 3-5. USEPA may require a written follow-up report for a hazardous substance spill.

If an extremely hazardous substance, as defined in the SARA Title III requirements (40 CFR Part 355), has been released, the IOSC must ensure it is reported to state and local agencies. Releases of extremely hazardous substances in excess of reportable quantities require immediate notification to the State of Hawaii Emergency Response Commission (SERC) and the Local Emergency Planning Committee (LEPC) as required in SARA Title III, 40 CFR Part 355: Emergency Planning and Notification. Initial notification must be by telephone or in person. Telephone numbers are provided in Table 3-5. A written follow-up report is also required, containing the information detailed in the previous Section (Incident Log).

The regulatory reportable quantities (RQs) of hazardous and extremely hazardous substances used and stored at USAG-HI facilities is available upon request from the EPCRA Program Manager at DPW Environmental. Complete lists of RQs of hazardous substances, as defined in CERCLA, 40 CFR Part 302, and SARA Title III, 40 CFR Part 355, are provided in Appendix C.

Releases of unlisted hazardous wastes in excess of the RQ also requires reporting under CERCLA regulations and in some cases reporting of releases of hazardous wastes to EPA under the RCRA regulation in 40 CFR 265 Subpart C.

Spills of reportable quantities under the State Contingency Plan (Hawaii Administrative Rules, Title 11, Department of Health, Chapter 451) will be reported to the SERC and to the LEPC. Refer to Section 3.4.2, Incident Log, for guidelines on reporting the incident to state and local agencies. Verbal and written follow-up notifications shall be made within timeframes specified in the State Contingency Plan. In general, verbal notifications shall be made to the SERC and LEPC as soon as possible; written notifications shall be postmarked within 30 days. Verbal notification for oil spills/releases of less than 25 gallons on land is not required.

Releases which, based on the nature, gravity, potential for adverse publicity, or potential serious consequences, will also be immediately reported to IMPC-PARO in accordance with AR 190-40, Serious Incident Report, and also to the DPW Operations Officer. A copy of all written follow-up notifications to the SERC and LEPC will also be provided to IMPC-PARO and the Staff Judge Advocate (SJA).

For reportable spills/releases caused by contractors/tenants, the contractors/tenants are responsible for making all regulatory verbal and written notifications.

3.4.3.2 Releases of Oil to Navigable Waters

Releases of oil into navigable waters must immediately be reported to the National Response Center or the U.S. Coast Guard in accordance with 40 CFR 110: EPA Regulations on Discharge of Oil. Reportable releases are defined as those in excess of water quality standards or cause a visible sheen on the water surface, a discoloration of adjoining shorelines, or form a sludge or emulsion beneath the water surface or on adjoining shorelines. A follow-up written report to EPA, within 60 days, is required for oil spills of 1,000 gallons or more, or if two oil spills, each exceeding 42 gallons, occur within a 12-month period. Refer to Final Rule amending requirements of the Oil Pollution Prevention regulation at 40 CFR 112 dated 26 December 2006.

Table 3-4. List of Persons/Agencies to be Notified of Spills

Name/Agency	Telephone Number
SEWAGE TREATMENT PLANTS:	
Schofield Barracks/Wheeler Army Airfield (SB, Wheeler, Kunia, and Helemano Wastewater)	656-1330/864-0842 621-3098
Sand Island Wastewater Treatment Plant (Ft. Shafter, Ft. DeRussy,TAMC, and Aliamanu wastewater)	847-8307
IMCOM-Pacific Region Office (IMCOM-PARO), Environmental Office	438-3080 (phone) 438-8688 (fax)
REGULATORY AGENCIES	
National Emergency Response Center:	800-424-8802 (24 hours)
Environmental Protection Agency (Region IX, San Francisco)	800-300-2193(24 hours)
U.S. Coast Guard, Marine Safety Office (Honolulu)	541-2477/842-2600
State Emergency Response Commission, Hawaii Department of Health, Hazard Evaluation and Emergency Response	(808)586-4249 (808) 247-2191(24 hours)
Local Emergency Planning Committees (notification required by SARA Title III) Hawaii Oahu	911 For Emergencies Non Emergency Numbers 936-0858 723-8960
Name/Agency	**Telephone Number**
Local Fire Departments (notification required by SARA	

Title III)	
Hawaii (Hilo)	961-8297 961-8336 (after hours)
Oahu (Honolulu)	723-7101/7162 911 (after hours)

3.4.3.3 Underground Tank Releases

Release reporting, investigation, and confirmation requirements for underground tanks are listed in Subpart E of the EPA Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (40 CFR 280). The State of Hawaii has adopted its own UST regulations, HAR, Chapter 11-281. The Hawaii Department of Health responsible for administering the State UST program has published the document the "Technical Guidance Manual For Underground Storage Tank Closure and Release Response." This manual describes release response, notification, and reporting requirements for releases from USTs.

3.4.4 Restoration of Spill Sites

The ECO or IRT as applicable will assure the proper disposal of spilled oil and other petroleum wastes. If the spilled material can be classified as a hazardous waste under RCRA, it must be properly managed and disposed of in accordance with the Installation Hazardous Waste Management Plan.

For releases, spills, or leaks from underground tanks, initial abatement measures, site characterization, free product removal, investigations for soil and groundwater clean up, and corrective action must be in accordance with EPA Underground Tank Regulations, 40 CFR 280.60 through 280.66. The HDOH "Technical Guidance Manual For Underground Storage Tank Closure and Release Response" reflects federal requirements and includes Hawaii specific requirements. The State of Hawaii Office of Hazard Evaluation and Emergency Response has established general soil and groundwater Environmental Action Levels for contaminants that are commonly associated with releases from UST systems. Current EALs are Accessible at _www.hawaii.gov/health/environmental/hazard/eal2005.html.

Remedial procedures and clean up levels for other contaminants in soils or water are governed by the National Oil and Hazardous Substances Pollution Contingency Plan under CERCLA (40 CFR 300).

Table 3-5. Tier 1 Action Levels for Soil and Groundwater

Contaminant	Groundwater (mg/L)	Soil (mg/Kg)

Contaminant	Groundwater (mg/L)	Soil (mg/Kg)
Benzene	0.005	0.05
Toluene	1.0	16
Ethylbenzene	0.14	0.50
Xylenes	10	23
MTBE	0.020	0.005
Benzo(a)pyrene	0.0002	1.0
Acenaphthene	0.32	18
Fluoranthene	0.013	11
Naphthalene	0.24	41
PCE	0.005	0.29
1,1-DCE	0.046	0.47
Vinyl chloride	0.002	0.18
TCE	0.005	0.01
1,1,1-TCA	0.20	0.10
PCBs (all)	0.0005	1
Lead (total)	0.0056	400
Cadmium (total)	0.005	38
TPH-residual fuels	5,000	5,000
TPH-middle distillates	5,000	5,000
TPH-gasoline	2,000	2,000

Source: State of Hawaii "Technical Guidance Manual For Underground Storage Tank Closure and Release Response," March 2000 (Drinking Water Source Threatened), p. 5-29.

3.5 SPILL RESPONSE SUPPLIES

3.5.1 Response Kit for Minor Spills

Each activity responsible for management of oil or hazardous material will maintain a spill response kit compatible with the material stored for containing and cleaning-up minor spills and for controlling major spills until the IRT or DPW contractor can respond. The contents of the kit should be tailored to the needs of each unit/activity based on worst case scenarios considering the amount of oil, fuel or hazardous substances stored at the activity, the type of operations conducted, proximity of surface water or drains, and proximity to immediate spill response support agencies (e.g., fire department, IRT). It is recommended that a basic kit shall include the following:

- A supply of granular absorbent that will absorb both oil-based and water-based liquids, including oils, solvents, caustics, and acids. The granular absorbent can also be used for over packing leaking drums or other containers and is effective in cleaning up oil spills on asphalt surfaces.

- Absorbent pillows, pads, socks, and booms. For spills of oil, hydrophobic absorbent media which absorbs hydrocarbons (oil) but not water are recommended in situations where rainfall is imminent or occurring or when absorbent material will be left in place

overnight or for a period of time. Hydrophobic oil-absorbing media is also effective in absorbing oil sheen on surface water (e.g. secondary containment, swales, etc.).

- Loose absorbent media. There are effective loose absorbent media that may be used including recycled sorbents and biobased sorbents (e.g. made from peat moss). These materials may absorb more oil per pound therefore requiring less storage space; however, may be less effective that the granular clay type.

- Straight edge, non-sparking shovels (fabricated with non-ferrous metal, with a polypropylene coating on the blade, or fully fabricated from polypropylene).

- At least two empty DOT approved open-head over-pack/salvage drums.

- Open-head DOT approved containers of assorted sizes for packaging spill residues (such as 10 gallons and 55-gallons).

- Grounding equipment for transfer of flammable materials.

- Brooms and non-sparking dustpans.

- Polyethylene bags with ties.

- Rubber gloves, rubber aprons, rubber boots (or clothing recommended by the Safety Officer).

- Safety goggles.

- Absorbent rags or paper towels.

- Strong adhesive backed tape (e.g., duct tape) for labeling and for sealing triwalls, etc.

- Drain blocks and covers/mats and storm drain covers.

- Drip pans or other secondary containment equipment. (Note: For emergency situations, or where containment area is larger than a drip pan, absorbent pads placed over impervious plastic bags can form an effective temporary catchment device for small leaks under vehicles/equipment.)

- For facilities or operations where there is a potential for spills to migrate to soil, excavation may be required. At least two DOT-Approved supersacks (a woven polypropylene FIBC (Flexible Intermediate Bulk Container)) or triwalls (made of cardboard) with liners capable of containing at least one cubic yard of soil (four times the volume of a 55-gallon drum). Although supersacks do not deteriorate like the triwalls will when exposed to UV or rain, they are for limited outdoor storage. Supersacks have “loop lifts” which allow the sacks to be lifted using forklifts, can be folded up and easily stored in small spaces, and are significantly less costly than triwalls. Triwalls may be

easier to fill; however, must be kept dry to maintain their integrity, and are difficult to transport and store due to the size. Both the supersacks and triwalls must be mounted on sturdy pallets in good condition in order to turn in the contaminated soil in to the TAP, since when filled, the contents may weigh close to 2,000 pounds.

- All facilities with potential for oil runoff (especially at motorpools and maintenance facilities) are recommended to install hydrophobic oil-absorbing drain inserts which can be positioned inside stormwater inlets to absorb residual oil runoff.

Items in the spill kit should be stored together in a well-marked and Accessible location. Typically, spill response materials are stored in yellow over pack drums and are readily Accessible and identifiable by facility personnel. The unit ECO or alternate person at each activity/organization shall maintain the kit, replenishing supplies as needed. The location of the kit should be posted with the list of emergency contacts.

It is not necessary to purchase commercially available spill kits, which are costly and do not contain all the supplies necessary. Nor is it necessary to purchase specialized protective clothing (such as Tyvek suits), unless it is specifically recommended by the Installation Safety Officer; the protective clothing that is normally used in the workplace when handling hazardous substances should be sufficient for response to minor spills.

Personnel shall be trained in the use of the equipment and supplies contained in the kit.

3.5.2 IRT Spill Supplies

The DPW Environmental and the DPW Unit will maintain a supply of absorbent materials and spill clean up equipment to supplement the spill kits to be maintained by individual organizations. A back-up supply should include those items suggested above for the minor spill kits. DPW Environmental supplies are stored at Building 6045, Schofield Barracks East Range, and DPW Unit supplies will be maintained at the DPW maintenance and TAP facilities at Schofield Barracks East Range Building 6040, Fort Shafter Building 422, and Pohakuloa Training Area. IRT support units will provide an inventory of spill recovery material to DPW Environmental annually by October 1 of each year. The list will detail type and quantity of material on hand.

4.0 EMPLOYEE TRAINING AND BRIEFINGS

The cause of most oil or hazardous substance spills on USAG-HI facilities is accidents involving lack of proper attention to detail, closely followed by discharges resulting from equipment failures. Most equipment failures can be avoided by proper inspection and maintenance. Consequently, an important factor in an effective spill prevention program is training which emphasizes good work practices, inspection, and maintenance.

It is critical that units and activities adhere to regular scheduled maintenance and inspections as specified in site SOPs. When working with or handling oil or hazardous substances, personnel

should be aware of the potential for discharges and perform their tasks with attention to detail and avoid "cutting corners."

USAG-HI training requirements are largely dictated by individual conditions and responsibilities; however, all units and activities must participate in the Environmental Compliance Officer (ECO) Program. Within 30 days of appointment, ECOs must attend the 3-day basic ECO course administered by DPW Environmental, followed by an annual refresher. The training schedule is posted on the DPW website at https://dpwhawaii.army.mil/ECO (File Name: ECO Training Class). Subject matter includes regulatory requirements for the storage and handling of POL, hazardous material/wastes, reporting and record keeping, and spill prevention and response. ECOs are responsible for ensuring their individual facilities are operated IAW regulations and DPW guidelines. ECOs act as unit level trainers and serve as unit/activity level spill coordinators. A well-trained ECO backed by their Chain of Command brings relevant information and training to their respective units.

The ECOs and supervisors in all POL and hazardous material handling/storage areas are responsible for indoctrinating their personnel in spill prevention and response procedures and regulations. The ECOs should tailor the general elements of this plan to their own unique operation. Records of all training showing the date and content of the training shall be kept with other personnel training records.

4.1 INITIAL TRAINING

USAG-HI official policy requires that all personnel who handle or transport hazardous materials be trained IAW with federal, DoD, Army, and USAG-HI regulations and guidelines.

- For all units/activities, identify the Primary and Alternate ECO responsible for the individual Unit/Activity. ECOs must attend the DPW ECO course within 30 days of appointment. Under no circumstances will any unit deploy without a qualified ECO.

- All personnel handling hazardous materials must receive Hazard Communication training required by 29 CFR, Part 1910.1200 (may be conducted by ECO), and general awareness training in recognizing and identifying hazardous materials within 90 days of being assigned.

- All personnel handling hazardous materials or oil must be adequately trained in the performance of their job.

- Personnel working in areas with oil or hazardous materials must be trained on the location of spill response kits, and actions to take in the event of a spill or release.

- Document all training and maintain records for at least three years.

- Drivers transporting hazardous materials must receive training IAW 49 CFR, Part 172.704 and 177.816 (general awareness training and Safe Transportation of Hazardous Materials Course), and DoD 4500.9-R, Chapter 204.

- Drivers transporting bulk fuel (500-gallons or more) must complete the 40-hour Bulk Fuel Handlers Course taught by their command.

- In some cases units deployed in the field may have to designate qualified personnel as Unit Response Team members who will respond to releases in the field until relieved by a HazMat Response Team (DoD, municipality or contractor). They require Initial Response training, OSHA Hazardous Waste Operations and Emergency Response training includes 40 hours of initial training and annual 8 hour refresher training for personnel involved in emergency response.

The training for the Installation Response Team members will be more extensive than the general personnel training guidelines presented in this section. Specific recommendations for IRT training are presented in Section 4.3.

4.2 FOLLOW-UP TRAINING

All units/activities and contractor and tenant organizations handling oil and hazardous substances in their daily operations will provide basic spill prevention and response training to their personnel, at a minimum on an annual basis.

All employees whose job involves the storage or handling of petroleum products or hazardous substances should receive refresher training from their supervisor or a designated representative (usually the ECO) at least quarterly as required by the IHWMP. This training may be accomplished individually or in groups, in briefings, or complete reviews. This refresher training should include:

• A review of the pertinent sections of this plan including procedures and requirements in Section 2 and 3 of this plan and the appropriate site-specific appendices related to the employee's job responsibilities.

• A discussion of spills since the last refresher training that can serve as examples of the need for proper procedures.

• A review of spill reporting and emergency response procedures

• An opportunity for employee feedback on conditions in their specific work area, including discussions of the results of any inspections relative to spill prevention.

• A reaffirmation by the employee of his or her understanding of the SPCC program and the possible ramifications of non-compliance with spill prevention procedures.

4.3 INSTALLATION RESPONSE TEAM (IRT) TRAINING

In-depth training at the appropriate level in emergency response and hazardous waste operations training under OSHA 1910.120 shall be provided to IRT members if they will be directly responding to spills of a hazardous nature. OSHA Hazardous Waste Operations and Emergency Response training includes 40 hours of initial training and annual 8 hour refresher training for personnel involved in emergency response. Responders that are taking aggressive action, for example shutting valves on fuel tanks during a fire, require specific training, and are required be trained to "first responder level." The training must be provided by qualified providers and must encompass emergency planning, emergency procedures, and personal protective equipment. Records must be kept of all training. If a contractor will be providing direct emergency response services, IRT personnel need not receive the degree of training required under OSHA unless they are required to be directly on-site. Since for Army and USAG-HI caused spills, cleanup of large spills and spills where advanced personal protective equipment (PPE) is required will generally be contracted out, IRT members other than IOSCs will only require initial responder training which is provided at the ECO class and at unit/activity quarterly training.

Additional training shall include (as required by job description):

- Training program development, for training installation personnel
- Oil and hazardous substance incident response and contingency planning
- Response procedures
- Health and safety regulations and practices for hazardous substance spill response
- Spill prevention planning, control, and countermeasures
- Environmental protection
- Hazardous waste generation for treatment, storage and disposal facilities
- Hazardous waste packaging and transportation
- Federal, State and local regulations

At a minimum, IOSCs should receive the following training:

- Incident Command Training as described in OSHA 1910.120
- Hazardous Waste Operations and Emergency Response (HAZWOPER) 40 hour course.

4.4 UNIT RESPONSE TEAM (URT) TRAINING

Units that are deployed under field conditions and have no direct or immediate support available from a Facility IRT for a spill incident may need to assign qualified personnel to a URT. Every unit must have a qualified person who has been designated as an ECO in writing. The ECO will serve as the On Scene Commander until an Installation/Municipal Fire Department or Response Team has arrived on the scene. Assigned URT members must have as a minimum the following training:

- OSHA Hazardous Waste Operations and Emergency Response training includes 40 hours of initial training and annual 8 hour refresher training

- Health and safety regulations and practices for hazardous substance spill response.

- Hazard Communication training required by 29 CFR, Part 1910.1200.

- Trained on the location of spill response kits, and actions to take in the event of a spill or release.

5.0 RECOMMENDATIONS

5.1 INTRODUCTION

Summaries of recommendations for USAG-HI facilities that have the potential for oil product spills are provided in the Access database - Appendix A. The facilities addressed include:

Aliamanu Military Reservation (AMR)
East Range (ER)
Fort DeRussy (FDR)
Fort Shafter (FS)
Helemano Military Reservation (HMR)
Kilauea Military Camp (KMC)
Pohakuloa Training Area (PTA)
Schofield Barracks (SB)
Tripler Army Medical Center (TAMC)
Wheeler Army Air Field (WAAF)

5.2 RECOMMENDED CORRECTIVE ACTIONS

5.2.1 Aboveground Storage Tanks (ASTs)

An inspection of existing ASTs was conducted while preparing this plan, and recommendations are provided in the Access Database referenced in Appendix A of this plan. ASTs are inspected annually; refer to the AST Program Manager for the most recent information. Currently only visual inspections are conducted. It is recommended that tanks be periodically inspected by a certified tank inspector and that integrity testing be conducted according to an established

schedule. The frequency and scope of testing should be conducted in accordance with a standard such as the Steel Tank Institute (STI) Standard SP-001.

5.2.2 Field Fueling Operations

A standard procedure for field fueling operations should be developed and implemented. Procedures should include storing fuel vehicles in proper containment, placing drip pans under hose connections, fuel dispensers, and other potential spill points, and having absorbent materials readily available. A standard checklist can be used to ensure that units are in compliance with the established standard procedures. At Pohakuloa Training Area and other temporary field fueling sites, initial inspection and an environmental clearance of the fueling sites should be conducted.

5.2.3 GIS Map Layer Revisions

Some of the USAG-HI GIS system map layers have discrepancies that should be corrected in order to maintain accurate records both for current use and for future project planning. It is recommended that these map layers be updated.

5.2.4 Dining Facilities

Several of the dining facilities had discrepancies related to inadequacy of secondary containment volume, security, and spills. In cases where facilities consistently produce minimal quantities of waste cooking oil (less than 55 gallons per month), the 55 gallon drums should be replaced with smaller capacity drums to alleviate the secondary containment and other requirements. In addition, dining facilities should be periodically inspected by DPW-ED to ensure that the storage areas are in compliance with all aspects of the SPCC regulations.

6.0 PLAN REVIEW AND AMENDMENT PROCEDURES

6.1 INTRODUCTION

Plan Certification

In accordance with 40 CFR 112 and AR 200-, this SPCCP must be reviewed and certified by a Registered Professional Engineer (PE). The PE, after examination of the facility by him/her or his representative, and having good knowledge of the provisions of 40 CFR 112, will certify the plan has been prepared in accordance with good engineering practices.

6.1.1 Plan Review and Amendments

A review and evaluation of the SPCC Plan must be accomplished within five years from the date that the last review was done. Any amendment must be implemented as soon as possible, but not later than six months following preparation of any amendment. Completion of the review and

evaluation must be documented and a statement signed as to whether the Plan will be amended, either at the beginning or end of the Plan or in a log or an appendix to the Plan. The following words will suffice, "I have completed review and evaluation of the SPCC Plan for (name of facility) on (date), and will (will not) amend the Plan as a result."

A Registered Professional Engineer (PE) must certify any technical amendments to the Plan in accordance with 40 CFR 112.3(d).

The Regional Administrator may require an installation to amend the SPCCP if he finds that it does not meet the requirements of 40 CFR 112.4 or that amendment is necessary to prevent and contain discharges from an installation facility.

USAG-HI is also required to amend the SPCCP for any of the following reasons:

- As required by the USEPA after review of the plan, submitted because of an oil or hazardous substance spill event
- When there is a change in facility design, construction, operations, or maintenance, which materially affects the potential for a discharge
- If the required five-year review of the plan indicates more effective control and prevention technology will significantly reduce the likelihood of an oil or hazardous substance spill event (if such technology has been field proven)
- If the DPW finds that there is a condition requiring immediate action to prevent the discharge or risk of discharge of oil or hazardous substance
- Whenever an amendment to federal, state or local legislation, affecting this plan, or changes in Department of Defense or U.S. Army policy occurs. Particular attention should be given to changes in reportable spill quantities for oil and liquid hazardous substances.

All technical plan amendments, except those proposed by the EPA Regional Administrator or as directed under 33 CFR 154, must be certified by a Registered Professional Engineer. The DPW will keep a copy of all amendments to this plan and will note such amendments on the Record of Review and Amendments page at the front of this plan.

6.2 USEPA REQUIRED SPCC PLAN REVIEW AND AMENDMENTS

USAG-HI must submit the SPCC Plan and any amendments to the EPA whenever:

- A discharge of more than 1,000 gallons (approximately 20 drums) of oil into navigable waters in a single spill event occurs

- A discharge of oil in harmful quantities occurs into navigable waters in two reportable spill events within any 12-month period. A discharge of harmful quantities, as defined in 40 CFR, Part 110, includes discharges which:

  - Violate applicable water quality standards

  - Cause a film or sheen upon the surface of the water, cause a sludge or emulsion to be deposited beneath the surface of the water, or cause a discoloration of adjoining shorelines

Within 60 days of the occurrence of either of these two conditions, the USAG-HI must submit to the EPA Regional Administrator (Region IX, 215 Fremont Street, San Francisco, CA 94015) the following:

- Name of the facility

- Name of the owner or operator of the facility

- Location of the facility

- Description of the facility

- Date of initial facility operation

- Maximum storage or handling capacity of the facility and current normal daily throughput

- A complete copy of the Spill Prevention and Response Plan with any amendments

- The cause of such spill, including a failure analysis of the system or subsystem in which the failure occurred. The failure analysis is to examine and explain the reason for the failure resulting in the spill event. The analysis should be explicit, definitive, and not general. For instance, it would be inadequate to simply report that the cause of the spill was the failure of a storage tank. The failure analysis should indicate in some detail the nature of the failure that caused the spill, such as a vehicle collision, etc

- The corrective actions and/or countermeasures taken, including an adequate description of equipment repairs and/or replacements

- Additional preventive measures taken or contemplated to minimize the possibility of recurrence

- Such other information as the USEPA Regional Administrator may require

The USEPA will review the information and may require USAG-HI to amend the plan. When USEPA proposes to require an amendment to the plan, USAG-HI will be notified by certified

mail or by personal delivery. The USEPA will specify the terms of such an amendment. Within 30 days from receipt of this notice, USAG-HI may submit written information, views, and arguments on the proposed amendment requirement. After considering all material presented, the USEPA will notify USAG-HI of the amendment required or will rescind the notice. USAG-HI must amend the plan as required within 30 days after such notice, unless the Regional Administrator, for good cause specifies another effective date. The amended plan must be implemented as soon as possible but not later than six months after the amendment becomes a part of the plan, unless the Regional Administrator specifies another date.

6.3 FACILITY MODIFICATION REVIEW AND AMENDMENTS

Whenever there is a modification in facility design, construction, operations, or maintenance activities, which materially affects the potential for a discharge as described in 40 CFR 112.1(b), USAG-HI is required to amend this plan to reflect such a change. Examples of changes that may require amendment of this plan include, but are not limited to: commissioning or decommissioning containers; replacement, reconstruction, or movement of containers; reconstruction, replacement or installation of piping systems; construction or demolition that might alter secondary containment structures, changes of product or service; or revision of standard operation or maintenance procedures at a facility.

The DPW is responsible for reviewing all plans for new construction, maintenance or remodeling to determine if amendment of the plan is required. If the plan must be amended, the amendment must be prepared within six months and implemented as soon as possible, but not later than six months following the preparation of the amendment.

6.4 DEPARTMENT OF THE ARMY REQUIRED REVIEW AND AMENDMENTS

USAG-HI is required by AR 200-1 and Federal regulation to complete a review and evaluation of the SPCCP at least every 5 years and update it as necessary. This review must include an assessment of new technology that has become available for the prevention of spills since the plan was last reviewed. Additionally, a complete facility inspection must be performed to verify conformance with the requirements of the plan and that past recommendations have been implemented. As a result of this review and evaluation, the plan must be amended within six months to include more effective prevention and control technology if the technology will significantly reduce the likelihood of a spill event and if it has been field proven at the time of the review. A PE must recertify the plan when changes occur in installation design, construction, operation, or mission.

6.5 INSTALLATION SPILL CONTINGENCY PLAN REVIEW AND AMENDMENTS

The Installation Spill Contingency Plan (ISCP) will be integrated into the SPCCP which will provide coordination of response activities within the facility, minimize duplication, and simplify plan development and maintenance. It will be reviewed and amended when the SPCCP is reviewed, as required by AR 200-1 and Federal regulation. The DPW will be responsible for conducting the ISCP review.

All organizations affected by the ISCP are encouraged to review the plan more frequently as required. Any proposed amendments or changes to the plan should be directed to the DPW SPCCP Coordinator for review. Accepted changes to the plan will be sent to individuals and organizations on the original distribution list. Changes should be logged on the Record of Review and Amendments page at the front of this plan. Examples of some circumstances, which may warrant more frequent plan review and update, are as follows:

- When a water pollution discharge permit (for the discharge of a hazardous substance) or a hazardous waste management permit is issued, reissued, or amended
- When facility changes occur which increase the potential for spills or change the spill prevention and response procedure methods and equipment
- When the ISCP fails or proves to be ineffective in the prevention of or response to a spill
- At the request of the U.S. EPA Regional Administrator, U.S. EPA Enforcement Division Director, or applicable state agency director
- When changes occur in the DPW, Installation On-Scene Coordinator, Installation Response Team, or spill response equipment list
- After enactment of, or amendment to, pertinent Federal or State legislation, or changes in Department of Defense or U.S. Army policy. Particular attention should be given to changes in reportable spill quantities for oil and liquid hazardous substances
- After pertinent modifications of Federal, Regional, and State spill contingency plans
- After any changes in adjacent land and water use that would affect spill prevention and response considerations

6.6 PLAN CERTIFICATION

All changes to the plan of a technical nature will be reviewed by a registered professional engineer and certified to have been prepared in accordance with good engineering practices, after on-site examination of the facility and IAW with Title 40 CFR Part 112.

IDDE APPENDIX J
Wastewater Spill Standard Operating Procedures

This page intentionally left blank.

1. Reference

Hawaii Administrative Rules, Chapter 11-62 (HAR 11-62), Appendix C, Responses for Wastewater Spills, Overflows, and Discharges ("Spills")

2. List of Enclosures

Enclosure 1. Directorate of Public Works (DPW) Wastewater Spill Notification Form
Enclosure 2. HAR 11-62, Appendix C
Enclosure 3. Public Affairs Office (PAO) Notification Form
Enclosure 4. Map for NAVFAC Hawaii Environmental Services Laboratory

3. DPW Points of Contact. See Table 1 below. For routine communications, email or call a Division's main contacts (names in bold). For urgent communications, begin by calling Environmental Division's main contacts. If the first-listed contact is unavailable, leave a message and continue calling down the contact list.

Table 1 – DPW Points of Contact		
	Division	Phone
	Environmental	656-3105
	Environmental	656-3317
	Environmental	656-5301
	Environmental	656-5790
	Operations & Maintenance	655-1321
	Engineering	656-3295
	Engineering	656-3064

4. Responding to Wastewater Spills. Typically the DPW Service Order Desk is the first to notify the Environmental Division of a wastewater spill. If you receive a call for a wastewater spill, follow the procedure below.

a. Collect the following spill information on the DPW Wastewater Spill Notification Form (Enclosure 1)

(1) Name and phone number of person who reported the spill, for call-back as needed

(2) Date of spill

(3) Time spill started and stopped

(4) Location of spill

(5) Duration of spill

(6) Approximate volume spilled in gallons

(7) Cause of spill

(8) Actions taken to stop and clean up spill

(9) Ultimate fate of spill (e.g. ground, storm drain, stream, lake, ocean)

b. Contact DPW Operations and Maintenance Division (OMD) or DPW Engineering Branch if more information is needed.

Typically the DPW Service Order Desk contacts OMD to initiate spill response containment and clean up actions. Roland Kauweloa 655-1321 / 864-1386 will make a determination on the responsible party and call the appropriate spill response clean up team. The wastewater collection systems on Army properties are owned, operated and maintained by Aqua Engineers (AQUA), Island Palm Communities (IPC) or DPW.

If a spill occurs from an AQUA or IPC owned line then the respective owner is responsible for all reporting, response and cleanup activities. AQUA or IPC will provide a copy of their spill response actions to DPW Environmental. (Note: AQUA owns only portions of the wastewater collection system on all installations.)

If the spill occurs from a DPW line then OMD will activate a DPW spill response team to stop the spill, pump/disinfect the area, and make repairs to the problem area. If needed, contract assistance is coordinated by the DPW Engineering Branch: Karl Santa 656-3295 / 864-5696 or Colin Watanabe 656-3064 / 864-0731.

During containment and clean up, AQUA or other spill response teams shall employ to the maximum extent possible best management practices to prevent wastewater and disinfection water from entering additional storm drains.

c. Initiate Response and Reporting per HAR 11-62, Appendix C. Once the line has been identified as DPW property and OMD has initiated the spill response containment and clean up team, follow the spill response guidelines in HAR 11-62, Appendix C (Enclosure 2).

The role of the DPW Environmental Division is to notify the State of Hawaii Department of Health (HDOH) and initiate the procedures as defined in HAR 11-62, Appendix C. ***Generally, notification is required for major spills including any spill that is 1,000 gallons or more, chronic, poses a substantial public health threat (any quantity), or enters an open drainage ditch, stream, lake, or ocean (any quantity).***

All major spills are also immediately reported verbally to the Director of Public Works or, in his absence, the Deputy Director of Public Works.

5. Responding to Wastewater Spills that Enter State Waters (Excluding R-1)

a. Notify the Hawaii Department of Health Clean Water Branch. Spill response requirements vary depending on the type of wastewater (e.g. R-1, Reclaimed Water), quantity, and location of spill. Refer to HAR 11-62, Appendix C (Enclosure 2) for specific information. Currently R-1 is generated only at the Schofield Barracks Wastewater Treatment Plant (WWTP), and future distribution lines are not in use. Thus the only R-1 spills that can occur are at the WWTP, and AQUA will provide the DPW Environmental Division with a report of actions.

During normal work hours, if any amount of wastewater (excluding R-1) enters state waters, including drainage ditches, immediately notify the HDOH personnel in the order they appear below and provide the information collected on Enclosure 1.

NAME	CELL PHONE	EMAIL
Watson Okubo	927-3122	watson.okubo@doh.hawaii.gov
Dale Mikami	753-3434	clinton.mikami@doh.hawaii.gov
Alec Wong	265-6828	alec.wong@doh.hawaii.gov
Mike Tsuji	265-6829	michael.tsuji@doh.hawaii.gov

If the spill occurs after hours or on a weekend or holiday, call the State After Hours Operator at 247-2191. (Watson Okubo and Dale Mikami take turns to be on call after normal working hours, weekends, and holidays.)

b. Press Release. A press release is required for spills greater than 1,000 gallons or lesser quantities that pose substantial threat to public health. Contact the Public Affairs Office (PAO) at the appropriate number below and provide the information on the PAO Notification Form (Enclosure 3).

PAO Internal Communication (for military and on-post community)	656-3155
PAO External Communication (for media and off-post community)	656-3160
After Hours	226-2706 (PAO director) and 256-9813
Fax	656-3162

c. Warning Signs. Warning signs are located in the 1st floor storage closet (4 metal signs on posts in drum) and in the 3rd floor Clean Water Program area behind the construction plan caddy (laminated/metal signs and plastic ties). Post signage at the spill site and around the impacted area. Take photos of the spill site and the locations where signs are posted. Submit a map to HDOH showing spill and sign locations. HDOH will advise you if and where more signs are required. Signs shall not be removed without approval from HDOH.

d. Monitoring. Spills greater than 1,000 gallons require sampling. HDOH will advise you of sampling locations. If sampling is required, contact the NAVFAC Hawaii Environmental Services Laboratory for sample bottles. Points of contact are Duane Morita 471-0768 / 347-2653 or Stuart Kaneshiro 474-3704. The Lab is open on weekends and holidays. See Map for NAVFAC Hawaii Environmental Services Laboratory (Enclosure 4).

Use the sample bottles to take grab samples of the spill location and upstream and downstream, or as designated by HDOH. Try to sample in an area where water is flowing and avoid floating debris and small insects or fish. As needed, coordinate shoreline monitoring and testing with HDOH. Notify HDOH immediately with test results. Conduct additional testing as required by HDOH.

e. Reporting. A written report must be submitted to HDOH within five (5) calendar days for spills that entered Waters of the United States or for spills greater than 1,000 gallons. The report must contain the date and time of spill, amount released, cause of spill, location of spill, cleanup activities, actions to prevent future spills, summary of monitoring (lab data), photo documentation, map of sample locations and public notification procedures.

6. Wastewater Spills to Ground Only - With Public Access (Excluding R-1)

a. Notify the Hawaii Department of Health Wastewater Branch. If 1,000 gallons or more of wastewater (excluding R-1) discharges to the ground only during normal work hours, immediately notify the HDOH personnel in the order they appear below and provide the information collected on Enclosure 1.

NAME	CELL PHONE	EMAIL
Watson Okubo	927-3122	watson.okubo@doh.hawaii.gov
Dale Mikami	753-3434	clinton.mikami@doh.hawaii.gov
Alec Wong	265-6828	alec.wong@doh.hawaii.gov
Mike Tsuji	265-6829	michael.tsuji@doh.hawaii.gov

If the spill occurs after hours or on a weekend or holiday, call the State After Hours Operator at 247-2191. (Watson Okubo and Dale Mikami take turns to be on call after normal working hours, weekends, and holidays.)

b. Press Release. A press release is required for spills greater than 1,000 gallons or lesser quantities that pose substantial threat to public health. Contact the Public Affairs Office (PAO) at the appropriate number below and provide the information on the PAO Notification Form (Enclosure 3).

PAO Internal Communication (for military and on-post community)	656-3155
PAO External Communication (for media and off-post community)	656-3160
After Hours	226-2706 (PAO director) and 256-9813
Fax	656-3162

c. Warning Signs. Warning signs are located in the 1st floor storage closet (4 metal signs on posts in drum) and in the 3rd floor Clean Water Program area behind the construction plan caddy (laminated/metal signs and plastic ties). Post signs at and near the spill site. Submit a map to HDOH showing spill and sign locations. HDOH will advise you if and where more signs are required. Signs shall not be removed without approval from HDOH.

d. Reporting. A written report must be submitted to HDOH within five (5) calendar days for spills greater than 1,000 gallons. The report must contain the date and time of spill, amount released, cause of spill, location of spill, cleanup activities, actions to prevent future spills, summary of monitoring (lab data), map of sample locations, and public notification procedures.

7. Wastewater Spills to Ground Only - No Public Access (Excluding R-1)

a. Notify the Hawaii Department of Health Wastewater Branch. If 1,000 gallons or more of wastewater (excluding R-1) discharges to the ground only, within 24 hours notify the HDOH Wastewater Branch 586-4294 / Fax 586-4300 and provide the information collected on Enclosure 1.

b. Reporting. A written report must be submitted to HDOH within five (5) calendar days for spills greater than 1,000 gallons. The report must contain the date and time of spill, amount released, cause of spill, location of spill, cleanup activities, actions to prevent future spills, summary of monitoring (lab data), map of sample locations, and public notification procedures.

8. Minor Spills.

a. Definition. Minor spills are those that are less than 1,000 gallons, do not enter an open drainage ditch, stream, lake, or ocean (any quantity), and do not pose an immediate health threat (any quantity).

b. Reporting. Minor spills, except spills at the Schofield Barracks WWTP, are either reported by AQUA to HDOH or compiled and reported in writing by DPW Environmental to HDOH on a quarterly basis (1st quarter by the end of April, 2nd quarter by the end of July, 3rd quarter by the end of October, and 4th quarter by the end of January). If in doubt, one can report to HDOH Wastewater Branch 586-4294 / Fax 586-4300 any time there is a spill.

9. Review and Revisions. The DPW Environmental Division will review and update this procedure at least annually.

HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
DIRECTORATE OF PUBLIC WORKS
SCHOFIELD BARRACKS, HAWAII 96857-5013

Enclosure (1)

DPW WASTEWATER SPILL NOTIFICATION FORM

1. Person receiving call - Your Name/Phone Number: _____
2. Obtain the following information from the caller.
   a. Name of Person Calling: _____
   b. Phone Number of Person Calling: _____
   c. Date of Spill (day/month/year): _____
   d. Time Spill Reported: _____
   e. Time Arrived on Site: _____
   f. Time Spill Stopped: _____
   g. Location of Spill: Installation _____ Bldg No: _____ Street: _____

Spill Location (Place "X")		(Manhole or Line Number)
Lateral		
Clean Out		
Line		
Manhole		
Wastewater Pump Station		
Other		

   h. Approximate volume spilled (gallons): to ground _____ to storm drain _____ total _____.
   i. Cause of spill: ❍ Mechanical (pump/motor/control failure) ❍ Loss of Power ❍ Operational Error
❍ Pipe Break ❍ Excess Flow from Storm ❍ Grease ❍ Tree Roots ❍ Other (specify) _____
   j. Actions taken to clean up the spill: ❍ Notified Entomology ❍ Sprayed Disinfectant
❍ Clean up Spill Area ❍ Barricades & Warning Signs ❍ Other (specify) _____
   k. Actions taken to resolve cause of spill: ❍ Jet Wash Line ❍ Mechanically Routed Line ❍ Other _____
_____
   l. Fate of Spill (ground, storm drain, stream, lake, ocean, where did it go?): _____
_____

3. Verbally notify the following, if the spill is 1000 gallons or greater, chronic, poses a substantial public health threat (any quantity), or enters a stream, lake, or ocean (any quantity).

   a. Phone Numbers:
   ❑ Director of Public Works 656-1289
   ❑ or Deputy Director of Public Works 656-1288
   ❑ Does Not Enter Surface Water: 586-4294 (DOH Wastewater Branch); Fax: 586-4300
   ❑ Enters Surface Water 586-4309 (DOH Clean Water Branch); Fax: 586-4352
   ❑ After Work Hours: 247-2191 (State After Hours Operator)
   ❑ Public Affairs Office Normal Hours 656-3155 (Internal Communication: military and on-post community)
   656-3160 (External Communication: media and off-post community)
   ❑Public Affairs Office After Hours 226-2706 (PAO director) and 256-9813; Fax: 656-3162

   b. Name, Office, Date/Time of Person(s) Contacted:
   (1) _____
   (2) _____
   (3) _____
4. Return this form to the Clean Water Program Manager 656-2878 or in his absence, Chief, Compliance/Pollution Prevention Branch, Environmental Division, DPW (Fax: 656-1039).

CHAPTER 11-62 APPENDIX C

RESPONSES FOR WASTEWATER SPILLS, OVERFLOWS, AND DISCHARGES ("SPILLS")

April 15, 1997

Table of contents

1. Points of contact
2. Spills into state waters, excluding R-1 water from recycled water systems
3. Spills into state waters of R-1 water from recycled water system
4. Spills to ground only - with public access
5. Spills to ground only - with no public access
6. Spills to ground only - R-1 water only
7. Press release
8. Monitoring of state water
9. Reporting
10. Modifications by the director

1. Points of contact

Agency	Phone	Fax
Clean Water Branch (CWB)	586-4309	586-4352
Wastewater Branch (WWB)	586-4294	586-4352
Environmental Health Programs (EHP)		
Hawaii District Health Office	933-4371	933-4669
Kauai District Health Office	241-3323	241-3480
Maui District Health Office	984-8234	984-8237
State Hospital Operator (SHO)	247-2191	
Communications Office		586-4444

2. Spills from any facility into state waters, excluding R-1 water from recycled water systems

a. Applicability. Any wastewater spill which enters into state waters from a public or private wastewater system.

(1) "State waters" has the meaning defined in HRS section 341-D, and includes drainage ditches, whether or not water is always flowing in them.

(2) Exclusion. Spill of R-1 water covered by Appendix J to HAR chapter 11-5, "NPDES General Permit Authorizing Discharges of R-1 Water from Recycled Water Systems". That general permit does not cover spills from treatment works.

b. Immediate notice to DOH. If a spill occurs during working hours:

(1) The wastewater system owner or its agent (owner/agent) shall immediately notify the CWB of any spill into state waters; and

(2) If a spill occurs on the neighbor islands, the owner/agent shall also immediately notify their respective district environmental health program chief.

If a spill occurs during non-working hours:

(1) Contact the state hospital operator; and

(2) The next working day notify the CWB and the respective district EHP chief with a follow-up call.

c. Press Release. The owner/agent shall immediately send out a press release for spills of a thousand gallons or more and for lesser spills if they present a substantial threat to public health. A press release shall comply with section 7. A press release is not required if the owner/agent demonstrates that the spill was of R-1 water and that BMPs as approved by the director were implemented.

d. Disinfection. The owner/agent shall disinfect wastewater which is continuously being spilled into nearshore waters if sufficient disinfection contact time is available. Best judgment should be used in determining the amount of chlorine added to the discharge if chlorine is used as a disinfectant. Disinfection is not required if the owner/agent demonstrates that the spill was either R-1 or R-2 water and that BMPs as approved by the director were implemented.

e. Warning signs. The owner/agent shall immediately post warning signs in the area(s) likely to be affected by the spill and where public access is possible. Posting of warning signs is not required if the owner/agent demonstrates that the spill was of R-1 water and that BMPs as approved by the director were implemented.

The director shall also assure that a sufficient number of warning signs have been posted and the locations are adequate. Authorization to remove the signs shall also come from the director.

f. Monitoring. The owner/agent shall conduct bacterial monitoring for any spill greater than 100 gallons or when public health may be threatened in accordance with section 8. Monitoring is not required if the owner/agent demonstrates that the spill was R-1 water and that BMPs as approved by the director were implemented.

g. Reporting. The owner/agent shall report to the CWB under section 9.a.

3. Spills into state waters of R-1 water from recycled water systems

a. Applicability. Any spills of R-1 water covered by Appendix J to HAR chapter 11-55, "NPDES General Permit Authorizing Discharges of R-1 Water from Recycled Water Systems."
   (1) "State waters" has the same meaning defined in HRS section 342D-1, and includes drainage ditches, whether or not water is always flowing in them.
   (2) Exclusion. The general permit does not cover spills from treatment works.

b. Requirements. Among other things, the general permit requires filing a Notice of Intent before any discharge, compliance with standard conditions in appendix A of chapter 11-55, implementation of best management practices (BMPs), monitoring of discharges, avoiding violations of water quality criteria, and specified reporting. The full statement of requirements appears in the general permit.

4. Spills to ground only - with public access

a. Applicability. Any wastewater spill from a wastewater system onto the ground and that does not enter state waters but is in an area which is or may be accessible to the public.
   (1) In this appendix, the public includes hotel, apartment, and condominium residents and guests, or condominium apartment owners at their own condominium, and management personnel and building or facility staff, unless the person is specifically an operator of the wastewater system or a manager of the property.
   (2) In this appendix, areas inaccessible to the public include areas:

(a) Confined within a fenced or walled (six foot high with locked gate or door) area; and

(b) Contact with the spill is limited to wastewater system operating personnel and management personnel for the property owner or lessee.

(3) Exclusion. Spills of R-1 water provided the owner/agent demonstrates that the spill was of R-1 water and that BMPs as approved by the director were implemented.

b. Immediate notice to DOH. If a spill of a thousand gallons or more occurs during working hours:

(1) On Oahu, the wastewater system owner/agent shall immediately notify the WWB; or

(2) On the neighbor islands, the owner/agent shall immediately notify their respective district EHP chief.

If a spill of a thousand gallons or more occurs during non-working hours:

(1) Contact the state hospital operator; and

(2) The next working day notify the WWB or on the neighbor islands, the respective district EHP chief with a follow-up call.

c. Press release. The owner/agent shall immediately send out a press release for spills of a thousand gallons or more, and for lesser spills if they present a substantial threat to public health. A press release shall comply with section 7.

d. Disinfection. The owner/agent shall disinfect the wastewater that is spilled onto the ground if the wastewater remains ponded on the ground for any sufficient length of time or if the discharge continues for any significant duration. Disinfection is not required if the owner/agent demonstrates that the spill was R-2 water and that BMPs as approved by the director were implemented.

e. Warning signs. The owner/agent shall immediately post warning signs in the vicinity of the spill area.

f. Clean up. All spill sites shall be cleared of all debris and standing wastewater, and disinfected pursuant to section 4.d.

   In areas containing standing wastewater which cannot be removed, the owner/agent shall limit public access by having barricades or other means.

g. Reporting. The owner/agent of a public wastewater system shall report to the WWB as follows:
   (1) For spills of a thousand gallons or more, the owner/agent shall report to the WWB under section 9.a.
   (2) For spills less than a thousand gallons, immediate notice and reporting are not required. A tabulated summary of all spills less than a thousand gallons each shall be submitted to the WWB on a quarterly basis in accordance with section 9.b.
   (3) Exfiltration. Reporting of leaks or breaks in pipelines discovered during inflow/infiltration repair work is not required. These situations are considered exfiltration.

5. Spills to ground only - with no public access

a. Applicability. All wastewater spills from any public or private wastewater system that does not enter state waters and are in areas inaccessible to the public.
   (1) The public and inaccessibility are described in section 4.a.
   (2) Exclusion. Spills of R-1 water provided the owner/agent demonstrates the spill was of R-1 water and that BMPs as approved by the director were implemented.

b. Immediate notice to DOH. If a spill of a thousand gallons or more, and for spills occurring more than twice within a 12 month period within the confines or fence line of a wastewater system, the owner/agent shall notify the WWB within 24 hours.

c. Reporting. For spills of a thousand gallons or more, and for spills occurring more than twice within a 12 month period within the confines or fence line of a wastewater system, the owner/agent shall report to the WWB under section 9.a.

d. Recording. The owner/agent shall record and tabulate the date and time of the spill, the amount released, the cause(s) for the spill, clean up efforts, and remedial actions taken to prevent future spills for all spills greater than 50 gallons as they happen. The owner/agent shall keep the records and tabulations on site and make the records and tabulation available to the director for inspection and copying.

6. Spills to ground only - R-1 water only

a. Applicability. Spills of R-1 water provided the owner/agent demonstrates the spill was of R-1 water and that BMPs as approved by the director were implemented.

b. Notice to DOH.
   (1) For spills of a thousand gallons or more occurs, the wastewater system owner/agent shall notify the WWB at least by phone by the end of the next working day. The notice shall provide the information required by section 6.d(1), below.
   (2) For spills of less than a thousand gallons, but more than fifty gallons, next day notice is not required, but the wastewater system owner/agent shall record the information and report as required by section 6.d.

c. Warning signs. For spills greater than fifty gallons, the owner/agent shall immediately post warning signs in the vicinity of the spill area.

d. Reporting. The owner/agent of a wastewater system shall report in writing to the WWB as follows:
   (1) Information of each spill shall include at least the spill's date, time, location, quantity, the reason for the spill, and any corrective action.
   (2) For spills more than fifty gallons, a tabulated summary shall be submitted to the WWB each year with the summary report required by section 11-62-28.

7. Press release

The press release shall describe the location of the spill, the amount of wastewater released, what caused the spill, and what is being done to correct the situation. Also, include a contact person and telephone number (including an after hours/weekend contact). At a minimum, the press release shall be faxed or telephoned to the following:

a. Associated Press (for radio dissemination);
b. Major statewide and island newspapers;
c. Major television news stations;
d. Department of Health, Communications Office, Oahu
e. CWB if into state waters, otherwise WWB; and
f. For neighbor island spills, also include faxing the press release to the respective island DHOs.

8. Monitoring of state waters

Monitoring shall begin as soon as possible and be conducted in the receiving water area affected by the spill. Bacterial monitoring is not required if the owner/agent demonstrates that the spill was of R-1 water and that BMPs as approved by the director were implemented.

For spills entering fresh or brackish waters, the bacterial monitoring shall consist of sampling for the following indicator organisms:

a. Fecal coliform; and
b. Clostridium perfringens.

For spills entering marine waters, the bacterial monitoring shall consist of sampling for the following indicator organisms:

a. Enterococci; and
b. Clostridium perfringens.

Results of the bacterial monitoring shall be submitted to the director in care of the CWB immediately. Monitoring shall continue until notification to stop is received from the director. With the approval of the director, on a case by case situation, some protocol requirements such as sampling or sign posting may be waived.

The director shall also be informed of the sampling stations and may modify the number of stations and site selection.

The director may require additional bacterial monitoring by the owner/agent to supplement their existing monitoring program, as may be necessary or appropriate.

9. Reporting

a. When required above, the owner/agent shall submit a written report of the details of the spill within five (5) calendar days of the incident to the director in care of the CWB or WWB as applicable. The director may waive the five day written reporting requirement on a case by case basis provided that the director receives a request for waiver prior to the due date of the report.

The report shall include the date and time of the spill, the amount released, the cause(s) of the spill, location where the spill entered state waters (storm drains, ditches, streams, etc.), clean up efforts, remedial actions to prevent future spills, a summary of the monitoring data, a map of the

sampling locations and public notification procedures if applicable.

b. For spills not reported under section 9.a. and when required above, the owner/agent shall tabulate the following information: the date and time of the spill, the amount released, the cause(s) for the spill, clean up efforts, and remedial actions taken to prevent future spills. The owner/agent shall submit each quarter's tabulation to the WWB within 30 days after the quarter.

10. Modifications by the director

With the approval or under the direction of the director, response requirements may be increased, changed, reduced, or eliminated. For example, the director may require the owner/agent to post additional Warning Signs as needed or may assist in the removal of warning signs.

Situation	Immediate Notification to	Press Release[1*]	Disinfect[**]	Warning Signs[*]	Clean Up[2]	Monitor[*]	Follow Up Written Report to
Into State Waters - All Wastewater Systems (Section 2)	CWB or EHP (SOSC/SHO)	yes	yes	yes	no	yes	CWB
Not Into State Waters w/Public Access - Public Wastewater Systems (Section 3)[*]	WWB or EHP (SOSC/SHO)[*]	yes	yes	yes	yes	no	WWB[*]
Not Into State Waters w/Public Access - Private Wastewater Systems (Section 4)[*]	WWB or EHP (SOSC/SHO)[*]	yes	yes	yes	yes	no	WWB[*]
Not Into State Waters w/o Public Access - All Wastewater Systems (Section 5)[*]	WWB[*]	no	yes	yes	yes	no	WWB[*]

[*]Except for proven R-1 water and BMP Compliance

[**]Except for proven R-2 water and BMP Compliance

[1]If spill greater than or equal to 1,000 gallons or spill may threaten public health

[2]Or barricade if clean up not possible

HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
DIRECTORATE OF PUBLIC WORKS
SCHOFIELD BARRACKS, HAWAII 96857-5013

Enclosure (3)

PUBLIC AFFAIRS OFFICE NOTIFICATION FORM

Faxed to PAO. Date:_____ Time:_____. Fax No. 655-9290, phone: 655-4815.

Media Notification Required By DOH When Spills Occur

Instructions for filling in the press release statement.

The Army reports a spill of ____(how many)___ gallons of ___(what)___ at ____(location)_____. The spill occurred at ___(time)___ hours on ___(date)___. The cause of the spill was _____.

The Army is _____(doing what to remedy)____. Clean-up should be completed by ____(date & time)____.

(DPW Notifier. Name:_____ Phone No.:_____)

(Fill in the blanks as marked with information provided by DPW. Then call and give the completed following statement to the two news services. DOH requires us to notify: UPI at 533-1828, 0530-0100 hours.; and AP at 533-2422, 0500-2330 hours.)

Press Release Statement.

"The Army reports a spill of _____ gallons of _____ at _____. The spill occurred at _____ hours on _____. The cause of the spill was _____ _____.

The Army is _____

_____. Clean up should be completed by _____.

The U.S. Army Garrison, Hawaii, Public Affairs Office, 655-4221/4815, will provide more information as it becomes available."

(UPI Notified. Date:_____ Time:_____)

(AP Notified. Date:_____ Time:_____)

IDDE APPENDIX K
Island Palm Communities (IPC) Legal Authority

This page intentionally left blank.

Resident Guide & Community Standards Handbook

Effective February 15, 2011

Welcome 7
Frequently Used Numbers 8
SECTION 1 Operations 11
1.1 Hours of Operation 11
1.2 Regional Leasing Offices 11
1.3 Policy Changes 11
1.4 Rental Policies 11
1.5 Resident Processing Procedures. 11
1.6 Move-in Process. 12
1.7 Collection of Rent and Other Receipts. 12
1.8 Security Deposits and Fees 13
1.9 Housing Agreement Terms & Guide Enforcement Policy 13
1.10 Evictions, Violations and Delinquent Accounts 13
1.10.1 Minor Violations 13
1.10.2 Major Violations 14
1.10.3 Corrective Action 14
1.11 Residency Requirements 15
1.12 Guest Policy 15
1.13 Resident Responsibilities 15
1.14 Commercial Enterprises Policy 16
1.15 In-home Childcare 16
1.16 Temporary Absences of Residents from Units 16
1.17 Access to Homes 16
1.18 Abandonment Policy 16
1.19 Dispute Resolution Procedure. 16
1.20 Weapons and Firearms 17
1.20.1 Registration 17
1.20.2 Restrictions 17
1.20.3 Violations 17
1.21 Noise Control 17
1.22 Housekeeping. 18
1.23 Fire Safety 18
1.23.1 Reporting. 18
1.23.2 Resident Responsibilities 18
1.23.3 Carbon Monoxide 18
1.24 Incidents 18
1.25 Resident Moves 18
SECTION 2
Traffic Regulations, Parking Restrictions and Vehicle Procedures . . 21
2.1 Speed Limit 21
2.2 Operating Areas 21
2.3 Parking. 21
2.4 Child Supervision in a Vehicle. 21
2.5 Installation Regulations 21
2.6 RV Parking Restrictions 22
2.7 Vehicle Maintenance. 22
2.7.1 Appearance 22
2.7.2 Vehicle Registration and Decals 22
2.7.3 Abandoned Vehicles 22
2.7.4 All Terrain Vehicles (ATVs). 22

back to table of contents

SECTION 3 Child Supervision 25

3.1 Responsibilities 25

3.2 Supervision 25

3.3 Prohibited Play Areas 25

SECTION 4 Pet Policies 27

4.1 Guidelines for Pet Owners 27

4.2 Disposal of Deceased Pets 28

SECTION 5
Utility Consumption and Conservation. 31

5.1 General 31

5.2 Method 31

5.3 Energy Reduction 31

5.4 Violations 31

5.5 Solar Water Heaters 31

5.6 Utility Billing Program. 32

SECTION 6
Alterations, Additions and Construction . 35

6.1 Alterations to Homes 35

6.1.1 Approval 35

6.1.2 Community Projects 35

6.2 Fences 35

6.3 Storage Sheds 35

6.4 Antennas 35

6.5 Satellite Dishes 35

6.5.1 Requirements 35

6.5.2 Responsibilities 35

6.5.3 Guidelines 36

6.6 Locks, Latches, and Dead Bolts 36

6.7 Security Alarm Systems 36

6.8 Lawn Ornaments 36

6.9 Rocks 36

6.10 Painting 37

6.10.1 Guidelines. 37

6.10.2 Restrictions 37

6.10.3 Borders and Wallpaper 37

6.11 Nails. 37

6.12 Pools, Hot tubs and Jacuzzi 37

6.13 Trampolines 37

6.14 Waterbeds 37

6.15 Pet Houses 37

6.16 Patio, Lawn Furniture, Toys
and Playground Equipment 38

6.17 Ornamental Lighting for Holidays 38

6.18 Tents, Tarps and Covers 38

back to table of contents

SECTION 7

Miscellaneous 41

7.1 Tree Swings, Tree Hammocks, Tree Houses and Signage 41

7.2 Bicycles, Skateboards, Scooters, Tricycles, Roller Blades and Like Equipment. 41

7.2.1 Playgrounds 41

7.2.2 Amenities 41

7.3 Basketball Backboards 41

7.4 Yard and Garage Sales 42

7.5 Fireworks 42

7.6 Appliances 42

7.6.1 General. 42

7.6.2 Policy 42

SECTION 8

Maintenance Program 45

8.1 Maintenance and Repair Overview 45

8.2 Service Calls 45

8.2.1 Service Call Classifications 45

8.3 Preventive Maintenance Work. 46

8.4 Pest Control Services 46

8.5 Refuse Collection and Recycling. 46

8.6 Grounds and Landscape Maintenance Program 47

8.7 Air Conditioner Window Unit and Ceiling Fan Installation Policy 47

SECTION 9

Crisis Management/Disasters 51

9.1 Warnings 51

9.2 Procedures and Directives 51

SECTION 10

Self Help 51

10.2 Lawn and Garden 51

SECTION 11

Renter's Insurance Policy. 51

11.1 Renter's Insurance Guidelines 51

SECTION 12

Move-Out Procedures 52

12.1 Resident Occupancy Agreement Termination/Vacate Procedures. 52

12.2 Pre-termination Inspection 52

12.3 Termination Inspection 53

12.4 Cleaning Requirements 53

ENCLOSURE 1

Mold Disclosure. 55

Information and Steps for Prevention 55

1. About Mold 55

2. Prevent Mold 55

3. Avoid Mold Growth. 55

4. Biocides 56

5. Compliance 56

ENCLOSURE 2

Pesticide-impacted Soil Disclosure. . . 57

Pesticide-impacted Soil Disclosure 57

back to table of contents

back to table of contents

Welcome

E komo mai! Welcome to Island Palm Communities. Our team is committed to providing military families an enjoyable experience during their stay in the islands, and we pride ourselves on delivering quality and efficient services. Community centers in each neighborhood are staffed with property management professionals that understand the special needs of military families and are eager to support you.

To maintain a safe, enjoyable, and pleasant community for all our families, we have established the "Island Palm Communities Resident Guide & Community Standards Handbook." It is intended to help you understand our services, policies and procedures, and explain what your responsibilities are as a resident. The policies found in this handbook apply to all Island Palm Communities residents. It is an addendum to your Resident Occupancy Agreement and is legally binding. We encourage you to familiarize yourself with policies in this handbook and share the information with your family.

It is our goal to be actively involved in our communities when it comes to providing property management services and community activities that will enhance resident life. We look forward to your family becoming a part of Island Palm Communities.

Mahalo!

Tom Adams
Director of Property Management

Island Palm Communities LLC is a partnership between developer Lend Lease and the U.S. Army. It is responsible for asset, property and maintenance management, including the development, design, construction and renovation of homes within Island Palm Communities.

back to table of contents

Frequently Called Numbers

For all medical, fire or police emergencies, call 911

Island Palm Communities Regional Leasing Offices

North Regional Office	877-487-4323	215 Duck Road, Bldg. 950, Schofield Barracks, HI 96857
South Regional Office	888-939-3346	111 7th Street, Bldg. 1004, Ft. Shafter, HI 96819

Island Palm Communities Community Centers

Aliamanu	275-3850	182 Kauhini Road, Honolulu, HI 96818
AMR Rim/Red Hill	275-3860	261 Halawa View #102, Honolulu, HI 96818
Canby	275-3760	403 Gordon Road, Wahiawa, HI 96786
Fort Shafter/Tripler	275-3820	225 Austin Road, Bldg. 1064, Honolulu, HI 96818
Patriot/Hamilton	275-3720	206 Thomas Paine, Bldg. 105, Wahiawa, HI 96786
Helemano	275-3780	173 Romero Road, Bldg., P1 Wahiawa, HI 96786
Kalakaua	275-3750	2535 Waianae Uka Avenue, Wahiawa, HI 96786
Porter	275-3770	1301 McCornack Road, Wahiawa, HI 96786
Kaena (Santa Fe)	275-3730	5485 Gallup Street, Wahiawa, HI 96786
Wheeler	275-3790	100 Vought Avenue, Bldg. 685, Wahiawa HI 96786

Maintenance Services

Maintenance Office - North Region	457-4075
Maintenance Office - South Region	457-4050

back to table of contents

Schools

Aliamanu Elementary	421-4280
Aliamanu Middle	421-4100
Ft. Shafter Elementary	832-3560
Hale Kula Elementary	622-6380
Helemano Elementary	622-6336
Leilehua High School	622-6550
Makalapa Elementary	421-4110
Moanalua High School	837-8455
Moanalua Elementary	831-7878
Moanalua Middle	831-7850
Mokulele Elementary	421-4180
Nimitz Elementary	421-4165
Radford High School	421-4200
Red Hill Elementary	831-7866
Solomon Elementary	624-9500
Wahiawa Elementary	622-6393
Wahiawa Middle	622-6500
Webling Elementary	483-7240
Wheeler Elementary	622-6400
Wheeler Middle	622-6525

Utilities

Contact ista Customer Service for utility billing questions	800-569-3014 or inquiries@ista-na.com
Oceanic Time Warner (telephone, TV cable, internet)	643-4411

Other frequently called numbers

American Red Cross (Schofield Barracks)	655-4927
American Red Cross (Tripler AMC)	433-6631
Army Community Services (Fort Shafter - South)	438-9285
Army Community Services (Schofield Barracks - North)	655-4227
Auto Skills Center, Fort Shafter	438-9402
Auto Skills Center, Schofield Barracks	655-9368
Child Development Services	655-8380/5314
Crisis Hotline	521-4555
Family Advocacy Program	655-4779
Fort Shafter PX	843-1969
Job Information Center	438-8446
Joint Military Family Abuse Shelter	533-7125
Military Operator	449-7110

back to table of contents

back to table of contents

Section 1

Operations

1.1 Hours of Operation

Community Centers

Monday through Friday	8 a.m. – 5 p.m.
Saturday	By appointment only
Sunday	Closed

North Regional Office
Monday, Wednesday and Friday • 8 a.m. to 5 p.m.
Tuesday, Thursday • 7 a.m. to 6 p.m.
Saturday • 10 a.m. to 2 p.m.

South Regional Office
Monday - Friday • 8 a.m. to 5 p.m.

Island Palm Communities community centers and regional offices are closed on most federal and approved holidays. Office hours may change based on demand. Emergency maintenance services are available 24 hours a day. Refer to page 8 of this handbook for a list of telephone numbers.

1.2 Regional Leasing Offices

Regional leasing offices are located at Schofield Barracks (215 Duck Road, Building 950) and at Fort Shafter (111 7th Street, Building 1004).

As part of our community-based management strategy, property staff is located in each community. Community centers are designed to foster communications with residents and make it easier for residents to interact with Island Palm Communities property staff. Island Palm Communities maintenance service operations are centrally located in the north and south.

1.3 Policy Changes

Periodically, revisions to the "Island Palm Communities Resident Guide & Community Standards Handbook" will be necessary. Residents will be notified in writing 45 days prior to any changes, and notices also will be posted to www.IslandPalmCommunities.com.

1.4 Rental Policies

Island Palm Communities will accept applications for housing from families as they in-process. Advance applications from Service Members who are on Permanent Change of Station (PCS) orders to military units on Oahu may be submitted prior to arrival. Applications are located on the Island Palm Communities website and can be submitted online, emailed or faxed to our regional leasing offices. Referred applications are put onto a wait list, which is managed by Island Palm Communities according to priority, pay grade, bedroom entitlement, and eligibility date. Applicants on the wait list are offered homes as they become available.

Declination of an offer
If an applicant declines an offer, the applicant will be placed at the bottom of the wait list appropriate to the senior Service Member's rank and bedroom requirement. This policy is established to ensure that all eligible Service Members are afforded the opportunity to be offered a home.

Temporary Living Allowance
Temporary Living Allowance (TLA) is managed by the Army Housing Services Office co-located within Island Palm Communities regional leasing offices.

1.5 Resident Processing Procedures

When a prospective resident arrives at an Island Palm Communities regional leasing office, an Island Palm Communities team member interviews each prospective resident and explains the following policies and procedures:

- Types and locations of houses and availability
- Rental policies, lease content, and resident guide
- Loaner furniture and appliance policies
- Pet policies and fee
- Amenities and services

The Island Palm Communities team member will:

- Provide maps of Island Palm Communities and floor plans of homes (if available)
- Accompany the resident to view neighborhoods

Guidelines for Waitlist and Housing Assignment

Assignment Provisions
Housing will not be made available unless the Service Member has at least *six* months remaining on his or her tour as verified by the Enlisted Record Brief/Officer Record Brief. Service Members married to other Service Members whose spouses accompany them on their tour are authorized assignment to family housing. Unmarried Service Members with accompanying (Command-sponsored) family members

back to table of contents

also are authorized family housing contingent upon those family members residing with them for more than six months in a calendar year as substantiated by legal documents.

Eligibility

An eligibility date is assigned and the Service Member is placed on the applicable waiting list by rank, bedroom and location preference (north or south). The eligibility date is defined as the date the Service Member departed his or her last duty station, as long as the Service Member applies for housing within seven days of arrival. Adjustments to the eligibility date will be made

Eligibility for housing will be based on the following priority

CATEGORY	PRIORITY
Key and essential accompanied or unaccompanied military or civilian personnel (including active duty Coast guard) assigned or attached for duty at the installation or at a Coast Guard or Marine facility. Key and Essential list is proposed by senior unit commanders and approved by the Garrison Commander	1
Accompanied military personnel (including active duty Coast guard) assigned or attached for duty at the installation or at a Coast Guard or Marine facility.	2
Accompanied military personnel (including active duty Coast guard) assigned or attached for duty within a 50 mile radius of the installation or at a Coast Guard or Marine facility.	3
Unaccompanied family members of military personnel (including active duty Coast guard) assigned or attached for duty at the installation or at a Coast Guard or Marine facility.	4
Unaccompanied military personnel (married and single, including active duty Coast guard) assigned or attached for duty as stated in priority categories 2 and 3. *	5
Retired military personnel (including retired Coast guard) and spouses or widowed spouses of retired military personnel (including retired or active duty Coast Guard).	6
DOD and Federal Agency civilians (other than designated key and essential).	7
DOD Contractors.	8
No-military, non-DOD or no-Federal Agency personnel not included in priority categories 1 through 8 (general public)	9

for special duty tours, such as dependent restricted tours. When placed on the waiting list, the Service Member will sign a form to notify Island Palm Communities of any changes in personal information such as phone numbers, e-mail address or off-post address.

1.6 Move-in Process

Upon move-in, each resident will complete a move-in inspection with an Island Palm Communities team member. A brief home orientation is conducted and notes are made concerning any items that show existing wear and tear. Upon move-out, the move-in inspection is compared with current conditions to determine if any damage, beyond normal wear and tear, has occurred and if any damage charges need to be assessed.

All residents will be invited to a Resident Forum within 30 days after move-in. This forum will provide valuable information on:

1. Resident Activities
2. The Island Palm Communities Resident Advisory Board
3. Recycling and Sustainability
4. Island Palm Communities Resident Guide and CommunityStandards Handbook
5. Overview of Island Life

1.7 Collection of Rent and Other Receipts

The rent is collected monthly by allotment for active duty residents and by cashier's check, money order, debit card, MasterCard and Visa for retirees and DoD civilians. The allotment shall be adjusted periodically as the Basic Allowance for Housing (BAH) changes. Monthly rent is paid per lease agreement. If the Hawaii BAH for a resident's rank is decreased, but the Hawaii BAH received by the resident is protected at a higher rate, the allotment will continue at the protected Hawaii BAH rate. In cases where a tenant's Hawaii BAH is rate protected due to changes in the Hawaii BAH, the tenant agrees that rent shall equal Hawaii BAH with dependents rate as shown on the senior Service Member's Leave and Earnings Statement (LES) residing at the premises. Residents should review their LES to ensure the correct BAH allotment for monthly rent is reflected. Residents should immediately notify their community center staff if LES does not reflect the correct allotment for monthly rent or if an insufficient amount of rent via allotment is being paid to Island Palm Communities. Residents are responsible for payment of monthly rent until such time as the home is cleared through Island Palm Communities.

The resident shall notify Island Palm Communities property management of any changes in his/her family status, military status, or pay grade within 14 days of such changes. Failure to report changes may be considered a minor violation. Under no circumstances will a resident be terminated from Family housing due to a reduction in pay grade without prior approval of Island Palm Communities government partner (RCI) at the Army Housing Office. If a resident's pay grade is downgraded,

back to table of contents

the resident may be reassigned, with Army Housing Office approval, to another available unit commensurate to the resident's bedroom requirement and pay grade. The resident is responsible for payment of moving expenses related to any move caused by a pay decrease or increase. Upon move-in, the resident is responsible for paying the pro-rated rent for the first month. Pro-rated rent is calculated by dividing the monthly rent amount by a 30 day month to determine a daily rate and multiplying by the number of days in the month that the home will be occupied. Acceptable forms of payment are cashier's check, money order, debit card, MasterCard and Visa. Once the resident accepts the home, the exact amount that is due upon move-in is then disclosed. Residents sign an acknowledgment form indicating that he/she is aware of the amount due at move-in.

The monthly rental rate shall equal the Hawaii BAH with dependants rate for the senior Service Member resident at the premises, unless modified in writing and agreed upon by the resident and Island Palm Communities. Resident certifies to Island Palm Communities that he or she is the senior Service Member resident at the premises and resident agrees that if any other resident at the premises becomes the senior Service Member resident at the premises, he or she will be required to sign an agreement and become the "Resident." Payment is due on the first day of the month for the previous month's rent (payment in arrears) for active duty Service Members. DoD civilians and retirees are required to pay rent on the first day of the month for payment of the current month's rent (payment in advance).

1.8 Security Deposits and Fees

Security deposits or background credit check fees are not charged for active duty personnel; however, pet fees are applicable. Please refer to Section 4, Pet Policies for details. DoD civilians and retirees are required to pay a security deposit and fees associated with background check.

1.9 Housing Agreement Terms & Guide Enforcement Policy

Island Palm Communities is responsible for the enforcement of the Resident Occupancy Agreement and the "Island Palm Communities Resident Guide & Community Standards Handbook." When Island Palm Communities is made aware that the terms of the Resident Occupancy Agreement or the "Island Palm Communities Resident Guide & Community Standards Handbook" are not being followed, the resident will be advised of such violation through verbal notification, citation or letter. Any necessary follow-up letters that result in termination of residency are sent to the resident and to the Service Member's Command, Installation's Community Compliance Section, and the Army Housing Office as explained in Section 1.11. If necessary, a meeting with the resident will be scheduled as soon as possible to resolve all issues and to clarify any misunderstandings between the parties. Island Palm Communities property management always will strive to work with residents to resolve problems.

If any issue cannot be resolved, either Island Palm Communities or the resident may elect to escalate the dispute to include Army Housing Office representatives and the Service Member's Command. If the parties agree on a resolution, they will enter into a settlement agreement or a consent order that memorializes the terms of the recommendation. Not withstanding the foregoing and regardless of whether a dispute has been the subject of a mediation, at the election of either Island Palm Communities or the resident, any dispute between Island Palm Communities and the resident shall be resolved by binding arbitration in accordance with the Dispute Resolution procedures referenced in Section 1.19.

1.10 Evictions, Violations and Delinquent Accounts

Residents who fail to comply with the terms of their Resident Occupancy Agreement and the "Island Palm Communities Resident Guide & Community Standards Handbook" are subject to various remedies, including reports to Command, fees to bring the home into compliance, fines, or possible eviction.

Community directors will assist the community manager in notifying the Soldier's chain of command prior to the resident's referral into the debt collection process. If payment is not made or a payment plan agreed upon and adhered to, the resident may be issued a five day notice to quit, which may result in eviction if left unresolved.

Residents are responsible to pay all amounts due prior to clearing their Island Palm Communities home. In the event accounts remain unpaid they will be sent to a collection agency.

1.10.1 Minor Violations

The processes and penalties for minor violations of the Resident Occupancy Agreement or the "Island Palm Communities Resident Guide & Community Standards Handbook" are described in Island Palm Communities Citation Process chart found on page 14 and are described below.

Examples of minor violations include, but are not limited to:

back to table of contents

- Failure to maintain yard and property appearance standards
- Parking in front of or within 15 feet of a fire hydrant or mailboxes
- Parking in alleyways (vehicles may be towed)
- Unauthorized commercial activities, including home child care
- Excessive noise that disturbs others (see Section 1.22)
- Unauthorized construction or alteration to any Island Palm Communities structure
- Unauthorized or improper installation of window air conditioner units
- Unauthorized vehicle maintenance
- Curfew violations by minors
- Failure to allow maintenance staff access to homes for needed work
- Unauthorized or illegal RV, automobile, jet ski, boat, or any other recreational vehicle storage at the resident's home or in surrounding community
- Failure to maintain residence, parking areas, yards, and surrounding areas
- Excessive or improper utility usage
- Vehicles parked on the grass or on prohibited streets

IPC Citation Process

Resident violates IPC Guidelines (verbal / citation)

Step 1 (verbal/citation)

IPC informs the resident of the violation with a personal visit. A citation is issued and a copy kept in the resident's file. Resident has 72 hours to correct the violation

Step 2 (Warning Letter)

If the violation has not been corrected the resident is issued a Warning Letter Resident has 48 hours to correct the violation or be assessed a $50 fine.

Copy of Violation Letter sent to AHO and the SMs Chain of Command

Step 3 (Final Warning Letter with $50 fine)

If the violation has not been corrected the resident will receive a Final Warning Letter with an automatic $50 fine Resident has 24 hours to correct the violation and pay the $50 fine.

Copy of Violation Letter sent to Installation's Community Compliance Section, AHO and the SMs Chain of Command

Step 4 ($150 fine or Termination)

If the violation has not been corrected and the $50 fine has not been paid a $150 fine will be issued. Resident has 24 hours to pay the fine and correct the violation or a Request for Termination of Housing will be initiated.

Copy of Violation Letter sent to Installation's Community Compliance Section, AHO and the SMs Chain of Command

- Storage of personal items in carports
- Placing storage containers, commonly referred to as "PODS," in driveways, on roads, in open vehicle stalls or on any Island Palm Communities property without prior written authorization from community center. Use of PODS is limited to a maximum of seven calendar days and is subject to removal without notice at the resident's expense.
- Use of unauthorized storage sheds in common areas without prior written authorization from community center

1.10.2 Major Violations

Violations of the Resident Occupancy Agreement or the "Island Palm Communities Resident Guide & Community Standards Handbook" of a serious nature may result in immediate eviction. If the violation is not immediately corrected after appropriately notifying the resident of the violation in accordance with Section 1.10, Island Palm Communities may proceed with an eviction. In addition, Island Palm Communities will contact the resident's chain of Command, Installation's Community Compliance Section and the Army Housing Office for consultation and appropriate action. Violations of a serious nature include, without limitation, the following:

- Serious misconduct, including repeat minor offenses involving the resident, Family member or guest
- Inherently dangerous or criminal actions
- Domestic disturbances
- Non-payment of damage charges
- Pet policy violations (including pet abandonment)
- Poor sanitary practices or housekeeping, including failure to properly dispose of refuse or store refuse containers
- Felony convictions
- Misconduct, which results in injury or property loss to a neighbor, Island Palm Communities or the government
- Criminal activity by any member of the household or a guest
- Spousal or child abuse
- Failure to pay rent; failure to authorize (or discontinuance of) allotment
- Misuse, discharging or brandishing a weapon in the housing area
- Improper sublease or assignment of housing agreement
- Failure to comply with a Letter of Warning for a minor violation
- Unauthorized guests living in home

back to table of contents

1.10.3 Corrective Action

Island Palm Communities reserves the right to take corrective action for violations not corrected by the resident after citation has been given if the violation affects the health or safety of other residents. Resident will be charged as needed for corrective actions. These items include but are not limited to:

1. Unkempt yards

a. Lawn not mowed

i. Three days to correct

ii. $40 fee for contract lawn service

b. Excessive items in yard

i. Three days to correct

ii. $100 pick up and storage fee

iii. $100 re-delivery fee

2. Trampolines

a. Unsafe/unauthorized trampolines

i. Three days to correct

ii. $100 disassembly fee

iii. $75 removal fee

3. Improper storage of HHG

a. HHG stored in carport, outside fenced area, etc.

i. Three days to correct

ii. Fee dependent upon volume/weight of items

4. Improperly installed A/C units

a. A/C unit installed by resident improperly

i. Three days to correct

ii. $125 to repair/re-install properly

5. Swimming Pools

a. pools left in yards with standing water

i. Three days to correct

ii. $35 fee to remove/empty

6. Animal feces

a. Feces in yards that prevents landscaping service

i. Three days to correct

ii. $35 to remove

7. Hazardous materials

a. Tires, batteries, paint, oils, flammable liquids, etc.

i. Three days to correct

ii. $100 fee to pick up and dispose

8. Illegally Parked/Abandoned Vehicles

a. Will be towed at owner's expense

1.11 Residency Requirements

The resident will only be entitled to Family housing in an Island Palm Communities community during his or her military service, unless otherwise approved. The Resident Occupancy Agreement shall be subject to termination by Island Palm Communities immediately upon the earlier of (1) the cessation of his or her military service or (2) the discontinuance of BAH. In addition, all residents, including children, shall be accounted for within the Resident Occupancy Agreement. The resident agrees that those included within the Resident Occupancy Agreement are the only persons who are permitted to reside in the home. It is the resident's responsibility to notify Island Palm Communities of any change in the number of individuals living in the home in writing within 14 days.

If the resident becomes ineligible for Island Palm Communities Family housing due to divorce or legal separation, no dependents, drug conviction, felony conviction, or cessation of military service, the Resident Occupancy Agreement will be terminated.

1.12 Guest Policy

The resident is responsible for his or her guests, including any damage, theft or violations of the Resident Occupancy Agreement or the "Island Palm Communities Resident Guide & Community Standards Handbook" caused by guests. Residents shall notify their respective community center in writing of all guests staying more than seven days, but less than 29 days. No guest or visitor may stay in the home for more than 30 days without the expressed written consent of Island Palm Communities. Island Palm Communities will review and approve requests for guest(s) staying longer than 30 days on a case-by-case basis and in accordance with any deployment and installation policies. The request should provide specific reasons for the exception. A guest is defined as a person or persons, including military personnel and their Family members, who do not reside in Island Palm Communities communities or elsewhere on the island of Oahu. Military personnel and their Family members attached for duty on the island of Oahu are not permitted to be a registered guest of Island Palm Communities residents.

1.13 Resident Responsibilities

Island Palm Communities will mow front and side yards, excluding fenced areas and planter beds. Additionally, Island Palm Communities will mow backyards that are not fenced.

back to table of contents

Residents are responsible for the following items:

- Mowing, edging, watering lawns and all plants within the private fenced areas
- Weeding of flower/plant beds
  Watering lawns as needed and in according to installation guidelines (check with your community center for guidelines). Watering is prohibited between 0900 and 1700. Specific questions regarding resident responsibilities should be referred to the community manager.
- Gardening
  Flower beds should be kept free of grass, weeds, dead plants, and trash. Separate trash from grass and plant debris before placing in designated green waste bins. Historically, the soil around homes has been treated with pesticides; therefore, Island Palm Communities does not permit residents to dig in or disturb the soil. There is also a potential risk for plants to be affected by historical pesticide use. For this reason, growing fruits and vegetables and eating fruit from existing trees is not permitted. (Refer to Enclosure 2, page 57.)
- Cleaning of refuse collection areas, including collection containers
- Receiving prior written approval from community center for personally installed landscaping features.
- Planting of trees and/or bushes, including fruit trees, is strictly prohibited. Decorative flowers are permitted, however, the resident may be required to remove flowers and restore the landscaping to its original condition prior to move out.
- Storing bicycles, carts, toys or other personal items, to avoid a hazardous situation or unsightly appearance and must be stored in an approved location
- Cooperating with contractors or maintenance personnel to accomplish needed maintenance and repair or contracted projects
- Practicing fire safety in and around Island Palm Communities housing
- Maintaining a safe and sanitary living environment, commonly referred to as housekeeping, inside and outside of homes at all times
- Ensuring personal residence, including exterior, is maintained during extended absences (e.g. unaccompanied tours, deployments, deferred travel, personal travel, etc.) according to Island Palm Communities standards
- Providing Island Palm Communities with an emergency phone number and a local point of contact before departing the area, if the absence will be longer than seven days

1.14 Commercial Enterprises Policy

Contact your Island Palm Communities community center for procedures on receiving approval for commercial enterprises.

1.15 In-home Childcare

Residents desiring to provide childcare services in their private residences only can do so if they are under the direction of the Child and Youth Services (CYS) Certified Family Child Care Program. All childcare programs are subject to Army Regulation 608-10. Any costs associated with modifications required to sustain business or obtain licensing will be the responsibility of the resident. The only exceptions to this policy are for those residents providing intermittent childcare not exceeding 10 hours per week on a regular basis and for persons who provide childcare in the child's home. Island Palm Communities is not responsible or liable for any misconduct, negligence or other offenses by any childcare provider and is in no way associated with the Child and Youth Services program(s) other than allowing their programs to continue to operate. Any modifications or alterations to the building required for certification by CYS must be done in compliance with the Resident Occupancy Agreement, the "Island Palm Communities Resident Guide & Community Standards Handbook," and the Historic Homes Addendum (if applicable), and will be paid for by the resident. The resident must return the home to its original condition prior to move-out.

1.16 Temporary Absences of Residents from Units

When residents are planning to be away from their home for more than seven days they must notify their community center in advance and in writing, and they must provide a local emergency contact. In the event of an absence from the home, the resident is required to arrange for adequate care of the residence. Required care includes, but is not limited to, lawn maintenance, collection of mail, removal of newspapers, etc. Pets may not be left unattended. Should an emergency arise, Island Palm Communities property management may enter the housing unit to ensure the integrity and safety of the unit and surrounding units. Written notice of such entry will be left in a conspicuous location.

1.17 Access to Homes

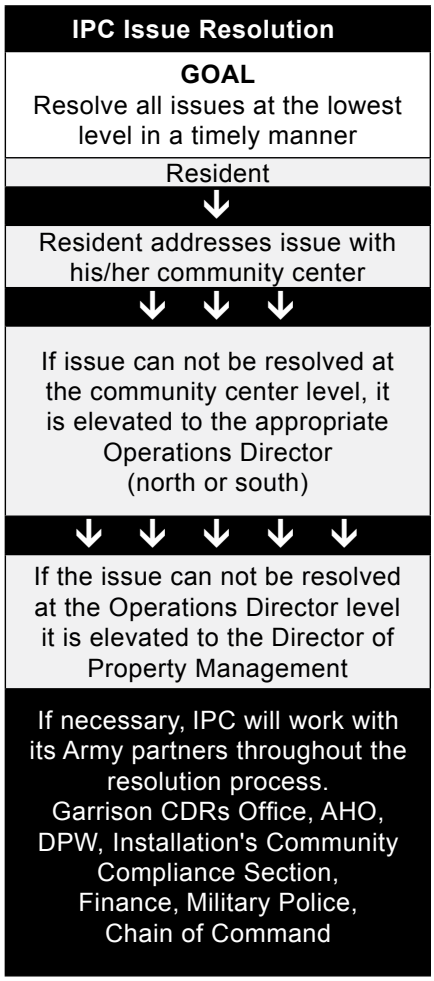
Island Palm Communities will maintain keys for all its homes. With the exception of life-threatening or property-threatening emergencies, all Island Palm Communities staff members must receive the resident's written permission to enter a home for any

back to table of contents

other reason than completing a service request called in by the resident or a preventative maintenance service repair. No home will be entered if a minor child is present without an adult who is 18 years of age or older at the home. The intent of this policy is to allow Island Palm Communities to enter the home for routine maintenance requests.

1.18 Abandonment Policy

Homes are considered abandoned when, after 30 days, there is no reasonable evidence other than the presence of personal property that the home is occupied and the resident has failed to notify Island Palm Communities. Failure to pay rent may be considered evidence of abandonment. Island Palm Communities will determine, in conjunction with the Army Housing Office and the Service Member's Command, if a unit is abandoned. If a unit is reclaimed by Island Palm Communities, the resident will be responsible for the cost of damages, cleaning, disposal or storage of personal effects and any unpaid rent. Island Palm Communities is not responsible for personal belongings left in an abandoned home.



1.19 Dispute Resolution Procedure

Island Palm Communities desires to work out any disputes with residents amicably and to a satisfactory resolution for both parties. However, if this is not possible, Island Palm Communities may use all options described in Section 1.10 to settle disputes. If this fails, Island Palm Communities or the resident has the option to choose binding arbitration using the most recent standards provided by the State of Hawaii Dispute Resolution process.

Island Palm Communities requires that residents live amicably within its communities. Residents and their guests shall respect the quiet use and enjoyment of other residents. In the event a resident dispute should arise, residents are encouraged to solicit Command involvement. Requests for resident moves will not be entertained as a result of resident disputes. Island Palm Communities will engage the Service Member's chain of Command, Installation's Community Compliance Section or the Garrison Commander's office to resolve issues between parties. Island Palm Communities reserves the right to terminate all parties for continued disputes that substantially interfere with the right to quiet enjoyment of other residents in the community.

1.20 Weapons and Firearms

1.20.1 Registration

Weapons, firearms, bows, arrows and ammunition may be retained in Island Palm Communities homes provided that the weapons and firearms are properly safeguarded under lock and key and have been properly registered. All firearms must be registered with the State of Hawaii (Honolulu Police Department), Provost Marshall's office and with the resident's respective community center.

1.20.2 Restrictions

Government-owned weapons, firearms, bows, arrows and ammunition are not allowed in Island Palm Communities areas unless authorized by the Department of the Army. The use of these and any weapons in the Island Palm Communities Family housing area is prohibited. Violations of this policy will result in immediate eviction. Paint ball, BB, air-soft guns, etc. are inherently dangerous and therefore are prohibited for use in Island Palm Communities communities. Resident will be responsible for any and all damages to persons and property.

back to table of contents

1.20.3 Violations

Misuse, discharging or brandishing a weapon, conducting activity determined to be illegal, or irresponsible handling of a weapon by a resident will not be tolerated and will result in eviction.

1.21 Noise Control

Excessive noise is prohibited on the installation. Quiet hours are observed between 2200 – 0630 daily. For enforcement purposes, "excessive" is defined as:

- Music vibrations or other sounds emanating from homes, yards or automobiles that can be heard from a distance of 30 feet or more in any direction of the house
- Noise in a public place that, under the circumstances, is unreasonably disturbing to the quiet and comfort of another person within the housing area
- Residents should be aware that excessive noise travels easily through building structures. Residents should refrain from excessive noise so as not to disturb the quiet use and enjoyment of their neighbors

1.22 Housekeeping

The Army Housing Office and Island Palm Communities will investigate potential health or safety hazards resulting from poor housekeeping in coordination with:

- The resident's Chain of Command
- Family Advocacy Program
- Child Protective Services
- Others as appropriate

Poor housekeeping may result in eviction.

1.23 Fire Safety

1.23.1 Reporting

In case of fire, call 911. Residents are required to immediately report all fires regardless of size to the Installation Fire Department and Island Palm Communities. Residents should have an evacuation plan in case of fire. The fire department will, upon request, conduct a courtesy inspection and assist residents in developing an evacuation plan.

1.23.2 Resident Responsibilities

Residents are responsible for testing smoke detectors monthly and detectors shall not be disconnected. Additionally:

1. Resident Activities
2. The Island Palm Communities Resident Advisory Board
3. Recycling and Sustainability
4. Island Palm Communities Resident Guide and Community Standards Handbook
5. Overview of Island Life

- Immediately report malfunctioning smoke detectors to Island Palm Communities
- Keep housing number (address) clearly visible from the street at all times. Do not block or cover housing number with personal items
- Do not store flammable materials in water heater closet, near water heaters or gas-operated dryers. Flammable materials must be stored in well-ventilated areas outside the home; if no properly vented storage is available, flammable materials are prohibited
- Fueling of lawn mowers and other fuel-powered equipment and dispensing of any flammable liquids must be done outside of all buildings, including garages
- Gas-powered lawn mowers, edgers, tillers, etc. shall not be refueled until sufficient time is allowed for engine to cool
- Grills (charcoal and gas) must be used in accordance with local safety codes and installation regulations. They are not to be used on covered patios and balconies, in carports or any other covered area, and must be used at least 15 feet away from any housing structure. Propane or other gas grill tanks cannot be stored inside or within 15 feet of any building
- The use of fire pits, wood stoves or open burning of any kind is prohibited
- Do not store, stack, or keep firewood on the premises as it harbors insects and rodents
- Fireplaces in historic homes are only aesthetic and not approved for use. Any liability occurring from the use of fireplaces is the responsibility of the resident
- Extension cords are intended for occasional use and shall not be used on a permanent or semi-permanent basis inside or outside of any Island Palm Communities home

back to table of contents

1.23.3 Carbon Monoxide

If you suspect carbon monoxide exposure:

- Immediately remove everyone from inside the house
- Leave home as is
- Go to a neighbor's house and call 911
- Inform Island Palm Communities immediately
- Wait within a safe distance from your home until the fire department and Island Palm Communities arrive
- Do not re-enter your house until the fire department clears it for occupancy

1.24 Incidents

Should any incident happen at a home or in the neighborhood where a bodily injury of any kind occurs, it is the resident's responsibility to notify Island Palm Communities no later than the next business day. Required information includes location, date, time and type of incident that occurred. In addition, a list of people injured, the nature of the injury or injuries, as well as any witnesses to incident must be provided.

1.25 Resident Moves

Resident moves are authorized for Families that experience changes in eligibility for the number of bedrooms needed to accommodate an increase in Family size, a change in rank (i.e. JNCO to SNCO or Company Grade to Field Grade, etc.) or for a medical board recommendation that requires a move. Appropriate documentation is required to support a request. These types of moves will be made at the Service Member's expense. Resident moves are authorized when relocation is necessary due to Island Palm Communities development. In the case of a required relocation due to Island Palm Communities development, the resident is given a minimum 120-day written notice and the move is made at the expense of Island Palm Communities only if the resident occupies another home within Island Palm Communities. Costs incurred to relocate or reestablish telephone/cable TV/satellite TV/internet service shall be the responsibility of the resident. If the resident chooses to reside in off-post housing or in another Service (Navy, Air Force or Marine) housing area, the resident will incur the move cost. Resident may choose to terminate his or her lease with Island Palm Communities anytime after receiving their written 120-day notice. Island Palm Communities will not pay for moves to an off post location for any reason.

back to table of contents

back to table of contents

Section 2

Regulations, Parking Restrictions and Vehicle Procedures

2.1 Speed Limit

The speed limit in all residential areas is 15 miles per hour unless otherwise posted. Speed limit for areas with alleyways is 5 miles per hour.

2.2 Operating Areas

Privately owned vehicles (POV) are limited to hard surface roads designed for vehicular traffic. Operating a POV on sidewalks, bicycle paths, grass areas, recreation areas, or any area not specifically designed for vehicular traffic is strictly prohibited. Only bicycles and pedestrians may use dirt trails and paths.

2.3 Parking

Recreational vehicles such as trailers, campers and boats (including jet skis and motocross bikes) may not be parked in housing areas. Vehicles other than recreational vehicles (RVs), which are properly licensed, display current safety and registration, may be parked in driveways, garages and parking lots. Parking in common parking lots will be on a first-come, first-served basis and cannot be parked longer than 24 hours. It is imperative vehicles are parked in their designated locations (examples: garages, driveways, carports, parking pads, if provided). Residents who reside in a home with a garage or carport must use it for vehicle parking only. These areas may not be used for storage, auto repairs, home-based businesses, workshops, additional living space or any other purpose.

Vehicles parked on the street pose a hazard for children, pets and other vehicles. In addition, vehicles parked in this manner can restrict access for emergency vehicles and service vehicles such as postal trucks, refuse trucks, moving vans, and school buses. Where applicable, residents will be assigned one designated parking stall per home. Any additional parking spaces are on a first-come, first-served basis. As parking is very limited, parking is for Island Palm Communities residents and their guests only. Additionally, no parking is allowed in the following areas:

- In a location that interferes with resident mailbox access
- In a location that interferes with resident access to their assigned driveway or carport
- Within 15 feet of a fire hydrant, mailboxes or any location marked by a red curb
- On curbs, sidewalks, lawns or grassy areas at any time
- In front of refuse and recycling containers located at curbside pick-up areas
- In cul-de-sacs (in a manner that restricts emergency vehicle access)
- Where “No Parking” signs are posted
- Within 30 feet of an intersection
- Behind garages in alley ways – vehicles will be towed

Inoperable vehicles are allowed to be parked for a period of not longer than 30 days with the proper static permit issued by the Provost Marshall. The proper static permit shall be prominently displayed on the inside front windshield. Improperly registered vehicles may not be parked in the housing area. Violators may be issued a citation. If the problem is not corrected or presents a traffic or safety hazard, the vehicle will be towed immediately in accordance with installation regulations and at the owner’s expense.

Residents are permitted to park only those vehicles registered in their name on Island Palm Communities property. Residents may not park or store vehicles belonging to another (i.e. storing or watching a vehicle for a friend while he/she is deployed or off-island).

2.4 Child Supervision in a Vehicle

No child under 10 years of age shall be left unattended in a vehicle under any circumstances or for any length of time unless the child is supervised by a person 12 years of age or older. Under no circumstances may any child be left in a vehicle with the engine running or in a vehicle with the keys left in the ignition.

2.5 Installation Regulations

Traffic regulations on the installation are detailed in current USAG, Hawaii regulations. Consult these existing documents for information on punitive measures for traffic regulations enforced by Military Police (examples: parking where prohibited on sidewalks, in crosswalks, within 15 feet of fire hydrants, against the flow of traffic, and in front of public driveways). Additionally:

- Use of cell phones while driving is not permitted

back to table of contents

- Residents must not interfere with the parking rights of other residents
- Residents may not park oversized vehicles and equipment in housing areas (examples: 18-wheelers, tractor-trailers, dump trucks, etc.)

2.6 RV Parking Restrictions

Island Palm Communities does not have designated RV lots. Recreational vehicles such as trailers, campers and boats (including jet skis and motocross bikes) may not be parked in housing areas. Please contact Installation's Community Compliance Section for information on approved RV, boat and jet ski parking areas. The exception to this policy is an RV that is parked at the housing unit for no more than three hours for loading or unloading. If the resident has an emergency that requires parking longer than the policy permits, the resident must notify and receive written permission from its Island Palm Communities Community Center and the Provost Marshall Office.

2.7 Vehicle Maintenance

Vehicle repair and maintenance activities are not allowed in any housing area at any time, except for the replacement of a flat tire or charging of a battery. Ft. Shafter Flats and Schofield Barracks (on Duck Road) have automotive centers established for vehicle maintenance purposes.

2.7.1 Appearance

Island Palm Communities wants to ensure that housing areas do not take on a “junkyard” appearance. Oil spills or leaks in driveways will result in a citation if not cleaned properly.

2.7.2 Vehicle Registration and Decals

- Vehicles must be registered with and issued a DoD decal by the Provost Marshall Office
- Vehicles must have a current registration and safety check and proof of insurance as required by the State of Hawaii
- Vehicles must have DoD decal or installation pass displayed on the windshield

Vehicles found on Island Palm Communities property that are not in compliance with the above requirements will be cited and reported to the Military Police. If the owner has not taken corrective action to satisfy the registration and safety requirements within three working days, the vehicle will be reported to the Military Police for further action thay may include removal of the vehicle. Island Palm Communities reserves the right to remove any vehicle from its property that is illegally parked or presents a safety hazard to the community at the owner’s expense.

2.7.3 Abandoned Vehicles

Notify your community center if you are aware of an abandoned vehicle. Residents departing the island permanently or on a temporary basis may not abandon their vehicle in Island Palm Communities, and residents must show proof of vehicle shipment or sale prior to move-out from housing. If a resident would like to dispose of a vehicle, contact the Provost Marshall for more information.

2.7.4 All Terrain Vehicles (ATVs)

ATVs are not allowed to be operated or stored in housing areas.

back to table of contents

back to table of contents

back to table of contents

Section 3

Child Supervision

3.1 Responsibilities

Parents are responsible for the conduct of their children at all times. Parents are liable for damages caused by the conduct of their children.

3.2 Supervision

Parents or guardians are responsible for children under their control or supervision. Family members under 10 years of age must be supervised at all times. Minors 16 years of age or younger will not be unsupervised for more than a 24-hour period. Additionally, all juveniles under 16 years of age must be supervised by a parent, guardian or an adult authorized by a parent or guardian between the hours of 2200 – 0400. Parents or guardians are responsible for children under their control or supervision to abide by these curfew restrictions. Juveniles will not involve themselves in wanton destruction, vandalism or violations of the Resident Occupancy Agreement, "Island Palm Communities Resident Guide & Community Standards Handbook," installation policies and Hawaii state law. Parents or guardians are responsible for damages to persons or property that involve their children or children under their supervision. Damage, destruction or vandalism to Island Palm Communities property by juveniles or other family members may result in immediate termination of the lease. Offenses of this nature will be reported to the proper authorities and may result in legal actions.

Refer to Installation's Community Compliance Section regulations regarding home alone procedures. A copy can be obtained at your community center. Every resident, employee and member of the community must report known or suspected violations of this policy and suspected child abuse to the Family Advocacy Program, Child Protective Services or Military Police. Please refer to the list of frequently called numbers located on page 9 of this guide.

3.3 Prohibited Play Areas

Children are prohibited from playing in the following areas:

- Around unoccupied buildings and houses
- At any construction site, whether or not work is in progress
- Near government or contractor equipment (lawn mowers, construction equipment, maintenance trucks, etc.)
- In drainage ditches, culverts or water retention areas
- Near school buildings when school is not in session
- In creeks, water catchments, landslide areas and other similar areas; pay particular attention after rain fall
- In carports, garages, driveways, roadways, office buildings or other unapproved recreation areas
- In parks, playgrounds, basketball courts, skate parks, community centers or other recreation areas during hours of darkness

It is the resident's responsibility to ensure that their children understand that they are prohibited from playing in areas specified above, and that they may be held accountable if their children are found in these areas.

Key Authorizations

Children 10 years of age and older who are identified in the Island Palm Communities Resident Occupancy Agreement and have appropriate government-issued identification, may be given a house key.

back to table of contents

back to table of contents

Section 4

Pet Policies

4.1 Guidelines for Pet Owners

The following policies enhance the existing rules for control and treatment of pets and wild animals. All existing Department of Army Regulations as well as USAG, Hawaii regulations are in effect. Check with your community center for additional information. Be advised that pet damages can be a significant expense to owners. Pet ownership is a privilege that will be extended to all residents at Island Palm Communities. Remedies for non-compliance with the provisions of the pet policy include loss of pet ownership privileges and/or termination of residency for repeated violations. Island Palm Communities recognizes the importance of pets to residents. With this in mind, the established rules are designed to encourage the healthy raising and maintaining of all pets. Pet owners must abide by the following requirements and policies:

- Owners must register pets with their Island Palm Communities community center; a maximum of two pets in any combination will be allowed
- Upon move-in, or whenever a pet is acquired, residents must pay a non-refundable pet fee of $75 per pet
- Pets that are routinely kept in cages or tanks such as hamsters, fish, birds and rabbits are not subject to pet fees; however, may be subject to de-flea or other such treatment if required to remove a pest infestation
- Owners must register pets with the Installation Veterinary Services as outlined by the post or Army regulations
- Residents may not board any dog of a breed (including a mixed breed) that is deemed “aggressive or potentially aggressive” unless the dog is a certified military working dog that is being boarded by its handler/trainer. Pit bull Terriers, Staffordshire Terriers, Rottweilers, Doberman Pinschers, Chows, Wolf hybrids or dogs with any of these breeding combinations are strictly forbidden on Hawaii Army installations and in Island Palm Communities. This prohibition also extends to other dogs that demonstrate a propensity for dominant or aggressive behavior as indicated by any of the following types of conduct:
- Unprovoked barking, growling, or snarling at people approaching the animal
- Aggressively running along fence lines when people are present
- Biting or scratching people
- Escaping confinement or restriction to chase people
- All dogs and cats must wear pet collars; pet collars must have a current rabies immunization tag attached
- All dogs and cats must have appropriate microchip identification as required by Hawaii State Law
- Pet owners must have proof of immunization by a certified veterinarian that is valid for at least 12 months
- Pet owners are responsible for the behavior of their pets at all times
- Outdoor pets that are unsupervised must be contained within a fenced area. Pets leashed, but not contained within a fenced area must be supervised at all times. Pets must not be left tied anywhere or left unattended in carports or garages. Pets are strictly prohibited from running loose. Pets are not allowed to create a noise disturbance in the community; pets are subject to the same guidelines as defined in Section 1.21
- Pets are not to be left alone for more than 24 hours
- Pets are not to be left in a vacant vehicle at any time
- For sanitary reasons, pets are not allowed in or around playgrounds, sports fields, picnic or other recreation areas
- Residents are required to maintain a sanitary living environment for their pets and are required to clean animal waste on a daily basis; animal waste occurring while walking a pet must be cleaned immediately
- Pet owners are financially responsible for damages caused by their pets
- Small animals such as birds, fish and guinea pigs are allowed as long as they are properly caged and cared for
- Wild animals, farm animals and exotic animals (examples: pigs, rats, mice, chickens, monkeys, reptiles, spiders, snakes) are not allowed
- Raising animals for commercial purposes will not be allowed

back to table of contents

- Residents whose pets have litters must notify their respective community center and make arrangements for adoption within twelve (12) weeks of birth
- Guide dog regulations have exceptions to some of the rules as defined by Title 40, U.S.C., Section 291
- Pets must have shelter and clean water if maintained outdoors; see Section 6.16 regarding installation of pet houses
- Any modifications to the homes for pets (pet grills, reinforced fence) are strictly prohibited without prior written consent of Island Palm Communities. Resident will be required to restore the home to its original condition prior to move out
- Leashes, pet dishes, feces, etc. must be removed from resident's yard on scheduled contract mowing days. Items that are left in yards could be damaged by landscapers and will not be replaced if damaged. Service will not be performed if resident fails to comply
- Upon termination of the Resident Occupancy Agreement, the resident is responsible to pay a de-flea charge to Island Palm Communities prior to clearing his or her home, even though the home may not be carpeted. Resident has the option to have the home treated by a professional service provider of their choice and provide a receipt of services upon move out
- Resident will be responsible for carpet cleaning charges if pet stains are identified during the pre- and/or final inspection
- Residents may not abandon their animals upon their departure from Hawaii
- Documented animal bites/attacks will be investigated and may be subject to revocation of pet privileges

Island Palm Communities and USAG, Hawaii may terminate pet privilege if policies and guidelines for pet ownership are violated

Island Palm Communities reserves the right to:

- Determine additional requirements for tenant liability insurance
- Terminate tenant lease for failure to remove aggressive or unruly pets
- Assess pet fees and assess additional charges for damages
- Grant exceptions to this Pet Policy after validation from USAG, Hawaii that it does not conflict with existing Army policy

4.2 Disposal of Deceased Pets

Owners are responsible for disposing of deceased pets. Residents should call the Installation Veterinary Services for proper disposal procedures. Deceased pets are not to be buried on the premises.

back to table of contents

back to table of contents

back to table of contents

Section 5

Utility Consumption and Conservation

5.1 General

As an Army family, it is of utmost importance to be responsible users of your utilities. This means actively conserving your family's energy and water use. By making a conscious effort to reduce your utility consumption, you will be helping the Army save natural and financial resources that can be better used in protecting our nation and providing services and support to our Soldiers and families. You also will be an integral part of Island Palm Communities effort to create sustainable communities and be good stewards of the environment in which we live and work.

While it is important to be responsible users wherever you live, conservation is of higher importance in Hawaii. Because the Hawaiian Islands are geographically isolated, natural resources for are more scarce, and consequently, more expensive. By being mindful about your utility usage, you and your family will be doing your part to support national security by maintaining Hawaii as a strategic military outpost.

For more information about Island Palm Communities conservation efforts, log on to www.IslandPalmCommunities.com.

5.2 Method

Your family's utility conservation efforts are required by several important items of legislation and policy:

- Army Residential Communities Initiative ("RCI") Resident Utility Policy (Updated 28 Aug 2008)
- Department of Defense (DoD) Directive 4140.25 (Dated 12 April 2004)
- DoD Instruction 4170.11 (Dated 22 Nov 2005)
- Energy Policy Act of 2005, 42 USC 15801, (Dated 8 Aug 2005)
- Municipal Services Agreement between the U.S. Army and Island Palm Communities (Dated 1 Apr 2005)

Housing consumes about 30 percent of the total energy used on military installations. The Energy Policy Act of 2005 requires all federal facilities to reduce their energy consumption by 20 percent per gross square foot. This goal requires a concerted conservation effort by both residents and Island Palm Communities. Residents must:

- Comply with installation energy conservation directives and guidelines
- Reduce energy waste
- Conserve water whenever possible

5.3 Energy Reduction

The following are some guidelines residents can follow to reduce energy consumption:

- Shut down all air conditioning units, lights, and other appliances every time you leave your home
- Maintain temperatures within a range of 74-80 degrees Fahrenheit when operating air-conditioning units. Central A/C units must be left in "auto" position at all times
- Close all doors and windows when operating air-conditioning units (this also prevents mold)
- Turn off all outdoor lights during daylight hours
- Turn off lights in unoccupied rooms
- Minimize water use when cleaning sidewalks or driveways
- Use cold water to operate garbage disposals and clothes washers
- Run fully-loaded dishwashers to save energy and water costs
- Remove excess food from dishes prior to running dishwasher
- Avoid using washers and dryers during peak electrical demand periods
- Do not keep the refrigerator setting too cold
- Ensure that refrigerator and freezer door seals are airtight
- Turn off computers and other unneeded electrical items when not in use

5.4 Violations

Residents may be cited for violations of energy conservation guidelines.

5.5 Solar Water Heaters

As part of Island Palm Communities and the Army's plan to build and maintain sustainable communities, all new homes

back to table of contents

are equipped with a solar water heater system. The system in place uses both the sun's energy and traditional water heater implements to heat water. If you are experiencing problems with hot water, contact Island Palm Communities maintenance staff for assistance. Water heaters are located in the maintenance room on the exterior of the home, which allows Island Palm Communities maintenance staff to conduct preventive maintenance and repairs without entering a home. Residents do not have access to this room.

5.6 Resident Utility Billing Program

In an effort to encourage the efficient use of energy and ultimately reduce consumption, the Office of the Secretary of Defense (OSD) established a utility consumption that holds the Soldier and his/her family responsible for their utilities. In coordination with USAG, Hawaii leadership, Island Palm Communities is responsible for implementing and managing the resident utility program. It is not a profit center for the Army or Island Palm Communities. Money saved goes directly back into Island Palm Communities communities to benefit Soldiers and families.

In July 2010, USAG, Hawaii launched a mock billing program. The program seeks to:

- Create awareness among families about their household electrical consumption
- Help families exceeding electrical consumption reduce their use
- Prepare families for USAG, Hawaii's utility billing program

During the mock billing period, energy consumption reports residents receive are not bills to be paid. The report is a tool that shows a family how much electricity it is using and compares it to the amount it should be using (referred to as a baseline). At Island Palm Communities, families only will be responsible for electricity.

Actual billing will begin in 2011. At time of publication of this guide, a specific date was not established. However, in accordance with the OSD policy utility billing must begin no more than 12 months after launching the mock billing program.

Resident responsibilities

It is the family's responsibility to use electricity according to their baseline. If usage exceeds the assigned amount of electricity usage, it is within the jurisdiction of the Army's policy to require the family to pay for their usage above and beyond their baseline. However, if usage is below the baseline, families also may be rewarded for conserving by receiving a monetary rebate or other incentive. Residents will be notified of their monthly usage on statements via mail or online.

In accordance with this program and other Army, DoD, or government directives:

- You may be required to grant access to your home for meter reads, maintenance, or administrative activities
- You may be required to undergo utility outages for activities such as meter installs, maintenance, or replacement
- You may be notified in advance of an outage by email, voicemail, mail, or flyer. If notified of an electrical outage, Island Palm Communities recommends residents shut down or unplug sensitive electrical equipment (e.g., computers and televisions) in advance and for the duration of any outage window
- Upon notification of a power outage, it is the resident's responsibility to comply with Island Palm Communities recommendations; Island Palm Communities shall assume no liability for damages to property caused by planned outages
- Participate in utility audits if your utility consumption is deemed to be excessive or abnormal
- Attend educational programs or work with Island Palm Communities staff to reduce your utility consumption
- Work with a collection agent for utility payments past due if your account is delinquent

Support for residents

To support the Army's utility program, Island Palm Communities will provide energy-saving tips and educational programs to families through information and resources found on its website. Additionally, Island Palm Communities retains a full-time utilities manager with access to several resources to assist families. The utilities manager can be reached at IPCutilities@ipchawaii.com or at 275-3165.

For more information about the utilities program, go to www.IslandPalmCommunities.com.

back to table of contents

back to table of contents

Section 6

Alterations, Additions and Construction

6.1 Alterations to Homes

New construction, additions or alterations by residents to Island Palm Communities homes, including garages, carports, patios and surrounding grounds are not allowed. Residents will not nail, screw, staple or bolt items into any exterior siding or roof (please see section 6.17 for approved methods for displaying holiday lighting). This policy is inclusive of satellite dishes. Requests for minor alterations must be submitted in writing to the resident's community center for approval prior to any work being done. Additional restrictions apply to historic homes. Please contact your community center for complete details.

6.1.1 Approval

Unless the resident has written permission from Island Palm Communities to leave the alteration in place, alterations will be removed and the cost to restore the area or housing structure to its original condition will be done at the resident's expense prior to the resident's move-out. Residents are liable for damages to houses and yard areas resulting from alterations.

6.1.2 Community Projects

Projects for construction or improvement for the general benefit of the community are initiated by Island Palm Communities in coordination with the Army Housing Services Office and the community. If you have suggestions for community projects, please submit them in writing to your Island Palm Communities community center.

6.2 Fences

Due to ongoing development, construction and renovations, existing fences may be removed when a change of occupancy occurs. In some communities, residents may erect a new fence with prior written approval obtained through their community center. See your community center staff for complete process and procedures regarding installation of fences. Residents are liable for any damages done to underground utilities. Community center may perform an inspection after the fence has been erected. Island Palm Communities is not responsible for maintaining fences erected by residents. Historical restrictions may apply. Hanging of any personal items such as carpet, clothing or plastic over fencing is strictly prohibited.

6.3 Storage Sheds

Written approval for the placement of sheds or utility structures must be obtained through the community center prior to installation. A utility clearance is required before installing storage sheds to prevent placement of sheds over utility lines. Shed sizes shall not exceed 10' x 10'. Residents are responsible for:

- Removing personally-owned or rented storage sheds prior to move-out
- Restoring turf upon removal of storage shed
- Damages to any property caused by the installation or removal of a storage shed. Additionally, storage sheds are not to be placed in any common area, garage or carport areas. Island Palm Communities is not responsible for a resident's personal property stored in resident-installed or existing Island Palm Communities storage sheds.

6.4 Antennas

Installation companies must follow guidelines approved by Island Palm Communities and in accordance with standards set by the installation. Contact your community center for written approval prior to installation. Residents are responsible for any damages caused by the installation and removal of antennas.

- Antennas may not penetrate roofs, siding or fences
- Antennas may be installed to a separate pole alongside the building with prior written approval from Island Palm Communities and must not interfere with other residents' radio, TV or stereo equipment
- Residents are responsible for all costs associated with cable TV installation and removal
- Residents are responsible for removing antenna and cable TV equipment prior to final move-out inspection

6.5 Satellite Dishes

6.5.1 Requirements

Approval for satellite dishes of any size must be requested in writing prior to installation. The equipment must follow the guidelines set forth in Section 6.5.3 and the applicable satellite dish agreement.

back to table of contents

6.5.2 Responsibilities

Damages resulting from the installation or removal of a satellite dish are the responsibility of the resident. It is the resident's responsibility to ensure that the private company hired to install a dish complies with the guidelines found in Section 6.5.3.

6.5.3 Guidelines

Satellite dish systems must be installed in a manner that is not unsightly and does not damage the house, garage, carport, fence or any Island Palm Communities-owned property. Additionally:

- Satellite dishes may not be installed or placed on the roof of any Island Palm Communities home or structure
- Satellite dishes may not be attached to exterior siding, carports, garages, fences or walls. Satellite dishes may be mounted on a tripod placed in the backyard. Satellite dishes will not be placed in side yards, front yards or common areas
- Holes will not be made in exterior siding, fences or walls
- Tree limbs will not be cut in an effort to obtain a better signal
- Cable runs for satellite dish must not be used or installed in such a manner as to create a safety hazard. Residents are responsible for ensuring that installer comply with safety requirements and may be held responsible for correction or told to remove the system entirely
- Vendor or installer will use existing cable wiring from junction box at residence and will not change box location
- Vendor or installer must not install additional junction boxes on exterior wall of housing
- When required to install a second parallel cable, it must be cosmetically acceptable and the existing entrance hole will be used and must be approved in writing prior to installation
- Only one satellite dish is permitted per home
- Resident is responsible for removing system and restoring grounds prior to move-out. Residents will be charged for removal and restoration if not properly completed
- Improperly installed systems or systems installed without prior written permission from Island Palm Communities will be removed at resident's expense

6.6 Locks, Latches, and Dead Bolts

- Residents that wish to have their locks changed should contact their community center. Residents must pay for this service unless a copy of a Military Police blotter is provided indicating the resident's safety is at risk
- Chain locks, flip locks, barrel bolts, surface bolts, or other types of security door guards will not be permitted unless requested and approved in advance and in writing by the community manager
- Residents needing assistance due to lock-outs during normal operating hours need to contact their community center. After hours, contact Island Palm Communities through the after hours maintenance number in section 8 of this guide. There will be a $100 charge for resident lock-outs that require a locksmith or occur after hours
- Residents will not change locks, install deadbolts or duplicate keys for their housing unit
- Residents will be charged for the repair or replacement of locks in violation of this policy

6.7 Security Alarm Systems

Resident-installed security alarms requiring electrical wiring will not be permitted. Security systems not hard-wired will be permitted, however, security codes must be provided to your community center for access during emergencies or maintenance visits. Residents are responsible for damages caused by the installation or removal of resident installed security systems.

6.8 Lawn Ornaments

Residents may place lawn ornaments on lawns if decorations are maintained and will not interfere with lawn service provided by Island Palm Communities. Lawn ornaments are defined as decorative objects placed in the grassy area of a property and are limited to 18 inches tall and 24 inches wide. Fountains and other water moving ornaments/decorations are permitted with prior written approval by your community center and are limited to no more than one such feature per home of a size no more than 18 inches tall and 24 inches wide. Holiday lawn decorations are permitted as defined in section 6.17. See your community center for details.

6.9 Rocks

Rocks may be used for edging, as stepping-stones or for mulching. Residents are responsible for removal of all rocks installed around the residence prior to move-out unless the resident has approval in writing from the community manager to leave the rocks in place.

back to table of contents

6.10 Painting

Residents are provided with a copy of the Lead-based Paint Addendum as a part of the Resident Occupancy Agreement and Resident Welcome Packet. Island Palm Communities strongly advises residents to review this document prior to considering any paint work. Residents should be aware that the presence of lead-based paint is possible in any building built before 1978. Therefore, if you find peeling or chipping paint in your home, please notify your community center immediately.

6.10.1 Guidelines

Residents are permitted to paint one accent wall per room if:

- They submit the signed paint policy agreement prior to painting
- They adhere to standards for preparing and painting interior walls
- Paint and supplies are at the resident's expense after coordination and approval by Island Palm Communities
- Resident uses a color, type and brand of paint specified by Island Palm Communities
- Resident agrees to pay Island Palm Communities a $250 fee for the cost to reinstate the original home condition
- Painting is not allowed in historical homes or Island Palm Communities new construction homes built after 2006

If a resident's work does not meet established standards, additional repairs by Island Palm Communities will be done at resident's expense.

6.10.2 Restrictions

Residents will not paint:

- The exterior of housing, including doors, patio, concrete enclosures, sheds, sidewalks, or any other Island Palm Communities property
- Exterior housing privacy fences

6.10.3 Borders and Wallpaper

- Wall paper application is not authorized in any Island Palm Communities home.
- Borders may be installed but should be temporary and easily removed. Borders cannot be permanently attached. Residents will remove all borders and restore wall area to original condition prior to move-out. Expenses incurred for restoration repairs performed by Island Palm Communities are the responsibility of the resident
- Borders and/or wall paper are not authorized in historic homes

6.11 Nails

Residents will remove nails, picture hangers and screws from walls before move-out

6.12 Pools, Hot Tubs and Jacuzzi

Safety First! Small wading pools that allow not more than 18 inches of water are permitted. An adult (18 years or older) must be present to supervise pool use, and pools must be emptied after each use. Pools are not to be utilized in the front or sides of housing units. Hot tubs, Jacuzzi and spas are not permitted for use in housing units except when there is a documented medical need. Written requests must be submitted to Island Palm Communities and verified by the Army Medical Board before installation and use. If a written request is approved by Island Palm Communities, the resident must contact Island Palm Communities upon completion of the installation to ensure proper plumbing installation and to prevent potential leaks and damage during operation.

6.13 Trampolines

Trampolines are inherently dangerous for the owner and, more importantly, for children. Therefore, Island Palm Communities enforces a strict policy surrounding trampolines.

All trampolines must have safety netting and meet all safety guidelines for installation as required by the manufacturer. Trampolines left outdoors unattended or overnight must have a lock and be placed in your fenced yard. If your yard does not have a fence, you live in an apartment-style building or there is not enough space within the fence, a trampoline is not permitted. Residents are responsible for damages or personal injury associated with a trampoline. Residents must have appropriate liability insurance prior to set-up, and they must provide a copy of insurance to their community center that will be kept on file. Trampolines must be installed on a level surface area and be clear of overhead hazards such as roof line, trees and power lines. Island Palm Communities will not modify existing ground areas or tree canopy to accommodate a trampoline. Additional guidelines apply to the historic homes. Contact your community center for more information.

back to table of contents

6.14 Waterbeds

Waterbeds are allowed only on the first floor of homes with concrete slabs. Residents are responsible for all damages caused by use of waterbeds.

6.15 Pet Houses

Pet houses may be placed in a fenced back yard only, and residents must ensure the structure is:

- Of sound construction
- Painted
- Neat in appearance
- Cleaned of animal waste daily
- Kept free of ticks, fleas, and other parasites
- Removed prior to move-out

Residents are required to restore grounds where a pet house was present prior to move-out, and residents are responsible for any damages caused by the installation and removal of pet houses.

6.16 Patio, Lawn Furniture, Toys and Playground Equipment

Patio, lawn furniture, toys, and playground equipment must be placed in the backyard. If there is no backyard, the side yard may be allowed with written permission from your community center. The number of pieces of equipment will be determined based upon safety, available space and overall curb appeal. If playground or other equipment hinders Island Palm Communities lawn services, the resident becomes responsible for maintaining the area. Lawn equipment must be complete and have no defects so as not to cause safety or health concerns. The resident is completely responsible for the supervision, safety and maintenance of the equipment. The resident also is responsible for any damage or injury due to installation or use of the equipment.

6.17 Ornamental Lighting for Holidays

Residents are not allowed on roofs for any reason.

Reasonable use of inside and outside electric ornamental lighting is authorized. Do not penetrate roofs, siding or fascia with nails, staples, bolts, screws, etc. to install lighting. Use is restricted to dates and times provided by the installation. This information can be obtained at your Island Palm Communities community center. Note the following:

- Residents may use clips or tape that is specifically designed to install temporary holiday lighting
- Residents will carefully inspect and control ornamental lighting to avoid fire
- Extension cords are intended for occasional use and shall not be used on a permanent or semi-permanent basis inside or outside of any Island Palm Communities home

Use of ornamental lighting is authorized as follows:

- Two weeks prior to and one week after all nationally recognized holidays

Thirty days prior to and two weeks after the Christmas/New Year season

- Residents will ensure that all self-installed lighting will be used in proper applications and meet safety regulations
- Outdoor lighting and electrical cords must be Underwriter Laboratory (UL) approved and designed for outdoor use
- Residents are responsible for any damage and/ or liability resulting from the use of ornamental lighting
- Practice energy conservation and limit the use of ornamental lighting to the evening time from dusk until 2300 hrs
- Do not leave lighting on during daylight hours

Additional guidelines apply to historic homes. Please contact your community center for more information.

6.18 Tents, Tarps and Covers

Tents, tarps, screens or covers are not permitted anywhere on the exterior of the premises unless written permission is received from an Island Palm Communities community center. Temporary, one-day exceptions will be made with written authorization by Island Palm Communities for family events. Roll-up shades are prohibited.

back to table of contents

back to table of contents

back to table of contents

Section 7

Miscellaneous

7.1 Tree Swings, Tree Hammocks, Tree Houses and Signage

Tree swings, tree hammocks, tree houses of any type are strictly prohibited on Island Palm Communities property at any time. Residents may not affix any signage to trees within Island Palm Communities property or trees within installation property.

7.2 Bicycles, Skateboards, Scooters, Tricycles, Roller Blades and Like Equipment

Bicycle riders and other types of road and sidewalk equipment operators must comply with the rules of the roadway for motor vehicles. All should be neatly stored and not left on front lawns or common areas. Additionally:

- Abide by traffic signs and signals; pedestrians have the right-of-way
- Bicycles must be secured to a fixed object with an appropriate locking device when not in use
- All bicycles must be registered with Provost Marshall's Office
- When present, obey traffic control personnel
- Use of appropriate safety gear is required
- No equipment may be operated on tennis courts, basketball courts or in and around community centers and office buildings
- No trick riding is allowed on the grounds, including jumping curbs, scraping curbs or riding curbs
- Parents must supervise their children to ensure all rules are followed

7.2.1 Playgrounds

Hours of operation for all playgrounds are from 0600 to 1900 daily. Playgrounds, pavilions, skate parks, basketball courts, and tot lots are closed during the hours of darkness. Residents are required to report any vandalism to the military police and community center. Residents also are encouraged to identify vandals and report misuse and abuse of playground equipment to the community center.

Reports may be made anonymously to www.militarycrimetips.com.

7.2.2 Island Palm Communities Amenities

Island Palm Communities constructs, manages and operates facilities that are designed for the residents of the communities they support. Community centers with activity rooms, exercise rooms, theaters and pools are available for all Island Palm Communities residents in all communities. Any Island Palm Communities resident is permitted to use the amenities of all Island Palm Communities facilities, regardless of what community they reside in.

Activity rooms and theaters: Activity rooms may be reserved by any Island Palm Communities resident in any community. A $100 refundable deposit, payable in advance of event, is required to reserve Island Palm Communities activity rooms or theaters. Reservations are accepted in the order the request is received. Residents will be responsible for leaving the rooms clean and ready for the next resident. Residents who do not clean rooms after they use it will lose their deposit, which will be used to cover the costs of cleaning. If additional cleaning is required to return the facility to satisfactory condition, additional charges may apply. Residents also will be financially responsible for any missing items or damages incurred while they have use of the rooms. Lost items or damage charges also may result in loss of deposit if damage exceeds $100.

Exercise rooms: All Island Palm Communities residents are authorized to use the equipment, contingent upon space available at the time they wish to exercise. Contact the community center that has the exercise equipment for information on access to the room.

Pools: All pools built by Island Palm Communities are privately-owned and to be used solely by Island Palm Communities residents and guests.

- All residents 13 years and over will be issued a pool pass, which is required for admission
- Children under 13 years must be accompanied by a responsible adult
- There is no lifeguard on duty
- Residents are responsible for their safety and the safety of their dependents and guests
- Pool rules are clearly posted and must be followed

back to table of contents

- Failure to abide by the rules may result in loss of pool privileges

7.3 Basketball Backboards

- Portable basketball backboards may only be positioned alongside driveways
- Backboards will not be placed in common area parking lots
- Backboards that block access for trash collection or lawn service equipment will be removed without notice
- Backboards will not be located within 10 feet of streets, alleyways, or cul-de-sacs
- Backboards must be moved back into carport, garage or backyard when not in use
- Residents must restore grass areas damaged by basketball hoops prior to move-out
- Damaged backboards or backboards that are found to be unsafe must be removed immediately
- Backboards must be removed or disposed of prior to move out

7.4 Yard and Garage Sales

These guidelines are contingent on the existing Force Protection Condition. Island Palm Communities residents may hold yard and garage sales in the housing area under the following guidelines:

- Sales must take place during daylight hours on Saturdays only and must be approved by the community center
- Signs may only be displayed on the day of the sale and must be removed on the same day
- Signs may not be affixed to trees, poles, street lights, community signs or mailboxes. Residents are encouraged to purchase stake type signs available at local hardware stores to advertise for yard sales. Signs must be removed on the same day after completion of the sale
- Items must be removed from yard when sale is over
- Residents are limited to one garage or yard sale every six months, excluding organized neighborhood sales

7.5 Fireworks

Fireworks are extremely dangerous and are a fire hazard within the housing community. Fireworks are prohibited on all installations and in all housing areas.

7.6 Appliances

7.6.1 General

Do not operate or store dishwashers, dryers, freezers, ranges, refrigerators and washers outside or in garages or carports. The only exception is homes that currently have outdoor washer and dryer facilities.

7.6.2 Policy

Residents are permitted to use their own personal appliances. Coordination of removal of Island Palm Communities appliances must be scheduled in advance through your community center. Installation of a resident-owned household appliance is the sole responsibility of the resident and is done at resident's expense. Additionally:

- Residents are responsible for the connection of resident-owned washers and dryers
- If upon move-in or transfer to another Island Palm Communities home the dryer plug for resident-owned dryers must be changed from a 3- to 4-prong, Island Palm Communities may complete this as a normal work order request. Resident is responsible for purchasing the appropriate type dryer cord
- When disconnecting washers, residents must ensure that the water connection is turned completely off and does not leak when the hoses are removed
- Residents may install freezers inside the home only
- Requests to install water lines for resident-owned appliance with an ice maker must be submitted and approved in writing prior to installation. If a waterline or plumbing problem occurs the resident will be responsible for all repairs and damages
- Window air-conditioners are not authorized without prior written approval from an Island Palm Communities community center. Please see section 8.8 of this guide for installation requirements. Installation guidelines and forms are available on our website
- Residents are responsible for disposal of resident-owned appliances and window air-conditioner in accordance with state and local laws. See your Island Palm Communities Community Center for locations that accept appliances and window air-conditioners for disposal

back to table of contents

back to table of contents

Section 8

Maintenance Program

8.1 Maintenance and Repair Overview

Island Palm Communities provides comprehensive maintenance services to ensure that safe functional homes are provided to all residents. Goals of the maintenance program are:

- Provide prompt, competent, and convenient maintenance services that ensure resident satisfaction
- Protect and improve the physical assets of Island Palm Communities

8.2 Service Calls

Residents may initiate service calls 24 hours a day, seven days a week by calling the respective maintenance service desk.

Maintenance Services - North 457-4075
Maintenance Services - South 457-4050

Residents can obtain a Permission to Enter (PTE) form at their community center, which authorizes maintenance repairs in their homes without their presence. Residents who do not authorize PTE must be present at the time service is performed. Missed appointments will result in a rescheduling fee of $35. Service calls are classified as Emergency, Urgent or Routine. Working hours may change based on demand, see Figure 8-1 for details.

During regular hours of operation, trained service order coordinators perform all tasks including the receipt of service calls, classification and appointment scheduling. After regular hours of operations, an answering service will determine the category of calls received (emergency, urgent, routine). The service will refer routine service calls to the maintenance service desk during regular hours of operation, and emergency and urgent service calls will be immediately referred to an on-call service technician. Residents are required to perform minor maintenance tasks in their home before calling the maintenance service desk. By doing so, maintenance personnel will be able to concentrate their efforts on work that requires their special skills. Such tasks include plunging toilets and sinks, tightening screws on hinges, replacing light bulbs, resetting garbage disposals and other simple maintenance tasks that can be done without specialized training or tools.

The resident is responsible for:

- Replacing light bulbs (Fluorescent light bulbs are available at the community center)
- Resetting circuit breakers
- Replacing doorstops or bumpers
- Replacing or tightening loose screws on hinges and tightening

Category	Day of Week	Times
Emergency	Monday – Sunday	24 Hours/Day
Urgent	Monday – Friday	0800 – 1700
Routine	Monday – Friday	0800 – 1700

Figure 8-1: Service call working hours

The goals established for service response and completions are displayed in Figure 8-2.

Maintenance Type	Response Times/Completion Goals
Emergency	Respond with a phone call within 30 minutes and arrive at the site within 2 hours. Work until emergency is contained or controlled.
Urgent	Respond within 8 hours during business hours and after hours. On site within 8 hours until urgent issue is contained or controlled.
Routine	Respond to call within 3 business days (M-F 0800 – 1700 Hrs). Complete within 3 business days following response (subject to resident availability to be present for work if no PTE is provided).

Figure 8-2: Goals established for service response and completions.

back to table of contents

cabinet hardware

- Providing and cleaning air filters to window units, if applicable
- Removing foreign matter from toilets, sinks and bathtub drains with a "plumber's friend" (rubber suction cup plunger)
- Turning off water valve in case a toilet overflows
- Weeding and upkeep of flower and plant beds
- Properly disposing of CFL bulbs; contact community center for guidance
- Maintaining the premises by cleaning the lanai, sidewalks, porches, driveways, and/or other walking surfaces of plant or other growth that may create an unsafe condition. This cleaning task must be completed whenever this type of growth occurs.

Residents will promptly report to Island Palm Communities repairs that are beyond the capability of the resident.

Residents will not:

- Adjust gas burners
- Repair leaky pipes
- Repair or replace faulty wiring
- Install additional wall outlets, ceiling fans or other electrical fixtures, including hot tubs, Jacuzzi, or spas
- Replace or repair Island Palm Communities-owned equipment or appliances
- Plant trees or bushes without written approval of the community manager
- Attach nails, staples, brackets or any other item to the outside of the home

8.2.1 Service Call Classifications

Service calls are classified as Emergency, Urgent or Routine based on the established criteria and responded to accordingly. Emergency service calls include:

Breaks in water, wastewater or gas lines, gas leaks, equipment failures (example: air conditioning for EFMP Program participants whose need for emergency air conditioning repair has been approved by the TAMC Medical Board, or refrigerator inoperative), utility outages and doors and windows that cannot be secured

Urgent service calls are those that are not an emergency, but require quick attention. Typical calls include contained water leaks, one of two or more toilets or sinks clogged or a partial power loss (example: no power upstairs). Urgent service calls will be completed as quickly as possible given the constraints of ordering parts.

Routine service calls are those that do not meet the definition of emergency or urgent service calls. The dispatcher will review work requirements and notify residents of approximate date or time that service can be expected. Residents will promptly report to Island Palm Communities repairs that are beyond the capability of the resident.

8.3 Preventive Maintenance Work

All homes are required to have certain preventive maintenance work performed at various times of the year. This work is required to ensure the safe and efficient operation of all installed equipment as well as the exterior structure. Preventive maintenance is as follows:

- Island Palm Communities-owned HVAC units will be inspected and preventive maintenance will be performed as needed
- Inspection of smoke detectors
- Exterior inspections and informal condition assessments (foundation settling, mold, roof and gutter cleaning, as well as trimming of hedges, bushes and trees) will be performed annually or as needed
- Residents may not direct the work performed by maintenance

Residents will be called at home or at duty station by the maintenance service coordinator to schedule all preventive maintenance work when access to the interior of the home is required. A letter may be sent in lieu of a phone call notifying resident of the date of service. If residents are not home at the scheduled time of service, the service still will be performed and notification of such service will be left on the resident's door. For planned utility outages, affected residents will be notified at least 48 hours prior to the planned outage if the information is available. Otherwise, residents will be notified as quickly as Island Palm Communities is aware of the utility outage. Notification to residents may include a combination of the following methods: announcement on the Island Palm Communities website, a flyer delivered to each housing unit, announcement in the Hawaii Army Weekly if sufficient lead time permits, information signs posted in the community, a posted notice at a community center or telephone (Call Max) message.

back to table of contents

8.4 Pest Control Services

Household pest control services will be provided as part of an exterior preventive maintenance program. This service is managed through the service call process. Household pests consist of infestations of ants, roaches, rodents, silverfish, spiders, wasps, centipedes, scorpions, termites, hornets and bees. The resident is required to keep their residence in clean condition and food stored in sealed containers. In a tropical environment failure to properly store food will invite unwanted pests. Residents are required to treat minor pest problems. All homes are treated during the Change of Occupancy Maintenance (COM) and serviced as needed to remove pests. Island Palm Communities staff will educate residents on appropriate steps for pest control and will treat for infestation after an inspection by the community center staff and review of the methods used by the resident to eliminate the problem. Pest control for infestation due to pet ownership will be the responsibility of the resident.

8.5 Refuse Collection and Recycling

Refuse and recycling collections and bulk pick-up will be provided to residents weekly on designated days. Residents will be notified of scheduled refuse and recycling pick-up days at the time of move-in by community center staff.

Bulk pick-up includes items such as furniture or other large items. Due to environmental concerns, bulk pick-up will not include appliances or other mechanical assemblies that contain oils or other fluids. Hazardous waste will not be picked up by the refuse collection company. Residents must take items such as air conditioners, batteries and propane tanks to an appropriate disposal site. Information can be found on the IPC website or by contacting an IPC community center.

Residents are encouraged to recycle green waste. Green waste such as limbs, fronds and large leaves should be neatly bundled and tied together in a neat package not to exceed 4 feet in length by 2 feet in width. Loose green waste should be placed in a plastic bag or a cardboard box. Green waste should be placed at the curb for pick up in accordance with your community center recycling schedule.

Residents should place all trash/refuse in bags to prevent insects and other pests from being attracted to refuse cans. Residents should periodically rinse out refuse cans/containers to prevent odors. Old cooking oil may be disposed of in regular trash but should be placed in a suitable, non-breakable container prior to placing in trash. Automotive oils may not be placed in refuse cans/containers at any time unless an approved automotive oil disposal kit is used. As a reminder, automotive repairs including changing of oils are prohibited in Island Palm Communities housing areas.

Refuse and recycling cans and bulk items should be placed curbside, not earlier than 5 p.m., the evening prior to pick-up. Refuse and recycling cans must be returned to their storage area immediately following pick-up, but no later than 5 p.m. on day of pick-up.

8.6 Grounds and Landscape Maintenance Program

Grounds maintenance will be performed for all common areas, facilities, front and side yards of all homes. Additional work cannot be directed by residents. Common area maintenance will include:

- Mowing
- Edging
- Routine tree-shrub pruning
- Mulching

Island Palm Communities will mow all areas to within 50 feet from the back of occupied units. Residents who have been approved to have personal designated space in the side yards are responsible to mow and edge that area. Grounds and landscaping crews will not mow or edge around resident's personal items. Residents who trim bushes or other planted materials are required to bag or bundle the green waste and put at the designated collection area on collection day. Mowing responsibility will be discussed upon move-in with a map of resident requirements for their home.

8.7 Conditioner Window Unit and Ceiling Fan Installation Policy

Air Conditioner Window Units

Island Palm Communities policy limits the number of air conditioner window units its service department will install per home. Island Palm Communities may also limit the number of air conditioner window units per home due to safety considerations resulting from the varied electrical capacity in each house.

The following restrictions may apply:

Only one air conditioner unit per circuit or circuit breaker is allowed. Additional electrical work or wiring will not be provided. Individual air conditioner units cannot exceed 12,000 btu/110 volts.

back to table of contents

Two- and Three-bedroom Homes
Island Palm Communities service department will provide upon request the labor and materials to install one resident-furnished window unit for two- and three-bedroom homes where existing circuit amperage safely permits.

Four- and Five-bedroom Homes
Island Palm Communities Service department will provide upon request the labor and materials to install up to two resident-furnished window units where existing circuit amperage safely permits.

All Island Palm Communities-installed, resident-furnished air conditioners must be new and in original packaging.

Resident Installed Units
Window units installed by the resident must be pre-approved by the community manager and must be safely installed according to community standards. A Window Unit Air Conditioner Installation Form must be completed and turned into the community center where it will be kept on file. Installation standards also include the exterior painting of spacing lumber used for installation. Residents must supply all materials needed for safe and proper installation. A post-installation inspection will be performed by the community manager to ensure compliance.

Island Palm Communities Family Care Package Benefit
If circuit amperage safely permits, Island Palm Communities will install any additional window units purchased by a resident who is registered with Island Palm Communities Family Care Package program for deployed Families. Air conditioner units must be new, in original packaging and not exceed 12,000 btu/110 volts. Only one unit per circuit or circuit breaker is permitted. This will require one hour per air conditioner unit installation from the Island Palm Communities Family Care Package time. Spouses may use the remaining Island Palm Communities Family Care Package time to remove personal air conditioner units. This will require one hour per unit from the Island Palm Communities Family Care Package time.

Ceiling Fan Installation Policy

Two- and Three-bedroom Homes
Island Palm Communities will provide upon request the labor and materials to install one new, resident-furnished, approved ceiling fan for two- and three- bedroom homes where existing wiring and proper ceiling support safely allow. Check with your community center to see if your home meets standards.

Four- and Five-bedroom Homes
Island Palm Communities will provide upon request the labor and materials to install two new, resident-furnished, approved ceiling fans for four- and five-bedroom homes where existing wiring and proper ceiling support safely allow. Check with your community center to see if your home meets standards.

Approved ceiling fans can be purchased at most home improvement stores. Fans must be 52-inch, five-blade Hunter or Hampton Bay brand in any style or color with a lighting kit. Ceiling fans will become the property of Island Palm Communities and cannot be removed upon departure or relocated to other rooms or dwellings.

Island Palm Communities Family Care Package Benefit
Additional resident-furnished, approved ceiling fans may be installed using Island Palm Communities Family Care Package time for Families registered with Island Palm Communities Family Care Package program. This will require one hour per ceiling fan installation from the Island Palm Communities Family Care Package time. Ceiling fans will become the property of Island Palm Communities and cannot be removed upon departure or relocated to other rooms or dwellings.

Island Palm Communities service department air conditioner window unit and ceiling fan installations are done as a convenience to our residents. Installations will be scheduled on a first-come, first-served basis when required maintenance requests permit. Installation waiting times may vary, so we appreciate your patience.

back to table of contents

back to table of contents

back to table of contents

SECTION 9 Crisis Management / Disaster Situations

9.1 Warnings

Island Palm Communities works in conjunction with the Department of the Army in following the published installation procedures for Emergency Warning Announcements, inclement weather and other emergency situations. A listing of emergency shelters is provided in the Resident Welcome Packet, and also can be found online at www.IslandPalmCommunities.com. You may be directed to one of these shelters during an actual emergency. Please take time to familiarize yourself with shelter locations. All Families should have an emergency evacuation plan, including a designated place to meet outside the home. Emergency announcements may be made:

- In person
- On local radio or television
- By siren alarm
- Via public address system
- Via automated voice messaging notification system (Call Max)

Island Palm Communities will attempt to inform, warn, advise and help save lives and protect property. It will be everyone's personal responsibility to make adequate preparations to protect themselves and those for whom they are responsible. Residents are required to cooperate with Military officials, police, fire department personnel and Island Palm Communities staff during emergencies in order to safeguard lives and property.

In the event of disaster situations such as the pending arrival of a major hurricane, Island Palm Communities residents are advised to shelter in place unless otherwise directed by Island Palm Communities and/or law enforcement personnel. All Island Palm Communities residents are highly encouraged to maintain a disaster readiness kit able to sustain their Family/pet(s) for at least three days. After an emergency, all Army-affiliated personnel (Soldiers and family members) are to report their status to their command at the first available opportunity. In some cases, the Secretary of Defense will direct all DOD-affiliated personnel in the affected area to report their accountability status as soon as possible. When this happens, if you have access to the Internet you are to report your status online through the Army Disaster Personnel Accountability and Assessment System (ADPAAS) at https://adpaas.army.mil. For more useful information and tips on how to prepare a Family disaster readiness kit, please refer to your annual Island Palm Communities Hurricane Readiness guide or visit www.ready.gov or www.ready.army.mil.

9.2 Procedures and Directives

Emergency procedures and recommendations will be provided to the resident in handouts or announcements when they become known.

SECTION 10 Self-help Supplies

10.1 Lawn and Garden

A small inventory of lawn equipment will be maintained at each community center. These items are available for loan during business hours and must be returned by the next business day. Lawn mowers, small gardening tools, and weed-eaters are among the items available. Gas for mowers and trimmers is not provided. Items are loaned on a first -come, first-served basis. Charges will be assessed for any items returned late, damaged, or not cleaned.

Late Fee.....$10.00 per day
Cleaning.....$20.00
Damage.....Actual cost to repair or replace

SECTION 11 Renter's Insurance Policy

11.1 Renter's Insurance Guidelines

As a renter of housing with Island Palm Communities, each active duty Service Member in our homes is provided with renter's insurance at no cost. This insurance provides a limited

back to table of contents

coverage for personal property located within the home. Please take time to review the policy to assure it meets your personal needs. This policy consists of the following major components:

- Personal property coverage
- Per incident deductible
- Liability insurance

The contents deductible under the policy is $250 per occurrence. Resident is responsible for any/all deductibles as applicable.

It should be noted that this renters insurance excludes loss from sewage backups, pollution, war/terrorism, spoilage/power failure or intentional loss. Also, property such as business data, motor vehicles, RV/ATVs, credit cards, animals, pets, birds, or fish are not covered. The renter's insurance policy does not cover all types of flooding. Losses of personal property caused by Acts of Nature are not covered by this policy. Other liability exclusions also apply. Residents are encouraged to contact the insurance company at the number provided on the Renter Insurance Summary handout provided to you upon move-in. If you need another copy, please see your community center staff during normal business hours.

Residents are encouraged to supplement this basic renter's insurance based upon their own assessment of the amount of property or liability coverage needed to protect their own interests. There are numerous insurance companies that offer additional limits for personal property and liability insurance.

Residents should take all reasonable and necessary actions to protect their personal property from loss. To prevent loss from theft please make sure that you secure your personal property when left unattended. Please contact the Military Police if you have questions on how to keep your home safe from loss through theft.

SECTION 12 Move-out Procedures

12.1 Resident Occupancy Agreement Termination/ Vacate Procedures

The Resident Occupancy Agreement includes a clause requiring residents to notify Island Palm Communities of their intent to vacate. Residents must notify their community center in writing 28 days prior to vacating or as soon as notification of transfer to another duty station is received. All other reasons that will result in the termination of the Resident Occupancy Agreement, such as retirement, also require a 28-day notice. If the home has been pre-offered, the move-out date may not be extended. If the home is to be cleared by anyone other than the Service Member, a Residential Communities Initiative Special Power of Attorney (RCI SPOA) is required from the Service Member designating an agent to act on his/her behalf in matters regarding Island Palm Communities homes. This is a mandatory requirement. Residents may obtain a copy suitable for notarization at their community center office or online at www.IslandPalmCommunities.com.

Once the Island Palm Communities community center is notified that the Resident Occupancy Agreement will be terminated, a pre-inspection, a final inspection, change of occupancy maintenance (COM) and other required activities necessary to make the unit ready for the next resident will be scheduled. Military family members will be permitted to continue the Resident Occupancy Agreement while the resident is serving an unaccompanied or restricted tour or temporarily detailed within the United States. A military family member may be allowed to reside in a unit for up to the number of days allowed per DA policy after the death of sponsor, with full payment of rent in the amount equal to the BAH. If BAH is paid in one lump sum, rent must be paid to Island Palm Communities at time of receipt. In the case of MIA, POW or other status conditions, military family members may remain in the home until such time as the particular military service branch changes the Service Member's status or until such time as BAH is no longer authorized.

Pre-inspection

The Resident Occupancy Agreement requires a 28-day notice be given to the resident's community center prior to move-out, and residents are encouraged to provide early notice once their departure date is known. Receipt of early notices will assist in forecasting move-outs; therefore facilitate the notification and processing of incoming residents. Upon receipt of the move-out notice, Island Palm Communities property management will:

- Provide written acknowledgement of the move-out notice to the military member or designated agent, which will include confirmation of his or her move-out date
- Schedule a pre-inspection and final inspection with the Service Member

During the pre-inspection, Island Palm Communities Property Management will:

- Assess damages that the resident may be responsible for
- Inform resident of cleaning requirements
- Inform resident of proper disposal of hazardous materials
- Confirm final inspection date

back to table of contents

Final Inspection

During the final inspection, Island Palm Communities Property Management will:

- Provide a final damage cost assessment to the resident
- Determine need for additional estimates for repairs or replacement
- Take pictures of damages
- Collect amount due for damage charges, unpaid rent, and cleaning charges as applicable

During the termination inspection, the resident will:

- Ensure that all persons and personal property are removed from Island Palm Communities property
- Provide receipt of professional de-flea service completed no less than 5 days prior to move-out, or pay de-flea charge at resident's community center. Cost for Island Palm Communities contract de-flea services are available at community center and are subject to change without notice
- Return keys, garage door openers and other access items; residents are charged $10 for each lost key, $50 for lost mailbox key, $75 for each lost garage door opener and $20 for lost amenities key cards. Prices are subject to change without notice
- Provide an accurate forwarding address

If a Service Member leaves without paying the full amount due, collection procedures will start immediately. Collection activities include, but are not limited to, reporting the bad debt to collection agencies, all credit bureaus, and to the Service Member's command.

Cleaning Requirements

Island Palm Communities property management has established cleaning and lawn maintenance guidelines. For details about cleaning, contact your community center.

Island Palm Communities will provide cleaning and damage guidelines to residents upon home assignment and review the guidelines prior to the resident vacating. Damages beyond normal wear and tear include, but are not limited to, painting, carpet repair/replacement and pet damage. The resident will receive a damage/cleaning report and a statement of charges. Repairs will be accomplished in accordance with Island Palm Communities maintenance standards. Residents will be required to pay for damages/cleaning costs prior to move-out.

Items such as painting, flooring and appliances will be prorated based on useful life (with the exception of flooring under one year old which will be charged at replacement value).

A resident's responsibility to the home will not be terminated unless the home is appropriately cleaned.

back to table of contents

back to table of contents

Enclosure 1

Mold / Mildew Disclosure

Information and Steps for Prevention

It is our goal to maintain a quality living environment for residents. To help achieve this, it is important that residents and Island Palm Communities work together to minimize mold growth in their homes. The following important information outlines resident responsibilities and Island Palm Communities responsibilities.

About Mold

Mold is found virtually everywhere in our environment -- indoors and outdoors and in new and old structures. Molds are naturally occurring microscopic organisms, which reproduce by spores. All of us have lived with mold spores all our lives. Without molds we would be struggling with large amounts of dead organic matter. Mold breaks down organic matter in the environment and uses the end product for its food. Mold spores (like plant pollen) spread through the air and are commonly transported by shoes, clothing and other materials. When excess moisture is present inside a home, mold can grow. There is conflicting scientific evidence as to what constitutes a sufficient accumulation of mold that could lead to adverse health effects. Nonetheless, appropriate precautions need to be taken.

Prevent Mold

In order to minimize the potential for mold growth in your home, you must do the following:

- Keep your home clean, especially in kitchen and bathroom(s) and including carpets and floors. Regular vacuuming, mopping and using a household cleaner to clean hard surfaces are important to remove the household dirt and debris that harbors mold or food for mold. Immediately throw away moldy food
- Remove visible moisture accumulation on windows, walls, ceilings, floors and other surfaces as soon as reasonably possible. Look for leaks in washing machine hoses and discharge lines; especially if the leak is large enough for water to infiltrate nearby walls. Turn on any exhaust fans in the bathroom and kitchen before you start showering or cooking with open pots. When showering, be sure to keep the shower curtain inside the tub or fully close the shower doors. Also, experts recommend that after taking a shower or bath you: 1) wipe moisture off of shower walls, shower doors, bathtub, and bathroom floor; 2) leave bathroom door open until all moisture on mirrors and bathroom walls and tile surfaces has dissipated; and 3) hang up towels and bath mats so they will completely dry
- Keep your lanai/patio clean and free of mold growth by using a mold, mildew or algae cleaner and water solution. Excessive mold on lanai/patios can be carried into homes by a person's shoes or by pets. Keeping your lanai/patio and sidewalks clean is essential to preventing mold growth. Mold, mildew or algae cleaners are available at most local hardware and home improvement stores
- Promptly notify your community center about any air conditioning system problems you discover. Periodically check your hot water heater for leaks. Follow Island Palm Communities rules regarding replacement of air filters. Also, it is recommended you periodically open windows and doors when the out door weather is dry (i.e. humidity is below 50 percent) to help humid areas of your home dry
- Promptly notify your community center about any signs of water leaks, water infiltration or mold. Staff will respond in accordance with Hawaii state law and the Resident Occupancy Agreement to repair or remedy the situation, as necessary
- When operating air conditioning systems, keep all doors and windows closed

3. Avoid Mold Growth

If small areas of mold appear on non-porous surfaces (ceramic tile, formica, vinyl flooring, metal, wood, plastic) the Environmental Protection Agency (EPA) recommends that you first clean the areas with soap (or detergent) and water, let the surface dry, and then within 24 hours apply a pre-mixed, spray-on-type of household biocide such as Lysol Disinfectant, Pine-Sol Disinfectant (original pine-scented), Tilex Mildew Remover or Clorox Cleanup (Note: Only a few of the common household cleaners will actually kill mold). Tilex and Clorox contain bleach, which can discolor or stain. Be sure to follow the instructions on the container. Applying biocides without first cleaning the filth and oils from the surface is like painting over old paint without first cleaning and preparing the surface. Always clean and apply a biocide to an area five or six times larger than any visible mold because mold may be adjacent in quantities not yet visible to the naked eye. A vacuum cleaner with a high-efficiency

back to table of contents

particulate air (HEPA) filter can be used to help remove non-visible mold from porous items such as fibers in sofas, chairs, drapes and carpets provided the fibers are completely dry. Machine washing or dry cleaning will remove mold from clothes.

4. Biocides

Do not clean or apply biocides to visible mold on porous surfaces such as sheetrock walls or ceilings, or large areas of visible mold on non-porous surfaces. Instead, notify your community center and staff will take appropriate action.

Compliance

Complying with this information will help prevent mold growth in your home, and together residents and Island Palm Communities will be able to respond appropriately if problems develop that could lead to mold growth. If you have questions regarding this information, please contact your community center.

Enclosure 2

Pesticide-Impacted Soil Disclosure

About Pesticide-Impacted Soil

It is Island Palm Communities goal to maintain a quality living and pest-free environment for our residents. To help achieve this, it is important that our residents and Island Palm Communities work together to be aware of current and historical pesticide use, refrain from using pesticides in and around our homes, and minimize the disturbance of soils which may contain pesticides. Residents should be aware that many homes within the Island Palm Communities communities have had pesticides applied to the soil under the foundation slabs as a treatment for termites. As a result, our homes have the potential for pesticide-impacted soil to be present. Island Palm Communities has gone to great strides to address the historical use of pesticides, and continues to do so. For this reason, Island Palm Communities does not allow residents to dig or disturb soils within the Island Palm Communities communities. For more information please contact your Island Palm Communities community center.

back to table of contents

This page intentionally left blank.

IDDE APPENDIX L
U.S Army Corps of Engineers and Job Order Contract Legal Authority

This page intentionally left blank.

IDDE APPENDIX L
U.S Army Corps of Engineers Legal Authority

This page intentionally left blank.

52.223-5000 – GENERAL ENVIRONMENTAL STANDARDS

(a) While performing work on any US Army Garrison, Hawaii (USAG-HI) installations, the contractor will comply with Executive Orders 13423 "Strengthening Federal Environmental, Energy, and Transportation Management" signed by the President on 24 Jan 2007 and 13514, "Federal Leadership in Environmental, Energy, and Economic Performance" signed by the President on 8 Oct 2009 requiring the acquisition of environmentally preferable goods and services, use of sustainable environmental practices, purchase of biobased, energy efficient and recycled content products. More specifically, the Contractor will strive to improve upon their sustainability performance by taking actions to:

(1) Reduce energy consumption

(2) Reduce greenhouse gas emissions

(3) Conserve and protect water resources

(4) Eliminate waste, recycle, and prevent pollution

(5) Adopt sustainable technologies

(6) Procure environmentally preferable materials, products and services

(7) Maintain sustainable buildings

(8) Strengthen livability of the local community

(9) Inform and involve personnel in the achievement of these goals.

(b) The contractor will comply with the Government directives, permit conditions, installation policies and plans as administered by the Government. The Contractor will be held liable to pay for any environmental fines resulting from his operations, waste generated or other operational environmental requirements. As applicable, the Contractor will obtain environmental permits required for wastewater pretreatment, underground tanks, hazardous waste identification numbers, air pollution permit for temporary sources, storm water permits or other pertinent environmental permits.

(c) The contractor will review and comply with applicable policies, program documents and regulatory requirements as stipulated under each environmental program media below.

(1) Environmental program documents include, but are not limited to; the Installation Hazardous Waste Management Plan – USAG-HI Regulation 200-4, Asbestos Management Plan, Lead-based Paint Management Plan, Installation Spill Prevention, Control, and Countermeasures (SPCC) Plan, Integrated Natural Resources Management Plan, Integrated Cultural Resources Management Plan, Pollution Prevention Plan, and the Storm Water Pollution Prevention Plan available at the DPW Environmental Division. Environmental program documents can be downloaded from the installation sustainability and environmental management website at: http://www.garrison.hawaii.army.mil/sustainability/Environmental.aspx.

(2) Installation policies include, but are not limited to; the Environmental Compliance and Protection Program Policy Memorandum USAG-HI-4; Environmental Policy Memorandum USAG-HI-10; Authorized Use List Policy Memorandum USAG-HI-19, Waste Reduction and Recycling Policy Memorandum USAG-HI-25; Open Burn Policy Memorandum USAG-HI-51; Generator Control Policy Memorandum USAG-HI-55; Illicit Discharge Detection and Elimination Policy Memorandum USAG-HI-59; and the Joint USARPAC and IMCOM-Pacific Energy Conservation Policy Guidance. Installation Policy Memorandums are available for download at: http://www.garrison.hawaii.army.mil/command/documents.htm

(3) The contractor is also encouraged to view the online A to Z sustainability and environmental management guide for instructions on managing common environmental issues. The A to Z sustainability and environmental management guide is available at:
http://www.garrison.hawaii.army.mil/sustainability/AtoZ.aspx.

(d) The Contractor shall at all times keep the work area, including storage areas used by him, free from accumulations of waste material or rubbish and prior to completion of the work remove any rubbish from the premises and all tools, scaffolding, equipment and materials not the property of the Government. Upon completion of the work, the Contractor shall leave the work and premises in a clean, neat and workmanlike condition satisfactory to the Contracting Officer. If debris is not disposed of properly or the site is not left clean, the Government will clean the site at the expense of the contractor. The contractor will also be held liable for damages done to the environment as a result of disposal and/or cleanup.

(e) The contractor may be subject to unannounced Environmental Compliance Inspections by the DPW Environmental Division.

(f) Environmental and Safety Noncompliance Fees. The contractor shall be solely responsible for remedying all Federal, State and local environmental and safety violations or noncompliance and any payment of fines, penalties and fees levied as a result of the violations or noncompliance. The government reserves the right to withhold payment in the amount of the fines, penalties and fees levied if not paid by the contractor.

52.223-5003 -- EMERGENCY PLANNING COMMUNITY RIGHT TO KNOW ACT (EPCRA) HAZARDOUS SUBSTANCES (HS)

a) Contractors using EPCRA HS in the performance of any work while on USAG-HI installations are responsible for complying with the provisions of EPCRA regulations and submitting applicable reports (TIER II/TRI) to Federal and State regulatory agencies as applicable.

(b) Copies of reports for substances used in connection with work performed on USAG-HI installations shall be provided to the DPW Environmental Division, Attention: EPCRA Program Manager, STOP 253, 3rd Floor, 948 Santos Dumont Ave., Wheeler Army Airfield, phone 656-2878.
(c) Chemicals regulated under EPCRA HS are defined in EPA document EPA 550-B-98-017, Title III List of List, Consolidated List of Chemicals Subject to the Emergency Planning and Community Right to Know Act and Section 112(r) of the Clean Air Act Amended.

(d) The contractor is responsible for knowing which chemicals it uses or transports that are contained on the list. For convenience, the contractor may review a copy of the EPA document at the Directorate of Public Works (DPW) Environmental Division. The document can also be downloaded from the U.S. Environmental Protection Agency (EPA) at: http://www.epa.gov/ceppo/p-gen.htm.

(e) The contractor must maintain copies of Material Safety Data Sheets (MSDS's) of all chemicals used in the performance of any work while on USAG-HI installations. MSDSs must be readily available at the site location where the work is being performed.

(f) The contractor can request the list and locations of EPCRA HS currently utilized on USAG-HI installations by contacting the DPW Environmental Division EPCRA Program Manager. The contractor must provide name, company, contract number, date the contract was awarded and provide a description of the contract. A database of locations of chemicals will then be forwarded upon review and approval of request. Contractors working on USAG-HI installations are encouraged to review this database, which will provide information where potentially hazardous chemicals are stored.

(g) All spills of substances containing EPCRA HS will be immediately reported to the Directorate of Public Works Spill Response line at 656-1111 and the USAG-HI, Public Affairs Office at 656-3160 or 542-9489 (after hours). The

Contracting Officer must be notified during the first business hour immediately after. All waste generated from EPCRA HS being utilized will be immediately reported to the DPW Environmental Office, phone: 656-2878.

(h) All Contractors utilizing substances containing EPCRA HS will perform the following prior to contract start.

(1) Review the Installation Spill Prevention, Control, and Countermeasures (SPCC) Plan and the Installation Hazardous Waste Management Plan – USAG-HI Regulation 200-4 available at the DPW Environmental Division or from the from the installation sustainability and environmental management website at: http://www.garrison.hawaii.army.mil/sustainability/Environmental.aspx. Upon review, the contractor or designated responsible employee shall sign a certification statement that they have reviewed and understand the contents of these documents.

(2) Provide a listing and MSDS copies of oil and Hazardous Substance (HS) products projected to be utilized in the performance of any work while on USAG-HI installations to the DPW Environmental Division. The estimated average and maximum quantities of each material anticipated to be on-site at any given time shall also be provided to the DPW Environmental Division EPCRA Program Manager, STOP 253, 3rd Floor, 948 Santos Dumont Ave., Wheeler Army Airfield, phone 656-2878 and to building 6040 East Range for material to be bar-coded. The contractor must ensure the product listing is current and updated as frequently as necessary and/or at a minimum, on an annual basis by 1 January of each year.

(3) Provide the name, office phone number, and cellular phone number of a company spill response point of contact. The point of contact must be trained in spill response.

(4) Provide a copy of an agreement with a hazardous materials spill response company in the event of a spill.

(5) Provide copies of employees training certificates on environmental and spill response training.

(6) Appoint a primary and alternate Environmental Compliance Officer in writing.

(7) Develop a notification procedure in the event of a spill to include phone numbers of response personnel, support agencies, National Response Center, State Hazard Evaluation Emergency Response Office and Civil Defense.

(8) Accomplish all spill notifications as required by the U.S. Environmental Protection Agency and State of Hawaii to the Hazard Evaluation Emergency Response Office, Local Emergency Response Commission and National Response Center. Copies of written spill notifications shall be provided to the DPW Environmental Division.

(9) All spills caused by the contractor will be cleaned up under supervision of the contractor and a qualified hazardous materials spill response company, at no cost to the government, in accordance with all applicable laws and regulations and to the satisfaction of the DPW Environmental Division.

(10) The contractor shall pay for disposal cost of all contaminated materials to include but not limited to soil, sorbent materials, disposable equipment and other materials contaminated by the spill. Ensure all disposals are in accordance with all applicable laws and regulations at authorized disposal facilities.

52.223-5004 -- SPILLS OF PETROLEUM/OIL/LUBRICANTS OR HAZARDOUS MATERIALS/HAZARDOUS WASTE

(a) The contractor will prepare and maintain a site-specific spill plan, including notification procedures for spills/releases. The spill plan will include phone numbers of response personnel, support agencies, National Response Center, State Hazard Evaluation Emergency Response Office and Civil Defense. The contractor will provide a copy of the spill plan to DPW Environmental Division upon request.

(b) The contractor shall provide immediate response to stop, contain, and clean-up all spills of oil and other hazardous substances that result from his performance under this contract.

(c) The contractor must report all spills immediately to the DPW Spill Response line at (808) 656-1111 in accordance with the Installation SPCC Plan. Additionally, the contractor shall notify the COR of the incident during normal business hour or the first business hour following the incident.

(d) The contractor will accomplish all spill notifications and written spill reports as required by the U.S. Environmental Protection Agency, State of Hawaii Hazardous Evaluation Response Office, Local Emergency Planning Commission and National Response Center, in accordance with applicable laws and regulations.

(e) The contractor will provide a copy of spill notifications and written reports to the DPW Environmental Division.

(f) All spills caused by the Contractor will be cleaned up under the supervision of the Contractor and/or a qualified hazardous waste/materials spill response company, at no cost to the USAG-HI, in accordance with all applicable laws and regulations and to the satisfaction of the DPW Environmental Division. If cleanup is not accomplished in a timely fashion, or to the satisfaction of the DPW Environmental Division, the Government will assist with the final cleanup, and the Contractor will provide appropriate reimbursement of cleanup costs.

(g) The contractor will pay for all clean up, management, and disposal cost of all contaminated materials to include but not limited to soil, sorbent materials, disposable equipment and other materials contaminated by the spill. The contractor will ensure waste disposal is accomplished in accordance with all applicable laws and regulations and at an authorized/permitted treatment and disposal facilities.

(h) The contractor will pay any fines or penalty charges associated with a citation issued by federal, state or local officials as a result of the accident.

(i) Contractors handling bulk fuel must be trained to do so, and mobile fuel operations must be approved by the DPW Environmental Division.

(j) Off-Post Spills. The contractor shall be responsible for and pay for cleanup of off-post spills in accordance with directions received from appropriate local authorities (e.g., Honolulu Fire Department, State Civil Defense, etc.). Off-post spills in connection with work performed under this contract shall also be reported to the DPW Spill Response line at (808) 656-1111 and the COR.

(k) Discovery of other than contractor-caused spills. The contractor shall report any spills of hazardous materials to the DPW Spill Response line at (808) 656-1111 and the COR upon discovery.

52.223-5005 -- HAZARDOUS WASTE (HW) and NON-REGULATED WASTE (NRW).

(a) The Contractor will comply with the Environmental Compliance and Protection Program Policy Memorandum USAG-HI-4.

(b) The Contractor will determine, based on generation of hazardous waste(s) resulting from their operation/activities their respective hazardous waste generator status. The contractor is responsible to manage HW and NRW generated on-site from inception to disposal in accordance with all applicable, federal, state, and local regulations. All costs associated with disposal are borne by the Contractor.

52.223-5006 -- RECYCLING PROGRAM

(a) The contractor will comply with USAG-HI Policy Memorandum 25, Waste Reduction and Recycling, requiring diversion of solid waste to the fullest possible. More information can be found on the installation sustainability and environmental management website at: http://www.garrison.hawaii.army.mil/sustainability/Recycling.aspx

(b) Identify a recycling POC to DPW Environmental Division to include name, phone number and email address.

(c) Report quantities of refuse disposed and recycled to DPW Environmental Division as part of the work performed under this contract as applicable.

52.223-5007 -- CLEAN AIR.

(a) The contractor will comply with the Open Burn Policy Memorandum USAG-HI-51.

(b) The contractor will obtain air pollution permit for temporary sources in the performance of this contract as applicable.

(c) Contractors that install, operate, or maintain generators in the performance of this contract will comply with the USAG-HI Generator Control Policy Memorandum USAG-HI-55. In accordance with this policy, contractors will provide DPW Environmental Division with an inventory of the generators, and will consult with the DPW Environmental Division before installing or operating new generators.

(d) Contractor will comply with the following Army Ozone Depleting Chemicals Policy Memorandums, available for download at http://www.garrison.hawaii.army.mil/sustainability/CleanAir.aspx:

(1) Memorandum for Change In Army Policy for the Elimination of Ozone Depleting Chemicals, 07 Jan 2003.

(2) Memorandum for Equipment and Real Property Containing Class I Ozone-Depleting Substances (ODS), 16 Jun 2004.

(3) Memorandum for R-22 Refrigerant Use on Army Installations, 12 Jun 2008

52.223-5008 -- CLEAN WATER

(a) The contractor will comply with Illicit Discharge Detection and Elimination Policy Memorandum USAG-HI-59.

(b) The contractor will comply with the USAG-HI Storm Water Pollution Prevention Plan and Clean Water Best Management Practices available for download at:
http://www.garrison.hawaii.army.mil/sustainability/CleanWater.aspx

(c) The contractor will obtain Industrial Wastewater Discharge Permits (IWDP), National Pollutant Discharge Elimination System (NPDES) permits and/or obtain authorization to discharge to the installation Municipal Separate Storm Sewer Systems (MS4) as applicable.

(d) Contractors operating or using USAG-HI wash racks in the performance of this contract will ONLY use approved cleaners. Approved cleaners list is available for download at:
http://www.garrison.hawaii.army.mil/sustainability/AtoZ/ApprovedCleaners.pdf

(1) Contractors operating or using USAG-HI wash racks must prevent wash rack outflow from discharging directly into storm water drains by ALWAYS turning on the washing spigots, even if using a pressure washer.

(2) Contractors occupying a facility with an oil water separator and wash rack in the performance of this contract, must remove debris that could obstruct the proper functioning of the equipment and wastewater flow.

52.223-5009 -- NATURAL AND CULTURAL RESOURCES PROGRAM

(a) The contractor will comply with USAG-HI Range Standard Operating Procedures (SOPs). All personnel who use the ranges must complete a mandatory pre-brief covering issues associated with Natural and Cultural Resources.

(b) The contractor must be cognizant of the potential environmental impact and liability their actions could have, if specified procedures are not followed on Army lands. The contractor must be aware that USAG-HI manages more than 100 threatened and endangered species including plants, snails, birds, bats, insects and their critical habitat and over 1,300 prehistoric archaeological sites, including temple structures, stone markers, fishing shrines, habitation sites, caves, rock shelters, mounds, burial platforms, earth ovens, stone walls and enclosures, agricultural terraces, irrigation canals, petroglyphs and trails.

(c) The contractor shall take every precaution to prevent starting wildfires at training areas and must put them out if they do occur. The contractor must report all wildfires to range control immediately at 808-655-1434.

(d) The contractor must be familiar with the policy and restrictions regarding the types of ammunition that can be used under the different Burn Indices (BI) and on the different ranges.

(e) The contractor must comply with the non-smoking policy at training areas and only allow smoking in designated areas.

(f) The contractor must comply with the range best management practices to prevent the spread of invasive plant species from one training area to another by always washing vehicles, gears and equipment before starting new training activities.

(g) The contractor will stay out of areas marked with Seibert Stakes. Seibert stakes are placed along roads and within vegetated areas to advise personnel of unsafe or hazardous range or training conditions and/or environmentally sensitive off-limit areas.

(h) The contractor will refer to the installation sustainability and environmental management website at: http://www.garrison.hawaii.army.mil/sustainability/NaturalResources.aspx and http://www.garrison.hawaii.army.mil/sustainability/CulturalResources.aspx for additional information.

52.223-5010 -- NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

As applicable, and upon request by the Government, the contractor will comply with the NEPA process, notify the DPW Environmental Division and complete a Record of Environmental Consideration (REC) for actions such as, but not limited to:

(1) Actions that could impact historic structures, cultural and natural resources

(2) Minor renovation or new construction

(3) Actions that introduce new training vehicles, maneuvers, and weapons

(4) Replacing or removing floor tiles, ceiling tiles, sound proofing material, lighting fixtures, carpet, serving line equipment, natural gas unit

(5) Installing interior doors, windows, partitions, security cameras, rerouting ductwork

52.223-5011 -- SUSTAINABLE ENVIRONMENTAL MANAGEMENT (SEM) SYSTEM

(a) The contractor will be familiar with and comply with the installation's Environmental Policy Memorandum USAG-HI-10 and all 18 components of the installation SEM system manual in conformance with the ISO 14001 standard. The SEM system manual is available for download at: http://www.garrison.hawaii.army.mil/sustainability/SEM.aspx

(b) In accordance with OPORD IMPC-HI-ZA 02-09, the contractor will train all personnel in SEM awareness provided by DPW Environmental Division upon contract award. Refer to the installation Sustainable and Environmental Management website at http://www.garrison.hawaii.army.mil/sustainability/Training.aspx for information about the online training logging and access procedure.

(c) The contractor will support, as applicable, USAG-HI in achieving the reduction and environmental improvement goals identified in the installation Strategic and Sustainability Plan, as well as Executive Order 13514. The Contractor will strive to accomplish these goals by implementing and promoting green practices to help reduce their environmental footprint, fostering an ethic that takes the Army beyond environmental compliance to sustainability.

(d) Appoint a SEM point of contact to DPW Environmental Division to include Name, phone number and email address upon request by the Government.

52.223-5012 -- SELF-HELP PROJECTS

(a) While performing work and/or occupying facilities on any US Army Garrison, Hawaii (USAG-HI) installations, the contractor will consult with the DPW Environmental Division ***before*** beginning any self-help projects for guidelines on how to comply with historical property requirements and for verification of potential asbestos, lead-based paint and other environmental health hazards associated with the proposed self-help project.

(b) You can read more about asbestos and lead-based paint at: http://www.garrison.hawaii.army.mil/sustainability/AsbestosLead.aspx

52.223-5013 -- ENERGY AND WATER CONSERVATION

(a) Upon request by the Government, the contractor will appoint a Unit Energy Conservation Officer (UECO) and Building Energy Monitor (BEM) and fully participate in the Garrison's energy and water conservation program.

(b) Appointed BEM and UECO must attend the training class provided by the DPW Engineering Branch.

(c) The appointed UECOs and BEMs are responsible for ensuring energy-saving measures are being enforced in each building and to provide regular reports to DPW Engineering Branch showing how well the contractor is doing at conserving energy.

(d) More information can be found on the installation sustainability and environmental management website at: http://www.garrison.hawaii.army.mil/sustainability/Energy.aspx

52.223-5014 -- SUSTAINABLE ACQUISITIONS

(a) The contractor will provide products and services in the performance of this contract which are energy-efficient (Energy Star or Federal Energy Management Program (FEMP) designated), water-efficient, biobased,

environmentally preferable (e.g. Electronic Product Environmental Assessment Tool (EPEAT) certified), non-ozone depleting, contain recycled content, or are non-toxic or less toxic alternatives, where such products and services meet the Government's performance requirements;

(b) More information can be found on the installation sustainability and environmental management website at: http://www.garrison.hawaii.army.mil/sustainability/SustAcquisition.aspx.

RCO-HI LOCAL CLAUSES
GENERAL INFORMATION APPLICABLE TO CONTRACTORS

52.203-5000 -- CONTRACTUAL RELATIONSHIPS

The Contractor's personnel shall at all times be under the supervision of the Contractor and not under the supervision of the Government or any of its officers or employees. Any discrepancies or noncompliance with the contract provisions or specifications will be brought to the attention of the employee's supervisor or foreman in charge for necessary corrective action.

52.203-5001 -- MISCONDUCT OF CONTRACTOR EMPLOYEES

(a) The Contractor agrees to utilize only experienced, responsible, and capable people in the performance of the work. The Contracting Officer may require the contractor to correct instances of misconduct by employees working on this contract. In addition, the Contracting Officer may direct the contractor employee be escorted from the Army installation if determined that such action is necessary to protect the interests of the Army. The Installation Commander or appointed designee has the authority to bar contractor employees from the installation when determined to be in the best interest of Army.

(b) The Contracting Officer may require that the contractor remove from the Government job employees who endanger persons or property.

52.203-5002 -- CIVILIAN EMPLOYMENT OF MILITARY PERSONNEL EMPLOYEES

No military personnel assigned, attached or on TDY to any military unit shall be employed by the Contractor to perform work under this contract unless and until he or she has furnished the Contractor written approval of his immediate Commander, and in no event shall such personnel be utilized in a supervisory capacity in performance of the contract work.

52.236-5007 -- PRECAUTIONS FOR THE PROTECTION OF EXISTING UTILITIES (INCLUDES COMMUNICATIONS) AND FACILITIES.

(a) Contractors are required to ensure necessary precautions and obtain required permits to protect government utilities and facilities. Contracts involving dredging, excavating, blasting and grading operations, demolition of structure and the moving of heavy and/or bulky equipment shall be subject to the following procedures and conditions:

(1) Verify that testing procedures comply with contract requirements.

(2) Verify that facilities and testing equipment are available and comply with the testing standards.

(3) Check test instrument calibration data against certified standards.

(4) Verify that recording forms, including all of the test documentation requirements, have been prepared.

1.4 HANDLING AND STORAGE

Provide controls, procedures and documentation with each shipment, that meet requirements of each section of the specifications.

Include documentation with each shipment that consist of documentation required by the contract along with specifications required to identify, store, preserve, operate, and maintain the items shipped.

1.5 SEQUENCING AND SCHEDULING

Notify the Government at least 48 hours prior to scheduled inspections and tests.

Provide 48 hour notice to the Government of the date when the contract work will begin at the site.

When Contractor suspends work for 5 calendar days or longer prior to completion, notify the Contracting Officer. Do not resume work without notification of the Contracting Officer.

Notify the Contracting Officer at least 48 hours in advance of backfilling or encasing any underground utility.

Acceptance of plan. Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes in his CQC plan and operations as necessary to obtain the quality specified.

Notification of Changes. After acceptance of the OC plan, the Contractor shall notify the KO in writing of any proposed change. Proposed changes are subject to acceptance by the KO.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 57 20.00 10

ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. AIR FORCE (USAF)

AFI 32-1053	(2009) Integrated Pest Management Program

U.S. ARMY (DA)

DA AR 200-1	(2007) Environmental Protection and Enhancement

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2008; Change 1-2010; Change 3-2010; Errata 1-2010) Safety and Health Requirements Manual
WETLANDS DELINEATION MANUAL	(1987) Corps of Engineers Wetlands Delineation Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

33 CFR 328	Definitions of Waters of the United States
40 CFR 150 - 189	Pesticide Programs
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 279	Standards for the Management of Used Oil
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
40 CFR 68	Chemical Accident Prevention Provisions
49 CFR 171 - 178	Hazardous Materials Regulations

1.2 DEFINITIONS

1.2.1 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

1.2.2 Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2.3 Contractor Generated Hazardous Waste

Contractor generated hazardous waste means materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of material brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e. methyl ethyl ketone, toluene etc.), waste thinners, excess paints, excess solvents, waste solvents, and excess pesticides, and contaminated pesticide equipment rinse water.

1.2.4 Installation Pest Management Coordinator

Installation Pest Management Coordinator (IPMC) is the individual officially designated by the Installation Commander to oversee the Installation Pest Management Program and the Installation Pest Management Plan.

1.2.5 Project Pesticide Coordinator

The Project Pesticide Coordinator (PPC) is an individual that resides at a Civil Works Project office and that is responsible for oversight of pesticide application on Project grounds.

1.2.6 Land Application for Discharge Water

The term "Land Application" for discharge water implies that the Contractor must discharge water at a rate which allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, discharge into defined drainage areas, or discharge into the "waters of the United States" must occur. Land Application must be in compliance with all applicable Federal, State, and local laws and regulations.

1.2.7 Pesticide

Pesticide is defined as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, or intended for use as a plant regulator, defoliant or desiccant.

1.2.8 Pests

The term "pests" means arthropods, birds, rodents, nematodes, fungi, bacteria, viruses, algae, snails, marine borers, snakes, weeds and other organisms (except for human or animal disease-causing organisms) that adversely affect readiness, military operations, or the well-being of personnel and animals; attack or damage real property, supplies, equipment, or vegetation; or are otherwise undesirable.

1.2.9 Surface Discharge

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, and/or "waters of the United States" and would require a permit to discharge water from the governing agency.

1.2.10 Waters of the United States

All waters which are under the jurisdiction of the Clean Water Act, as defined in 33 CFR 328.

1.3 GENERAL REQUIREMENTS

Minimize environmental pollution and damage that may occur as the result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work must be protected during the entire duration of this contract. Comply with all applicable environmental Federal, State, and local laws and regulations. Any delays resulting from failure to comply with environmental laws and regulations will be the Contractor's responsibility.

1.4 SUBCONTRACTORS

Ensure compliance with this section by subcontractors.

1.5 PAYMENT

No separate payment will be made for work covered under this section. Payment of fees associated with environmental permits, application, and/or notices obtained by the Contractor, and payment of all fines/fees for violation or non-compliance with Federal, State, Regional and local laws and regulations are the Contractor's responsibility. All costs associated with this section must be included in the contract price.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval or information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Environmental Protection Plan; G

The environmental protection plan.

1.7 ENVIRONMENTAL PROTECTION PLAN

Prior to commencing construction activities or delivery of materials to the site, submit an Environmental Protection Plan for review and approval by the Contracting Officer. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental issues which the Contractor must address during construction. Issues of concern must be defined within the Environmental Protection Plan as outlined in this section. Address each topic at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but are considered necessary, must be identified and discussed after those items formally identified in this section. Prior to submittal of the Environmental Protection Plan, meet with the Contracting Officer for the purpose of discussing the implementation of the initial Environmental Protection Plan; possible subsequent additions and revisions to the plan including any reporting requirements; and methods for administration of the Contractor's Environmental Plans. The Environmental Protection Plan must be current and maintained onsite by the Contractor.

1.7.1 Compliance

No requirement in this Section will relieve the Contractor of any applicable Federal, State, and local environmental protection laws and regulations. During Construction, the Contractor will be responsible for identifying, implementing, and submitting for approval any additional requirements to be included in the Environmental Protection Plan.

1.7.2 Contents

Include in the environmental protection plan, but not limit it to, the following:

a. Name(s) of person(s) within the Contractor's organization who is(are) responsible for ensuring adherence to the Environmental Protection Plan.

b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.

c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

d. Description of the Contractor's environmental protection personnel training program.

e. An erosion and sediment control plan which identifies the type and location of the erosion and sediment controls to be provided. The plan must include monitoring and reporting requirements to assure that the control measures are in compliance with the erosion and sediment control plan, Federal, State, and local laws and regulations. A Storm Water Pollution Prevention Plan (SWPPP) may be substituted for this plan.

f. Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil

materials including methods to control runoff and to contain materials on the site.

g. Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan shall include measures to minimize the amount of mud transported onto paved public roads by vehicles or runoff.

h. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.

i. Drawing showing the location of borrow areas.

j. Include in the Spill Control plan the procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance regulated by 40 CFR 68, 40 CFR 302, 40 CFR 355, and/or regulated under State or Local laws and regulations. The Spill Control Plan supplements the requirements of EM 385-1-1. Include in this plan, as a minimum:

(1) The name of the individual who will report any spills or hazardous substance releases and who will follow up with complete documentation. This individual will immediately notify the Contracting Officer and [the local Fire Department, Facility Fire Department], Facility Response Personnel, and Facility Environmental Office in addition to the legally required Federal, State, and local reporting channels (including the National Response Center 1-800-424-8802) if a reportable quantity is released to the environment. Include in the plan a list of the required reporting channels and telephone numbers.

(2) The name and qualifications of the individual who will be responsible for implementing and supervising the containment and cleanup.

(3) Training requirements for Contractor's personnel and methods of accomplishing the training.

(4) A list of materials and equipment to be immediately available at the job site, tailored to cleanup work of the potential hazard(s) identified.

(5) The names and locations of suppliers of containment materials and locations of additional fuel oil recovery, cleanup, restoration, and material-placement equipment available in case of an unforeseen spill emergency.

(6) The methods and procedures to be used for expeditious contaminant cleanup.

k. A non-hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris and schedules for disposal.

(1) Identify any subcontractors responsible for the transportation and disposal of solid waste. Submit licenses or permits for solid waste disposal sites that are not a commercial operating facility.

(2) Evidence of the disposal facility's acceptance of the solid waste must be attached to this plan during the construction. Attach a copy of each of the Non-hazardous Solid Waste Diversion Reports to the disposal plan. Submit the report for the previous quarter on the first working day after the first quarter that non-hazardous solid waste has been disposed and/or diverted (e.g. the first working day of January, April, July, and October).

(3) Indicate in the report the total amount of waste generated and total amount of waste diverted in cubic yards or tons along with the percent that was diverted.

(4) A recycling and solid waste minimization plan with a list of measures to reduce consumption of energy and natural resources. Detail in the plan the Contractor's actions to comply with and to participate in Federal, State, Regional, and local government sponsored recycling programs to reduce the volume of solid waste at the source.

l. An air pollution control plan detailing provisions to assure that dust, debris, materials, trash, etc., do not become air borne and travel off the project site.

m. A contaminant prevention plan that: identifies potentially hazardous substances to be used on the job site; identifies the intended actions to prevent introduction of such materials into the air, water, or ground; and details provisions for compliance with Federal, State, and local laws and regulations for storage and handling of these materials. In accordance with EM 385-1-1, a copy of the Material Safety Data Sheets (MSDS) and the maximum quantity of each hazardous material to be onsite at any given time must be included in the contaminant prevention plan. Update the plan as new hazardous materials are brought onsite or removed from the site.

n. A waste water management plan that identifies the methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines. If a settling/retention pond is required, the plan must include the design of the pond including drawings, removal plan, and testing requirements for possible pollutants. If land application will be the method of disposal for the waste water, the plan must include a sketch showing the location for land application along with a description of the pretreatment methods to be implemented. If surface discharge will be the method of disposal, include a copy of the permit and associated documents as an attachment prior to discharging the waste water. If disposal is to a sanitary sewer, the plan must include documentation that the Waste Water Treatment Plant Operator has approved the flow rate, volume, and type of discharge.

o. A historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on the project site: and/or identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in the area are discovered during construction. Include in the plan

methods to assure the protection of known or discovered resources, identifying lines of communication between Contractor personnel and the Contracting Officer.

1.7.3 Appendix

Attach to the Environmental Protection Plan, as an appendix, copies of all environmental permits, permit application packages, approvals to construct, notifications, certifications, reports, and termination documents.

1.8 PROTECTION FEATURES

This paragraph supplements the Contract Clause PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS. Prior to start of any onsite construction activities, the Contractor and the Contracting Officer will make a joint condition survey. Immediately following the survey, the Contractor will prepare a brief report including a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the Contractor's assigned storage area and access route(s), as applicable. This survey report will be signed by both the Contractor and the Contracting Officer upon mutual agreement as to its accuracy and completeness. The Contractor must protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference which their preservation may cause to the work under the contract.

1.9 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS

Any deviations from the drawings, plans and specifications, requested by the Contractor and which may have an environmental impact, will be subject to approval by the Contracting Officer and may require an extended review, processing, and approval time. The Contracting Officer reserves the right to disapprove alternate methods, even if they are more cost effective, if the Contracting Officer determines that the proposed alternate method will have an adverse environmental impact.

1.11 NOTIFICATION

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with Federal, State or local environmental laws or regulations, permits, and other elements of the Contractor's Environmental Protection plan. After receipt of such notice, the Contractor will inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or equitable adjustments allowed for any such suspensions. This is in addition to any other actions the Contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation or Federal Law.

1.12 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE (HTRW) PERIMETER AIR MONITORING

For the protection of public health, monitor and control contaminant emissions to the air from HTRW remedial action area sources to minimize

short term risks that might be posed to the community during implementation of the remedial alternative in accordance with the following.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 ENVIRONMENTAL PERMITS AND COMMITMENTS

This paragraph supplements the Contractor's responsibility under the contract clause "PERMITS AND RESPONSIBILITIES. Obtaining and complying with all environmental permits and commitments required by Federal, State, Regional, and local environmental laws and regulations is the Contractor's responsibility.

3.2 LAND RESOURCES

Confine all activities to areas defined by the drawings and specifications. Identify any land resources to be preserved within the work area prior to the beginning of any construction. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without approval, except in areas indicated on the drawings or specified to be cleared. Ropes, cables, or guys will not be fastened to or attached to any trees for anchorage unless specifically authorized. Provide effective protection for land and vegetation resources at all times, as defined in the following subparagraphs. Remove stone, soil, or other materials displaced into uncleared areas.

3.2.1 Work Area Limits

Mark the areas that need not be disturbed under this contract prior to commencing construction activities. Mark or fence isolated areas within the general work area which are not to be disturbed. Protect monuments and markers before construction operations commence. Where construction operations are to be conducted during darkness, any markers must be visible in the dark. The Contractor's personnel must be knowledgeable of the purpose for marking and/or protecting particular objects.

3.2.2 Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved must be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques. Restore landscape features damaged or destroyed during construction operations outside the limits of the approved work area.

3.2.3 Erosion and Sediment Controls

Providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations is the Contractor's responsibility. Select and maintain the erosion and sediment controls such that water quality standards are not violated as a result of construction activities. The area of bare soil exposed at any one time by construction operations should be kept to a minimum. Construct or install temporary and permanent erosion and sediment control best management practices (BMPs) as required.

BMPs may include, but not be limited to, vegetation cover, stream bank stabilization, slope stabilization, silt fences, construction of terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels, and sedimentation basins. The Contractor's best management practices must also be in accordance with the National Pollutant Discharge Elimination System (NPDES) Storm Water Pollution Prevention Plan (SWPPP) which may be reviewed at the DPW Environmental Office. Remove any temporary measures after the area has been stabilized.

3.2.4 Contractor Facilities and Work Areas

Place field offices, staging areas, stockpile storage, and temporary buildings in areas as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities will be made only when approved. Erosion and sediment controls must be provided for onsite borrow and spoil areas to prevent sediment from entering nearby waters. Temporary excavation and embankments for plant and/or work areas must be controlled to protect adjacent areas.

3.3 WATER RESOURCES

Monitor all water areas affected by construction activities to prevent pollution of surface and ground waters. Do not apply toxic or hazardous chemicals to soil or vegetation unless otherwise indicated. For construction activities immediately adjacent to impaired surface waters, the Contractor must be capable of quantifying sediment or pollutant loading to that surface water when required by State or Federally issued Clean Water Act permits.

3.3.1 Cofferdams, Diversions, and Dewatering Operations

Construction operations for dewatering, removal of cofferdams, tailrace excavation, and tunnel closure will be controlled at all times to maintain compliance with existing State water quality standards and designated uses of the surface water body. Comply with the State of Hawaii water quality standards and anti-degradation provisions and the Clean Water Act Section 404,

3.4 AIR RESOURCES

Equipment operation, activities, or processes will be in accordance with all Federal and State air emission and performance laws and standards.

3.4.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from asphaltic batch plants; must be controlled at all times, including weekends, holidays and hours when work is not in progress. Maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Sprinkling, chemical treatment of an approved type, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. Provide sufficient, competent equipment available to accomplish these tasks.

Perform particulate control as the work proceeds and whenever a particulate nuisance or hazard occurs. Comply with all State and local visibility regulations.

3.4.2 Odors

Odors from construction activities must be controlled at all times. The odors must be in compliance with State regulations and/or local ordinances and may not constitute a health hazard.

3.4.3 Sound Intrusions

Keep construction activities under surveillance and control to minimize environment damage by noise. Comply with the provisions of the State of Hawaii rules.

3.4.4 Burning

Burning is prohibited on the Government premises.

3.5 CHEMICAL MATERIALS MANAGEMENT AND WASTE DISPOSAL

Disposal of wastes will be as directed below, unless otherwise specified in other sections and/or shown on the drawings.

3.5.1 Solid Wastes

Place solid wastes (excluding clearing debris) in containers which are emptied on a regular schedule. Handling, storage, and disposal must be conducted to prevent contamination. Employ segregation measures so that no hazardous or toxic waste will become co-mingled with solid waste. Transport solid waste off Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal. A Subtitle D RCRA permitted landfill will be the minimum acceptable offsite solid waste disposal option. Verify that the selected transporters and disposal facilities have the necessary permits and licenses to operate. Waste materials will be hauled to the approved off-site landfill site. Comply with site procedures, Federal, State, and local laws and regulations] pertaining to the use of landfill areas.

3.5.2 Chemicals and Chemical Wastes

Dispense chemicals ensuring no spillage to the ground or water. Perform and document periodic inspections of dispensing areas to identify leakage and initiate corrective action. This documentation will be periodically reviewed by the Government. Collect chemical waste in corrosion resistant, compatible containers. Collection drums must be monitored and removed to a staging or storage area when contents are within 6 inches of the top. Wastes will be classified, managed, stored, and disposed of in accordance with Federal, State, and local laws and regulations.

3.5.3 Contractor Generated Hazardous Wastes/Excess Hazardous Materials

Hazardous wastes are defined in 40 CFR 261, or are as defined by applicable State and local regulations. Hazardous materials are defined in 49 CFR 171 - 178. At a minimum, manage and store hazardous waste in compliance with 40 CFR 262 in accordance with the Installation hazardous waste management

plan]. Take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing. Segregate hazardous waste from other materials and wastes, protect it from the weather by placing it in a safe covered location, and take precautionary measures such as berming or other appropriate measures against accidental spillage. Storage, describing, packaging, labeling, marking, and placarding of hazardous waste and hazardous material in accordance with 49 CFR 171 - 178, State, and local laws and regulations is the Contractor's responsibility. Transport Contractor generated hazardous waste off Government property within 30 days in accordance with the Environmental Protection Agency and the Department of Transportation laws and regulations. Dispose of hazardous waste in compliance with Federal, State and local laws and regulations. Spills of hazardous or toxic materials must be immediately reported to the Contracting Officer[and the Facility Environmental Office]. Cleanup and cleanup costs due to spills are the Contractor's responsibility. The disposition of Contractor generated hazardous waste and excess hazardous materials are the Contractor's responsibility. Coordinate the disposition of hazardous waste with the Facility's Hazardous Waste Manager and the Contracting Officer.

3.5.4 Fuel and Lubricants

Storage, fueling and lubrication of equipment and motor vehicles must be conducted in a manner that affords the maximum protection against spill and evaporation. Manage and store fuel, lubricants and oil in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded must be stored in marked corrosion-resistant containers and recycled or disposed in accordance with 40 CFR 279, State, and local laws and regulations. Storage of fuel on the project site is not allowed. Fuel must be brought to the project site each day that work is performed.

3.6 RECYCLING AND WASTE MINIMIZATION

Participate in State and local government sponsored recycling programs. The Contractor is further encouraged to minimize solid waste generation throughout the duration of the project.

3.7 NON-HAZARDOUS SOLID WASTE DIVERSION REPORT

Maintain an inventory of non-hazardous solid waste diversion and disposal of construction and demolition debris. Submit a report through the Contracting Officer on the first working day after each fiscal year quarter, starting the first quarter that non-hazardous solid waste has been generated. Include the following in the report:

a. Construction and Demolition (C&D) Debris Disposed = in cubic yards or tons, as appropriate.

b. Construction and Demolition (C&D) Debris Recycled = in cubic yards or tons, as appropriate.

c. Total C&D Debris Generated = in cubic yards or tons, as appropriate.

3.8 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

Protect existing historical, archaeological, and cultural resources and be responsible for their preservation during the life of the Contract. If

during excavation or other construction activities any previously unidentified or unanticipated historical, archaeological, and cultural resources are discovered or found, all activities that may damage or alter such resources will be temporarily suspended. Resources covered by this paragraph include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rock or coral alignments, pavings, wall, or other constructed features; and any indication of agricultural or other human activities. Upon such discovery or find, immediately notify the Contracting Officer so that the appropriate authorities may be notified and a determination made as to their significance and what, if any, special disposition of the finds should be made. Cease all activities that may result in impact to or the destruction of these resources. Secure the area and prevent employees or other persons from trespassing on, removing, or otherwise disturbing such resources.

3.9 BIOLOGICAL RESOURCES

Minimize interference with, disturbance to, and damage to fish, wildlife, and plants including their habitat. The protection of threatened and endangered animal and plant species, including their habitat, is the Contractor's responsibility in accordance with Federal, State, Regional, and local laws and regulations.

3.10 PREVIOUSLY USED EQUIPMENT

Clean all previously used construction equipment prior to bringing it onto the project site. Ensure that the equipment is free from soil residuals, egg deposits from plant pests, noxious weeds, and plant seeds. Consult with the USDA jurisdictional office for additional cleaning requirements.

3.11 MAINTENANCE OF POLLUTION FACILITIES

Maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.12 MILITARY MUNITIONS

In the event military munitions, as defined in 40 CFR 260, are discovered or uncovered, the Contractor will immediately stop work in that area and immediately inform the Contracting Officer.

3.13 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel must be trained in all phases of environmental protection and pollution control. Conduct environmental protection/pollution control meetings for all personnel prior to commencing construction activities. Additional meetings must be conducted for new personnel and when site conditions change. Include in the training and meeting agenda: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection/pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, wetlands, and endangered species and their habitat that are known to be in the area.

3.146 CONTAMINATED MEDIA MANAGEMENT

Manage contaminated environmental media consisting of, but not limited to, ground water, soils, and sediments as required.

3.15 POST CONSTRUCTION CLEANUP

The Contractor will clean up all areas used for construction in accordance with Contract Clause: "Cleaning Up". Unless otherwise instructed in writing by the Contracting Officer, obliterate all signs of temporary construction facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. The disturbed area must be graded, filled and the entire area seeded unless otherwise indicated.

-- End of Section --

31 00 00

SECTION 31 00 00

EARTHWORK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
AASHTO T 224	(2001) Correction for Coarse Particles in the Soil Compaction Test

AMERICAN WATER WORKS ASSOCIATION(AWWA)

AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2006) Structural Welding Code - Steel

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

IDDE APPENDIX L
Job Order Contract Legal Authority

This page intentionally left blank.

3.10 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

CONTRACTOR

(Firm Name)

_____ Approved

_____ Approved with corrections as noted on submittal data and/or attached sheet(s).

SIGNATURE: _____

TITLE: _____

DATE: _____

3.11 SUBMITTAL CONTROL DOCUMENTS

Submittal control documents and all submittals to the Contracting Officer shall be addressed to:

U.S. Army Expeditionary Command
Regional Contracting Office-Hawaii
Attn: SFCA-PRH-C
Fort Shafter, Hawaii 96858-5025

SECTION 01430

ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

STATE OF HAWAII DEPARTMENT OF HEALTH (HIDOH)

HIDOH, Chapter 43	Administrative Rules, Title 11, Community Noise Control for Oahu.
HIDOH, Chapter 59	Administrative Rules, Ambient Air Quality Standards
HIDOH, Chapter 60	Administrative Rules, Air Pollution Control

1.2 GENERAL REQUIREMENTS

This section covers prevention of environmental pollution and damage as the result of demolition operations under this contract and for those measures set forth in other sections of the TECHNICAL PROVISIONS. For the purpose of this specification, environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants.

1.2.1 Subcontractors

Assurance of compliance with this section by subcontractors will be the responsibility of the Contractor.

1.2.2 Notification

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with the aforementioned Federal, State or local laws or regulations, permits, and other elements of the Contractor's environmental protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of proposed corrective action and take such action as may be approved. If the Contractor fails to comply within receipt of such notice, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or costs or damages allowed to the Contractor for any such suspension.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-18 Records

Environmental Protection Plan; G4

Within 21 calendar days of award, the Contractor shall submit in writing an environmental protection plan for approval. Approval Contractor's plan will not relieve the Contractor of his responsibility for adequate and continuing control of pollutants and other environmental protection measures. The environmental protection plan shall include but not be limited to the following:

a. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.

b. Methods for protection of features to be preserved within authorized work areas. The Contractor shall prepare a listing of methods to protect resources needing protection; i.e. trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, archaeological, and cultural resources.

c. Procedures to be implemented to provide the required environmental protection and to comply with the applicable laws and regulations. The Contractor shall set out the procedures to be followed to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures set out in accordance with the environmental protection plan.

d. Location of the solid waste disposal area.

e. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials.

f. Environmental monitoring plans for the job site, including land, water, air, and noise monitoring.

g. Traffic control plan.

h. Methods of protecting surface and ground water during construction activities.

i. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or non-use. Plan should include measures for marking the limits of use areas.

j. Plan of borrow area(s).

k. Training for his personnel during the construction period.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 PROTECTION OF ENVIRONMENTAL RESOURCES

The environmental resources within the project boundaries and those affected outside the limits of permanent work under this contract shall be protected during the entire period of this contract. The Contractor shall confine his activities to areas defined by the drawings and specifications.

3.1.1 Land Resources

Prior to the beginning of any demolition, the Contractor shall identify all land resources to be preserved within the Contractor's work area. Except in areas indicated on the drawings or specified to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy land resources including trees, shrubs, grasses, topsoil, and land forms without special permission from the Contracting Officer. No ropes, cables, or guys shall be fastened to or attached to any trees for anchorage unless specifically authorized. Where such special emergency use is

permitted, the Contractor shall provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs.

3.1.1.1 Work Area Limits

Prior to any demolition, the Contractor shall mark the areas that are not required to accomplish all work to be performed under this contract. Isolated areas within the general work area which are to be saved and protected shall also be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, the markers shall be visible. The Contractor shall convey to his personnel the purpose of marking and/or protection of all necessary objects.

3.1.1.2 Protection of Landscape

Trees, shrubs, grasses, land forms and other landscape features indicated and defined to be preserved shall be clearly identified by marking, fencing, or wrapping with boards, or any other approved techniques.

3.1.1.3 Reduction of Exposure of Unprotected Erodible Soils

Earthwork brought to final grade shall be finished as indicated and specified. Side slopes and back slopes shall be protected as soon as practicable upon completion of rough grading. All earthwork shall be planned and conducted to minimize the duration of exposure of unprotected soils. Except in instances where the constructed feature obscures borrow areas, and waste material areas, these areas shall not initially be cleared in total. Clearing of such areas shall progress in reasonably sized increments as needed to use the areas developed as approved by the Contracting Officer.

3.1.1.4 Protection of Disturbed Areas

Such methods as necessary shall be utilized to effectively prevent erosion and control sedimentation, including but not limited to the following:

a. Retardation and Control of Runoff: Runoff from the demolition site shall be controlled by construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses, and any measures required by areawide plans approved under Paragraph 208 of the Clean Water Act.

b. Erosion and Sedimentation Control Devices: The Contractor shall construct or install all temporary and permanent erosion and sedimentation control features as required. Temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing, and mulching shall be maintained until permanent drainage and erosion control facilities are completed and operative.

3.1.1.5 Contractor Facilities and Work Areas

a. Location of staging areas, and stockpile storage, shall be placed in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only on approval by the Contracting Officer.

b. Temporary Excavations and Embankments: Temporary excavations and embankments for work areas shall be controlled to protect adjacent areas from despoilment.

3.1.2 Disposal of Wastes

Disposal of wastes shall be as specified in Section 01900 MISCELLANEOUS PROVISIONS and as specified hereinafter.

3.1.2.1 Solid Wastes

Solid wastes shall be removed from Government-controlled property daily unless otherwise directed to do so as not to allow accumulation at the demolition jobsite. All handling and disposal shall be conducted to prevent contamination. Segregation measures shall be employed such that no hazardous or toxic waste will become commingled with solid waste. The Contractor shall transport all solid waste off Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal. The Contractor shall comply with site procedures and with Federal, State, and local laws and regulations pertaining to use of landfill areas.

3.1.2.2 Chemical Wastes

Chemical wastes shall be stored in corrosion resistant containers, removed from the work area and disposed of in accordance with Federal, State, and local laws and regulations.

3.1.2.3 Hazardous Wastes

The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing and shall collect waste in suitable containers observing compatibility. The Contractor shall transport all hazardous waste off Government property and dispose of it in compliance with Federal, State, and local laws and regulations. Spills of hazardous or toxic materials shall be immediately reported to the Contracting Officer. Cleanup and cleanup costs due to spills shall be the responsibility of the Contractor.

3.1.3 Historical, Archaeological, and Cultural Resources

Existing historical, archaeological, and cultural resources within the Contractor's work area will be so designated by the Contracting Officer if any has been identified. The Contractor shall take precautions to preserve all such resources as they existed at the time they were pointed out to him. The Contractor shall provide and install all protection for these resources so designated and shall be responsible for their preservation during this contract. If during excavation or other demolition activities in areas with existing or known resources, as well as in any other work area, any previously unidentified or unanticipated resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. These resources or cultural remains (prehistoric or historic surface or subsurface) include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rocks or coral alignments, pavings, wall, or other constructed features; and any indication of agricultural or other uses. Upon such discovery or find, the Contractor shall immediately notify the Contracting Officer. When so notified, the Contracting Officer will initiate action so that prompt and proper data recovery can be accomplished. In the mean time, recording and preservation of historical and archaeological finds during construction activities shall be reported.

3.1.4 Water Resources

The Contractor shall keep demolition activities under surveillance, management, and control to avoid pollution of surface and ground waters. Special management techniques as set out below shall be implemented to control water pollution by the listed demolition activities which are included in this contract. In particular, toxic or hazardous chemicals shall not be applied to soil or vegetation in a manner that may cause contamination of the fresh water reserve.

3.1.4.1 Monitoring of Water Resources

Monitoring of water areas affected by demolition activities shall be the responsibility of the Contractor. All water areas affected by demolition activities shall be monitored by the Contractor.

3.1.5 Air Resources

The Contractor shall keep demolition activities under surveillance, management and control to minimize pollution of air resources. All activities, equipment, processes, and work operated or performed by the Contractor in accomplishing the specified demolition shall be in strict accordance with the HIDOH, Chapter 59 and HIDOH, Chapter 60, and all Federal emission and performance laws and standards. Ambient Air Quality Standards set by the Environmental Protection Agency shall be maintained for those demolition operations and activities specified in this section. Special management techniques as set out below shall be implemented to control air pollution by the demolition activities which are included in the contract.

3.1.5.1 Particulates

a. Dust particles, aerosols, and gaseous by-products from all demolition activities, processing and preparation of materials, such as asphaltic batch plants, shall be controlled at all times, including weekends, holidays and hours when work is not in progress.

b. The Contractor shall maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause the air pollution standards mentioned in paragraph Air Resources, hereinbefore, to be exceeded or which would cause a hazard or nuisance. Sprinkling, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated at such intervals as to keep the disturbed area damp at all times. The Contractor must have sufficient competent equipment available to accomplish this task. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs.

3.1.5.2 Hydrocarbons and Carbon Monoxide

Hydrocarbons and carbon monoxide emissions from equipment shall be controlled to Federal and State allowable limits at all times.

3.1.5.3 Odors

Odors shall be controlled at all times for all demolition activities, processing and preparation of materials.

3.1.5.4 Monitoring of Air Quality

Monitoring of air Quality shall be the responsibility of the Contractor. All air areas affected by the demolition activities shall be monitored by the Contractor. Monitoring results will be periodically reviewed by the Government to ensure compliance.

3.1.6 Sound Intrusion

The Contractor shall keep demolition activities under surveillance, and control to minimize damage to the environment by noise. The Contractor shall comply with the provisions of the HIDOH, Chapter 43.

3.2 POST DEMOLITION CLEANUP

The Contractor shall clean up area(s) used for demolition.

3.3 RESTORATION OF LANDSCAPE DAMAGE

The Contractor shall restore all landscape features damaged or destroyed during demolition operations outside the limits of the approved work areas. Such restoration shall be in accordance with the plan submitted for approval by the Contracting Officer. This work will be accomplished at the Contractor's expense.

3.4 MAINTENANCE OF POLLUTION CONTROL FACILITIES

The Contractor shall maintain all constructed facilities and portable pollution control devices for the duration of the contract or for that length of time demolition activities create particular pollutant.

3.5 TRAINING OF CONTRACTOR PERSONNEL IN POLLUTION CONTROL

The Contractor shall train his personnel in all phases of environmental protection. The training shall include methods of detecting and avoiding pollution, familiarization with pollution standards, both statutory and contractual, and installation and care of facilities (vegetative covers, and instruments required for monitoring purposes) to ensure adequate and continuous environmental pollution control.

SECTION 01900

MISCELLANEOUS PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

DOT-01	(1988) Manual on Uniform Traffic Control Devices for Streets and Highways, as amended, Federal Highway Administration

DEPARTMENT OF TRANSPORTATION (HIDOT)

DOT-HSS	(1985) Standard Specification for Road and Bridge Construction, Department of Transportation, State of Hawaii, Highways Division

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-09 Reports

Inspection of Existing Conditions; *FIO*

A written report with color photographs noting the condition of the existing adjacent facilities at the time of the inspection. One copy of the report including photographs shall be submitted to the Contracting Officer, prior to demolition.

SD-18 Records

Dust Control; *GA*.

Method(s) of dust control.

Safety Plan; *GA*.

Submit a safety plan in accordance with the clause in SPECIAL CONTRACT REQUIREMENTS entitled "SAFETY REQUIREMENTS."

1.3 CONTRACTOR QUALITY CONTROL

To assure compliance with contract requirements, the Contractor shall establish and maintain quality control for materials and work covered by all sections of the TECHNICAL PROVISIONS. Records shall be maintained for all operations including sampling and testing.

IDDE APPENDIX M
Environmental Compliance Officer (ECO) Training Documents

This page intentionally left blank.

U.S. Army Garrison Hawaii

Environmental Compliance Program

Storm Water Pollution Prevention:

Only Rain Down the Drain!

Storm Water Pollution Prevention

What you must do

Be on the look out ~ Report it!

eWATCH

PREVENTING POLLUTION
THE BEST SOLUTION

http://www.garrison.hawaii.army.mil/sustainability/SpillPreventionResponse.aspx

MINIMIZE RISK OF HARMFUL POLLUTANTS TO THE ENVIRONMENT

SPILL RESPONSE LINE

(808) 656-1111

Call immediately to report spills of hazardous substances.

For emergencies call 911

Storm Water Pollution Prevention

What you must do

- Know where storm drains are and protect them in the event of a spill.
- Prevent fuel, oil, grease, antifreeze, and foreign material from going down a drain– **even if it is equipped with an oil-water separator or grease trap.**

Anything that enters a storm drain is discharged into the water bodies we use for swimming, fishing, and providing drinking water.

Storm Water Pollution Prevention

"A Drop in the Bucket"

Storm Water Pollution Prevention

What you must do

- Keep drains clean and free of sediment and debris.
- Mark drains that flow to the ocean to help prevent accidental dumping.
- **Inspect storm drains at least MONTHLY as part of your monthly Environmental Compliance Inspection.**

Storm Water Pollution Prevention

What you must do

- Place drip pans under parked vehicles.
- Position the pan to capture any obvious leaks or drips.
- Empty drip pans if heavy rain is expected (to prevent overflow).
- Replace broken or missing drip pans.
- Position spill kits near areas where spills are likely to occur.

Storm Water Pollution Prevention

What you must do

- Keep trash containers closed or covered.
- Cover piles of scrap metal and other waste materials.
- Store waste and stockpiled materials on pallets.
- Never put oil or hazardous materials in the trash.

Storm Water Pollution Prevention

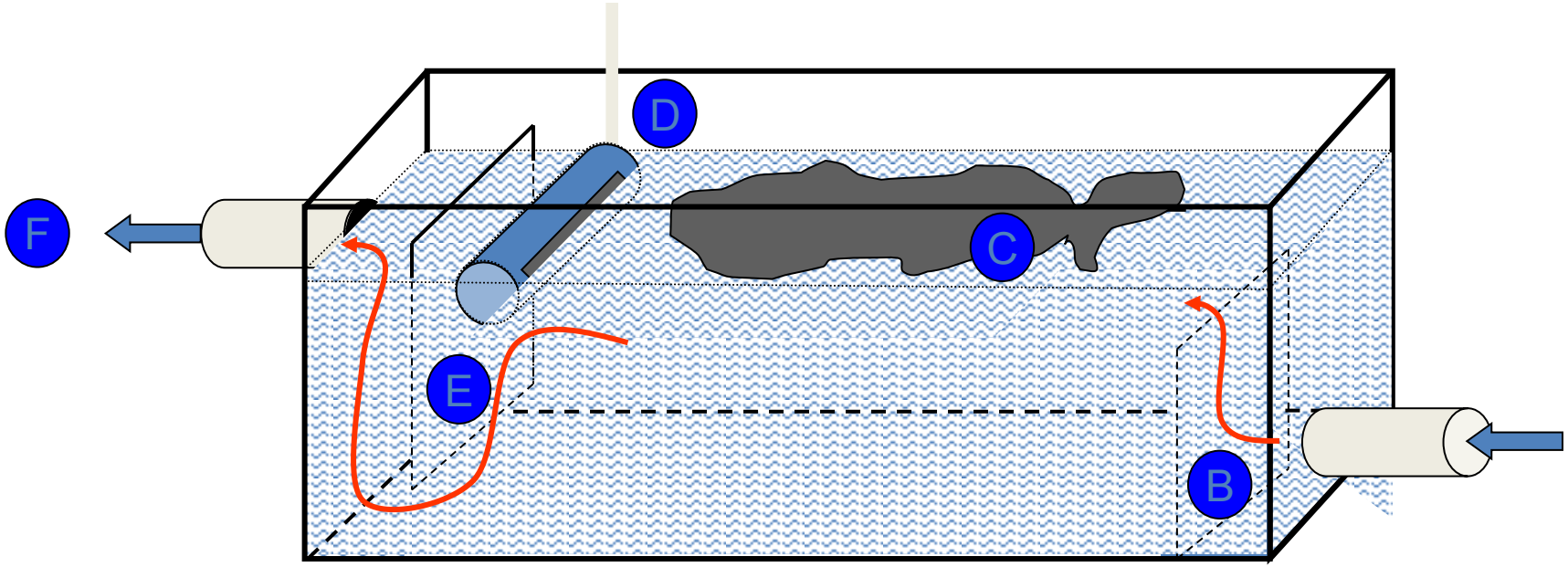
What you must do

- Wash vehicles only in designated areas.
- **Use only approved detergents.** ***(Non approved detergents reduce the effectiveness of oil/water separators).***
- Try to minimize overspray. Keep water within the boundaries of the wash rack.

Note: *In the "bad" photo the vehicle is parked outside the wash rack.*

Storm Water Pollution Prevention

Oil Water Separators



Storm Water Pollution Prevention

Fuel Operations

- **Conducting fuel operations in the motorpool is prohibited without prior authorization from the Environmental Division.**

- Sample request documents are available on the ECO website.

- Ensure a spill kit is available when fueling or defueling.
- Place drip pans under connections to collect leaks and drips.
- Perform fueling operations on a hard surface with little or no slope.
- Never disable or circumvent emergency shut offs.

Storm Water Pollution Prevention

What you must do

- **Park fuel trucks empty, or within secondary containment.**
- Concrete containment is best. Temporary containment is sufficient if maintained.
- If no containment is available, park fuel trucks where leaks or spills would do the least damage (i.e. on a hard surface away from storm drains).
- Always have a spill kit located near or on fuel trucks.

Storm Water Pollution Prevention

What you must do

- Whenever possible, perform maintenance activities indoors.
- Always perform maintenance involving fluid changes indoors.
- Don’t leave engines or other oily parts exposed to the elements when no maintenance is occurring.

Spill Prevention & Response

Storm Water Pollution Prevention: Spill Prevention & Response

Prevent Spills BEFORE they occur:

Store all Haz Mat with **secondary containment and with overhead protection.**

Storm Water Pollution Prevention: Spill Prevention & Response

- Spill kits located at or near all HM storage locations will ensure a quick response to contain small spills.

- These kits must be accessible and contain the appropriate response materials for the HM/HW being stored.

Storm Water Pollution Prevention: Spill Prevention & Response

- ***<u>Personal Safety</u>*** *and the* ***<u>Safety of Others</u>*** *are the primary considerations when responding to a spill.*

If you cannot safely respond to and cleanup a HM spill, activate the Installation Response Team by calling 656-1111.

Storm Water Pollution Prevention: Spill Prevention & Response

If it can be done safely, wear the proper personal protective equipment (PPE) and clean up spills immediately upon discovery:

<u>Initial Response Actions</u>:

1. Stop the spill
2. Protect the drains
3. Clean the spill. **ALL SPILLS MUST BE CLEANED UP WITHIN 72-HOURS**
4. **Report <u>ALL</u> spills to the DPW Environmental Division <u>656-1111.</u>**

•For small, manageable spills, clean up IAW unit/activity spill plan.

•Use absorbent material/rags to absorb the remaining material.

•Make the proper waste determination for disposal of spill residue.

Storm Water Pollution Prevention: Spill Prevention & Response

Storm Water Pollution Prevention: Spill Prevention & Response

Schofield Barracks pesticide spill cleanup by the Installation Response Team.

DO NOT attempt to cleanup dangerous spills on your own.

CALL the DPW SPILL LINE 656-1111!

Storm Water Pollution Prevention: Spill Prevention & Response

WAAF acid spill cleanup by Spill Response contractors.

Storm Water Pollution Prevention: Spill Prevention & Response

The DPW Environmental Division
Emergency Spill Notification Line

656-1111

REPORT ALL SPILLS!

G. Storm Water Pollution Prevention Plan/ Best Management Practices (BMP)

			YES	NO	N/A	Comments	Citation
1		Is the complex clean, neat and in good repair and are proper signs displayed?	☐	☐	☐		**USAG-HI SWPPP BMP01.** *Neat work areas reduce pollution by reducing potential for spills and storm water exposure to contaminants.*
2		Is equipment clean and in good condition or labeled for repair and are maintenance records current?	☐	☐	☐		**USAG-HI SWPPP BMP02.** *Regular cleaning maintains a neat appearance and is needed to inspect for leaks and drips.*
3		Are trash bins closed?	☐	☐	☐		**USAG-HI SWPPP BMP01.** *Trash bins should be closed and there should be no excess rubbish in the work areas.*
4		Are parts, supplies, scrap metal, wood, and other materials stored on pallets and in a manner to minimize exposure to storm water run-off?	☐	☐	☐		**USAG-HI SWPPP BMP05.** *Materials such as parts, supplies, scrap metal and wood should be stored on pallets if kept outside to minimize exposure to storm water runoff.*
5	★	Are liquids, POLs, parts, supplies, and other materials located away from storm drains and stored on covered secondary containment?	☐	☐	☐		
6		Are chemicals stored in the secured areas?	☐	☐	☐		**USAG-HI SWPPP BMP03.** *Security features include fences with locked gates, industrial chemicals stored in secured areas, and locks on fuel pumps when not in use.*
7	★	Are drums, hazardous materials, hazardous and non-regulated wastes properly labeled and stored to prevent discharge to storm drains/State waters?	☐	☐	☐		**USAG-HI SWPPP BMP01,16, 17, 18.** *Drums should be stored inside areas with permanent containment features to prevent contamination of storm water and soil in event of a spill.*
8	★	Are fuel transfer operations authorized by DPW Env Div and are they properly conducted to prevent discharge into the storm water system?	☐	☐	☐		**USAG-HI SWPPP BMP21.** *Spill-response materials shall be placed at readily accessible locations in fueling areas so that spills can be immediately cleaned.*
9	★	Are fuel trucks properly emptied/contained, inspected and maintained and are fuel pumps secured when not in use?	☐	☐	☐		**USAG-HI SWPPP BMP22, 23.** *Fuel-hauling trucks and portable POL tanks should be stored empty or in areas with containment curbs or trench drains to intercept spills.*
10		Are spill response materials and neutralizing compounds for chemicals present?	☐	☐	☐		**USAG-HI SWPPP BMP04.** *Areas used to store corrosive chemicals should have appropriate neutralizing compounds and containment materials.*
11	★	Are spills/leaks cleaned up to prevent storm water contamination?	☐	☐	☐		**USAG-HI SWPPP BMP28.** *Minor spills are cleaned by the organization that caused the spill and must be reported by the ECO to the DPW Environmental Division.*
12		Are vehicles parked on paved surfaces with drip pans?	☐	☐	☐		**USAG-HI SWPPP BMP06, 07.** *Vehicles should be parked on an impermeable surface. Drip pans should be placed below engines and other potential areas of leakage on vehicles and equipment that are parked or stored outside and exposed to storm water. Water in drip pans should be visually inspected for oil or other contaminants and properly cleaned as needed.*
13	★	Are drip pans located beneath leaking vehicles and are they maintained and replaced regularly?	☐	☐	☐		

G. Storm Water Pollution Prevention Plan/ BMPs			YES	NO	N/A	Comments	Citation
14		Is there no discoloration/no oil sheen or visible illicit discharges in storm water basins or storm drains?	☐	☐	☐		**USAG-HI SWPPP BMP08, 11.** *Drains should be inspected monthly by the ECO to see if sediment is clogging the storm water system. The inspection should also check for possible contaminants in the storm water system such as oil stains on sediment, an odor of fuel or other chemicals coming from the storm water system, or a discoloration of water or oily sheen on water. Discharge of non-storm water to storm water conveyance features is prohibited.*
15		Is the wash rack/trench drain cleaned regularly?	☐	☐	☐		**USAG-HI SWPPP BMP15.** *Weekly inspections by the ECO shall check for debris in trench and floor drains, verify that pipes are not blocked, and note the amount of sediment in grit chambers and settling basins. If necessary, the ECO shall contact DPW to arrange for cleaning or repair of drains and washracks.*
16		Are trench drains adequate to intercept spills?	☐	☐	☐		**USAG-HI SWPPP BMP19.** *Weekly inspections by the ECO shall verify that work involving the handling, disbursement, or transfer of significant liquids is done only in areas with containment features or that material spills in areas without containment features can be quickly controlled with spill-response equipment on site.*
17		Is the oil water separator serviced and maintained quarterly and are contractor servicing records maintained at the facility?	☐	☐	☐		**USAG-HI SWPPP BMP10, 11,14.** *The ECO shall verify that oil-water separators and other facilities to treat industrial wastewater are cleaned and inspected according to maintenance contracts administered by DPW.*
18		Are storm drains stenciled and cleaned regularly?	☐	☐	☐		**USAG-HI SWPPP BMP08, 13.** *Inlets to the storm water system should have signs stenciled or posted nearby stating that the storm water inlets lead to the ocean (contact DPW Env Div for storm drain markers).*
19	★	Is only storm water going to storm system?	☐	☐	☐		**USAG-HI SWPPP BMP09.** *Storm water outside of contained process areas such as wash racks, maintenance platforms, and fueling areas should not flow to oil-water separators or enter the sanitary sewer system. Monthly visual inspections by the ECO should verify that, as far as can be determined and except for designated areas, storm water will only flow to the storm water system and not enter the sanitary-sewer system.*

SECTION 4: Construction Site Runoff Control Program
CON APPENDIX

This page intentionally left blank.

CON APPENDIX A
City and County of Honolulu Storm Water Best Management Practice Manual

This page intentionally left blank.

CITY AND COUNTY OF HONOLULU
STORM WATER BEST MANAGEMENT PRACTICE MANUAL

CONSTRUCTION

FINAL

November 2011

By:
City and County of Honolulu
Department of Environmental Services
Kapolei, Hawaii

E Mālama I Ka Wai Ola
Protect our waters...
FOR LIFE

TABLE OF CONTENTS

TABLE OF CONTENTS ..... **i**

LIST OF FIGURES ..... **iii**

LIST OF TABLES ..... **iv**

LIST OF ACRONYMS ..... **v**

ACKNOWLEDGEMENTS ..... **viii**

LIST OF FACT SHEETS ..... **ix**

SIGNIFICANT ADDITIONS AND REVISIONS MADE FROM 2003 CASQA CONSTRUCTION BMP HANDBOOK ..... **xi**

SECTION 1: INTRODUCTION **1-1**

1.1 MANUAL PURPOSE AND SCOPE 1-1

1.1.1 Users of the Manual *1-2*
1.1.2 Organization of the Manual *1-2*
1.1.3 Relationships to Other Manuals *1-3*

1.2 CONSTRUCTION SITES AND THEIR IMPACTS ON WATER QUALITY 1-4

1.2.1 Pollutants Associated with Construction Activities *1-4*
1.2.2 Erosion and Sedimentation *1-5*
1.2.3 Other Pollutants *1-7*
1.2.4 Impacts of Erosion and Sedimentation, and Other Pollutants *1-8*

1.3 REGULATORY PROGRAM 1-9

1.3.1 Federal NPDES Program *1-9*
1.3.2 State NPDES Programs *1-10*
1.3.3 Municipal NPDES Programs *1-12*

1.4 DEFINITIONS 1-12

1.5 REFERENCE 1-13

SECTION 2: SITE-SPECIFIC CONSTRUCTION BMP PLAN (SSBMPP) **2-1**

2.1 ASSESS CONSTRUCTION SITE AND PLANNED ACTIVITIES 2-2

2.1.1 Contractor Activities *2-2*
2.1.2 Disturbed Areas and Erosion Potential *2-2*
2.1.3 Site History *2-2*

2.2 IDENTIFY AND SELECT BMPS 2-2

2.2.1 Define BMP Objectives *2-3*
2.2.2 Identify BMP Categories *2-4*
2.2.3 Select BMPs *2-4*

2.3 SITE INSPECTIONS 2-5

2.4 BMP MONITORING 2-5

2.5 BMP MAINTENANCE 2-6
2.6 STORM WATER POLLUTION CONTROL DOCUMENTATION 2-7

SECTION 3: EROSION AND SEDIMENT CONTROL BMPS 3-1

3.1 EROSION CONTROL 3-1
3.2 SEDIMENT CONTROL 3-2
3.3 WIND EROSION CONTROL 3-3
3.4 TRACKING CONTROL BMPS 3-4
3.5 EROSION AND SEDIMENT CONTROL BMP FACT SHEET FORMAT 3-4
3.6 BMP FACT SHEETS AND OBJECTIVES 3-4
3.7 EROSION CONTROL FACT SHEETS EC-1
3.8 SEDIMENT CONTROL FACT SHEETS SE-1
3.9 WIND EROSION CONTROL FACT SHEETS WE-1
3.10 TRACKING CONTROL FACT SHEETS TC-1

SECTION 4: NON-STORM WATER MANAGEMENT AND MATERIAL MANAGEMENT BMPS 4-1

4.1 NON-STORM WATER MANAGEMENT BMPS 4-1
4.2 WASTE MANAGEMENT & MATERIALS POLLUTION CONTROL BMPS 4-2
4.3 FACT SHEET FORMAT 4-3
4.4 BMP FACT SHEETS 4-3
4.5 NON-STORM WATER MANAGEMENT FACT SHEETS NS-1
4.6 WASTE MANAGEMENT AND MATERIALS POLLUTION CONTROL FACT SHEETS WM-1

SECTION 5: GLOSSARY 5-1

LIST OF FIGURES

Figure 1-1: Honolulu Storm Water BMP Manual - Construction 1-2
Figure 1-2: Project Lifecycle 1-3
Figure 3-1: Example Fact Sheet..... 3-4
Figure 4-1: Example of Fact Sheet 4-3

LIST OF TABLES

Table 1-1: Pollutant Impact on Water Quality 1-4
Table 1-2: Example of Dust Sources at Construction Sites 1-7
Table 1-3: Other Construction Activity Pollutants 1-8
Table 3-1: Erosion Control BMPs 3-1
Table 3-2: Temporary Sediment Control BMPs 3-2
Table 3-3: Wind Erosion Control BMPs 3-3
Table 3-4: Temporary Tracking Control BMPs 3-4
Table 3-5: Erosion, Sediment, Wind and Tracking Control and BMP Objectives 3-5
Table 4-1: Non-Storm Water Management BMP 4-1
Table 4-2: Waste Management & Materials Pollution Control BMP 4-2
Table 4-3: Quick Reference – Disposal Alternatives 4-3

LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Concrete
ADL	Aerially Deposited Lead
ANSI	American National Standards Institute
APHA	American Public Health Association
APWA	American Public Works Association
ASTM	American Society for Testing Materials
AWWA	American Water Works Association
BAT	Best Available Technology (economically available)
BCT	Best Conventional Technology (pollution control)
BFP	Bonded Fiber Matrix
BMPs	Best Management Practices
BOD	Biological Oxygen Demand
C&D	Construction and Demolition
CA	Contractor Activities
CASQA	California Stormwater Quality Association
CCS	Cellular Confinement System
CCH or City	City and County of Honolulu
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Register
COE or CORPS	United States Army Corporation of Engineers
CPI	Coalescing Plate Interceptor
CWA	Clean Water Act (Federal Water Pollution Control Act of 1972 as amended in 1987)
CWB	DOH, Environmental Services - Clean Water Branch
DDC	CCH, Department of Design and Construction
DLNR	State of Hawaii, Department of Land and Natural Resources
DOH	State of Hawaii, Department of Health
DTS	CCH, Department of Transportation Services
DPP	CCH, Department of Planning and Permitting
EC	Erosion Control BMP
EIR	Environmental Impact Report
EMC	Event Mean Concentration
ENV	CCH, Department of Environmental Services
EOS	Equivalent Opening Size

ESA	Environmentally Sensitive Area
ESCM	Erosion and Sedimentation Control Measures
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
GIS	Geographical Information System
H:V	Horizontal to Vertical Ratio
HAR	Hawaii Administrative Rules
HAR 11-55	HAR, Title 11, Chapter 55
Hazmat	Hazardous Material
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDOA	State of Hawaii, Department of Agriculture
HDPE	high density polyethylene
HED	CORP, Honolulu Engineering District
HIOSH	Hawaii Occupational Safety and Health
HSG	Hydrologic Soil Groups
HWYs	DOT-Highways Division
IPM	Integrated Pest Management
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
MSDS	Material Safety Data Sheet
NGPC	Notice of General Permit Coverage
NOAA	National Oceanographic and Atmospheric Administration
NOC	Notice of Cessation
NOEC	no observed effects concentration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRC	National Response Center
NRCS	Natural Resources Conservation Service
NS	Non-Storm Water Management BMP
NSF	National Science Foundation
NURP	National Urban Runoff Program
O&G	Oil and Grease
O&M	Operations and Maintenance
OSDS	Onsite disposal system
OSHA	Occupational Safety and Health Administration
OSWM	DOH, Office of Solid Waste Management
P2	Pollution Prevention

PAHs	Polyaromatic Hydrocarbons
PAM	Polyacrylamide
PCC	Portland Concrete Cement
PCS	petroleum-contained soil
PLS	Pure Live Seed
PPT	Pollution Prevention Team
POTW	Publicly Owned Treatment Works
PSD	Particle Size Distribution
RCRA	Resource Conservation and Recovery Act
RECPs	rolled erosion control products
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SC	Sediment Control BMP
SIC	Standard Industrial Classification
SID	Slope Interruption Device
SPCC	Spill Prevention Control and Countermeasure
SSBMPP	Site-Specific Construction BMP Plan
SWMP	Storm Water Management Program
SWQ	ENV, Storm Water Quality Branch
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TR	Tracking Control BMP
TSS	Total Suspended Solids
UFC	Uniform Fire Code
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
WE	Wind Erosion Control BMP
WEF	Water Environment Federation
WM	Waste Management and Materials Pollution Control BMP

ACKNOWLEDGEMENTS

This City and County of Honolulu (CCH or City) Best Management Practices (BMP) manual is based upon the California Stormwater Quality Association (CASQA) Stormwater Best Management Practice Handbooks (2003). These handbooks were originally published in 1993 by the California Stormwater Quality Task Force (SWQTF), the predecessor of CASQA. This manual also includes selected BMPs from the State of Hawaii Department of Transportation (DOT), Highways Division (HWYs), Construction BMP Field Handbook (2006).

Disclaimer

Information contained in CASQA products and this manual is to be considered general guidance and is not to be construed as specific recommendations for specific cases. Users of this manual assume all liability directly or indirectly arising from use of this manual. The mention of commercial products, their source, or their use in connection with information in CASQA and this manual is not to be construed as an actual or implied endorsement, recommendation, or warranty of such product. This disclaimer is applicable whether information from the CASQA products and this manual is obtained in hard copy form or downloaded from the Internet.

Technical Contributions

The development of CCH Storm Water BMP Manual - Construction was guided by technical contributions from representatives of regulatory agencies (water quality and health), industry, transportation, and consulting. The quality of this manual is a result of the diverse expertise and experience of the technical contributors.

Frederick Berg, Hawaii Developer's Council

Jeremy Kimura, State of Hawaii, Department of Land and Natural Resources (DLNR) Engineering Division

Russell Leong, US Army Corps of Engineers (COE or CORP), Honolulu Engineering District (HED)

Curtis Masuda, DOT-HWYs

Reef Migita and Joanna Seto, Department of Health (DOH), Clean Water Branch (CWB)

LIST OF FACT SHEETS

Erosion Control (EC) Fact Sheets

EC-0 Employee/Subcontractor Training
EC-1 Scheduling
EC-2 Preservation of Existing Vegetation
EC-3 Hydraulic Mulch
EC-4 Hydroseeding
EC-5 Soil Binders
EC-7 Geotextiles and Mats
EC-8 Wood Mulching
EC-9 Earth Dikes and Drainage Swales
EC-10 Velocity Dissipation Devices
EC-11 Slope Drains
EC-12 Streambank Stabilization
EC-14 Seeding, Planting and Sodding
EC-15 Slope Roughening/Terracing
EC-16 Topsoil Management

Sediment Control (SE) Fact Sheets

SE-1 Silt Fence
SE-2 Sediment Basin
SE-3 Sediment Trap
SE-4 Check Dams
SE-5 Fiber Rolls
SE-6 Gravel Bag Berm
SE-7 Street Sweeping and Vacuuming
SE-8 Sandbag Barrier
SE-10 Storm Drain Inlet Protection
SE-11 Chemical Treatment
SE-12 Location of Potential Sources of Sediment
SE-13 Level Spreader
SE-14 Rip-Rap & Gabion Inflow Protection
SE-15 Vegetated Buffer Strips and Channels
SE-16 Compost Socks and Berms

Wind Erosion Control (WE) Fact Sheets

WE-1 Wind Erosion Control

Tracking Control (TR) Fact Sheets

TR-1 Stabilized Construction Entrance/Exit
TR-2 Stabilized Construction Roadway
TR-3 Entrance/Outlet Tire Wash

Non-Storm Water Management (NS) Fact Sheets

NS-1 Water Conservation Practices
NS-2 Dewatering Operations
NS-3 Paving and Grinding Operations
NS-4 Temporary Stream Crossing
NS-5 Clear Water Diversion
NS-6 Illicit Connection/Discharge
NS-7 Potable Water/Irrigation
NS-8 Vehicle and Equipment Cleaning
NS-9 Vehicle and Equipment Fueling
NS-10 Vehicle and Equipment Maintenance
NS-11 Pile Driving Operations
NS-12 Concrete Curing
NS-13 Concrete Finishing
NS-14 Material over Water
NS-15 Demolition Adjacent to Water
NS-16 Temporary Batch Plants

Waste Management (WM) and Materials Pollution Control Fact Sheets

WM-1 Material Delivery and Storage
WM-2 Material Use
WM-3 Stockpile Management
WM-4 Spill Prevention and Control
WM-5 Solid Waste Management
WM-6 Hazardous Waste Management
WM-7 Contaminated Soil Management
WM-8 Concrete Waste Management
WM-9 Sanitary/Septic Waste Management
WM-10 Liquid Waste Management

SIGNIFICANT ADDITIONS AND REVISIONS MADE FROM 2003 CASQA CONSTRUCTION BMP HANDBOOK

Many additions and revisions were made to the contents of CASQA Stormwater Best Management Practice Handbook Construction, January 2003, in order to be used for this City and County of Honolulu Storm Water Best Management Practices Manual. General changes include the following:

- An updated list of acronyms with local definitions and terms.
- Specific references to State of California, Regional Water Control Board, counties, and cities regulatory framework have been changed to applicable State of Hawaii and CCH references throughout the drafted document.
- Section 2, Site Specific Construction BMP Plan (SSBMPP), references current DOH CWB, Hawaii Administrative Rules (HAR) Title 11, Chapter 55, Water Pollution Control Appendix C NPDES General Permit Authorizing Discharges of Storm Water Associated with Construction Activity.
- A caveat has been inserted wherever estimated unit prices and costs are given. The unit prices and costs in this Manual reflect California's unit prices from the 1990's to 2003. Since then, unit prices have escalated significantly and costs in Hawaii are generally higher when compared to California.
- CASQA BMP fact sheet numerical indexes have changed due to additions and deletions of BMP fact sheets.
- In additional to CASQA BMPs, fact sheet information was also taken from the current CCH BMP Manual for Construction Sites in Honolulu, dated May 1999.

EC-0 Employee/ Subcontractor Training	*EC-0 is based on CA40 Employee Training (pp. 1-31 to 1-32).* *Employee/Subcontractor Training was inserted to ensure that the purposes of the BMPs and the basics of storm water management are clear to all those involved. The emphasis on employee/subcontractor training is a necessity to optimize the effects of the BMPs. Proper training will lead to correct identification and usage of the BMPs and will also promote more active employee/subcontractor involvement.*
EC-15 Slope Roughening/ Terracing	*EC-15 has been edited from highway design grading, and replaced with City ROH Section 14-14 and subdivision rules for grading and ESC42 Slope Roughening/Terracing (pp. 2-63 to 2-65).* *Slope Roughening/Terracing provides small depression for trapping sediment and aid in establishment of vegetation. BMP methods relating to vegetation should be strongly encouraged to take advantage of Hawaii's constant, tropical weather.*

SE-12 Location of Potential Sources of Sediment	*SE-12 is based on ESC3 Location of Potential Sources of Sediment (pp. 2-10 to 2-11).* *Identifying the sources of sediment and erosion will prevent future problems. It is more economically efficient to prevent sedimentation and erosion than it is to address the long term damages.*
WM-5 Solid Waste Management	*WM-5 references CA20 Solid Waste Management (pp. 1-15 to 1-18).* *Information regarding inert fill material and recycling from section CA20 has been added. Inert fill is frequently generated in construction sites therefore it is important to note how it should be properly disposed. Encouraging recycling and reuse help to reduce trash and preserve the environment.*

- Fact sheet information was taken from DOT-HWYs Construction BMP Field Manual, September 2006, for the following revised sections:

EC-14 Seeding, Planting and Sodding	*EC-14 is based on DOT EC-4 Seeding and Planting with additional information on sodding from EPA NPDES General Permit for Stormwater Discharge Requirements for Small and Large Construction Activities, 2008.* *Seeding, Planting and Sodding stabilize soil by covering the surface with vegetation, which also creates aesthetic value to the area. These methods immediately and efficiently assist infiltration. Seeding, planting and sodding are encouraged since they are especially effective in Hawaii's favorable weather.*
EC-16 Topsoil Management	*EC-16 is based on DOT SM-21 Top Soil Management.* *Topsoil management not only helps with the revegetation efforts, but through the reapplication of native topsoil it also plays a large role in reestablishing native vegetation. An initiative needs to be taken to preserve native Hawaiian plants, and thus EC-16 is a very applicable BMP fact sheet for CCH BMP Manual.*
SE-13 Level Spreader	*SE-13 is based on DOT SC-10 Level Spreader.* *Level spreaders condense the time needed for concentrated flows to settle and thus prevent erosion. The warm climate in Hawaii increases the effectiveness of this method and accelerates the settlement process even more.*
SE-14 Rip-Rap and Gabion Inflow Protection	*SE-14 is based on DOT SC-3 Rip-Rap and Gabion Inflow Protection.* *Rip-Rap & Gabion line drainageways and stabilize the flow channel along steep slopes. This BMP method can be applied to steep sloped worksites on the islands.*
SE-15 Vegetated Buffer Strips and Channels	*SE-15 is based on DOT SC-5 Vegetated Filter Strips and Buffers.* *Vegetated buffer strips and channels protect soil from erosion, increase infiltration, and remove sediment from surface runoff. It is an economical approach in Hawaii since the constant weather fosters the growth of vegetation.*

- CASQA references to sizing of the sedimentation basins were replaced with current CCH Rules for Soil Erosion Standards and Guidelines, dated April 1999. References to current rules are forthcoming.
- SE-1 Silt Fence was revised to allow metal stakes and not only wooden stakes. New callouts were inserted for geotextile fabric length and stake lengths.
- SE-2 Sediment Basin was revised to match current City and DOH CWB sizing criteria.
- SE-7 Street Sweeping and Vacuuming was replaced with local references.
- Deleted CASQA EC-6 Straw Mulch, EC-12 Polyacrylamide and SE-9 Straw Bale Barrier.
- Table 4-3 Quick Reference- Disposal Alternatives was added to the narrative part of Section 4. This table is from CA40 Employee/Subcontractor Training (pp. 1-33 to 1-39) of the City BMP Manual (May 1999).
- NS-2 Dewatering Operations was updated to reference DOH CWB requirements and a new Figure 1 Dewatering Permit Flow Chart was added.
- In WM-2 Material Use, sections from City BMP CA3 Structure Construction and Painting were added.
- In WM-3 Stockpile Management, sections from City ESC-25 Protection of Stockpiles were added.
- In section WM-7 Contaminated Soil Management, sections from City CA-22 Contaminated Soil Management were added.
- A few figures were updated to match BMP fact sheet narratives.
- For construction BMPs diverting runoff away from construction sites, hydraulic capacity is based upon a peak flow from a design 10-year, 1-hour storm to comply with Plate 1 in CCH - Department of Planning and Permitting (DPP) “Rules Relating to Storm Drainage Standards” in the following Fact Sheets:
  - EC-9 Earth Dikes and Drainage Swales,
  - EC-10 Velocity Dissipation Devices,
  - EC-11 Slope Drains,
  - SE-4 Check Dams, and
  - SE-11 Chemical Treatment.
- For construction BMPs within construction sites, hydraulic capacity is based upon a peak flow from a design 2-year, 1-hour storm in the following Fact Sheets:
  - SE-11 Chemical Treatment.
- In the originally released version of the Construction BMP Manual (July 2011) each Fact Sheets’ primary and secondary objectives were represented with check marks for both. In this updated version (November 2011) the primary objectives are represented by check marks and secondary objectives are represented by triangles on each Fact Sheet.

SECTION 1: INTRODUCTION

Note: Information contained in the Storm Water Best Management Practice (BMP) Manual is to be considered general guidance and is not to be construed as specific recommendations for specific cases. Users of the manuals assume all liability directly or indirectly arising from use of the products. Please refer to the Disclaimer in Acknowledgements.

Storm water runoff is part of the natural hydrologic process. However, human activities such as urbanization and construction can impact storm water runoff. Construction activities can alter natural drainage patterns and affect runoff water quality, adding pollutants to rivers, lakes, and streams as well as coastal bays and estuaries, and ultimately, the ocean. Urban runoff is a significant source of water pollution, causing possible declines in fisheries, restrictions on swimming, and limiting our ability to enjoy many of the other benefits that water resources provide (United States Environmental Protection Agency [USEPA], 1992). Urban runoff in this context includes all flows discharged from urban land uses into storm water conveyance systems and receiving waters and includes both dry weather non-storm water sources (e.g., runoff from landscape irrigation, etc.) and wet weather storm water runoff. In this manual, urban runoff and storm water runoff are used interchangeably.

For many years, the effort to control the discharge of storm water focused on quantity (e.g., drainage, flood control) and, to a limited extent, on quality of the storm water (e.g., sediment and erosion control). However, in recent years awareness of the need to improve water quality has increased. With this awareness Federal, State, and City programs have been established to pursue the ultimate goal of reducing pollutants contained in storm water discharges to our waterways. The emphasis of these programs is to promote the concept and the practice of preventing pollution at the source, before it can cause environmental problems (USEPA, 1992). However, where further controls are needed, treatment of polluted runoff may be required.

1.1 MANUAL PURPOSE AND SCOPE

The purpose of this manual is to provide general guidance for selecting and implementing BMPs that will eliminate or reduce the discharge of pollutants from construction sites to waters of the State. This manual also provides guidance on developing and implementing site-specific construction BMP plans (SSBMPP) that document the selection and implementation of BMPs for a particular construction project.

Even though minimum construction BMPs will be required in the revised Rules Relating to Soil Erosion Standards and Guidelines, this manual is to provide general guidance, such that a design engineer will need to exercise professional judgment to BMP design and application.

This manual provides the framework for an informed selection of BMPs, and development and implementation of a SSBMPP. However, due to the diversity in climate, receiving waters, and construction site conditions, this manual does not dictate the use of specific BMPs and therefore cannot guarantee compliance with National Pollutant Discharge Elimination System (NPDES) permit requirements or CCH requirements specific to the user's site.

1.1.1 Users of the Manual

This manual provides guidance suitable for use by a wide range of individuals involved in construction site water pollution control. Each user of the manual is responsible for working within their capabilities obtained through training and experience, and for seeking the advice and consultation of appropriate experts at all times.

The target audience for this manual includes: developers, including their planners and engineers; contractors, including their engineers, estimators, superintendents, foremen, tradesmen, and subcontractors; municipal agencies, including their engineers, municipal inspectors, building inspectors, permit counter staff, code enforcement officers, and construction staff; regulatory agencies, including permit staff and enforcement staff, and the general public with an interest in storm water pollution control.

1.1.2 Organization of the Manual

The manual is organized to assist the user in developing and implementing a storm water program for construction sites to reduce potential impacts to both storm water and non-storm water discharges on receiving waters. Sections of this manual are displayed in Figure 1-1.

Figure 1-1: Honolulu Storm Water BMP Manual - Construction

Section 1
Introduction
This section provides a general review of the sources and impacts of construction activity storm water discharges and provides an overview of the federal, state, and CCH programs regulating storm water discharges.

Section 2
Site-Specific BMPs Plan
This section navigates through the construction activities storm water permit. It covers minimum requirements, construction activity assessment, and BMP selection.

Section 3
Erosion and Sediment Control BMPs
This section provides an overview of BMPs for erosion, sediment, wind, and tracking control.

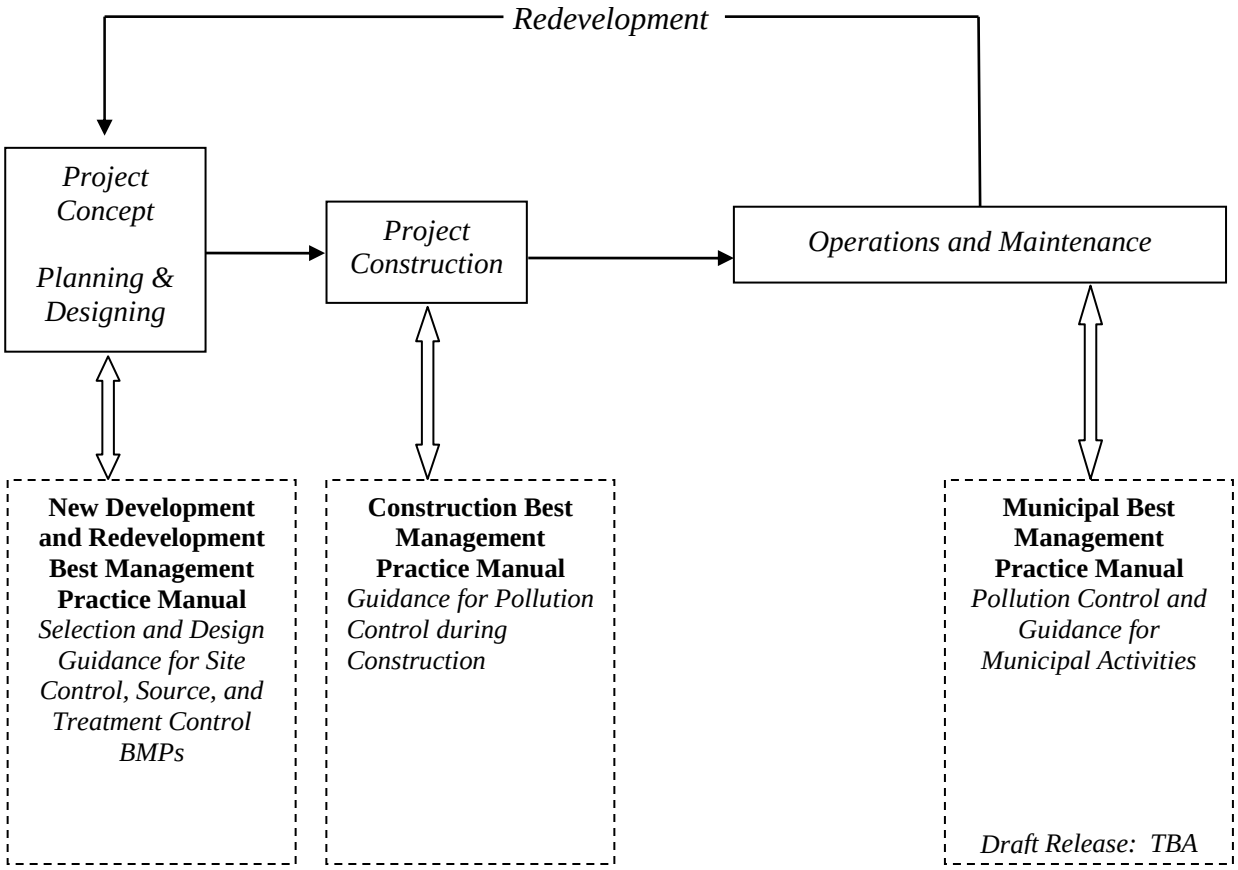
Section 4
Non-Storm Water Management and Material Management BMPs
This section provides an overview of BMPs for non-storm water management and materials management including waste materials.

Section 5
Glossary
This section identifies terms used in the BMP manuals.

1.1.3 Relationships to Other Manuals

This manual is one of three manuals. Collectively, the three manuals address BMP selection throughout the life of a project – from planning and design – through construction – and into operation and maintenance, shown in Figure 1-2. Individually, each manual is geared to a specific target audience during each stage of a project. This manual, the Construction Manual, addresses selection and implementation of BMPs to eliminate or to reduce the discharge of pollutants associated with construction activity. The remaining two manuals are under development and are planned to be released concurrently with this manual. Readers are encouraged to refer to the CASQA Handbooks for guidance. The CASQA Handbooks are available online at www.cabmphandbooks.com.

Figure 1-2: Project Lifecycle



For a comprehensive understanding of storm water pollution control throughout the lifecycle of the project, it is recommended that the reader obtain and become familiar with all three manuals. Typically, municipal storm water program managers, regulators, environmental organizations, and storm water quality professionals will have an interest in all three manuals. For a focused understanding of storm water pollution control during a single phase of the project lifecycle, a reader may obtain and become familiar with the manual associated with the appropriate phase. Typically, contractors, construction inspectors, some regulators, and some City staff may have an interest in a single manual.

1.2 CONSTRUCTION SITES AND THEIR IMPACTS ON WATER QUALITY

1.2.1 Pollutants Associated with Construction Activities

Storm water runoff naturally contains numerous constituents. However, urbanized and urban activities such as construction increase constituent concentrations to levels that impact water quality. Pollutants associated with storm water include sediment, nutrients, bacteria and viruses, oil and grease, metals, organics, pesticides, gross pollutants (floatables), and miscellaneous waste. Some constituents can also affect the pH of storm water. Storm water runoff can also be highly attractive to vector organisms, particularly mosquitoes, which can impact public health and become a legal liability. Storm water pollutants are described in Table 1-1.

Excessive erosion and sedimentation are perhaps the most visible water quality impacts due to construction activities. Other less visible impacts are associated with off-site discharge of pollutants such as metals, nutrients, soil additives, pesticides, construction chemicals, and other construction waste. The magnitude of storm water impacts depends on construction activities, climatic conditions, and site conditions. Development of a comprehensive site-specific BMPs plan requires a basic understanding of the impacts, pollutant sources and other contributing factors, as well as BMPs to eliminate or reduce these impacts.

Table 1-1: Pollutant Impact on Water Quality

Sediment	Sediment is a common component of storm water, and can be a pollutant. Sediment can be detrimental to aquatic life (primary producers, benthic invertebrates, coral reefs and fish) by interfering with photosynthesis, respiration, growth, reproduction, and oxygen exchange in water bodies. Sediment can transport other pollutants that are attached to it including nutrients, trace metals, and hydrocarbons. Sediment is the primary component of total suspended solids (TSS), a common water quality analytical parameter.
Nutrients	Nutrients including nitrogen and phosphorous are the major plant nutrients used for fertilizing landscapes, and are often found in storm water. These nutrients can result in excessive or accelerated growth of vegetation, such as algae, resulting in impaired use of water in lakes and other sources of water supply. For example, nutrients have led to a loss of water clarity in Lake Wilson. In addition, un-ionized ammonia (one of the nitrogen forms) can be toxic to fish.
Bacteria and viruses	Bacteria and viruses are common contaminants of storm water. For separate storm drain systems, sources of these contaminants include animal excrement and sanitary sewer overflow. High levels of indicator bacteria in storm water have led to the closure of beaches, lakes, and rivers to contact recreation such as swimming.
Oil and Grease	Oil and grease includes a wide array of hydrocarbon compounds, some of which are toxic to aquatic organisms at low concentrations. Sources of oil and grease include leakage, spills, cleaning and sloughing associated with vehicle and equipment engines and suspensions, leaking and breaks in hydraulic systems, restaurants, and waste oil disposal.

Metals	Metals including lead, zinc, cadmium, copper, chromium, and nickel are commonly found in storm water. Many of the artificial surfaces of the urban environment (e.g., galvanized metal, paint, automobiles, or preserved wood) contain metals, which enter storm water as the surfaces corrode, flake, dissolve, decay, or leach. Over half the trace metal load carried in storm water is associated with sediments. Metals are of concern because they are toxic to aquatic organisms, can bioaccumulate (accumulate to toxic levels in aquatic animals such as fish), and have the potential to contaminate drinking water supplies.
Organics	Organics may be found in storm water in low concentrations. Often synthetic organic compounds (adhesives, cleaners, sealants, solvents, etc.) are widely applied and may be improperly stored and disposed. In addition, deliberate dumping of these chemicals into storm drains and inlets causes environmental harm to waterways.
Pesticides	Pesticides (including herbicides, fungicides, rodenticides, and insecticides) have been repeatedly detected in storm water at toxic levels, even when pesticides have been applied in accordance with label instructions. As pesticide use has increased, so too have concerns about adverse effects of pesticides on the environment and human health. Accumulation of these compounds in simple aquatic organisms, such as plankton, provides an avenue for biomagnification through the food web, potentially resulting in elevated levels of toxins in organisms that feed on them, such as fish and birds.
Gross Pollutants	Gross Pollutants (trash, debris, and floatables) may include heavy metals, pesticides, and bacteria in storm water. Typically resulting from an urban environment, industrial sites and construction sites, trash and floatables may create an aesthetic "eye sore" in waterways. Gross pollutants also include plant debris (such as leaves and lawn-clippings from landscape maintenance), animal excrement, street litter, and other organic matter. Such substances may harbor bacteria, viruses, vectors, and depress the dissolved oxygen levels in streams, lakes, and estuaries sometimes causing fish kills.
Vector Production	Vector production (e.g., mosquitoes, flies, and rodents) is frequently associated with sheltered habitats and standing water. Unless designed and maintained properly, standing water may occur in treatment control BMPs for 72 hours or more, thus providing a source for vector habitat and reproduction (Metzger, 2002).

1.2.2 Erosion and Sedimentation

Soil erosion is the process by which soil particles are removed from the land surface by wind, water, or gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared or altered and left unprotected. Construction sites, if unprotected, can erode at rates in excess of one hundred times the natural background rate of erosion.

Sediment resulting from excessive erosion is a pollutant. Sedimentation is defined as the settling out of particles transported by water. Sedimentation occurs when the velocity of water is slowed sufficiently to allow suspended soil particles to settle. Larger particles, such as gravel and sand, settle more rapidly than fine particles such as silt and clay. Effective sediment control begins with proper erosion control, which minimizes the availability of particles for settling downstream.

Erosion from Rainfall Impact

The impact of raindrops on bare soil can cause erosion. On undisturbed soil protected by vegetation or other cover, the erosion is minimal. Construction activities increase the amount of exposed and disturbed soil, which increases erosion potential from rainfall.

Sheet Erosion

After rainfall strikes the ground, it flows in a thin layer for a short distance. The distance of sheet flow depends on slope, soil roughness, type of vegetative cover, and rainfall intensity. Erosion due to sheet flow on undisturbed soils is minimal but on soils disturbed by construction it is greater. However, sheet flows are capable of transporting soil particles dislodged by the impact of raindrops onto bare soil, and thus cannot be ignored. Sheet flow cannot be maintained for long distances. In general, sheet flow will tend to concentrate into rill flows within 300 to 400 ft.

Rill and Gully Erosion

As runoff accumulates, it concentrates in rivulets that cut grooves (rills) into the soil surface. Rills generally run parallel to one another and to the slope of the soil surface, if left unchecked, several rills may join together to form a gully. Rills are small enough to be stepped across, whereas a gully requires added effort to be traversed. The rate of rill erosion can easily be one hundred times greater than that of sheet flow, and the rate of gully erosion can easily be one hundred times greater than rill erosion. Due to the significant amount of sediment generated by rill and gully erosion, these types of erosion must be given top priority for elimination, reduction, and control. Rills and gullies form sooner on exposed soils than on vegetated soils.

Stream and Channel Erosion

In general, one or more of the following factors that may occur during construction can change the hydrology of the area to affect erosion of the banks and bottoms of natural drainage channels:

- Clearing the soil and re-contouring the site during construction may increase the volume and rate of runoff leaving the site;
- Replacing pervious natural ground with impervious cover such as buildings and pavement further increases runoff; and/or
- Detention basins used to capture sediment extend the duration of flows leaving the site.

Control of erosion in streams and channels downstream of the construction site is a complex issue and is usually best addressed by City and other government agencies (e.g. DLNR and CORPS) through a mechanism such as a comprehensive drainage master plan. Where these plans are available, City may specify specific BMP requirements applicable to construction projects, which in turn must be incorporated into a SSBMPP. Where these plans are not available, the goal should be to minimize the difference between the predevelopment, construction, and post-construction hydrographs, and to minimize increases in sediment discharges. In some situations, State or City may require developers of large projects to conduct a study of the specific impacts related to development of the project. This will most likely be the case where municipal permits include new development and redevelopment provisions.

Wind Erosion

Wind erosion is the result of material movement by the wind. Airborne particles are lifted and moved to another location. Suspended particles may impact on solid objects causing erosion by abrasion. Dust is defined as solid particles or particulate matters which are predominately large enough to eventually settle out from the air but small enough to remain temporarily suspended in the air for an extended period of time. Dust from a construction site originates from rock and soil surfaces, material storage piles and construction materials. It is generated by earthwork, demolition, traffic on unpaved surfaces, and strong winds. See Table 1-2.

Table 1-2: Example of Dust Sources at Construction Sites

Vehicle and Equipment Use	Exposed Areas	Contractor Activities
▪ Vehicle and equipment entering and leaving the project site ▪ Vehicle and equipment movement and use within the project site ▪ Sediment tracking off-site ▪ Temporary parking lots and staging areas ▪ On-site construction traffic	▪ Areas of exposed soil that have been cleared and grubbed ▪ Areas of exposed soil that have been excavated, filled, compacted, or graded ▪ Construction staging areas ▪ Vehicle and equipment storage and service areas ▪ Material processing areas and transfer points ▪ Construction roads ▪ Construction sites, bare ground areas ▪ Spill materials ▪ Construction stockpiles ▪ Soil and debris piles	▪ Land clearing and grubbing ▪ Earthwork including soil excavation, filling, soil compaction, rough grading, and final grading ▪ Drilling and blasting ▪ Material handling, including material stockpiling, transfer, and processing ▪ Batch dripping, dumping ▪ Conveyor transfer and stacking ▪ Material transferring ▪ Crushing, milling and screening operations ▪ Demolition and debris disposal ▪ Tilling

1.2.3 Other Pollutants

Erosion and sedimentation discharges are perhaps the most visible and significant source of pollutants associated with storm water at construction sites. However, other pollutants such as nutrients, bacteria, viruses, oil, grease, metals, organics, pesticides, gross pollutants, and vectors must always be considered, as they can be associated with both acute and chronic problems in receiving waters. Table 1-3 presents a matrix that identifies the most common source of these other pollutants at construction sites.

Table 1-3: Other Construction Activity Pollutants

Construction Activity	Pollutants						
	Sediments	Nutrients	Trace Metals	Pesticides	Oil, Grease, Fuels	Other Toxic Chemicals	Miscellaneous Waste
Construction Practices							
Dewatering Operations	X					X	
Paving Operations	X			X	X	X	X
Structure Construction/Painting			X			X	X
Material Management							
Material Delivery and Storage	X	X	X	X	X	X	
Material Use		X	X	X	X	X	
Waste Management							
Solid Waste	X	X					X
Hazardous Waste						X	
Contaminated Spills	X					X	
Concrete Waste							X
Sanitary/Septic Waste							X
Vehicle/Equipment Management							
Vehicle/Equipment Fueling						X	X
Vehicle/Equipment Maintenance						X	X

1.2.4 Impacts of Erosion and Sedimentation, and Other Pollutants

The impacts due to erosion and sedimentation can be placed in three categories:

- Degradation of aquatic and riparian ecosystems,
- Pollutant transport, and
- Erosion of land and sedimentation within waterways and public facilities (i.e. storm drains).

Sediment can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, reproduction, and oxygen exchange in water bodies. In addition, sediment particles can transport other pollutants that are attached to

them including nutrients, trace metals, and hydrocarbons. Sediment particles such as silts and clays are the primary components of TSS, a common water quality analytical parameter.

In addition to impacts directly associated with sedimentation, various pollutants can also be transported along with sediment particles leaving construction sites. Such pollutants include metals, nutrients, conventional pollutants, pesticides, and coliform. These pollutants often originate from organic components, plant residues, and nutrient elements within soils on the construction site, and are thus mobilized by erosion and later deposited downstream during sedimentation. Alternatively, these other pollutants may be generated independent of erosion and because of their nature can have significant detrimental effects to receiving waters.

Construction activity may cause increased erosion and sedimentation within waterways and public facilities. Some construction activity will increase impervious area and/or change drainage patterns, resulting in increased runoff volumes and rates, which have the potential to erode downstream watercourses. Other construction activities such as grading may increase erosion from the construction site by disturbing and exposing the soil. The eroded soil particles from the construction site may flow downstream and fill drainage systems, reservoirs, and harbors.

1.3 REGULATORY PROGRAM

The need to protect our environment has resulted in a number of laws and subsequent regulations and programs. In the following sections, various Federal, State, and City programs are discussed in relationship to the control of pollutants in storm water. The programs are expected to change over the next several years and the user is advised to contact State and City officials for further information.

1.3.1 Federal NPDES Program

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from any point source is unlawful unless the discharge is in compliance with a NPDES permit. The 1987 amendments to the CWA added Section 40 2(p), which establishes a framework for regulating municipal and industrial storm water discharges, including discharges associated with construction activities, under the NPDES Program.

On November 16, 1990, USEPA published final regulations that establish storm water permit application requirements. The regulations, also known as Phase I of the NPDES program, provide that discharges of storm water to waters of the Unites States from construction projects that encompass five or more acres of soil disturbance are effectively prohibited unless the discharge complies with an NPDES Permit.

On December 8, 1999, Phase II of the NPDES program expands the requirements by requiring operators of small Municipal Separate Storm Sewer Systems (MS4s) in urbanized areas and small construction sites to be covered under an NPDES permit and to implement programs and practices to control polluted storm water runoff. The program applies to:

- Operators of small MS4s located in “urbanized areas” as delineated by the Bureau of the Census. A “small” MS4 is any MS4 not already covered by the Phase I NPDES storm water program; and

- Small construction sites with a soil disturbance equal to or greater than one and less than five acres of land or part of a larger common plan of development which disturbs more than one acre.

1.3.2 State NPDES Programs

In Hawaii, the NPDES storm water permitting program is administered by State of Hawaii Department of Health (DOH) Clean Water Branch (CWB).

The CWB enforces the NPDES permits. The standard general permit conditions are found in the Hawaii Administrative Rules Title 11, Chapter 55 (HAR 11-55) Water Pollution, Appendix A Department of Health Standard Permit Conditions, and Appendix C NPDES General Permit Authorizing Discharges of Storm Water Associated with Construction Activity. This NPDES general permit for construction activities is normally triggered by projects covering one or more acres of land, such as the entire parcel(s) including paved, unpaved, disturbed, and undisturbed areas.

The CWB has established a construction general permit that can be applied to most construction activities in the state. Construction permittees may choose to obtain individual NPDES permits instead of obtaining coverage under the general permit, but this can be an expensive and complicated process, and its use should generally be limited to very large construction projects that discharge to critical receiving waters. Since individual permits are rare and would likely follow the general permit to a large extent, this manual is structured around the general permit.

In Hawaii, owners of construction projects of one or more acres may obtain NPDES permit coverage by filing a Notice of Intent (NOI) to be covered under the CWB, NPDES Notice of General Permit Coverage (NGPC), Appendix C, Discharges of Storm Water Associated with Construction Activities (General Permit). The NOI Form C can be downloaded (see Section 1.5 Reference). Construction activities discharging to City MS4 are restricted to conditions in the City's NPDES Permit HI S000002, effective March 31, 2006 and expiring September 8, 2009.

Requirements for individual NPDES permits are outlined in HAR 11-55. Generally, individual permits are triggered by sewage discharges or other point sources, including significant pollutant discharges(s) to State waters. The CWB Individual NPDES Form C and Guidelines (revised September 30, 2004) can be accessed at the CWB website

(http://hawaii.gov/health/environmental/water/cleanwater/forms).

The primary objectives of the general permit are to:

- Reduce erosion;
- Minimize or eliminate sediment in storm water discharges;
- Prevent materials used at a construction site from contacting storm water;
- Implement a sampling and analysis program if storm water is exposed to construction materials;
- Eliminate unauthorized non-storm water discharges from the construction sites;
- Implement appropriate measures to reduce potential impacts on waterways both during and after construction of projects; and
- Establish maintenance commitments on post-construction pollution control measures.

Failure to comply with the general permit may result in penalties and remedies provided in Chapter 342D Water Pollution of the Hawaii Revised Statues, and possible imprisonment.

Who must comply with the construction general permit?

- The general permit applies to storm water discharges associated with construction activity which disturbs one acre or greater of soil, or at discretion by the Director; and
- The owner of the land is responsible for compliance.

When is a project not eligible for coverage under the construction general permit?

- Storm water discharges into sanitary sewers, storm waters regulated under existing individual permits, or storm water discharges to categories with USEPA discharge limitations are not eligible for general permit coverage;
- Storm water discharges which initially enter a separate storm water drainage system are not eligible, unless a permit, license or equivalent written approval is granted by the owner(s) of the drainage system(s) allowing the discharge to enter their system(s);
- Storm water discharges for which the director has issued a NGPC under another general permit specific to that type of construction or industrial activity are not eligible; and
- Storm water discharges that the director finds more appropriately regulated under an individual permit are not eligible.

Who does not need to seek coverage under the construction general permit?

- Activities to maintain the original line, grade, and hydraulic function of a facility, and emergency activities, do not require coverage under the general permit; and
- Construction activities meeting all three of the following criteria do not require coverage under the general permit, but minimum BMPs apply: (1) result in soil disturbances of less than one acre, (2) are not part of a larger common plan of development that disturbs one or more acres of soil, and (3) do not constitute a threat to water quality.

How to comply with construction general permit?

- Submit NOI and pay fees prior to the beginning of construction. Allow 30 working days for processing the NOI. A copy of the NOI can be found at CWB website http://hawaii.gov/health/environmental/water/cleanwater/forms/genl-index.html; and
- Prepare and submit SSBMPP before construction begins. The plan describes:
  - The project location, site features, and materials/activities that may result in the off-site discharge of pollutants during construction;
  - Controls to be implemented during construction - BMPs selected to control erosion, the discharge of sediment, and other pollutant sources; and
  - An inspection and maintenance program for BMPs.
    - Keep the BMPs plan on the site; implement it during construction and revise it as needed to reflect all phases of construction; and
    - Submit Notice of Cessation (NOC) when construction is complete and conditions of termination listed in the NOC have been satisfied. A copy of the NOC can be found at http://hawaii.gov/health/environmental/water/cleanwater/forms/environmental/water/cleanwater/forms/index.html.

1.3.3 Municipal NPDES Programs

Phase I Municipal Storm Water Program and municipal NPDES Permits cover and regulate municipalities with populations of over 100,000, drainage systems interconnected with these municipalities' systems, or municipalities determined to be significant contributors of pollutants.

Municipalities with NPDES storm water permits for their own MS4s are responsible for developing a management program for public and private construction activities in their jurisdiction. Each program addresses appropriate planning and construction procedures; ensures the implementation, inspection, and monitoring of construction sites which discharge storm water into their systems; and provides for education and training for construction site operators.

Phase II of the Storm Water Program will regulate municipalities with populations less than 100,000, including urbanized areas (areas with a population of 50,000 and density greater than 1,000 people per square mile), cities, and county areas designated by the state based on site-specific criteria, and various State and Federal facilities. Each designated entity must submit a NOI along with a copy of its Storm Water Management Program (SWMP). The Phase II SWMP must address six minimum control measures, including the following measures related to construction activities:

- Illicit Discharge Detection and Elimination - Developing and implementing a plan to detect and eliminate illicit discharges to the storm drain system including illicit connections and illegal dumping;
- Construction Site Storm Water Runoff Control - Developing, implementing, and enforcing an erosion and sediment control program for construction activities that disturb one or more acres of land; and
- Post Construction Storm Water Management in New Development and Redevelopment - Developing, implementing, and enforcing a program to address discharges of storm water runoff from new and redevelopment areas.

While Phase I and Phase II programs for construction sites vary throughout the state, the programs have many similarities, including the requirement for construction sites to comply with the General Permit. For specific information on State and City program requirements, construction site owners must contact the storm water program representative, such as DOH CWB and City Department of Environmental Services (ENV) Storm Water Quality Branch (SWQ).

1.4 DEFINITIONS

Many of the most common terms related to storm water quality control are defined in the Glossary (see Section 5). Throughout the manual, the user will find references to the following terms:

Maximum Extent Practicable (MEP) means economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint source pollution control practices, technologies, processes, siting criteria, operating methods or other alternatives. (ROH Section 14-12.2 Definitions, and City & County of Honolulu (CCH) Best Management Practices Manual for Construction Sites in Honolulu, May 1999).

NPDES General Permit for Storm Water Discharges. NPDES is an acronym for National Pollutant Discharge Elimination System. NPDES is the national program for administering and regulating Sections 307, 318, 402, and 405 of the Clean Water Act (CWA). In Hawaii, the Clean Water Branch (CWB) has issued a general permit for storm water discharges associated with construction activities.

Notice of Intent (NOI) is a formal notice to the CWB submitted by the owner/operators of existing industrial facilities. The NOI provides information on the permittee, location of discharge, type of discharge and certifies that the permittee will comply with conditions of the construction general permit. The NOI is not a permit application and does not require approval.

Sediment includes particles of sand, clay, silt, and other substances that settle at the bottom of a body of water. Sediment can come from the erosion of soil or from the decomposition of plants and animals. Wind, water, and ice often carry these particles great distances.

Best Management Practices (BMP) is defined as any program, technology, process, siting criteria, operating method, measure, or device, which controls, prevents, removes, or reduces pollution.

Source Control BMPs are operational practices that prevent pollution by reducing potential pollutants at the source.

Treatment Control BMPs are methods of treatment to remove pollutants from storm water.

1.5 REFERENCE

Berman, L., C. Hartline, N. Ryan, and J. Thorne, (1991), *Urban Runoff: Water Quality Solutions.* American Public Works Association, Special Report #61.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

City and County of Honolulu, Department of Planning and Permitting: Rules Relating to Soil Erosion Standards and Guidelines, April 1999.

Clark County Stormwater Pollution Control Manual Best Management Practices for Business and Government Agencies, 2000. Clark County Environmental Services Division, November 2000. On-line: http://www.co.clark.wa.us/pubworks/BMPman.pdf

King County Stormwater Pollution Control Manual. Best Management Practices for Businesses. King County Surface Water Management, July 1995. On-line: http://dnr.metrokc.gov/wlr/dss/spcm.html

Metzger, M.E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer, 2002. *The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with Structural BMPs*. Stormwater 3(2): 24-39.

National Stormwater Best Management Practices Database. American Society of Civil Engineers, 1999. On-line: http://www.asce.org

Pierce County Stormwater Pollution Prevention Manual: A Guide to Best Management Practices for Industries, Businesses and Homeowners. Pierce County Public Works and Utilities. Revised March 2002. On-line: http://www.co.pierce.wa.us/services/home/environ/water/swm/sppman/index.html

State of California Department of Transportation (Caltrans), Stormwater Quality Handbooks, 2000.

State of California Department of Transportation (Caltrans), Stormwater Quality Handbooks. Construction Contractor's Guide and Specifications, 1997.

State of California Department of Transportation (Caltrans), Stormwater Quality Handbooks, 1993.

State of Hawaii Department of Health Clean Water Branch, Hawaii Administrative Rules Title 11, Chapter 55 (October 8, 2007). *http://www.hawaii.gov/health/environmental/water/cleanwater/forms/pdf/11-55.pdf*.

State of Hawaii Department of Health Clean Water Branch, NOI Form C and Guidelines: Appendix C-Storm Water Associated with Construction Activities. *http://www.hawaii.gov/health/environmental/water/cleanwater/about/forms/gen1-index.html1#CWB-NOI%20Form%20C*.

State of Hawaii Department of Health Clean Water Branch, Standard General Permit Conditions, Hawaii Administrative Rules, Title 11, Chapter 55, Appendix A. <*http://www.hawaii.gov/health/environmental/water/cleanwater/about/stdcond.htm1#GeneralPermitConditions*>.

State Water Resources Control Board (1999) *NPDES General Permit No. CA2000002: Waste Discharge requirements for Discharges of Storm Water Runoff Associated with Construction Activity*. On-line: http://www.swrcb.ca.gov/stormwtr/construction

Stormwater Managers Resource Center. On-line: http://www.stormwatercenter.net

United States Environmental Protection Agency, Region 9: Water Programs: NPDES Storm Water Program. On-line: http://www.epa.gov/region09/water/npdes/stormwater.html

United States Environmental Protection Agency (1992) *Draft Stormwater Pollution Prevention for Industrial Activities*, Office of Wastewater Enforcement and Compliance.

United States Environmental Protection Agency (2000) *Storm Water Phase II Final Rule*, Office of Water, On-line: http://www.epa.gov/npdes/pubs/fact1-0.pdf

Urban Runoff Quality Management. Water Environment Federation/American Society of Civil Engineers, 1998. On-line: http://www.wef.org

SECTION 2: SITE-SPECIFIC CONSTRUCTION BMP PLAN (SSBMPP)

For projects totaling one acre or more, and activities that disturb less than one acre of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb one acre or more of total land acres, a SSBMPP is required by DOH. Information on preparation and implementation of a construction activity SSBMPP can be found in the DOH, HAR 11-55 Water Pollution Control Appendix C NPDES General Permit Authorizing Discharges of Storm Water Associated with Construction Activity (General Permit), and City Department of Planning and Permitting (DPP) Rules Relating to Soil Erosion Standards and Guidelines (April 1999, or as amended).

The construction general permit for construction activity covers all areas of the State except for discharges in or to state waters classified by the department as "class 1, inland waters," "class AA, marine waters," and areas restricted in accordance with the State's "No Discharge" policy in HAR 11-54 Water Quality Standards. If a project site discharges runoff into such areas, then the general permit will not be applicable, and an individual NPDES permit will be needed.

DOH requires that SSBMPP must be prepared before construction begins, ideally during the project planning and design phases. This is because much of the information required by the SSBMPP is already part of the project design documentation, and because the design may need to be modified to incorporate controls during construction and post-construction. It may be completed at the end of the design phase or at the initiation of the construction phase prior to any activity with the potential to cause water pollution.

Implementation of the SSBMPP begins when construction begins, typically before the initial clearing, grubbing, and grading operations, since these activities can usually increase erosion potential on the site. During construction, the SSBMPP should be referred to frequently, and amended by the owner and contractors as changes occur in construction operations, which could have significant effects on the potential for discharge of pollutants.

For construction projects with sites totaling less than one acre, DPP's Rules Relating to Soil Erosion Standards and Guidelines (April 1999, or as amended) may apply. According to the standard, projects totaling 15,000 square feet or more for single-family or two-family dwelling uses, or 7,500 square feet or more for other uses, or in the event a proposed cut of fill is greater than 15 feet in height for single-family dwelling uses, or 7.5 feet in height for other uses, have been classified as Category 4 (large projects) and require submission and DPP approval of drainage and erosion control plans. The temporary erosion and sediment control measures included in the drainage and erosion control plan must be designed to limit soil loss during construction as determined by the Universal Soil Loss Equation (USLE) or alternately by using the Large Site BMP Checklist in the Rules Relating to Soil Erosion Standards and Guidelines (April 1999, or as amended). For the smaller projects (Category 2 and 3) requiring a grading permit where the area of the zoning lot or portion thereof subject to the permit is less than 15,000 square feet for single-family or two-family dwelling uses, or less than 7,500 square feet for other uses, minimum BMPs identified in the erosion control standard are required which are found the Minimum BMP Checklist. Under normal situations, DOH required construction general permit coverage is not necessary for projects classified as Category 2-4 based on size of projects.

2.1 ASSESS CONSTRUCTION SITE AND PLANNED ACTIVITIES

The planning phase is the source of much of the information needed for the SSBMPP. The basis for storm water pollution control decisions is also made at this phase via the normal review process with State or City. Information to be collected includes contractor activities, disturbed areas and erosion potential, and site history.

2.1.1 Contractor Activities

Information about contractor activities is required for the selection of proper BMPs. Details that should be recorded include:

- Equipment storage, cleaning and maintenance areas and activities;
- Points of ingress and egress to the construction site;
- Material loading, unloading, and storage practices and areas, including construction materials, building materials and waste materials; and
- Materials, equipment, or vehicles that may come in contact with storm water.

2.1.2 Disturbed Areas and Erosion Potential

The physical condition of the site and adjacent areas should be reviewed. A project layout showing what is being constructed, limits of construction, project schedule, and existing features should be developed. Site characteristics including drainage patterns, soils, vegetation, surface water bodies, and steep or unstable slopes should be noted. A hydrology report, soils report, and a grading/drainage plan should be prepared. Physical conditions at the site will change as construction progresses. The SSBMPP must be amended to address conditions as activities change at the site.

The hydrology reports should assess information such as drainage areas and patterns, rainfall information and expected run-on and runoff volumes and flow rates, etc. It is important for the preparer of the SSBMPPs to visit the site prior to writing the plan, and to confirm actual site conditions, such as drainage flow. A soil report will identify soil constraints, design criteria, and soil stability. Both of these reports are used in the preparation of the preliminary grading and drainage plan. The grading and drainage plan should identify areas of cut and fill, slope during and after grading, protection of existing vegetation, and areas of soil disturbance. They also form the technical basis for selection of erosion and sediment control BMPs.

2.1.3 Site History

Existing site characteristics such as vegetation, environmental features, and areas of historic contamination (natural and/or industrial or agricultural) should also be recorded on the project layout. Soil laboratory analysis may be required should prior contamination be suspected. The selection and implementation of construction BMPs will be affected by what existing features need to be protected or mitigated during construction.

2.2 IDENTIFY AND SELECT BMPS

The owner, the owner's design consultant, or the contractor, may select BMPs at the discretion of the owner. The contract between the owner and contractor should specify the responsibilities

of the owner and contractor with regards to storm water pollution control during construction. Owners must be aware that regardless of the contractual agreement between the owner and contractor with respect to BMP selection and implementation, the owner is ultimately responsible for compliance with the general permit.

A guide to selecting BMPs for construction activities is presented in the following sections. BMPs are generally selected in a three-step process:

- Define BMP objectives,
- Identify BMP category, and
- Select appropriate BMPs.

2.2.1 Define BMP Objectives

Selection and implementation of BMPs is based on the pollution risks associated with the construction activity. The pollution prevention objectives of BMPs are defined based on a review of information gathered during the assessment of the site and planned activities (Section 2.1). Once defined, BMP objectives are developed and BMPs selected. The BMP objectives for construction projects are as follows:

- Control of Erosion, and Discharge of Sediment:
  - Minimize Disturbed Areas: Only clear land which will be actively under construction in the near term (e.g., within the next 6-12 months), minimize new land disturbance during the rainy season, and avoid clearing and disturbing sensitive areas (e.g., steep slopes and natural watercourses) and other areas where site improvements will not be constructed. City Ordinance Section 14-15.1(e) states that the maximum sized parcel of land that may be opened for grading or grubbing is 15 acres. The area of land that may be opened may be reduced by the director of planning and permitting to control pollution and minimize storm damage.
  - Stabilize Disturbed Areas: Provide temporary stabilization of disturbed soils whenever active construction is not occurring on a portion of the site. Provide permanent stabilization during finish grade and landscape the site.
  - Protect Slopes and Channels: Safely convey runoff from the top of the slope and stabilize disturbed slopes as quickly as possible. Avoid disturbing natural channels. Stabilize temporary and permanent channel crossings as quickly as possible and ensure that increases in runoff velocity caused by the project do not erode the channel.
- Control Site Perimeter: Delineate site perimeter to prevent disturbing areas outside the project limits. Divert upstream run-on safely around or through the construction project. City storm drainage ordinance and rules state that such diversions must not cause downstream property damage (Reference: ROH Section "Rules Relating to Storm Drainage Standards Part II – DESIGN STANDARDS GENERAL CONDITIONS"), or be diverted into another watershed. Runoff from the project site should be free of excessive sediment and other constituents. Control tracking at points of ingress to and egress from the project site.
- Retain Sediment: Retain sediment-laden waters from disturbed, active areas within the site

- Manage Non-Storm Water Discharges and Materials:
  - Practice Good Housekeeping: Perform activities in a manner to keep potential pollutants from coming into contact with storm water or being transported off site to eliminate or avoid exposure.
  - Contain Materials and Wastes: Store construction, building, and waste materials in designated areas, protected from rainfall and contact with storm water runoff. Dispose of all construction waste in designated areas, and keep storm water from flowing onto or off of these areas. Prevent spills and clean up spilled materials.

2.2.2 Identify BMP Categories

Once the BMP objectives are defined, identify the category of BMP best suited to meet each objective. The particular BMP selected from each category depends on specific site conditions, construction activities, and cost considerations.

There are six BMP categories available for selection. They are:

- Erosion Control (EC),
- Sediment Control (SE),
- Wind Erosion Control (WE),
- Tracking Control (TR),
- Non-Storm Water Management (NS), and
- Waste Management and Materials Pollution Control (WM).

BMPs for erosion and sediment control are listed in the EC, SE, WE, and TR categories. BMPs for contractor activities are listed in the TR, NS, and WM categories.

2.2.3 Select BMPs

BMPs for Erosion and Sediment Control

BMPs for erosion and sediment control are selected to meet the BMP objectives based on specific site conditions, construction activities, and cost. Various BMPs may be needed at different times during construction since activities are constantly changing site conditions.

Selection of erosion control BMPs should be based on minimizing disturbed areas, stabilizing disturbed areas, and protecting slopes and channels. Selection of sediment control BMPs should be based on retaining sediment on-site and controlling the site perimeter. Erosion and sediment control BMPs are listed in the EC, SE, WE, and TR categories, which are presented in Section 3.

BMPs for Contractor Activities

Certain contractor activities may cause pollution if not properly managed. BMPs should be selected based on the contractor activities information collected in the BMPs plan. The materials and BMP objectives for contractor activities are practicing good housekeeping and containing materials and waste. BMPs for contractor activities are selected from the TR, NS and WM categories, which are presented in Sections 3 (TR) and 4 (NS, WM). Several considerations for selecting a BMP for contractor activities include:

- Is it expected to rain? Selection of a BMP is different for the rainy season versus the dry season. What activities can be postponed or re-scheduled until after the rains or performed during the dry season.
- How much water is being used? The more water used and wastewater generated, the more likely that pollutants transported by this water will reach the drainage system or be transported off site.
- What are the site conditions? BMPs may differ depending on whether the activity is conducted on a slope or flat ground near a drainage structure or watercourse. Conducting activities away from certain sensitive areas will reduce the cost and inconvenience of implementing BMPs.
- What about accidents? Controls for common activities should be established, and preparations should be made to allow for quick response to accidents or spills. In the event of a spill or exposure of construction compounds, what are the contingency plans for sampling the contaminated storm water? Can the analysis be done in the field or should laboratory analysis be required? Are sample bottles available on-site, appropriate test strips, etc.?

2.3 SITE INSPECTIONS

Weekly BMP inspections and maintenance by the contractor are required for projects impacting the City's storm drainage system. The City DPP "Construction Site BMPs Weekly Checklist" is available at the DPP website. For projects with one-acre or more of disturbed areas, the City's MS4 permit requires site inspections in accordance to the City's guidance "Inspection and Enforcement Program for Construction Sites (Jan 2000)," "Rules Relating to Soil Erosion Standards and Guidelines (April 1999)," and updates accepted by DOH.

At the onset of a construction project (e.g., clearing, grubbing, or earth movement) it may be more appropriate to perform inspection of the BMPs on a regular basis instead of just before and after a storm. This will allow sufficient time for any corrections or improvements to be made before the storm. An inspector should be identified in the BMPs plan. Inspection can usually be performed as part of a regular oversight and inspection of the project site.

For projects with disturbed areas totaling one acre or more; reference DOH HAR 11-55 Water Pollution Control Section 13 Record Retention. Record Retention require inspection records be retained for five years from the date they were generated. It is highly recommended that records be retained for at least five years following the date coverage is terminated under the general permit; even longer retention of records is recommended where sites have been subject to enforcement actions or are involved in litigation regarding issues covered by the permit.

2.4 BMP MONITORING

The type of BMP monitoring depends on which BMP is implemented. In the case of contractor activity BMPs, the monitoring consists of visual inspection to ensure that the BMP was implemented and maintained according to the BMPs plan. Such inspection would include:

- Looking for evidence of spills and resulting clean-up procedures (e.g., supplies of spill cleanup materials);
- Verifying adequacy of trash receptacles;

- Verifying waste disposal practices (e.g., recycle vs. hazardous waste bins);
- Examining integrity and use of containment structures;
- Verifying use of employee education programs for the various activities;
- Noting the location of activity (e.g., outdoor vs. indoor, concrete vs. grass); and
- BMPs for any chemicals or fuels not addressed in the BMPs plan must be developed.

In the case of erosion and sediment control BMPs, the monitoring program should consist of regular inspection to determine the following:

- Are erosion and sediment control BMPs installed properly? The BMPs plan should include details or references to allow for the proper construction of structural or vegetative erosion and sediment control devices. The inspector should ensure that these systems are installed according to the BMPs plan in the proper locations.
- Are the BMPs effective? The effectiveness of the BMP would be based on the presence of sediment behind or within control devices, the presence of sediment downstream of the site, and signs of erosion in stabilized areas after a storm event.
- Have drainage patterns changed? If the site has undergone significant grading operations, resulting in a change of drainage patterns, adjustment to the BMPs will likely be required to address this change. The inspector shall determine the extent of changes to the drainage pattern and the necessity for additional or reconfigured BMPs.
- Are areas stabilized as quickly as possible after completion of construction activities in an area? Disturbed active and inactive construction areas (inactive construction areas may be defined as areas in which no construction activity will occur for a period of 30 days or longer) should be stabilized as soon as practical. If construction, climatological, or other site conditions do not allow stabilization, the BMPs plan should define alternative approaches.
- Are the BMPs properly maintained? Maintenance of erosion and sediment control BMPs is critical. Erosion controls should be installed as soon as practical after an area becomes inactive, and before the onset of rain. The capacity of sediment controls must be restored prior to the next rain event.

2.5 BMP MAINTENANCE

The inspector should inspect the site on a regular basis, during and after any storm generating runoff to determine maintenance requirements and general condition of the installed system. DOH, ENV and/or Department of Design and Construction (DDC) inspectors may also inspect the site on a routine basis to assess the maintenance performed on the systems. All maintenance related to a storm event should be completed within 48 hours of the storm event. The following maintenance tasks should be performed on a regular basis:

- Removal of sediment from barriers and sedimentation devices,
- Replacement or repair of worn or damaged silt fence fabrics,
- Replacement or repair of damaged structural controls,
- Repair of damaged soil stabilization measures, and
- Other control maintenance as defined in each BMP fact sheet.

2.6 STORM WATER POLLUTION CONTROL DOCUMENTATION

Records of inspections, compliance certifications, and non-compliance reporting are to be retained for at least five years by the owner (Reference: DOH HAR 11-55 Water Pollution Control, 13 Record Retention). It is suggested that records of incidents such as spills or other releases be kept. Analyzing a history of this information can provide insight into modifying the BMPs. Photographs should also be kept.

Also, keep a record of maintenance activities or any other BMPs that are activity based. Activity based BMPs such as good housekeeping must be documented in each inspection; often, this documentation is the only evidence that the BMPs have been implemented.

SECTION 3: EROSION AND SEDIMENT CONTROL BMPS

3.1 EROSION CONTROL

Erosion control is any source control practice that protects the soil surface and prevents soil particles from being detached by rainfall, flowing water, or wind. Erosion control is also referred to as soil stabilization. Erosion control consists of preparing the soil surface and implementing one or more of the BMPs shown in Table 3-1, to disturbed soil areas.

Table 3-1: Erosion Control BMPs

BMP#	BMP Name
EC-0	Employee/Subcontractor Training
EC-1	Scheduling
EC-2	Preservation of Existing Vegetation
EC-3	Hydraulic Mulch
EC-4	Hydroseeding
EC-5	Soil Binders
EC-7	Geotextiles and Mats
EC-8	Wood Mulching
EC-9	Earth Dikes and Drainage Swales
EC-10	Velocity Dissipation Devices
EC-11	Slope Drains
EC-12	Streambank Stabilization
EC-14	Seeding, Planting and Sodding
EC-15	Slope Roughening/Terracing
EC-16	Topsoil Management

All inactive soil-disturbed areas on the project site, and most active areas prior to the onset of rain, must be protected from erosion. Soil disturbed areas may include relatively flat areas as well as slopes. Typically, steep slopes and large exposed areas require the most robust erosion controls; flatter slopes and smaller areas still require protection, but less costly materials may be appropriate for these areas, allowing savings to be directed to the more robust BMPs for steep slopes and large exposed areas. To be effective, erosion control BMPs must be implemented at slopes and disturbed areas to protect them from concentrated flows.

Some erosion control BMPs can be used effectively to temporarily prevent erosion by concentrated flows. These BMPs, used alone or in combination, prevent erosion by intercepting, diverting, conveying, and discharging concentrated flows in a manner that prevents soil detachment and transport. Temporary concentrated flow conveyance controls may be required to direct run-on around or through the project in a non-erodible fashion. Temporary concentrated flow conveyance controls include the following BMPs:

- EC-9, Earth Dikes and Drainage Swales,
- EC-10, Velocity Dissipation Devices, and
- EC-11, Slope Drains.

Use of R-1 water (treated and disinfected wastewater with significant reduction in viral and bacterial pathogens) for sprayers and sprinklers used to water temporary or permanent vegetation must consider compatible surrounding land use. See “Guidelines for the Treatment and Use of Recycled Water, DOH Wastewater Branch, (May 2002).”

3.2 SEDIMENT CONTROL

Sediment control is any practice that traps soil particles after they have been detached and moved by rain, flowing water, or wind. Sediment control measures are usually passive systems that rely on filtering or settling the particles out of the water or wind that is transporting them.

Sediment control practices include the BMPs listed in Table 3-2.

Table 3-2: Temporary Sediment Control BMPs

BMP#	BMP Name
SE-1	Silt Fence
SE-2	Sediment Basin
SE-3	Sediment Trap
SE-4	Check Dams
SE-5	Fiber Rolls
SE-6	Gravel Bag Berm
SE-7	Street Sweeping and Vacuuming
SE-8	Sandbag Barrier
SE-10	Storm Drain Inlet Protection
SE-11	Chemical Treatment
SE-12	Locations of Potential Sources of Sediment
SE-13	Level Spreader
SE-14	Rip-Rap & Gabion Inflow Protection
SE-15	Vegetated Buffer Strips and Channels

Sediment control BMPs include those practices that intercept and slow or detain the flow of storm water to allow sediment to settle and be trapped. Sediment control practices can consist of installing linear sediment barriers (such as silt fence, and sandbag barrier); providing fiber rolls, gravel bag berms, or check dams to break up slope length or flow; or constructing a sediment trap or sediment basin. Linear sediment barriers are typically placed below the toe of exposed and erodible slopes, down-slope of exposed soil areas, around soil stockpiles, and at other appropriate locations along the site perimeter.

A few BMPs may control both sediment and erosion, for example, fiber rolls and sand bag barriers. This manual classifies these BMPs as either erosion control (EC) or sediment control (SC) based on the BMPs most common and effective use.

Sediment control BMPs are most effective when used in conjunction with erosion control BMPs. The combination of erosion control and sediment control is usually the most effective means to prevent sediment from leaving the project site and potentially entering storm drains or receiving waters. Under most conditions, the general permit requires that the discharger implement an effective combination of erosion and sediment controls.

Under limited circumstances, sediment control alone may be appropriate. For example, applying erosion control BMPs to an area where excavation, filling, compaction, or grading is currently under way may not be feasible when storms come unexpectedly. Use of sediment controls by establishing perimeter control on these areas may be appropriate and allowable under the general permit provided the following conditions are met:

- Weather monitoring is under way;
- Inactive soil-disturbed areas have been protected with an effective combination of erosion and sediment controls;

- An adequate supply of sediment control materials is stored on-site and there are sufficient forces of labor and equipment available to implement sediment controls on the active area prior to the onset of rain; and
- The SSBMPP adequately describes the methods to protect active area.

Monitoring and maintenance of erosion and sedimentation control measures (ESCM) are necessary as specified in DPP's "Rules Relating to Soil Erosion Standards and Guidelines" (April 1999) Section 1-4.4.3.

The applicant shall also be required to submit a schedule for the monitoring and maintenance of ESCM. The name and phone numbers and means of contacting the individual responsible for the maintenance shall be provided. The responsible individual shall also be required to maintain a log of which ESCM was inspected, the time and date, any actions taken to maintain the ESCM, and any actions which need to maintain the ESCM.

When the required work is completed, a notation of the starting and finishing dates for the work shall be annotated into the inspection log. The responsible person shall also log, as necessary, the quantities and disposal site for sediment removed from an ESCM. The erosion and sedimentation control plan shall also include an emergency maintenance and repair plan for the ESCMs.

A plan for the long term monitoring and maintenance of permanent erosion control measures shall be submitted. The plan shall include the person or organization responsible for the monitoring and maintenance, the areas required for access to the permanent erosion control measures, the equipment, material and manpower requirements, the frequency and method of inspection, and any other information necessary to assess the monitoring and maintenance requirements.

3.3 WIND EROSION CONTROL

Wind erosion control consists of applying water or other dust palliatives to prevent or alleviate dust nuisance. Wind erosion control BMPs are shown in Table 3-3.

Table 3-3: Wind Erosion Control BMPs

BMP#	BMP Name
WE-1	Wind Erosion Control

Other BMPs that are sometimes applied to disturbed soil areas in order to control wind erosion are BMPs EC-1 through EC-5, shown in Section 0 of this manual. Be advised that many of the dust palliatives may contain compounds that have an unknown effect on storm water. A sampling and analysis protocol to test for storm water contamination from exposure to such compounds is required in the SSBMPP.

Use of recycled water for the purposes of wind erosion control must be approved by DOH Wastewater Branch.

3.4 TRACKING CONTROL BMPS

Tracking control consists of preventing or reducing the tracking of sediment off-site by vehicles leaving the construction area. Tracking control BMPs are shown in Table 3-4.

Attention to control of tracking sediment off site is highly recommended, as dirty streets and roads near a construction site create a nuisance to the public and generate constituent complaints to elected officials and regulators. These complaints often result in immediate inspections and regulatory actions.

Table 3-4: Temporary Tracking Control BMPs

BMP #	BMP Name
TR-1	Stabilized Construction Entrance/Exit
TR-2	Stabilized Construction Roadway
TR-3	Entrance/Outlet Tire Wash

3.5 EROSION AND SEDIMENT CONTROL BMP FACT SHEET FORMAT

A BMP fact sheet is a short document that gives all the information about a particular BMP. Typically, each fact sheet contains the information outlined in Figure 3-1. Completed fact sheets for each of the above activities are provided in Section 3.6.

Figure 3-1: Example Fact Sheet

EC-xx Example Fact Sheet
Description and Purpose
Suitable Applications
Limitations
Costs
Inspections and Maintenance
References

The fact sheets also contain side bar presentations with information on BMP objectives, targeted constituents, removal effectiveness, and potential alternatives.

3.6 BMP FACT SHEETS AND OBJECTIVES

BMP fact sheets for erosion, sediment, wind, and tracking controls follow. The BMP fact sheets are individually page numbered and are suitable for photocopying and inclusion in a site-specific BMPs plan.

Construction activities BMPs are designed to address one or more objectives to reduce the detrimental impact of pollutants caused by construction activities. Each BMP fact sheet lists the BMP objectives found on each front page, on the upper right-hand corner. A list of all the BMP fact sheets and their corresponding objectives are shown in Table 3-5.

Table 3-5: Erosion, Sediment, Wind and Tracking Control and BMP Objectives

BMP Category		BMP Objectives					
		Erosion Control	Sediment Control	Tracking Control	Wind Erosion Control	Non-Storm Water Management Control	Waste Management & Materials Pollution Control
Site Planning Considerations							
EC-0	Employee/Subcontractor Training						
EC-1	Scheduling	X	X	X	X		
EC-2	Preservation of Existing Vegetation	X	X				
SE-12	Location of Potential Sources of Sediment	X	X				
Vegetative Stabilization							
EC-3	Hydraulic Mulch	X			X		
EC-4	Hydroseeding	X			X		
EC-5	Soil Binders	X			X		
EC-8	Wood Mulching	X			X		
EC-14	Seeding, Planting and Sodding	X					
SE-14	Rip-Rap & Gabion Inflow Protection	X	X				
SE-15	Vegetated Buffer Strips and Channels	X	X				
SE-16	Compost Socks and Berms	X	X				
Physical Stabilization							
EC-7	Geotextiles and Mats	X			X		
EC-12	Streambank Stabilization	X	X			X	
EC-16	Topsoil Management	X	X		X		
SE-5	Fiber Rolls	X	X				
SE-6	Gravel Bag Berms	X	X				
SE-7	Street Sweeping and Vacuuming		X	X			
SE-8	Sandbag Barrier	X	X				
SE-13	Level Spreader	X					
TR-1	Stabilized Construction Entrance/Exit	X	X	X			
TR-2	Stabilized Construction Roadway	X	X	X			
TR-3	Entrance/Outlet Tire Wash		X	X			

BMP Category		BMP Objectives					
		Erosion Control	Sediment Control	Tracking Control	Wind Erosion Control	Non-Storm Water Management Control	Waste Management & Materials Pollution Control
Diversion Runoff							
EC-9	Earth Dikes and Drainage Swales	X					
EC-11	Slope Drain	X					
Velocity Reduction							
EC-10	Velocity Dissipation Devices	X					
EC-15	Slope Roughening/Terracing	X	X				
SE-4	Check Dams	X	X				
SE-10	Storm Drain Inlet Protection		X				
Sediment Trapping/Filtering							
SE-1	Silt Fence		X				
SE-2	Sediment Basin		X				
SE-3	Sediment Trap		X				
Other							
SE-11	Chemical Treatment		X				
WE-1	Wind Erosion Control		X		X		

3.7 EROSION CONTROL FACT SHEETS

EC-0 Employee/Subcontractor Training
EC-1 Scheduling
EC-2 Preservation of Existing Vegetation
EC-3 Hydraulic Mulch
EC-4 Hydroseeding
EC-5 Soil Binders
EC-7 Geotextiles and Mats
EC-8 Wood Mulching
EC-9 Earth Dikes and Drainage Swales
EC-10 Velocity Dissipation Devices
EC-11 Slope Drains
EC-12 Streambank Stabilization
EC-14 Seeding, Planting and Sodding
EC-15 Slope Roughening/Terracing
EC-16 Topsoil Management

E Mālama I Ka Wai Ola
Protect our waters...
FOR LIFE

Employee/Subcontractor Training EC-0

Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment

Nutrients

Trash

Metals

Bacteria

Oil and Grease

Organics

Potential Alternatives

None

Description and Purpose

Training programs ensure that all employees and subcontractors understand the requirements of the Storm Water Management Program Plan as applicable to their responsibilities. Training topics include but are not limited to storm water management, potential contamination sources, and BMPs.

Employee/subcontractor training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

Suitable Applications

Employees involved in the planning, design, or construction phase of construction, repair, or maintenance activities within the City and County of Honolulu or project rights-of-way.

Limitations

- Degree of employee motivation and incentive to learn about BMP implementation.
- Availability of staff time to coordinate and conduct training.

Implementation

- Integrate training regarding storm water quality management with existing training programs that may be required for your business by other regulations such as: the Safety and Health Program (Hawaii Occupational Safety and Health Standards), the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard (29 CFR 1910.120), the Spill Prevention Control and Countermeasure (SPCC) Plan (40 CFR 112), and the Hazardous Materials Management Plan (Business Plan).
- Provide storm water management training through courses, seminars, workshops, product demonstrations, employee meetings, posters, and bulletin boards.
- Provide field training programs conducted by trained personnel.
- Maintain commitment and request input from senior City and County of Honolulu or project management.
- Promote open communication between employees involved in various stages of the projects.
- Improve storm water quality management based on past experience involving water quality problems at construction sites. Implement revised practices and procedures in training.
- Increase employee awareness of requirements and procedures for BMP monitoring and reporting.
- Businesses, particularly smaller ones that may not be regulated by Federal, State, or City and County regulations, may use the information in this Manual to develop a training program to reduce their potential to pollute storm water.
- Use the quick reference on disposal alternatives (Table 1.2) to train employee/ subcontractors in proper and consistent methods for disposal.
- Consider posting the quick reference table around the job site or in the on-site office trailer to reinforce training.
- Train employee/subcontractors in standard operating procedures and spill cleanup techniques described in the fact sheets. Employee/Subcontractors trained in spill containment and cleanup should be present during the loading/unloading and handling of materials.
- Personnel who use pesticides should be trained in their use. The State Department of Agriculture, Pesticides Branch, licenses pesticide dealers, certifies pesticide applicators, and conducts on-site inspections.
- Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employee/subcontractors can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do on-site.

Costs

All of the above are low cost measures.

Inspection and Maintenance

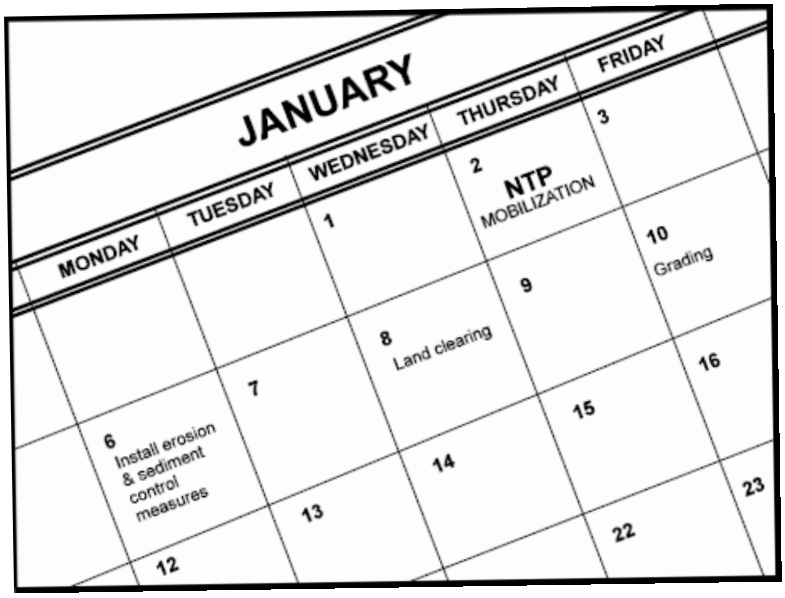
Provide annual training on construction BMP implementation for all employees involved with construction activities.

References

City & County of Honolulu, Best Management Practices Manual for Construction Sites in Honolulu, Department of Environmental Services, May 1999.

Knoxville BMP Manual, 2003

State of Hawaii DOT, Highways Division Construction BMP Field Manual, September 2006.



Objectives

EC – Erosion Control	√
SE – Sediment Control	▲
TR – Tracking Control	▲
WE – Wind Erosion Control	▲
NS – Non-Storm Water Management Control	▲
WM – Waste Management & Materials Pollution Control	▲

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Scheduling is the development of a written plan that includes sequencing of construction activities and the implementation of BMPs such as erosion control and sediment control while taking local climate (rainfall, wind, etc.) into consideration. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

Suitable Applications

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project especially during rainy season. Use of other, more costly yet less effective, erosion and sediment control BMPs may often be reduced through proper construction sequencing.

City Ordinance Section 14-14.2 (c) (2), Application for a Grading Permit, requires the grading permittee to include a statement of schedules and sequence of construction operations. For projects with 1 acre or more disturbed sites, the Hawaii State Department of Health (DOH) and Clean Water Branch (CWB) requires a schedule so that construction is sequenced to minimize the exposure time of the cleared surface area.

Limitations

- Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.

Implementation

- Avoid rainy periods. Schedule major grading operations during dry months when practical. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means or to install sediment trapping devices.
- Plan the project and develop a schedule showing each phase of construction. Clearly show how the rainy season relates to soil disturbing and re-stabilization activities. Incorporate the construction schedule into the site-specific BMPs plan.
- Include on the schedule, details on the rainy season implementation and deployment of:
  - Erosion control BMPs,
  - Sediment control BMPs,
  - Tracking control BMPs,
  - Wind erosion control BMPs,
  - Non-storm water BMPs, and
  - Waste management and materials pollution control BMPs.
- Include dates for activities that may require non-storm water discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, pavement cleaning, etc.
- Work out the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, foundation pouring utilities installation, etc., to minimize the active construction area during the rainy season:
  - Sequence trenching activities so that most open portions are closed before new trenching begins;
  - Incorporate staged seeding and re-vegetation of graded slopes as work progresses; and
  - Schedule establishment of permanent vegetation during appropriate planting time for specified vegetation.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year round to deploy erosion control and sediment control BMPs. Erosion may be caused during dry seasons by un-seasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year round, and retain and maintain rainy season sediment trapping devices in operational condition.
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.
- For additional Scheduling information, refer to the City & County of Honolulu, Department of Planning and Permitting "Rules Relating to Soil Erosion Standards and Guidelines" (April 1999), Section 1-4.4.2 Scheduling, Time Frame, and Sequencing of Construction.

Costs

Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost effectiveness of scheduling techniques should be compared with the other less effective erosion and sedimentation controls to achieve a cost effective balance.

Inspection and Maintenance

- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted.
- Amend the schedule prior to the rainy season to show updated information on the deployment and implementation of construction site BMPs.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

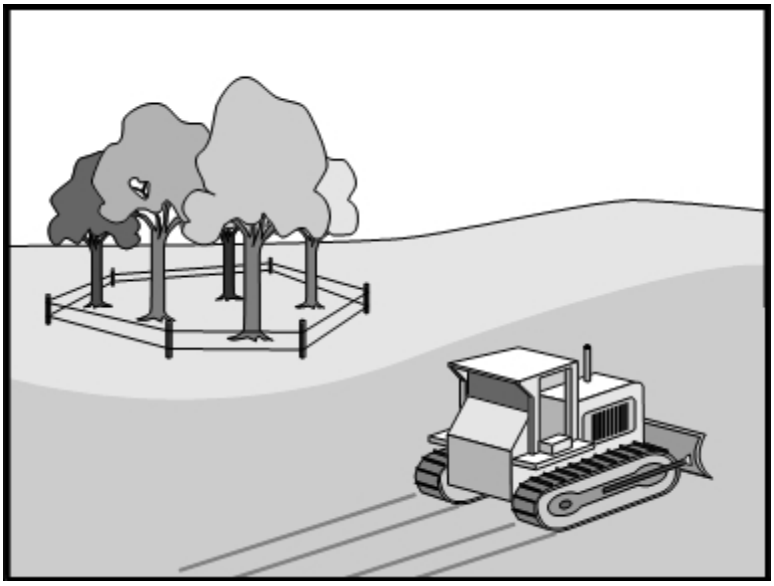
Hawaii Administrative Rules, Title 11, Chapter 55, Water Pollution Control, Appendix C, NPDES General Permit Authorizing Discharges of Storm Water Associated with Construction Activity, Hawaii State Department of Health (DOH) Clean Water Branch, p. 55-C-11 *http://www.hawaii.gov/health/about/rules/admrules.html*

Revised Ordinances of Honolulu Section 14, Article 15. Grading, Grubbing & Stockpiling, *http://www.honolulu.gov/menu/government/gov_resources/refs/index.html*

Stormwater Management for Construction Activities Developing Pollution Prevention Plans and Best Management Practices (EPA 832-R-92-005), U.S. Environmental Protection Agency, Office of Water, September 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Preservation of Existing Vegetation EC-2



Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Both State and City regulations recommend preservation of existing vegetation whenever feasible.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs, or occurs at a later date. This BMP is especially suitable to multi-year projects where grading can be phased.
- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.
- Areas where city, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.
- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.

Limitations

- Requires forward planning by the owner/developer, contractor, and design staff.
- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

Existing vegetation to be preserved on the site should be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots:
  - Orange colored plastic mesh fencing works well; and
  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.
- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

Costs

There is little cost associated with preserving existing vegetation if properly planned during the project design, and these costs may be offset by aesthetic benefits that enhance property values. During construction, the cost for preserving existing vegetation will likely be less than the cost of applying erosion and sediment controls to the disturbed area. Replacing vegetation inadvertently destroyed during construction can be extremely expensive, sometimes in excess of $10,000 per tree in California. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries should be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree should be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization:
  - Fertilize stressed or damaged broadleaf trees to aid recovery;
  - Fertilize trees in the late fall or early spring; and
  - Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft. to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.
- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

County of Sacramento Tree Preservation Ordinance, September 1981.

Hawaii Administrative Rules, Title 11, Chapter 55, Water Pollution Control, Appendix C, NPDES General Permit Authorizing Discharges of Storm Water Associated with Construction Activity, Hawaii State Department of Health (DOH) Clean Water Branch, p. 55-C-11.

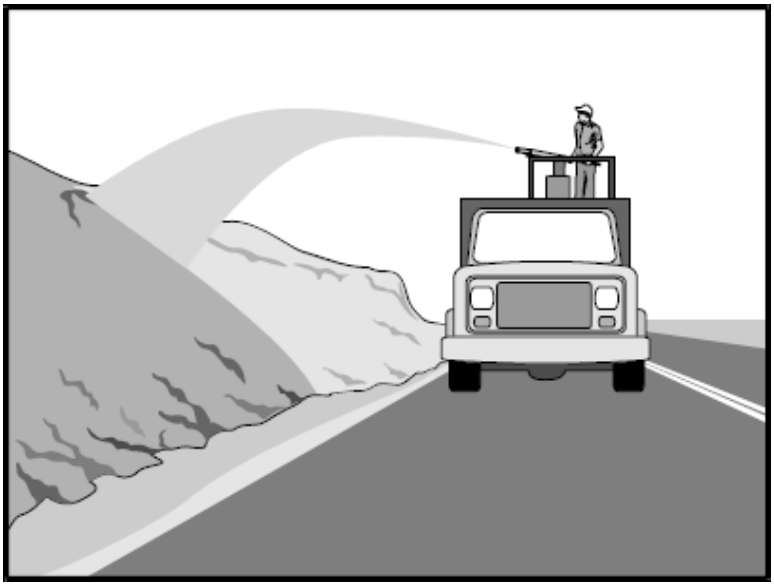
Revised Ordinances of Honolulu, Section 14, Article 15, Grading, Grubbing & Stockpiling.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydraulic Mulch EC-3



Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	▲
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-4 Hydroseeding

EC-5 Soil Binders

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Hydraulic mulch consists of various types of fiberous materials mixed with water and sprayed onto the soil surface in slurry form to provide a layer of temporary protection from wind and water erosion.

Suitable Applications

Hydraulic mulch is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established, and disturbed areas that will be re-disturbed following an extended period of inactivity.

Limitations

Wood fiber hydraulic mulches are generally short lived and need 24 hours to dry before rainfall occurs to be effective. May require a second application in order to remain effective for an entire rainy season.

Implementation

- Prior to application, roughen embankment and fill areas by rolling with a crimping or punching type roller or by track walking. Track walking should only be used where other methods are impractical.
- To be effective, hydraulic matrices require 24 hours to dry before rainfall occurs.
- Avoid mulch over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Hydraulic mulch can also include a vegetative component, such as seed, rhizomes, or stolons (see EC-4 Hydroseeding).

Standard Hydraulic Mulches

Standard hydraulic mulches are generally applied at a rate of 2,000 lb/acre and are manufactured containing approximately 5% tackifier (i.e. soil binder), usually a plant derived guar or psyllium type. Most standard mulches are green in color derived from food-color based dyes.

Hydraulic Matrices (HM) and Stabilized Fiber Matrices (SFM)

Hydraulic matrices and stabilized fiber matrices are slurries which contain increase levels of tackifiers/soil binders; usually 10% or more by weight. HMs and SFMs have improved performance compared to a standard hydraulic mulch because of additional percentage of tackifier and because of their higher typical application rates, 2,500 - 4,000 lb/acre. Hydraulic matrices can include a mixture of fibers, for example, a 50/50 blend of wood and paper fiber. In the case of and SFM, the tackifier/soil binder is specified as a polyacrylamide (PAM). Hydraulic matrices include a mixture of wood fiber and acrylic polymer or other tackifier as binder.

Bonded Fiber Matrix (BFM)

Bonded fiber matrix is a hydraulically applied system of fibers and adhesives that upon drying forms an erosion resistant blanket that promotes vegetation, and prevents soil erosion. BFMs are typically applied at rates from 3,000 lb/acre to 4,000 lb/acre based on the manufacturer's recommendation. A biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM should also be biodegradable and should not dissolve or disperse upon re-wetting. Typically, biodegradable BFMs should not be applied immediately before, during or immediately after rainfall if the soil is saturated. Depending on the product, BFMs typically require 12 to 24 hours to dry and become effective.

Mechanically-Bonded Fiber Matrix (MBFM)

Bonded fiber matrix (BFM) is a hydraulically applied system of fibers and adhesives that upon drying forms an erosion resistant blanket that promotes vegetation, and prevents soil erosion. BFMs are typically applied at rates from 3,000 lb/acre to 4,000 lb/acre based on the manufacturer's recommendation. A biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM should also be biodegradable and should not dissolve or disperse upon re-wetting. Typically, biodegradable BFMs should not be applied immediately before, during or immediately after rainfall if the soil is saturated. Depending on the product, BFMs typically require 12 to 24 hours to dry and become effective.

Costs

Average installed cost for hydraulic mulch categories are provided in table below. Note that Hawaii's unit prices are higher than California's unit prices

Hydraulic Mulch Type	Average Installed Cost
Standard Hydraulic Mulches	$2,600/acre
Hydraulic Matrices and Stabilized Fiber Matrices	
Guar-based	$3,000/acre
PAM-base	$4,050/acre
Bonded Fiber Matrix	$5,400/acre
Mechanically Bonded Fiber Matrix	$5,250/acre

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Maintain an unbroken, temporary mulched ground cover throughout the period of construction when the soils are not being reworked.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Controlling Erosion of Construction Sites Agricultural Information #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Sedimentation and Erosion Control, An Inventory of Current Practices Draft, US EPA, April 1990.

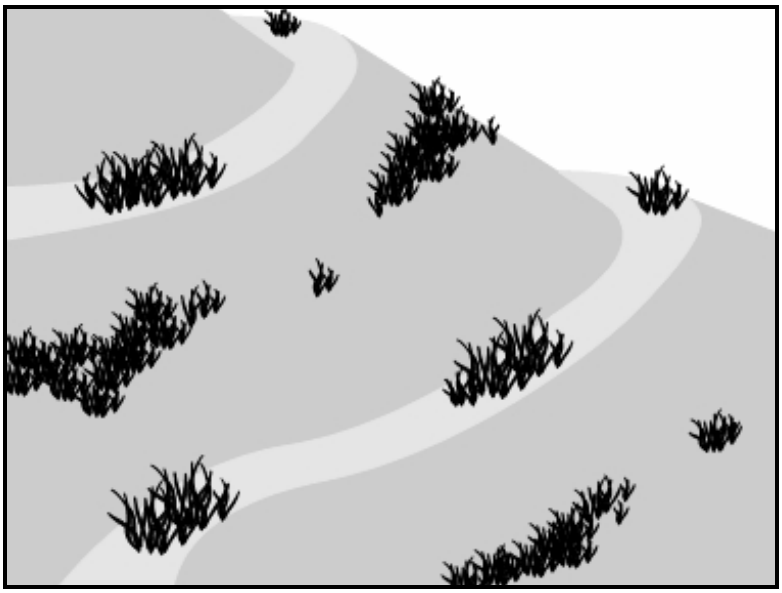
Soil Erosion by Water, Agriculture Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydroseeding EC-4



Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	▲
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-5 Soil Binders

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Hydroseeding typically consists of applying a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydro-mulch equipment, to temporarily protect exposed soils from erosion by water and wind.

Suitable Applications

Hydroseeding is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established, and disturbed areas that will be re-disturbed following an extended period of inactivity.

Limitations

- Hydroseeding may be used alone only when there is sufficient time in the season to ensure adequate vegetation establishment and coverage to provide adequate erosion control. Otherwise, hydroseeding should be used in conjunction with mulching (i.e., straw mulch).
- Steep slopes are difficult to protect with temporary seeding. Per EC-9 Earth Dikes and Drainage Swales, seeding is allowed for less than 5% slopes.
- Temporary seeding may not be appropriate in dry periods without supplemental irrigation.
- Temporary vegetation may have to be removed before permanent vegetation is applied.
- Temporary vegetation is not appropriate for short term inactivity.

Implementation

In order to select appropriate hydroseeding mixtures, an evaluation of site conditions should be performed with respect to:

- Soil conditions,
- Site topography,
- Season and climate,
- Vegetation types,
- Maintenance requirements,
- Sensitive adjacent areas,
- Water availability, and
- Plans for permanent vegetation.

Seed type should be carefully selected based upon anticipated soil type and future irrigation. For example, use of centipede or carpet grass seeds may perform better in soils with low fertility and moisture content.

The Hawaii office of the U.S.D.A. Natural Resources Conservation Service (NRCS) is an excellent source of information on appropriate seed mixes.

The following steps should be followed for implementation:

- Avoid use of hydroseeding in areas where the BMP would be incompatible with future earthwork activities and would have to be removed.
- Hydroseeding can be accomplished using a multiple step or one step process. The multiple step process ensures maximum direct contact of the seeds to soil. When the one step process is used to apply the mixture of fiber, seed, etc., the seed rate should be increased to compensate for all seeds not having direct contact with the soil.
- Prior to application, roughen the area to be seeded with the furrows trending along the contours.
- Apply a straw mulch to keep seeds in place and to moderate soil moisture and temperature until the seeds germinate and grow.
- All seeds should be in conformance with the State of Hawaii Department of Agriculture (HDOA). Each seed bag should be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test. The container should be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. All legume seed should be pellet inoculated. Inoculant sources should be species specific and should be applied at a rate of 2 lb of inoculant per 100 lb seed. Noxious species listed by HDOA are not permitted.
- Commercial fertilizer should conform to industry and suppliers requirements. Fertilizer should be pelleted or granular form.
- Follow up applications should be made as needed to cover weak spots and to maintain adequate soil protection.
- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

Costs

In California, average cost for installation and maintenance may vary from as low as $300 per acre for flat slopes and stable soils, to $1600 per acre for moderate to steep slopes and/or erosive soils. Note that Hawaii's unit prices are higher than California's unit prices.

Hydroseeding		Installed Cost per Acre
High Density	Ornamentals	$400-$1,600
	Turf Species	$350
	Bunch Grasses	$300-1,300
Fast Growing	Annual	$350-$650
	Perennial	$300-$800
Non-Competing	Native	$300-$1,600
	Non-Native	$400-$500
Sterile	Cereal Grain	$500

Source: Caltrans Guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Where seeds fail to germinate, or they germinate and die, the area should be re-seeded, fertilized, and mulched within the planting season, using not less than half the original application rates.
- Irrigation systems, if applicable, should be inspected daily while in use to identify system malfunctions and line breaks. When line breaks are detected, the system should be shut down immediately and breaks repaired before the system is put back into operation.
- Irrigation systems should be inspected for complete coverage and adjusted as needed to maintain complete coverage.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Hawaii Administrative Rules, Chapter 67, Seed Rules, Title 4, Subtitle 6, Hawaii State Department of Agriculture (HDOA), Division of Plant Industry http://www.hawaii.gov/hdoa/admin-rules.html.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Soil Binders EC-5

Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	▲
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Soil binders consist of applying and maintaining a soil stabilizer to exposed soil surfaces. Soil binders are materials applied to the soil surface to temporarily prevent water induced erosion of exposed soils on construction sites. Soil binders also prevent wind erosion.

Suitable Applications

Soil binders are typically applied to disturbed areas requiring short term temporary protection. Because soil binders can often be incorporated into the work, they are a good alternative to mulches in areas where grading activities will soon resume. Soil binders are also suitable for use on stockpiles.

Limitations

- Soil binders are temporary in nature and may need reapplication.
- Soil binders require a minimum curing time until fully effective, as prescribed by the manufacturer. Curing time may be 24 hours or longer. Soil binders may need reapplication after a storm event.
- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down slope.
- Soil binders do not hold up to pedestrian or vehicular traffic across treated areas.

- Soil binders may not penetrate soil surfaces made up primarily of silt and clay, particularly when compacted.
- Some soil binders may not perform well with low relative humidity. Under rainy conditions, some agents may become slippery or leach out of the soil.
- Soil binders may not cure if low temperatures occur within 24 hours of application.
- The water quality impacts of soil binders are relatively unknown and some may have water quality impacts due to their chemical makeup.
- A sampling and analysis plan should be incorporated into the site-specific BMPs plan as soil binders could be a source of non-visible pollutants.

Implementation

General Considerations

- Regional soil types will dictate appropriate soil binders to be used.
- A soil binder should be environmentally benign (non-toxic to plant and animal life), easy to apply, easy to maintain, economical, and should not stain paved or painted surfaces. Soil binders should not pollute storm water.
- Some soil binders may not be compatible with existing vegetation.
- Performance of soil binders depends on temperature, humidity, and traffic across treated areas.
- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

Selecting a Soil Binder

Properties of common soil binders used for erosion control are provided on the table at the end of this BMP. Use this table to select an appropriate soil binder. Refer to WE-1, Wind Erosion Control, for dust control soil binders.

Factors to consider when selecting a soil binder include the following:

- Suitability to situation - Consider where the soil binder will be applied, if it needs a high resistance to leaching or abrasion, and whether it needs to be compatible with any existing vegetation. Determine the length of time soil stabilization will be needed, and if the soil binder will be placed in an area where it will degrade rapidly. In general, slope steepness is not a discriminating factor for the listed soil binders;
- Soil types and surface materials - Fines and moisture content are key properties of surface materials. Consider a soil binder's ability to penetrate, likelihood of leaching, and ability to form a surface crust on the surface materials; and
- Frequency of application - The frequency of application can be affected by subgrade conditions, surface type, climate, and maintenance schedule. Frequent applications could lead to high costs. Application frequency may be minimized if the soil binder has good penetration, low evaporation, and good longevity. Consider also that frequent application will require frequent equipment clean up.

Plant-Material Based (Short Lived) Binders

Guar: Guar is a non-toxic, biodegradable, natural galactomannan (or plant carbohydrates/sugars) based hydrocolloid treated with dispersant agents for easy field mixing. It should be mixed with

water at the rate of 11 to 15 lb per 1,000 gallons. Recommended minimum application rates are as follows:

Application rates for Guar Soil Stabilizer

Slope (H:V):	Flat	4:1	3:1	2:1	1:1
lb/acre:	40	45	50	60	70

Psyllium: Psyllium is composed of the finely ground muciloid coating of seeds (from plantago plant) that is applied as a dry powder or in a wet slurry to the surface of the soil. It dries to form a firm but rewettable membrane that binds soil particles together but permits germination and growth of seed. Psyllium requires 12 to 18 hours drying time. Application rates should be from 80 to 200 lb/acre, with enough water in solution to allow for a uniform slurry flow.

Starch: Starch is non-ionic, cold water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 150 lb/acre. Approximate drying time is 9 to 12 hours.

Plant-Material Based (Long Lived) Binders

Pitch and Rosin Emulsion: Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin should be a minimum of 26% of the total solids content. The soil stabilizer should be non-corrosive, water dilutable emulsion that upon application cures to a water insoluble binding and cementing agent. For soil erosion control applications, the emulsion is diluted and should be applied as follows:

- For clayey soil: 5 parts water to 1 part emulsion, and
- For sandy soil: 10 parts water to 1 part emulsion.

Application can be by water truck or hydraulic seeder with the emulsion and product mixture applied at the rate specified by the manufacturer.

Polymeric Emulsion Blend Binders

Acrylic Copolymers and Polymers: Polymeric soil stabilizers should consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55% solids. The polymeric compound should be handled and mixed in a manner that will not cause foaming or should contain an anti-foaming agent. The polymeric emulsion should not exceed its shelf life or expiration date; manufacturers should provide the expiration date. Polymeric soil stabilizer should be readily miscible in water, non-injurious to seed or animal life, non-flammable, should provide surface soil stabilization for various soil types without totally inhibiting water infiltration, and should not re-emulsify when cured. The applied compound should air cure within a maximum of 36 to 48 hours. Liquid copolymer should be diluted at a rate of 10 parts water to 1 part polymer and the mixture applied to soil at a rate of 1,175 gallons/acre.

Liquid Polymers of Methacrylates and Acrylates: This material consists of a tackifier/sealer that is a liquid polymer of methacrylates and acrylates. It is an aqueous 100% acrylic emulsion blend of 40% solids by volume that is free from styrene, acetate, vinyl, ethoxylated surfactants or silicates. For soil stabilization applications, it is diluted with water in accordance with manufacturer's recommendations, and applied with a hydraulic seeder at the rate of 20 gallons/acre. Drying time is 12 to 18 hours after application.

Copolymers of Sodium Acrylates and Acrylamides: These materials are non-toxic, dry powders that are copolymers of sodium acrylate and acrylamide. They are mixed with water and applied to the soil surface for erosion control at rates that are determined by slope gradient:

Slope Gradient (H:V)	lb/acre
Flat to 5:1	3.0-5.0
5:1 to 3:1	5.0-10.0
2:2 to 1:1	10.0-20.0

Poly-Acrylamide and Copolymer of Acrylamide: Linear copolymer polyacrylamide is packaged as a dry flowable solid. When used as a standalone stabilizer, it is diluted at a rate of 11lb/1,000 gal of water and applied at the rate of 5.0 lb/acre.

Hydro-Colloid Polymers: Hydro-Colloid Polymers are various combinations of dry flowable poly-acrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 55 to 60 lb/acre. Drying times are 0 to 4 hours.

Cementitious-Based Binders

Gypsum: This is a formulated gypsum based product that readily mixes with water and mulch to form a thin protective crust on the soil surface. It is composed of high purity gypsum that is ground, calcined and processed into calcium sulfate hemihydrate with a minimum purity of 86%. It is mixed in a hydraulic seeder and applied at rates 4,000 to 12,000 lb/acre. Drying time is 4 to 8 hours.

Applying Soil Binders

After selecting an appropriate soil binder, the untreated soil surface should be prepared before applying the soil binder. The untreated soil surface should contain sufficient moisture to assist the agent in achieving uniform distribution. In general, the following steps should be followed:

- Follow manufacturer's written recommendations for application rates, pre-wetting of application area, and cleaning of equipment after use;
- Prior to application, roughen embankment and fill areas;
- Consider the drying time for the selected soil binder and apply with sufficient time before anticipated rainfall. Soil binders should not be applied during or immediately before rainfall;
- Avoid over spray onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.;
- Soil binders should not be applied to areas with standing water, under rainy conditions, or when the temperature is below 40°F during the curing period;
- More than one treatment is often necessary, although the second treatment may be diluted or have a lower application rate;
- Generally, soil binders require a minimum curing time of 24 hours before they are fully effective. Refer to manufacturer's instructions for specific cure time; and
- For liquid agents:
    - Crown or slope ground to avoid ponding;

- Uniformly pre-wet ground at 0.03 to 0.3 gal/yd^2 or according to manufacturer's recommendations;
- Apply solution under pressure. Overlap solution 6 to 12 in.;
- Allow treated area to cure for the time recommended by the manufacturer; typically at least 24 hours;
- Apply second treatment before first treatment becomes ineffective, using 50% application rate; and
- In low humidities, reactivate chemicals by re-wetting with water at 0.1 to 0.2 gal/yd^2.

Costs

Costs vary according to the soil stabilizer selected for implementation. The following are approximate costs in California:

Soil Binder	Cost per Acre
Plant-Material Based (Short Lived) Binders	$400
Plant-Material Based (Long Lived) Binders	$1,200
Polymeric Emulsion Blend Binders	$400[(1)]
Cementitious-Based Binders	$800

[(1)] $1,200 for Acrylic polymers and copolymers
Source: Caltrans guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Reapply the selected soil binder as needed to maintain effectiveness.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Sedimentation and Erosion Control, An Inventory of Current Practices Draft, USEPA, April 1990.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

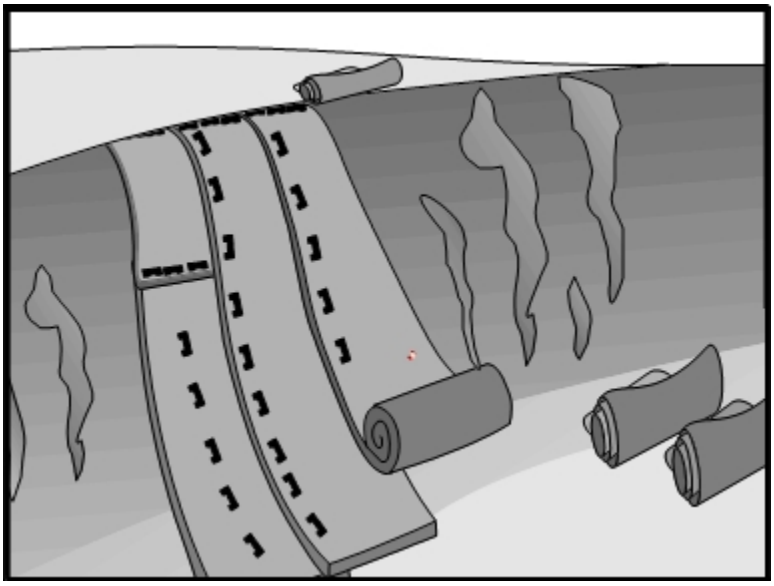
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Properties of Soil Binders for Erosion Control

Evaluation Criteria	Binder Type			
	Plant Material Based (Short Lived)	**Plant Material Based (Long Lived)**	**Polymeric Emulsion Blends**	**Cementitious-Based Binders**
Relative Cost	Low	Low	Low	Low
Resistance to Leaching	High	High	Low to Moderate	Moderate
Resistance to Abrasion	Moderate	Low	Moderate to High	Moderate to High
Longevity	Short to Medium	Medium	Medium to Long	Medium
Minimum Curing Time before Rain	9 to 18 hours	19 to 24 hours	0 to 24 hours	4 to 8 hours
Compatibility with Existing Vegetation	Good	Poor	Poor	Poor
Mode of Degradation	Biodegradable	Biodegradable	Photodegradable/ Chemically Degradable	Photodegradable/ Chemically Degradable
Labor Intensive	No	No	No	No
Specialized Application Equipment	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher
Liquid/Powder	Powder	Liquid	Liquid/Powder	Powder
Surface Crusting	Yes, but dissolves on rewetting	Yes	Yes, but dissolves on rewetting	Yes
Clean Up	Water	Water	Water	Water
Erosion Control Application Rate	Varies (1)	Varies (1)	Varies (1)	4,000 to 12,000 lbs./acre

(1) See Implementation for specific rates.

Geotextiles and Mats EC-7



Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	▲
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-8 Wood Mulching

Description and Purpose

Mattings of natural materials are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matting may be used to stabilize soils until vegetation is established.

Suitable Applications

Mattings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks where moving water at velocities between 3 ft/s and 6 ft/s are likely to wash out new vegetation and in areas where the soil surface is disturbed and where existing vegetation has been removed. Matting may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). Erosion control matting should be considered when the soils are fine grained and potentially erosive. These measures should be considered in the following situations:

- Steep slopes, generally steeper than 3:1 (H:V);
- Slopes where the erosion potential is high;
- Slopes and disturbed soils where mulch should be anchored;
- Disturbed areas where plants are slow to develop;
- Channels with flows exceeding 3.3 ft/s;
- Channels to be vegetated;
- Stockpiles; and
- Slopes adjacent to water bodies of Environmentally Sensitive Areas.

Limitations

- Properly installed mattings provide excellent erosion control but do so at relatively high cost. This high cost typically limits the use of mattings to areas of concentrated channel flow and steep slopes.
- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g. channels, steep slopes).
- Installation is critical and requires experienced contractors. The contractor should install the matting material in such a manner that continuous contact between the material and the soil occurs.
- Geotextiles and mats may delay seed germination, due to reduction in soil temperature.
- Blankets and mats are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).
- Blankets and mats should be removed and disposed of prior to application of permanent soil stabilization measures.
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and should be disposed of at a landfill.
- Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- The use of plastic should be limited to covering stockpiles or very small graded areas for short periods of time (such as through one imminent storm event) until alternative measures, such as seeding and mulching, may be installed.
- Geotextiles, mats, plastic covers, and erosion control covers have maximum flow rate limitations; consult the manufacturer for proper selection.
- Not suitable for areas that have heavy foot traffic (tripping hazard) - e.g., pad areas around buildings under construction.

Implementation

Material Selection

Organic matting materials have been found to be effective where re-vegetation will be provided by re-seeding. The choice of matting should be based on the size of area, side slopes, and surface conditions such as hardness, moisture, weed growth, and availability of materials.

The following natural and synthetic mattings are commonly used:

Plastic Covers

- Plastic sheeting should have a minimum thickness of 6 mils, and should be keyed in at the top of slope and firmly held in place with sandbags or other weights placed no more than 10 ft. apart. Seams are typically taped or weighted down their entire length, and there should be at least a 12 in. to 24 in. overlap of all seams. Edges should be embedded a minimum of 6 in. in soil.
- All sheeting should be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures should be repaired immediately. If washout or breakages occur, the material should be re-installed after repairing the damage to the slope.

Geotextiles

- Material should be a woven polypropylene fabric with minimum thickness of 0.06 in., minimum width of 12 ft. and should have minimum tensile strength of 150 lbs. (warp); 80 lbs. (fill) in conformance with the requirements in ASTM Designation: D4632. The permittivity of the fabric should be approximately 0.07 sEC-0 in conformance with the requirements in ASTM Designation: D4491. The fabric should have an ultraviolet (UV) stability of 70 percent in conformance with the requirements in ASTM designation: D4355. Geotextile blankets must be secured in place with wire staples or sandbags and by keying into tops of slopes to prevent infiltration of surface waters under geotextile. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
- Geotextiles may be reused if they are suitable for the use intended.

Erosion Control Blankets/Mats

- Biodegradable rolled erosion control products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. In order for an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together should also be biodegradable.
  - **Jute** is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
  - **Excelsior** (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 6 in. or longer. The excelsior blanket should be of consistent thickness. The wood fiber should be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and should be non-toxic and non-injurious to plant and animal life. Excelsior blankets should be furnished in rolled strips, a minimum of 48 in. wide, and should have an average weight of 0.8 lb/yd^2, ±10 percent, at the time of manufacture. Excelsior blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
  - **Straw blanket** should be machine produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket. Straw blanket should be furnished in rolled strips a minimum of 6.5 ft. wide, a minimum of 80 ft. long and a minimum of 0.5 lb/yd^2. Straw blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
  - **Wood fiber blanket** is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured to the

ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Coconut fiber blanket** should be a machine produced mat of 100 percent coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket. Coconut fiber blanket should be furnished in rolled strips with a minimum of 6.5 ft. wide, a minimum of 80 ft. long and a minimum of 0.5 lb/yd^2. Coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
- **Coconut fiber mesh** is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- **Straw coconut fiber blanket** should be machine produced mats of 70 percent straw and 30 percent coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket should be furnished in rolled strips a minimum of 6.5 ft. wide, a minimum of 80 ft. long and a minimum of 0.5 lb/yd^2. Straw coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.
  - **Plastic netting** is a lightweight biaxially oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
  - **Plastic mesh** is an open weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than ¼ in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
  - **Synthetic fiber with netting** is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense; three dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be re-vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which

must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Bonded synthetic fibers** consist of a three dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90 percent open area, which facilitates root growth. It's tough root reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- **Combination synthetic and biodegradable RECPs** consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Site Preparation

- Proper site preparation is essential to ensure complete contact of the blanket or matting with the soil.
- Grade and shape the area of installation.
- Remove all rocks, clods, vegetation or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.
- Prepare seedbed by loosening 2 to 3 in. of topsoil.

Seeding

Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all check slots and other areas disturbed during installation should be re-seeded. Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and the remainder after laying the mat. The protective matting can be laid over areas where grass has been planted and the seedlings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Check Slots

Check slots are made of glass fiber strips, excelsior matting strips or tight folded jute matting blanket or strips for use on steep, highly erodible watercourses. The check slots are placed in narrow trenches 6 to 12 in. deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.

Laying and Securing Matting

- Before laying the matting, all check slots should be installed and the friable seedbed made free from clods, rocks, and roots. The surface should be compacted and finished according to the requirements of the manufacturer's recommendations.
- Mechanical or manual lay down equipment should be capable of handling full rolls of fabric and laying the fabric smoothly without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.

Anchoring

- U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets to the ground surface.
- Wire staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
- Metal stake pins should be 0.188 in. diameter steel with a 1.5 in. steel washer at the head of the pin, and 8 in. in length.
- Wire staples and metal stakes should be driven flush to the soil surface.

Installation on Slopes

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the slope and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly;
- Unroll blanket down slope in the direction of water flow;
- Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft.;
- When blankets should be spliced, place blankets end over end (shingle style) with 6 in. overlap. Staple through overlapped area, approximately 12 in. apart;
- Lay blankets loosely and maintain direct contact with the soil. Do not stretch; and
- Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 (H:V) to 2:1 (H:V), require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 (H:V) to 3:1 (H:V), require a minimum of 1 ½ staples/yd^2.

Installation in Channels

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area;
- Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft. intervals along the channels;
- Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 to 3 in. above the crest of the channel side slopes;

- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in. intervals. Note: matting will initially be upside down in anchor trench;
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in;
- Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil;
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap;
- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench;
- Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots;
- Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals;
- Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil;
- Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench;
- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes; and
- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement)

- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes, or brooms for fine grading and touch up.
- Smooth out soil filling just exposing top netting of mat.

Temporary Soil Stabilization Removal

- Temporary soil stabilization removed from the site of the work should be disposed of if necessary.

Costs

Relatively high compared to other BMPs. Biodegradable materials: \$0.50 - \$0.57/yd^2. Permanent materials: \$3.00 - \$4.50/yd^2. Staples: \$0.04 - \$0.05/staple. Approximate costs for installed materials are shown below:

Rolled Erosion Control Products		Installed Cost per Acre
Biodegradable	Jute Mesh	\$6,500
	Curled Wood Fiber	\$10,500
	Straw	\$8,900
	Wood Fiber	\$8,900
	Coconut Fiber	\$13,000
	Coconut Fiber Mesh	\$31,200
	Straw Coconut Fiber	\$10,900
Non-Biodegradable	Plastic Netting	\$2,000
	Plastic Mesh	\$3,200
	Synthetic Fiber with Netting	\$34,800
	Bonded Synthetic Fibers	\$50,000
	Combination with Biodegradable	\$32,000

Source: Caltrans Guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Areas where erosion is evident should be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.
- Make sure matting is uniformly in contact with the soil.
- Check that all the lap joints are secure.
- Check that staples are flush with the ground.
- Check that disturbed areas are seeded.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

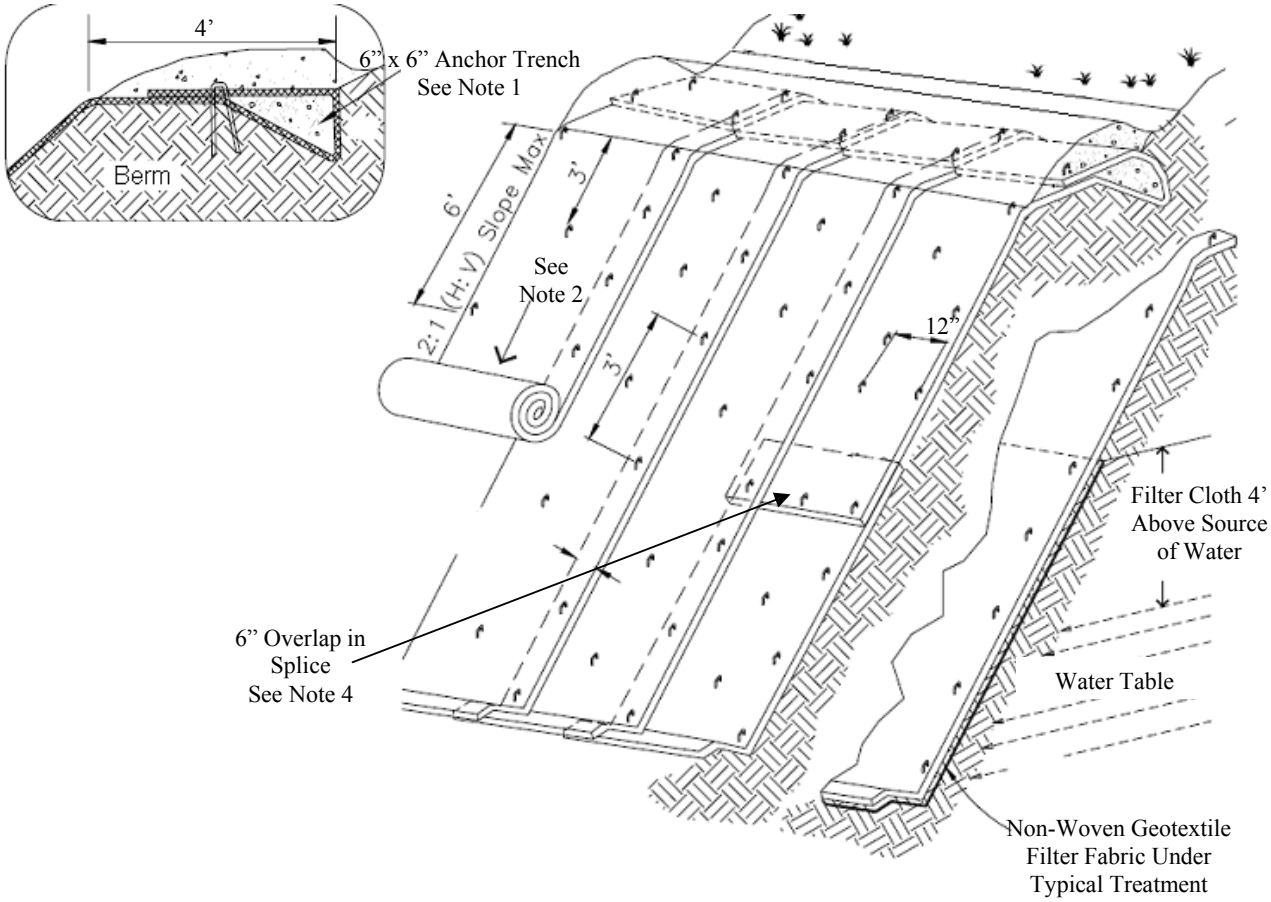
Guides for Erosion and Sediment Controls in California, USDA Soils Conservation Service, January 1991.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



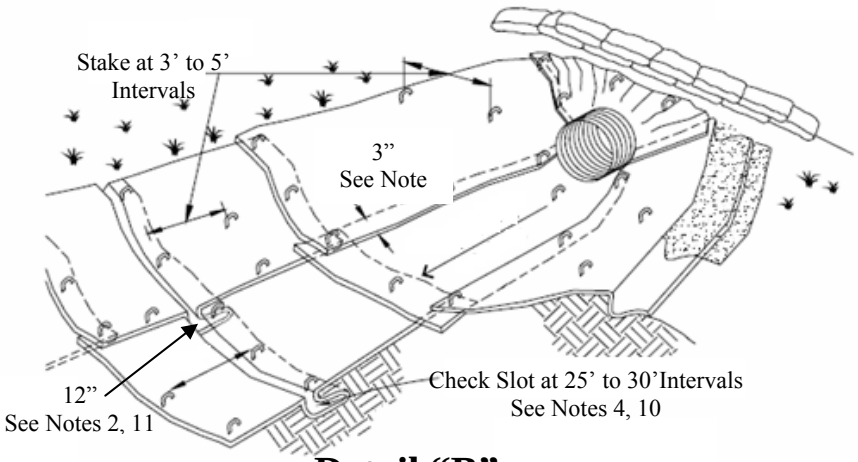
Detail "A"

Not to Scale

Notes:

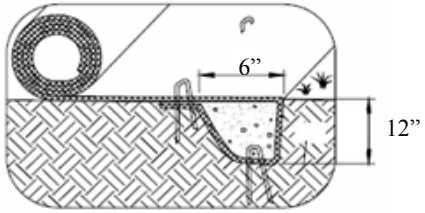
1. Begin at the top of the slope and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly.
2. Unroll blanket down slope in the direction of water flow.
3. Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft.
4. When blankets should be spliced, place blankets end over end (shingle style) with 6 in. overlap. Staple through overlapped area, approximately 12 in. apart.
5. Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
6. Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges.
7. Steep slopes, 1:1 (H:V) to 2:1 (H:V), require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 (H:V) to 3:1 (H:V), require a minimum of 1½ staples/yd^2.
8. Install per manufacturer's recommendations.
9. For Limitations, Geotextiles and Plastic Covers Specifications, Types of Erosion Control Blankets/Mats, and Site Preparations see EC-7.

Typical Slope Soil Stabilization

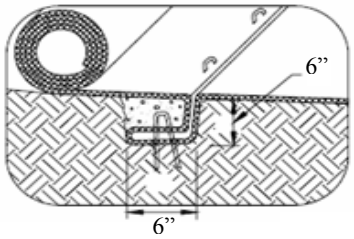


Detail "B"

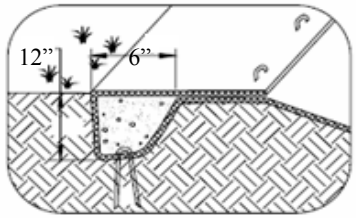
Isometric View, Not to Scale



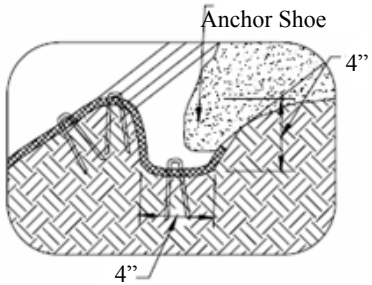
Initial Channel Anchor Trench
Not to Scale
See Note 3



Intermittent Check Slot
Not to Scale



Terminal Slope and Channel Anchor Trench
Not to Scale
See Note 3



Longitudinal Anchor Trench
Not to Scale
See Note 5

Notes:

1. Install per manufacturer's recommendations.
2. Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil.
3. Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area and at terminal slope.
4. Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft intervals along the channels.
5. Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 to 3 in. above the crest of the channel side slopes.
6. Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in. intervals. Note: matting will initially be upside down in anchor trench.
7. In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in.
8. Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap.
9. Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
10. Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots.
11. Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals.
12. Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil.
13. Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench.
14. Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
15. Seed and fill turf reinforcement matting with soil, if specified.
16. For Limitations, Geotextiles and Plastic Covers Specifications, Types of Erosion Control Blankets/Mats, and Site Preparations see EC-7.

Typical Soil Stabilization in Channels

Wood Mulching EC-8

Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	▲
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-7 Geotextiles and Mats

Description and Purpose

Wood mulching consists of applying a mixture of shredded wood mulch, bark or compost to disturbed soils. The primary function of wood mulching is to reduce erosion by protecting bare soil from rainfall impact, increasing infiltration, and reducing runoff.

Suitable Applications

Wood mulching is suitable for disturbed soil areas requiring temporary protection until permanent stabilization is established.

Limitations

- Not suitable for use on slopes steeper than 3:1 (H:V). Best suited to flat areas or gentle slopes or 5:1 (H:V) or flatter.
- Wood mulch and compost may introduce unwanted species.
- Not suitable for areas exposed to concentrated flows. Wood mulch produced from a tub type grinder interlocks with adjacent fibers and the mix is more resistant to concentrated flows compared to wood chips.
- May need to be removed prior to further earthwork.

Implementation

Mulch Selection

There are many types of mulches. Selection of the appropriate type of mulch should be based on the type of application, site conditions, and compatibility with planned or future uses.

Application Procedures

Prior to application, after existing vegetation has been removed, roughen embankment and fill areas by rolling with a device such as a punching type roller or by track walking. The construction application procedures for mulches vary significantly depending upon the type of mulching method specified. Two methods are highlighted here:

- Green Material: This type of mulch is produced by the recycling of vegetation trimmings such as grass, shredded shrubs, and trees. Methods of application are generally by hand although pneumatic methods are available:
  - As a temporary ground cover with or without seeding; and/or
  - Should be evenly distributed on site to a depth of not more than 2 in.
- Shredded Wood: Suitable for ground cover in ornamental or revegetated plantings.
  - Shredded wood/bark is conditionally suitable. See note under limitations;
  - Distribute by hand or use pneumatic methods;
  - Evenly distribute the mulch across the soil surface to a depth of 2 to 3 in; and
  - Sites which will include the demolition of large quantities of trees should consider the use of shredded wood covers as a temporary erosion control measure.
- Avoid mulch placement onto roads, sidewalks, drainage channels, existing vegetation, etc.

Costs

Average annual cost for installation and maintenance (3-4 months useful life) is around $4,000 per acre, but cost can increase if the source is not close to the project site in California. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident should be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.

Regardless of the mulching technique selected, the key consideration in inspection and maintenance is that the mulch needs to last long enough to achieve erosion control objectives. If the mulch is applied as a standalone erosion control method over disturbed areas (without seed), it should last the length of time the site will remain barren or until final re-grading and revegetation.

- Where vegetation is not the ultimate cover, such as ornamental and landscape applications of bark or wood chips, inspection and maintenance should focus on longevity and integrity of the mulch.
- Reapply mulch when bare earth becomes visible.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Controlling Erosion of Construction Sites Agriculture Information Bulletin #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

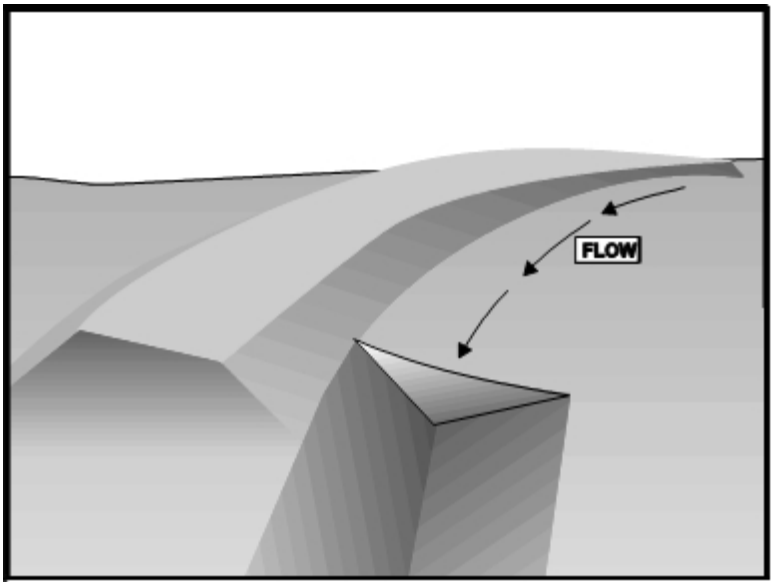
Sedimentation and Erosion Control, An Inventory of Current Practices Draft, U.S. EPA, April 1990.

Soil Erosion by Water Agricultural Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Earth Dikes and Drainage Swales EC-9



Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

An earth dike is a temporary berm or ridge of compacted soil used to divert runoff or channel water to a desired location. A drainage swale is a shaped and sloped depression in the soil surface used to convey runoff to a desired location. Earth dikes and drainage swales are used to divert off site runoff around the construction site, divert runoff from stabilized areas and disturbed areas, and direct runoff into sediment basins or traps.

Suitable Applications

Earth dikes and drainage swales are suitable for use, individually or together, where runoff needs to be diverted from one area and conveyed to another.

- Earth dikes and drainage swales may be used:
  - To convey surface runoff down sloping land;
  - To intercept and divert runoff to avoid sheet flow over sloped surfaces;
  - To divert and direct runoff towards a stabilized watercourse, drainage pipe or channel;
  - To intercept runoff from paved surfaces;
  - Below steep grades where runoff begins to concentrate;
  - Along roadways and facility improvements subject to flood drainage;
  - At the top of slopes to divert runon from adjacent or undisturbed slopes;

- At bottom and mid slope locations to intercept sheet flow and convey concentrated flows; and
- Divert sediment laden runoff into sediment basins or traps.

Limitations

Dikes should not be used for drainage areas greater than 10 acres or along slopes greater than 10 percent. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with City municipal requirements.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes should be stabilized immediately, which adds cost and maintenance concerns.
- Diverted storm water may cause downstream flood damage.
- Dikes should not be constructed of soils that may be easily eroded.
- Regrading the site to remove the dike may add additional cost.
- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drains and swales should conform to City floodplain management requirements.
- Earth dikes/drainage swales are not suitable as sediment trapping devices.
- It may be necessary to use other soil stabilization and sediment controls such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales, and ditches.

Implementation

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert storm water to a sediment trapping device or a stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off site and from undisturbed areas away from disturbed areas and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff. A dike prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversion dikes should not adversely impact adjacent properties and should conform to City floodplain management regulations, and should not be used in areas with slopes steeper than 10%.

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike at the top of a slope can divert runoff to a location where it can be brought to the bottom of the slope (see EC-11, Slope Drains). A combination dike and swale is easily constructed by a single pass of a bulldozer or grader and compacted by a second pass of the tracks or wheels over the ridge. Diversion structures should be installed when the site is initially graded and remain in place until post construction BMPs are installed and the slopes are stabilized.

Diversion practices concentrate surface runoff, increasing its velocity and erosive force. Thus, the flow out of the drain or swale should be directed onto a stabilized area or into a grade

stabilization structure. If significant erosion will occur, a swale should be stabilized using vegetation, chemical treatment, rock rip-rap, matting, or other physical means of stabilization. Any drain or swale that conveys sediment laden runoff should be diverted into a sediment basin or trap before it is discharged from the site.

General

- Care should be applied to correctly size and locate earth dikes, drainage swales. Excessively steep unlined dikes and swales are subject to erosion and gully formation.
- Conveyances should be stabilized.
- Use a lined ditch for high flow velocities.
- Select flow velocity based on careful evaluation of the risks due to erosion of the measure, soil types, overtopping, flow backups, washout, and drainage flow patterns for each project site.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff onto other property without securing written authorization from the property owner.
- When possible, install and utilize permanent dikes, swales, and ditches early in the construction process.
- Provide stabilized outlets.

Earth Dikes

Temporary earth dikes are a practical, inexpensive BMP used to divert storm water runoff. Temporary diversion dikes should be installed in the following manner:

- All dikes should be compacted by earth moving equipment;
- All dikes should have positive drainage to an outlet;
- All dikes should have 2:1 or flatter side slopes, 18 in. minimum height, and a minimum top width of 24 in. Wide top widths and flat slopes are usually needed at crossings for construction traffic;
- The outlet from the earth dike should function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a Sediment Trap (SE-3) or Sediment Basin (SE-2) when either the dike channel or the drainage area above the dike are not adequately stabilized;
- Temporary stabilization may be achieved using seed and mulching for slopes less than 5% and either rip-rap or sod for slopes in excess of 5%. In either case, stabilization of the earth dike should be completed immediately after construction or prior to the first rain;
- If riprap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

Channel Grade	Riprap Stabilization
0.5-1.0%	4 in. Rock
1.1-2.0%	6 in. Rock
2.1-4.0%	8 in. Rock
4.1-5.0%	8 in. – 12 in. Rock

- The stone riprap, recycled concrete, etc. used for stabilization should be pressed into the soil with construction equipment;
- Filter cloth may be used to cover dikes in use for long periods; and
- Construction activity on the earth dike should be kept to a minimum.

Drainage Swales

Drainage swales are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost effective diversion.

Standard engineering design criteria for small open channel and closed conveyance systems should be used (see the City drainage design manual). Unless City drainage design criteria state otherwise, drainage swales should be designed as follows:

- No more than 5 acres may drain to a temporary drainage swale;
- Place drainage swales above or below, not on, a cut or fill slope;
- Swale bottom width should be at least 2 ft.;
- Depth of the swale should be at least 18 in.;
- Side slopes should be 2:1 or flatter;
- Drainage or swales should be laid at a grade of at least 1 percent, but not more than 15 percent;
- The on-site swale should not be overtopped by the peak discharge from a 10-year storm with 1-hour duration, irrespective of the design criteria stated above;
- Offsite diversion swale should not be overtopped by the offsite peak discharge from a 10-year storm with 1-hour duration, irrespective of the design criteria stated above. Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built;
- Compact any fill material along the path of the swale;
- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent. For temporary swales, geotextiles and mats (EC-7) may provide immediate stabilization;
- Irrigation may be required to establish sufficient vegetation to prevent erosion;
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided;
- Permanent drainage facilities should be designed by a professional engineer (see the City drainage design criteria for proper design);
- At a minimum, the drainage swale should conform to predevelopment drainage patterns and capacities;
- Construct the drainage swale with a positive grade to a stabilized outlet; and
- Provide erosion protection or energy dissipation measures if the flow out of the drainage swale can reach an erosive velocity. Consider using protective lining such as vegetation, geotextile filter fabric, rip rap, or concrete lining.

Costs

- Cost in California ranges from $15 to $55 per ft. for both earthwork and stabilization and depends on availability of material, site location, and access.
- Small dikes: $2.50 - $6.50/linear ft. Large dikes: $2.50/yd^3.
- The cost of a drainage swale increases with drainage area and slope. Typical swales for controlling internal erosion are inexpensive, as they are quickly formed during routine earthwork. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed.
- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Association of Home Builders (NAHB). Stormwater Runoff & Nonpoint Source Pollution Control Guide for Builders and Developers. National Association of Home Builders, Washington, D.C., 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

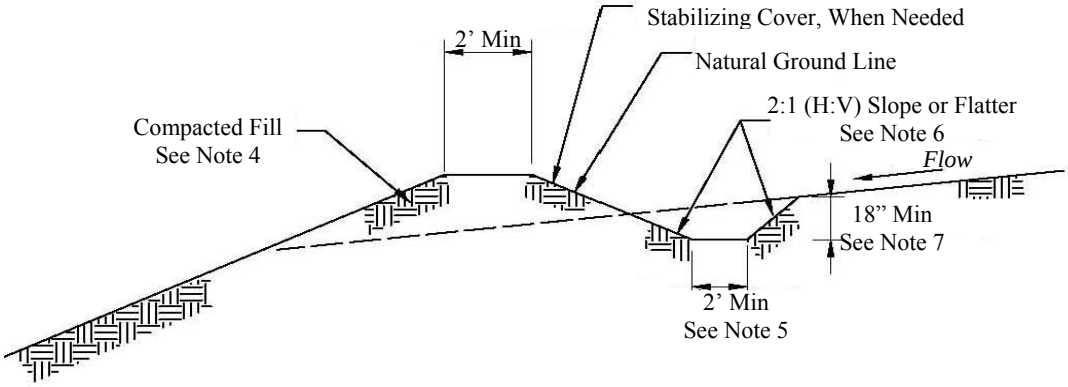
Rules Relating to Storm Drainage Standard, Department of Planning & Permitting, City & County of Honolulu, January 2000 (or revisions thereafter).

Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI, 1991.

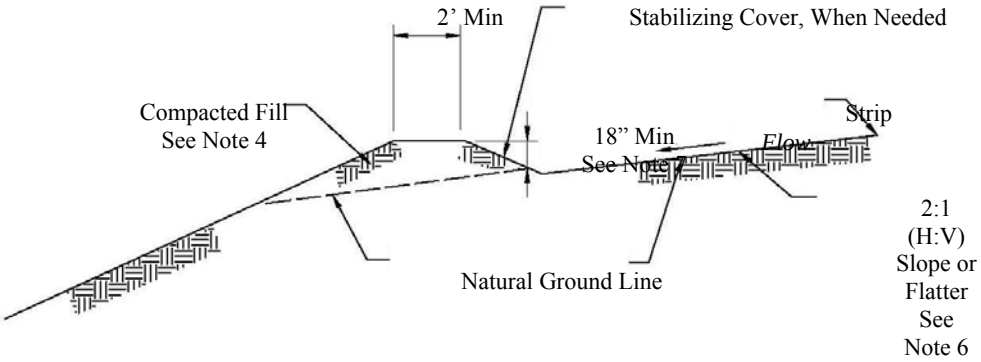
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



Drainage Swale Section "A"



Earth Dike Section "B"

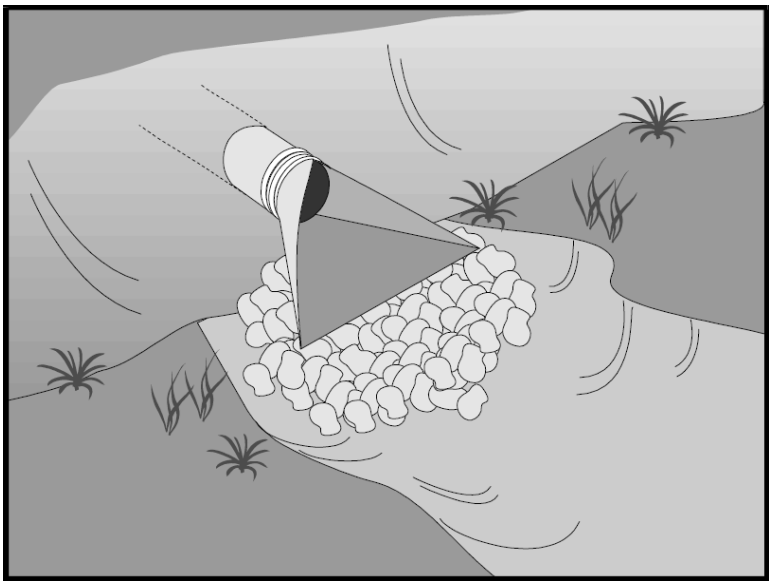
Notes:

1. Place drainage swales above or below, not on, a cut or fill slope.
2. Drainage or swales should be laid at a grade of at least 1 percent, but not more than 15 percent.
3. Remove all trees, stumps, obstructions, and other objectionable material from the swale.
4. Fill material along the path of the swale should be compacted to at least 90% compaction.
5. Swale top and bottom width should be at least 2 ft.
6. Side slopes should be 2:1 or flatter.
7. Depth of the swale should be at least 18 in.
8. Construct the drainage swale with a positive grade to a stabilized outlet.
9. Use a lined ditch for high flow velocities.
10. Temporary stabilization may be achieved using seed and mulching for slopes less than 5% and either rip-rap or sod for slopes in excess of 5%.
11. If rip-rap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

Channel Grade	Riprap Stabilization
0.5-1.0%	4 in. Rock
1.1-2.0%	6 in. Rock
2.1-4.0%	8 in. Rock
4.1-5.0%	8 in. – 12 in. Rock

Drainage Swale and Earth Dike

Velocity Dissipation Devices EC-10



Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble, which is placed at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows.

Suitable Applications

Whenever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This includes temporary diversion structures to divert runon during construction.

- These devices may be used at the following locations:
  - Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels;
  - Outlets located at the bottom of mild to steep slopes;
  - Discharge outlets that carry continuous flows of water;
  - Outlets subject to short, intense flows of water, such as flash floods; and
  - Points where lined conveyances discharge to unlined conveyances

Limitations

- Large storms or high flows can wash away the rock outlet protection and leave the area susceptible to erosion.
- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.

- Outlet protection may negatively impact the channel habitat.
- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause the grouted riprap to break up due to the resulting hydrostatic pressure.

Implementation

General

Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the outlet from developing small eroded pools (plunge pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Design and Layout

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate, and velocity should be considered in the outlet design. Compliance to city and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat are shown in the rock outlet protection figure in this BMP and should be considered minimum. The apron length and rock size gradation are determined using a combination of the discharge pipe diameter and estimate discharge rate: Select the longest apron length and largest rock size suggested by the pipe size and discharge rate. Where flows are conveyed in open channels such as ditches and swales, use the estimated discharge rate for selecting the apron length and rock size. Flows should be same as the culvert or channel design flow but never the less than the peak 10-year, 1-hour duration peak flow for temporary structures.

- There are many types of energy dissipaters, with rock being the one that is represented in the attached figure.
- Best results are obtained when sound, durable, and angular rock is used.
- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction. Grouted or wired tied rock riprap can minimize maintenance requirements.
- Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. It also serves to trap sediment and reduce flow velocities.
- Carefully place riprap to avoid damaging the filter fabric.
    - Stone 4 in. to 6 in. may be carefully dumped onto filter fabric from a height not to exceed 12 in.
    - Stone 8 in. to 12 in. should be hand placed onto filter fabric, or the filter fabric may be covered with 4 in. of gravel and the 8 in. to 12 in. rock may be dumped from a height not to exceed 16 in.
    - Stone greater than 12 in. should only be dumped onto filter fabric protected with a layer of gravel with a thickness equal to one half the D50 rock size, and the dump height limited to twice the depth of the gravel protection layer thickness.

- For proper operation of apron: Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in upper section of apron.
- Outlets on slopes steeper than 10 percent should have additional protection.

Costs

Costs are low if material is readily available. If material is imported, costs will be higher. Average installed cost is $150 per device in California. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subjected to non-storm water discharges daily while non-storm water discharges occur.
- Inspect apron for displacement of the riprap and damage to the underlying fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material.
- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.
- Temporary devices should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

County of Sacramento Improvement Standards, Sacramento County, May 1989.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursztynsky, P.E., McGraw Hill Book Company, 1986.

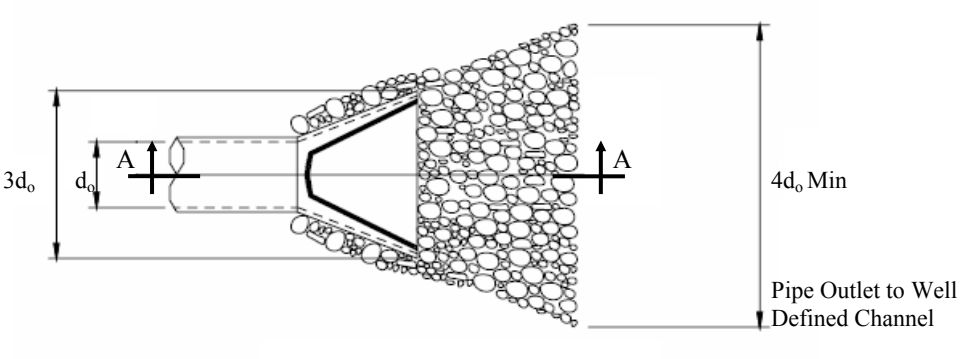
Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

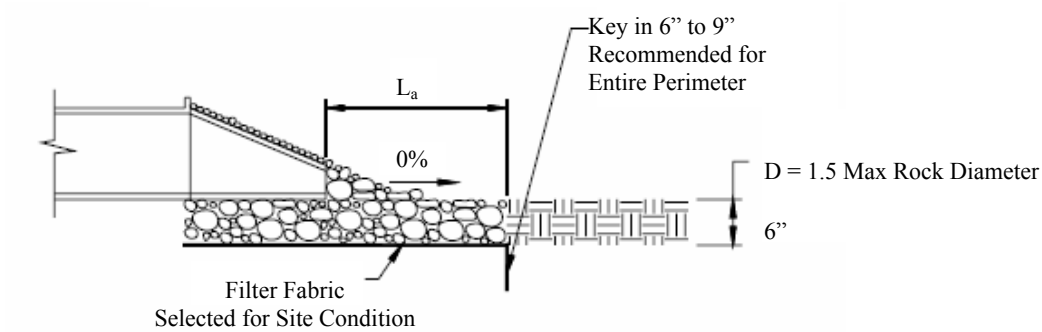
Rules Relating to Storm Drainage Standard, Department of Planning & Permitting, City & County of Honolulu, January 2000 (or revisions thereafter).

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



Plan"A"



Section A-A

Notes:

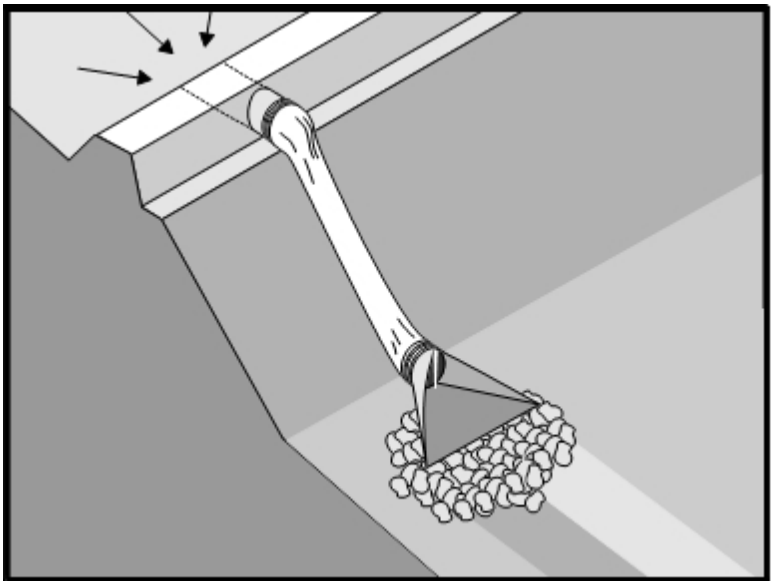
1. The apron length and rock size gradation are determined using the table above.
2. Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction. Grouted or wired tied rock riprap can minimize maintenance requirements.
3. Carefully place riprap to avoid damaging the filter fabric.
   a. Stone 4 in. to 6 in. may be carefully dumped onto filter fabric from a height not to exceed 12 in.
   b. Stone 8 in. to 12 in. should be hand placed onto filter fabric, or the filter fabric may be covered with 4 in. of gravel and the 8 in. to 12 in. rock may be dumped from a height not to exceed 16 in.
   c. Stone greater than 12 in. should only be dumped onto filter fabric protected with a layer of gravel with a thickness equal to one half the D50 rock size, and the dump height limited to twice the depth of the gravel protection layer thickness.
4. Outlets on slopes steeper than 10 percent should have additional protection.
5. Design should comply with city and state regulations.

Pipe Diameter, do (inches)	Discharge (ft^3/s)	Apron Length, La (ft)	Rip Rap D50 Diameter Min (inches)
12	5	10	4
	10	13	6
18	10	10	6
	20	16	8
	30	23	12
	40	26	16
24	30	16	8
	40	26	8
	50	26	12
	60	30	16

For larger or higher flows consult a Licensed Civil Engineer

Source: USDA- SCS

Slope Drains EC-11



Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-9 Earth Dike, Drainage Swales

Description and Purpose

A slope drain is a pipe used to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device, or stabilized area. Slope drains are used with earth dikes and drainage ditches to intercept and direct surface flow away from slope areas to protect cut or fill slopes.

Suitable Applications

- Where concentrated flow of surface runoff should be conveyed down a slope in order to prevent erosion.
- Drainage for top of slope diversion dikes or swales.
- Drainage for top of cut and fill slopes where water can accumulate.
- Emergency spillway for a sediment basin.

Limitations

Installation is critical for effective use of the pipe slope drain to minimize potential gully erosion.

- Recommendations given here are for temporary slope drains and not post construction. Check with other design guidance if post construction slope drains are to be installed.
- Maximum drainage area per slope drain is 10 acres. (For large areas use a paved chute, rock lined channel, or additional pipes).
- Severe erosion may result when slope drains fail by overtopping, piping, or pipe separation.

- During large storms, pipe slope drains may become clogged or over charged, forcing water around the pipe and causing extreme slope erosion.
- If the sectional downdrain is not sized correctly, the runoff can spill over the drain sides causing gully erosion and potential failure of the structure.

- Dissipation of high flow velocities at the pipe outlet is required to avoid downstream erosion.

Implementation

General

The slope drain is applicable for any construction site where concentrated surface runoff can accumulate and should be conveyed down the slope in order to prevent erosion. The slope drain is effective because it prevents the storm water from flowing directly down the slope by confining all the runoff into an enclosed pipe or channel. Due to the time lag between grading slopes and installation of permanent storm water collection systems and slope stabilization measures, temporary provisions to intercept runoff are sometimes necessary. Particularly in steep terrain, slope drains can protect unstabilized areas from erosion.

Installation

The slope drain may be a rigid pipe, such as corrugated metal, a flexible conduit, or a lined terrace drain with the inlet placed on the top of a slope and the outlet at the bottom of the slope. This BMP typically is used in combination with a diversion control, such as an earth dike or drainage swale at the top of the slope.

The following criteria should be considered when silting slope drains.

- Permanent structures included in the project plans can often serve as construction BMPs if implemented early. However, the permanent structure should meet or exceed the criteria for the temporary structure;
- Inlet structures should be securely entrenched and compacted to avoid severe gully erosion;
- Slope drains should be securely anchored to the slope and should be adequately sized to carry the capacity of the design storm and associated forces;
- Outlets should be stabilized with riprap, concrete or other type of energy dissipater, or directed into a stable sediment trap or basin. See EC-01, Velocity Dissipation Devices;
- Debris racks are recommended at the inlet. Debris racks located several feet upstream of the inlet can usually be larger than racks at the inlet, and thus provide enhanced debris protection and less plugging;
- Safety racks are also recommended at the inlet and outlet of pipes where children or animals could become entrapped;
- Secure inlet and surround with dikes to prevent gully erosion and anchor pipe to slope;
- When using slope drains, limit drainage area to 10 acres per pipe. For larger areas, use a rock lined channel or a series of pipes;
- Maximum slope generally limited to 2:1 (H:V) as energy dissipation below steeper slopes is difficult;

- Direct surface runoff to slope drains with interceptor dikes. See BMP EC-00, Earth Dikes and Drainage Swales. Top of interceptor dikes should be 12 in. higher than the top of the slope drain;
- Slope drains can be placed on or buried underneath the slope surface;
- Recommended materials include both metal and plastic pipe, either corrugated or smooth wall. Concrete pipe can also be used; and
- When installing slope drains:
  - Install slope drains perpendicular to slope contours;
  - Compact soil around and under entrance, outlet, and along length of pipe;
  - Securely anchor and stabilize pipe and appurtenances into soil;
  - Check to ensure that pipe connections are watertight;
  - Protect area around inlet with filter cloth. Protect outlet with riprap or other energy dissipation device. For high energy discharges, reinforce riprap with concrete or use reinforced concrete device;
  - Protect outlet of slope drains using a flared end section when outlet discharges to a flexible energy dissipation device; and
  - A flared end section installed at the inlet will improve flow into the slope drain and prevent erosion at the pipe entrance. Use a flared end section with a 6 in. minimum toe plate to help prevent undercutting. The flared section should slope towards the pipe inlet.

Design and Layout

The capacity for temporary drains intercepting offsite or on-site runoff should be sufficient to convey at least the peak runoff from a 10-year, 1-hour duration rainfall event. The pipe size may be computed using the Rational Method or alternate methods accepted by the City and County of Honolulu. Higher flows should be safely stored or routed to prevent any offsite concentration of flow and any erosion of the slope. The design storm is purposely conservative due to the potential impacts associated with system failures.

As a guide, temporary pipe slope drains should not be sized smaller than shown in the following table:

Minimum Pipe Diameter (Inches)	Maximum Drainage Area (Acres)
12	1.0
18	3.0
21	5.0
24	7.0
30	10.0

Larger drainage areas can be treated if the area can be subdivided into areas of 10 acres or less and each area is treated as a separate drainage. Drainage areas exceeding 10 acres should be designed by a Licensed Civil Engineer and approved by the agency that issued the grading permit.

Materials

Soil type, rainfall patterns, construction schedule, site requirements, and available supply are some of the factors to be considered when selecting materials. The following types of slope drains are commonly used:

- **Rigid Pipe:** This type of slope drain is also known as a pipe drop. The pipe usually consists of corrugated metal pipe or rigid plastic pipe. The pipe is placed on undisturbed or compacted soil and secured onto the slope surface or buried in a trench. Concrete thrust blocks should be used when warranted by the calculated thrust forces. Collars should be properly installed and secured with metal strappings or watertight collars;
- **Flexible Pipe:** The flexible pipe slope drain consists of a flexible tube of heavy-duty plastic, rubber, or composite material. The tube material is securely anchored onto the slope surface. The tube should be securely fastened to the metal inlet and outlet conduit sections with metal strappings or watertight collars;
- **Section Downdrains:** The section downdrain consists of pre-fabricated, section conduit of half round or third round material. The sectional downdrain performs similar to a flume or chute. The pipe should be placed on undisturbed or compacted soil and secured into the slope; and
- **Concrete-lined Terrace Drain:** This is a concrete channel for draining water from a terrace on a slope to the next level. These drains are typically specified as permanent structures and, if installed early, can serve as slope drains during construction, which should be designed according to the City and County of Honolulu's drainage design criteria.

Costs

Cost varies based on pipe selection and selected outlet protection in California. Note that Hawaii's unit prices are higher than California's unit prices.

Temporary Slope Drains

Corrugated Steel Pipes, Per Foot	
Size	**Supplied and Installed Cost (No Trenching Included)**
12"	$19.60 per LF
15"	$22.00
18"	$26.00
24"	$32.00
30"	$50.00
PVC Pipes, Per Foot	
Size	**Supplied and Installed Cost (No Trenching Included)**
12"	$24.50
14"	$49.00
16"	$51.00
18"	$54.00
20"	$66.00
24"	$93.00
30"	$130.00

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, at two-week intervals during the non-rainy season, or as required by State or City and County representatives.
- Inspect BMPs subjected to non-storm water discharges daily while non-storm water discharges occur.
- Inspect outlet for erosion and downstream scour. If eroded, repair damage and install additional energy dissipation measures. If downstream scour is occurring, it may be necessary to reduce flows being discharged into the channel unless other preventative measures are implemented.
- Insert inlet for clogging or undercutting. Remove debris from inlet to maintain flows. Repair undercutting at inlet and if needed, install flared section or rip rap around the inlet to prevent further undercutting.
- Inspect pipes for leakage. Repair leaks and restore damaged slopes.
- Inspect slope drainage for accumulations of debris and sediment.
- Remove built up sediment from entrances and outlets as required. Flush drains if necessary; capture and settle out sediment from discharge.
- Make sure water is not ponding onto inappropriate areas (e.g., active traffic lanes, material storage areas, etc.).
- Pipe anchors should be checked to ensure that the pipe remains anchored to the slope. Install additional anchors if pipe movement is detected.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Draft – Sedimentation and Erosion Control, An Inventory of Current Practices, U.S.E.P.A., April 1990.

National Association of Home Builders (NAHB). Stormwater Runoff & Nonpoint Source Pollution Control Guide for Builders and Developers. National Association of Home Builders, Washington, D.C., 1995.

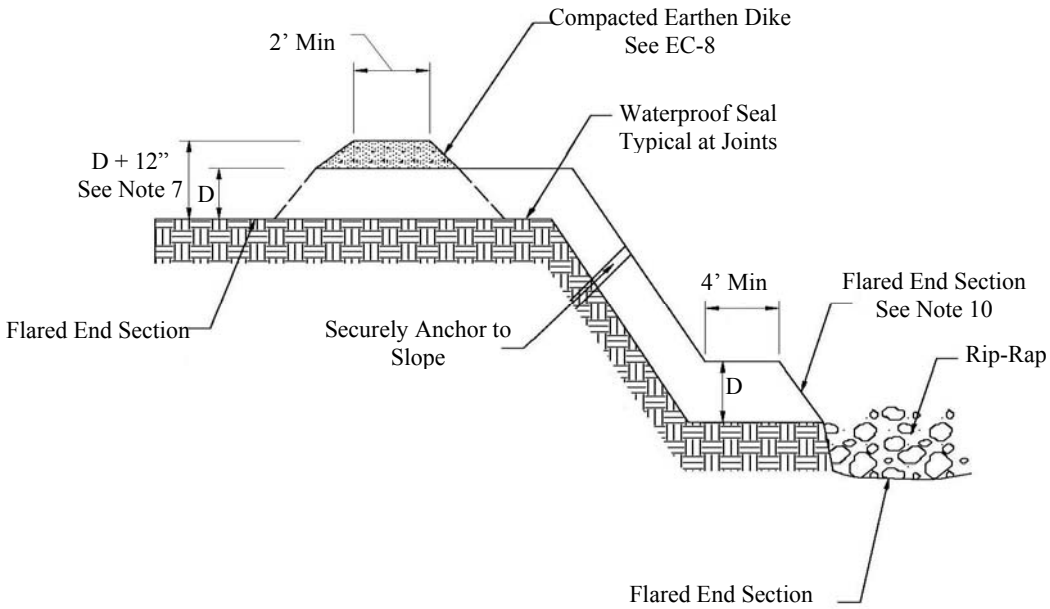
National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Rules Relating to Storm Drainage Standard, Department of Planning & Permitting, City & County of Honolulu, January 2000 (or revisions thereafter).

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



Section "A"

Notes:
1. Install slope drains perpendicular to slope contours.
2. Slope drains can be placed on or buried underneath the slope surface.
3. Compact soil around and under entrance, outlet, and along length of pipe.
4. Securely anchor and stabilize pipe and appurtenances into soil.
5. Check to ensure that pipe connections are watertight.
6. Protect area around inlet with filter cloth.
7. Top of interceptor dikes should be 12 in. higher than the top of the slope drain.
8. Maximum slope generally limited to 2:1 (H:V).
9. Direct surface runoff to slope drains with interceptor dikes. See BMP EC-00, Earth Dikes and Drainage Swales.
10. Protect outlet of slope drains using a flared end section when outlet discharges to a flexible energy dissipation device. The flared section should slope towards the pipe inlet.
11. The pipe size may be computed using the Rational Method or alternate methods accepted by the City and County of Honolulu.

As a guide, temporary pipe slope drains should not be sized smaller than shown in the following table:

Minimum Pipe Diameter, D (Inches)	Maximum Drainage Area (Acres)
12	1.0
18	3.0
21	5.0
24	7.0
30	10.0

12. Recommended materials include both metal and plastic pipe, either corrugated or smooth wall. Concrete pipe can also be used.

Typical Slope Drain

Streambank Stabilization EC-12

Objectives

EC – Erosion Control	√
SE – Sediment Control	▲
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	▲
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

Combination of erosion and sediment controls.

Description and Purpose

Stream channels, streambanks, and associated riparian areas are dynamic and sensitive ecosystems that respond to changes in land use activity. Streambank and channel disturbance resulting from construction activities can increase the stream's sediment load, which can cause channel erosion or sedimentation and have adverse affects on the biotic system. BMPs can reduce the discharge of sediment and other pollutants to minimize the impact of construction activities on watercourses. Streams on the 303(d) list and listed for sediment may require numerous measures to prevent any increases in sediment load to the stream.

Suitable Applications

These procedures typically apply to all construction projects that disturb or occur within stream channels and their associated riparian areas.

Limitations

Specific permit requirements or mitigation measures such as U.S. Army Corps of Engineers 404 permit, City and County of Honolulu Department of Planning and Permitting (DPP), State of Hawaii Department of Land and Natural Resources (DLNR) Commission on Water Resource Management (CWRM) Stream Channel Alteration Permit (SCAP), and approval by Department of Health (DOH) Clean Water Branch (CWB) supersede the guidance in this BMP.

- If numerical based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required. Streams listed as 303(d) impaired for sediment, silt, or turbidity, are required to conduct sampling to verify that there is no net increase in sediment load due to construction activities.

Implementation

- For instream work, a Clean Water Act Section 401 Water Quality Certification Permit is required by the State Department of Health (HAR 11-54 Water Quality Standards), and Section 404 permit (33 United States Doc 1344) is required by the US Army Corps of Engineers.
- For state stream alteration, as opposed to maintenance/repair of a state stream, the Department of Land and Natural Resources Stream Channel Alteration Permit is required (HAR 13-168 Water Use, Wells, and Stream Diversion Works; and HAR 13-169 Protection of Instream Uses of Water).
- The City's Grading Permit is required for grubbing over 15,000 square feet, cut 50 cubic yards, or fill over 50 cubic yards (ROH 14-13.5 Exclusions).

Planning

- Proper planning, design, and construction techniques can minimize impacts normally associated within stream construction activities. Poor planning can adversely affect soil, fish, wildlife resources, land uses, or land users. Planning should take into account: scheduling; avoidance of in-stream construction; minimizing disturbance area and construction time period; using pre-disturbed areas; selecting crossing location; and selecting equipment.

Scheduling

- Construction activities should be scheduled according to the relative sensitivity of the environmental concerns and in accordance with EC-1, Scheduling. Scheduling considerations will be different when working near perennial streams vs. ephemeral streams and are as follows.
- When working in or near ephemeral streams, work should be performed during the dry season. By their very nature, ephemeral streams are usually dry in the summer, and therefore, in-stream construction activities will not cause significant water quality problems. However, when tying up the site at the end of the project, wash any fines (see Washing Fines) that accumulated in the channel back into the bed material, to decrease pollution from the first rainstorm of the season.
- When working near ephemeral or perennial streams, erosion and sediment controls (see silt fences, straw bale barriers, etc.) should be implemented to keep sediment out of stream channel.

Minimize Disturbance

- Minimize disturbance through: selection of the narrowest crossing location; limiting the number of equipment trips across a stream during construction; and, minimizing the number and size of work areas (equipment staging areas and spoil storage areas). Place work areas away from stream channel. Field reconnaissance should be conducted during the planning stage to identify work areas.

Use of Pre-Disturbed Areas

- Locate project sites and work areas in areas disturbed by prior construction or other activity when possible.

Selection of Project Site

- Avoid steep and unstable banks, highly erodible or saturated soils, or highly fractured rock.
- Select project site that minimizes disturbance to aquatic species or habitat.

Equipment Selection

- Select equipment that reduces the amount of pressure exerted on the ground surface, and therefore, reduces erosion potential and/or use overhead or aerial access for transporting equipment across drainage channels. Use equipment that exerts ground pressures of less than 5 or 6 lb/in2, where possible. Low ground pressure equipment includes: wide or high flotation tires (34 to 72 in. wide); dual tires; bogie axle systems; tracked machines; lightweight equipment; and, central tire inflation systems.

Streambank Stabilization

Preservation of Existing Vegetation

- Preserve existing vegetation in accordance with EC-2, Preservation of Existing Vegetation. In a streambank environment, preservation of existing vegetation provides the following benefits.

Water Quality Protection

- Vegetated buffers on slopes trap sediment and promote groundwater recharge. The buffer width needed to maintain water quality ranges from 15 to 100 ft. On gradual slopes, most of the filtering occurs within the first 30 ft. Steeper slopes require a greater width of vegetative buffer to provide water quality benefits.

Streambank Stabilization

- The root system of riparian vegetation stabilizes streambanks by increasing tensile strength in the soil. The presence of vegetation modifies the moisture condition of slopes (infiltration, evapo-transpiration, interception) and increases bank stability.

Riparian Habitat

- Buffers of diverse riparian vegetation provide food and shelter for riparian and aquatic organisms. Minimizing impacts to fisheries habitat is a major concern when working near streams. Riparian vegetation provides shade, shelter, organic matter (leaf detritus and large woody debris), and other nutrients that are necessary for fish and other aquatic organisms. Buffer widths for habitat concerns are typically wider than those recommended for water quality concerns (100 to 1500 ft.).
- When working near watercourses, it is important to understand the work site's placement in the watershed. Riparian vegetation in headwater streams has a greater impact on overall water quality than vegetation in downstream reaches. Preserving existing vegetation upstream is necessary to maintain water quality, minimize bank failure, and maximize riparian habitat, downstream of the work site.

Limitations

- City ordinances regarding width, extent and type of vegetative buffer required may exceed the specifications provided here; these ordinances should be investigated prior to construction.

Streambank Stabilization Specific Installation

- As a general rule, the width of a buffer strip between a road and the stream is recommended to be 50 ft. plus four times the percent slope of the land, measured between the road and the top of stream bank.

Hydraulic Mulch

- Apply hydraulic mulch on disturbed streambanks above mean high water level in accordance with EC-3, Hydraulic Mulch to provide temporary soil stabilization.

Limitations

- Do not place hydraulic mulch or tackifiers below the mean high water level, as these materials could wash into the channel and impact water quality or possibly cause eutrophication (eutrophication is an algal bloom caused by excessively high nutrient levels in the water).

Hydroseeding

- Hydroseed disturbed streambanks in accordance with EC-4, Hydroseeding.

Limitations

- Do not place tackifiers or fertilizers below the mean high water level, as these materials could wash into the channel and impact water quality or possibly cause eutrophication.

Soil Binders

- Apply soil binders to disturbed streambanks in accordance with EC-5, Soil Binders.

Limitations

- Do not place soil binders below the mean high water level. Soil binder should be environmentally benign and non-toxic to aquatic organisms.

Geotextiles and Mats

- Install geotextiles and mats as described in EC-7, Geotextiles and Mats, to stabilize disturbed channels and streambanks. Not all applications should be in the channel, for example, certain geotextile netting may snag fish gills and are not appropriate in fish bearing streams. Geotextile fabrics that are not biodegradable are not appropriate for in stream use. Additionally, geotextile fabric or blankets placed in channels should be adequate to sustain anticipated hydraulic forces.

Earth Dikes, Drainage Swales, and Lined Ditches

- Convey, intercept, or divert runoff from disturbed streambanks using EC-9, Earth Dikes and Drainage Swales.

Limitations

- Do not place earth dikes in watercourses, as these structures are only suited for intercepting sheet flow, and should not be used to intercept concentrated flow.
- Appropriately sized velocity dissipation devices (EC-10) should be placed at outlets to minimize erosion and scour.

Velocity Dissipation Devices

- Place velocity dissipation devices at outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits or channels in accordance with EC-10, Velocity Dissipation Devices.

Slope Drains

- Use slope drains to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device or stabilized area in accordance with EC-11, Slope Drains.

Limitations

- Appropriately sized outlet protection and velocity dissipation devices (EC-10) should be placed at outlets to minimize erosion and scour.

Streambank Sediment Control

Silt Fences

- Install silt fences in accordance with SE-1, Silt Fence, to control sediment. Silt fences should only be installed where sediment laden water can pond, thus allowing the sediment to settle out.

Fiber Rolls

- Install fiber rolls in accordance with SE-5, Fiber Rolls, along contour of slopes above the high water level to intercept runoff, reduce flow velocity, release the runoff as sheet flow and provide removal of sediment from the runoff. In a stream environment, fiber rolls should be used in conjunction with other sediment control methods such as SE-1 Silt Fence. Install silt fence, or other erosion control method along toe of slope above the high water level.

Gravel Bag Berm

- A gravel bag berm or barrier can be utilized to intercept and slow the flow of sediment laden sheet flow runoff in accordance with SE-6, Gravel Bag Berm. In a stream environment gravel bag barriers can allow sediment to settle from runoff before water leaves the construction site and can be used to isolate the work area from the live stream.

Limitations

- Gravel bag barriers are not recommended as a perimeter sediment control practice around streams.

Rock Filter

Description and Purpose

- Rock filters are temporary erosion control barriers composed of rock that is anchored in place. Rock filters detain the sediment laden runoff, retain the sediment, and release the water as sheet flow at a reduced velocity. Typical rock filter installations are illustrated at the end of this BMP.

Applications

- Near the toe of slopes that may be subject to flow and rill erosion.

Limitations

- Inappropriate for contributing drainage areas greater than 5 acres.
- Requires sufficient space for ponded water.
- Ineffective for diverting runoff because filters allow water to slowly seep through.
- Rock filter berms are difficult to remove when construction is complete.
- Unsuitable in developed areas or locations where aesthetics is a concern.

Specifications

- Rock: open graded rock, 0.75 to 5 in. for concentrated flow applications.
- Woven wire sheathing: 1 in. diameter, hexagonal mesh, galvanized 20 gauge (used with rock filters in areas of concentrated flow).
- In construction traffic areas, maximum rock berm heights should be 12 in. Berms should be constructed every 300 ft. on slopes less than 5%, every 200 ft. on slopes between 5% and 10%, and every 100 ft. on slopes greater than 10%.

Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Reshape berms as needed and replace lost or dislodged rock, and filter fabric.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.

K-rail

Description and Purpose

This is temporary sediment control that uses K-rails to form the sediment deposition area, or to isolate the near bank construction area. Install K-rails at toe of slope in accordance with procedures described in NS-5, Clear Water Diversion.

Barriers are placed end to end in a pre-designed configuration and gravel filled bags are used at the toe of the barrier and at their abutting ends to seal and prevent movement of sediment beneath or through the barrier walls.

Appropriate Applications

- This technique is useful at the toe of embankments, cuts or fills slopes.

Limitations

- The K-rail method should not be used to dewater a project site, as the barrier is not watertight.

Implementation

- Refer to NS-5, Clear Water Diversion, for implementation requirements.

Instream Construction Sediment Control

There are three different options currently available for reducing turbidity while working in a stream or river. The stream can be isolated from the area in which work is occurring by means of a water barrier, the stream can be diverted around the work site through a pipe or temporary channel, or one can employ construction practices that minimize sediment suspension.

Whatever technique is implemented, an important thing to remember is that dilution can sometimes be the solution. A probable "worst time" to release high total suspended solids (TSS) into a stream system might be when the stream is very low; summer low flow, for example. During these times, the flow may be low while the biological activity in the stream is very high. Conversely, the addition of high TSS or sediment during a big storm discharge might have a relatively low impact, because the stream is already turbid, and the stream energy is capable of transporting both suspended solids, and large quantities of bedload through the system. The optimum time to "pull" in-stream structures may be during the rising limb of a storm hydrograph.

Techniques to minimize Total Suspended Solids (TSS)

- **Padding** - Padding laid in the stream below the work site may trap some solids that are deposited in the stream during construction. After work is done, the padding is removed from the stream, and placed on the bank to assist in re-vegetation.
- **Clean, washed gravel** - Using clean, washed gravel decreases solid suspension, as there are fewer small particles deposited in the stream.
- **Excavation using a large bucket** - Each time a bucket of soil is placed in the stream, a portion is suspended. Approximately the same amount is suspended whether a small amount of soil is placed in the stream, or a large amount. Therefore, using a large excavator bucket instead of a small one, will reduce the total amount of soil that washes downstream.
- **Use of dozer for backfilling** - Using a dozer for backfilling instead of a backhoe follows the same principles – the fewer times soil is deposited in the stream, the less soil will be suspended.
- **Partial dewatering with a pump** - Partially dewatering a stream with a pump reduces the amount of water, and thus the amount of water that can suspend sediment.

Washing Fines

Definition and Purpose

- Washing fines is an "in-channel" sediment control method, which uses water, either from a water truck or hydrant, to wash stream fines that were brought to the surface of the channel bed during restoration, back into the interstitial spaces of the gravel and cobbles.
- The purpose of this technique is to reduce or eliminate the discharge of sediment from the channel bottom during the first seasonal flow. Sediment should not be allowed into stream channels; however, occasionally in-channel restoration work will involve moving or otherwise disturbing fines (sand and silt sized particles) that are already in the stream, usually below bankfull discharge elevation. Subsequent re-watering of the channel can result in a plume of turbidity and sedimentation.
- This technique washes the fines back into the channel bed. Bedload materials, including gravel cobbles, boulders and those fines, are naturally mobilized during higher storm flows. This technique is intended to delay the discharge until the fines would naturally be mobilized.

Appropriate Applications

- This technique should be used when construction work is required in channels. It is especially useful in intermittent or ephemeral streams in which work is performed "in the dry," and which subsequently become re-watered.

Limitations

- The stream should have sufficient gravel and cobble substrate composition.
- The use of this technique requires consideration of time of year and timing of expected stream flows.
- The optimum time for the use of this technique is in the fall, prior to winter flows.
- Consultation with, and approval from the City, Department of Planning & Permitting (DPP), and Department of Health Clean Water Branch (CWB) may be required.

Implementation

- Apply sufficient water to wash fines, but not cause further erosion or runoff.
- Apply water slowly and evenly to prevent runoff and erosion.
- Consult with Department of Planning & Permitting (DPP) and Department of Health Clean Water Branch (CWB) for specific water quality requirements of applied water (e.g. chlorine).

Inspection and Maintenance

- None necessary.

Costs

Cost may vary according to the combination of practices implemented.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Inspect and repair equipment (for damaged hoses, fittings, and gaskets).

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

City & County of Honolulu, Department of Planning & Permitting Subdivision Rules and Regulations.

City & County of Honolulu, Revised Ordinances of Honolulu Section 14-14.2 Application for a Grading Permit.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

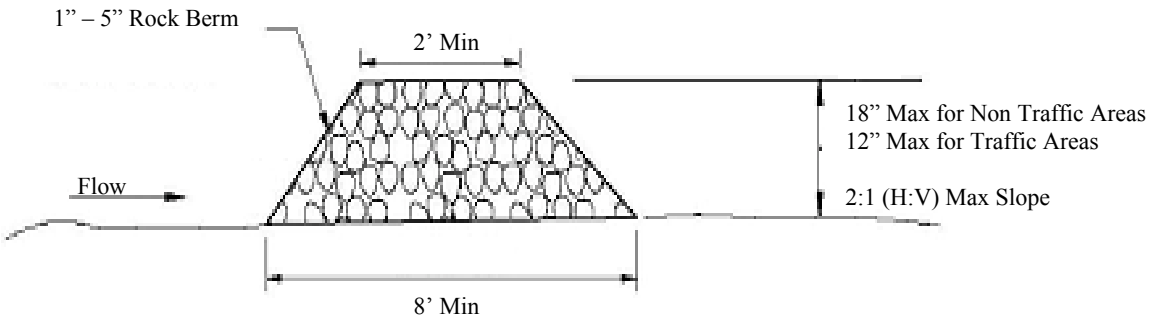
Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

Sedimentation and Erosion Control Practices, An Inventory of Current Practices (Draft), UESPA, 1990.

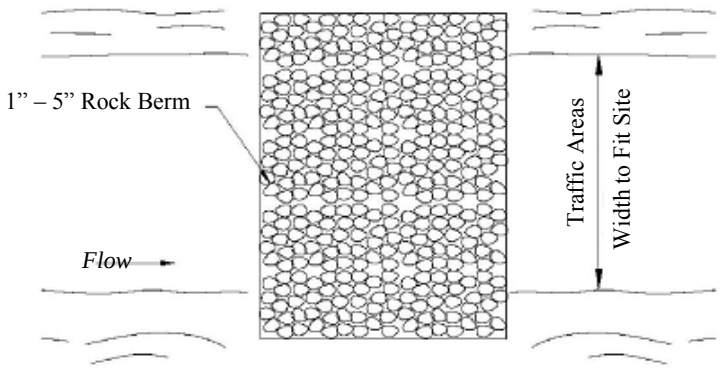
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



Section "A"
Not to Scale



Plan View
Not to Scale

Notes:
1. Slope hazard analysis is required for cut and fill slopes greater than 15 feet in height and a grade steeper than 40% or 2.5:1 (H:V).
2. Maximum slope cannot exceed 40% and any filling of lot cannot exceed 5 feet in depth.
3. Place work areas at least 50 ft. from stream channel.
4. The width of a buffer strip between a road and the stream is recommended to be 50 ft. plus four times the percent slope of the land.
5. In construction traffic areas, maximum rock berm heights should be 12 in.
6. Berms should be constructed every 300 ft. on slopes less than 5%, every 200 ft. on slopes between 5% and 10%, and every 100 ft. on slopes greater than 10%.
7. Use open graded rock, with 0.75 to 5 in. diameter for concentrated flow applications.
8. Woven wire sheathing: 1 in. diameter, hexagonal mesh, galvanized 20 gauge (used with rock filters in areas of concentrated flow).
9. Select equipment that reduces the amount of pressure exerted on the ground surface, and therefore, reduces erosion potential and/or use overhead or aerial access for transporting equipment across drainage channels. Use equipment that exerts ground pressures of less than 5 or 6 lb/in^2, where possible. Low ground pressure equipment includes: wide or high flotation tires (34 to 72 in. wide); dual tires; bogie axle systems; tracked machines; lightweight equipment; and, central tire inflation systems.

Typical Rock Filter

Seeding, Planting and Sodding EC-14

Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

Combination of erosion and sediment controls.

Description and Purpose

Seeding and planting of trees, vines, shrubs and ground cover, and sodding can temporarily or permanently stabilize soil in an area by covering the surface with vegetation and allowing storm water to infiltrate. Sodding is also the most immediately effective vegetation method available.

Suitable Applications

Soil stabilization during or after the construction phase applies to the following site conditions:

- Graded/cleared areas without on-going construction activity,
- Open space and fill areas,
- Steep slopes,
- Spoil piles or temporary stockpile of fill material,
- Vegetated swales,
- Landscape corridors, and
- Streambanks.

Installation Requirements

When seeding, planting or sodding consider the following:

- Type of vegetation,
- Site and seedbed preparation,
- Seasonal planting time,
- Fertilization, and
- Water.

Grasses

- Ground preparation requires fertilization and mechanical stabilization of the soil.
- Short-term temperature extremes and waterlogged soil conditions tolerable.
- Appropriate soil conditions include a shallow soil base, good drainage, and 2:1 or flatter slope.
- Quickly develops from seeds.
- Vigorous grass growth dependent on mowing, irrigating, and fertilizing.
- Trees and Shrubs.
- Selection dependent on vigor, species, size, shape, and potential wildlife food source.
- Consider wind/exposure and irrigation requirements.
- Use indigenous species where possible.

Vines and Ground Cover

- Lime and fertilizer required for ground preparation.
- Use appropriate seeding rates.
- Consider requirements for drainage, acidity, and ground slope.
- Use indigenous species where possible.
- Avoid species which require irrigation.

Limitations

- During dry periods without irrigation, permanent and temporary vegetation may not be appropriate.
- Improper application of fertilizer may contribute to storm water pollution.
- The cost of sod stabilization (relative to other vegetative controls) typically limits its use to situations where a quick vegetative cover is desired (e.g., steep or erodible slopes) and sites which can be maintained with ground equipment.
- Sod is sensitive to climate and may require intensive watering and fertilization.

Inspection and Maintenance

Monitor vegetation growth and water, fertilize, mow, and/or prune the grasses/plants as needed.

Costs

All of the above are low cost measures.

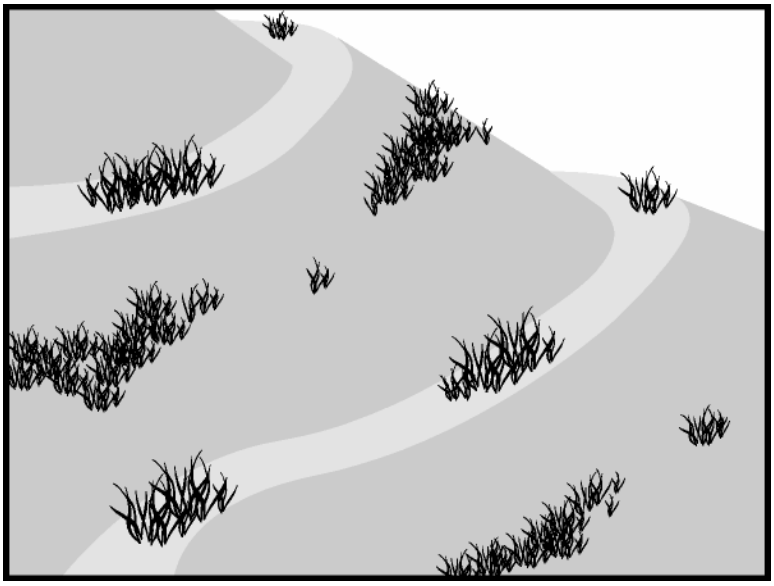
References

Caltrans Construction Site Best Management Practices Manual, 2003.

State of Hawaii DOT Highway Division, Construction BMP Field Manual, February 2007.

U.S. Environmental Protection Agency, NPDES General Permit for Stormwater Discharge Requirements for Small and Large Construction Activities, 2008.

Slope Roughening/Terracing EC-15



Objectives

EC – Erosion Control	√
SE – Sediment Control	▲
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Slope roughening/terracing creates microclimates for establishing vegetation, reduces runoff velocity, increases infiltration, and provides small depression for trapping sediment.

Surface roughening is recommended for all slopes steeper than 3:1, and greater than 5 vertical feet, providing some instate erosion protection on bare soil while vegetative cover is being established. It is an inexpensive, simple and short-term erosion control measure for roadway cut slopes.

Terracing usually is a more permanent measure used to stabilize a steep slope. Terraces should be designed by a licensed professional engineer and included in the project construction plans. City design criteria should be used.

Suitable Applications

- Any cleared area prior to seeding and planting.
- Recommended for cleared, erodible slopes steeper than 3:1 and higher than 5 feet prior to seeding and planting.

Implementation

- Slope roughening/terracing is performed in several ways:
  - Stair-step grading,
  - Grooving,
  - Furrowing,
  - Tracking,
  - Rough grading, and
  - No grading.

- Slope hazard analysis is required for cut and fill slopes greater than 15 feet in height and a grade steeper than 40% or 2.5:1 (H:V).
- City subdivision rules and regulations for lot grading specify that maximum slope cannot exceed 40% and any filling of lot cannot exceed 5 feet in depth.

Requirements

- Maintenance:
  - Inspect roughened slopes weekly and after rainfall for excessive erosion; and
  - Revegetate as quickly as possible.
- Cost (Source: EPA, 1992):
  - Surface Roughening: Performed at no (e.g., rough grading) to low (e.g., tracking) cost; and
  - Terracing: Average annual cost is $4 per linear foot (2 year useful life).

Limitations

- Roughening is of limited effectiveness on its own, but is used to speed revegetation.

Installation

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but they encourage water infiltration, speed the establishment of vegetation, and decreased runoff velocity. Rough, loose soil surfaces give lime, fertilizer, and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

- Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.
- Graded areas steeper than 3:1 should be stair-stepped with benches (See Figure 1). The stair stepping will help vegetation become attached and also trap soil eroded from the slopes above. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment.
- Graded areas with slopes greater than 3:1 but less than 2:1 should be roughened before seeding.

- It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening, as the soil surface is severely compacted and runoff is increased. Tracking can be accomplished in a variety of walls, including "track walking," or driving a crawler tractor up and down the slope, in leaving a pattern of cleat imprints parallel to slope contours.

Costs

All of the above are low cost measures.

References

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

Caltrans Construction Site BMP Manual, 2003.

City & County of Honolulu, Department of Environmental Services, Construction BMP Manual, March, 1999.

City & County of Honolulu, Department of Planning & Permitting Subdivision Rules and Regulations.

City & County of Honolulu, Revised Ordinances of Honolulu Section 14-14.2 Application for a Grading Permit.

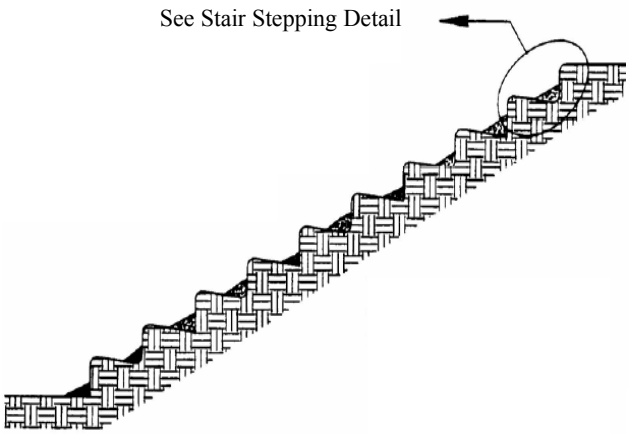
Handbook of Steel, Drainage & Highway Construction, American Iron and Steel Institute, 1983.

King County, Washington, Department of Natural Resources and Parks, Surface Water Design Manual, Jan 24, 2005.

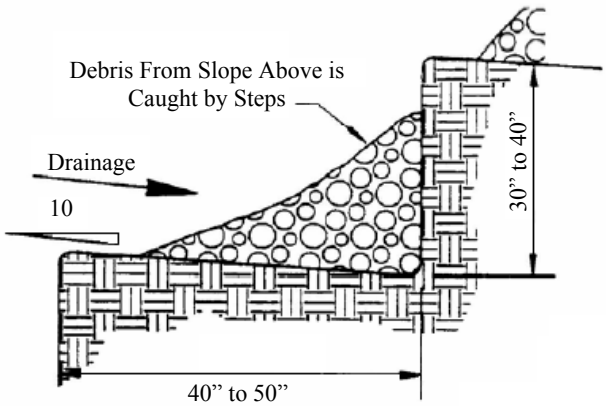
Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April, 1992.

State of Hawaii, Department of Transportation- Highway Division, Storm Water Permanent Best Management Practices Manual, March 2007.

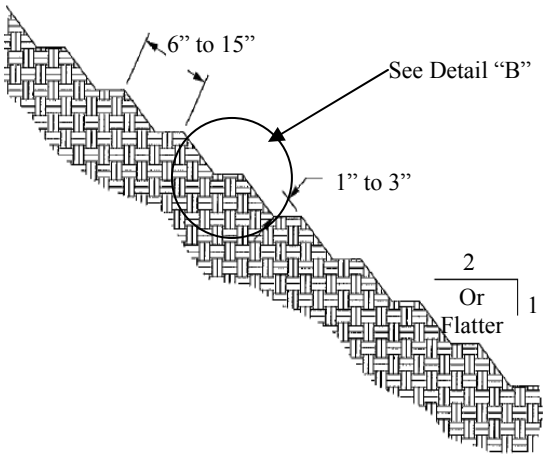
Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual- February 1992, Publication #91-75.



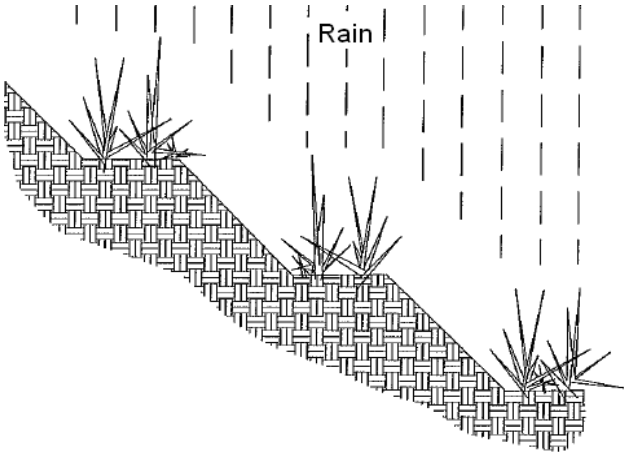
Stair Step Grading
Not to Scale



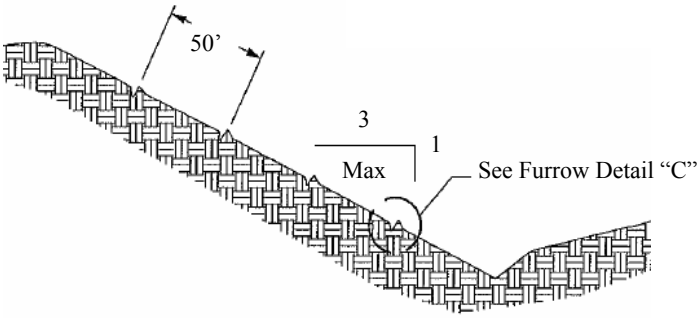
Stair Stepping Detail "A"
Not to Scale



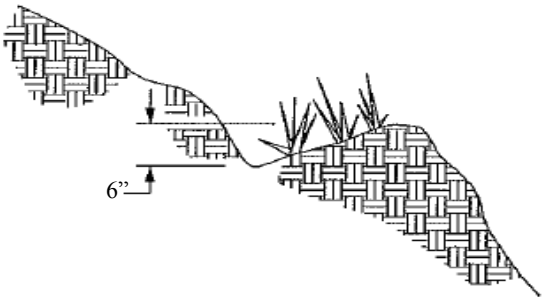
Grooving
Not to Scale



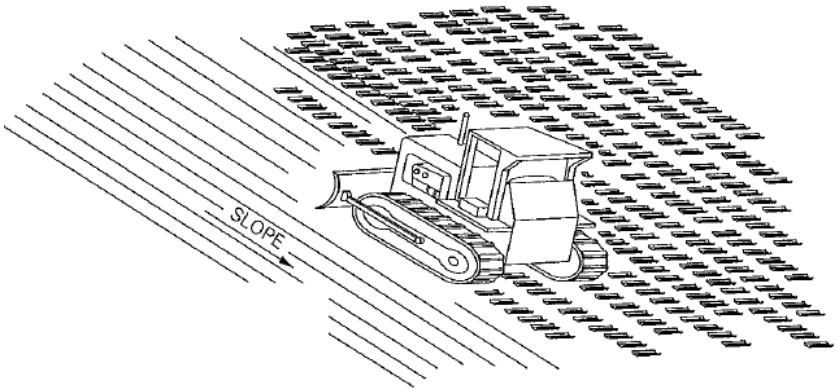
Grooving Detail "B"
Not to Scale



Furrowing
Not to Scale



Furrow Detail "C"
Not to Scale

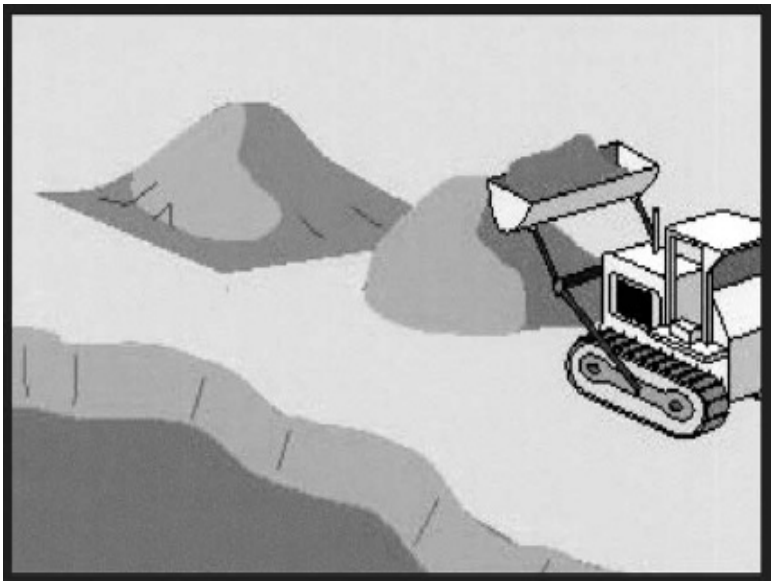


Tracking
Not to Scale

Notes:

1. Surface roughening may be applied to all slopes sleeper than 3:1, and greater than 5 vertical feet.
2. Slope hazard analysis is required for cut and fill slopes greater than 15 feet in height and a grade steeper than 40% or 2.5:1 (H:V).
3. Maximum slope cannot exceed 40% and any filling of lot cannot exceed 5 feet in depth.
4. Stairs should be wide enough to work with standard earth moving equipment.
5. Terraces should be designed by a licensed professional engineer.
6. Graded areas steeper than 3:1 should be stair-stepped with benches (Stair Step Grading).
7. Avoid excessive compacting of the soil surface when scarifying.

Topsoil Management EC-16



Objectives

EC – Erosion Control	√
SE – Sediment Control	▲
TR – Tracking Control	
WE – Wind Erosion Control	▲
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Reuse of native topsoil and other selected materials during revegetation activities. Salvaging, stockpiling, and reapplication of native topsoil are integral to successful revegetation efforts, especially for the reestablishment of native vegetation.

Suitable Applications

This BMP should be applied for the following conditions:

- Reestablishment of areas where vegetation with native plant species is desirable.
- Appropriate for sensitive habitat areas, floodplains, wetlands, and stream banks.

Limitations

- Stockpiles may limit the area available for construction activity.
- Runoff from stockpiles may adversely impact water quality.

Implementation

Consideration of the following items is necessary when developing a topsoil management plan:

- Quality and amount of native topsoil or growth medium.
- Area of surface disturbance to which topsoil or growth medium will be applied and the recommended depth of application.
- Methodology for salvaging topsoil or growth medium.

- Stockpile location, duration of storage, and required erosion control measures to protect stockpile.
- Feasibility of direct application of salvaged soils.
- Availability of other growth media to supplement topsoil reclamation.

Installation

- Conduct a site-specific soil survey of the area prior to soil disturbing activities to assess the location, depth, and amount of soils suitable for salvaging.
- Salvage and stockpile all suitable topsoil and other material for future use during revegetation of the area. Stockpile material in an area free of contamination from demolition or construction activities.
- Refer to WM-3 (Stockpile Management) in this manual when stockpiling salvaged topsoil.
- Carefully remove shrubs suitable for revegetation and store with the roots covered with mulch or loose soil.
- Cover or stabilize soil stockpiles with temporary measures such as mulch or temporary vegetation.
- Apply topsoil or growth medium directly to disturbed areas when practicable.
- Soil replacement depths are determined by factors such as soil depth prior to disturbance, type of vegetation, and physical and/or chemical properties of the material to be covered. A deeper soil layer is recommended for soils with poor physical and chemical properties. Testing (nutrients, pH, and toxicity factors) of replacement soils and material to be covered should be completed prior to reapplication.

Inspection and Maintenance

- Regularly inspect stockpiles for erosion and stabilize as necessary.
- Inspect stockpile covers to ensure adequate protection from wind and rain.
- Adequately water plantings until they are established.

Costs

All of the above are low cost measures.

References

State of Hawaii DOT, Highways Division Construction BMP Field Manual, September 2006.

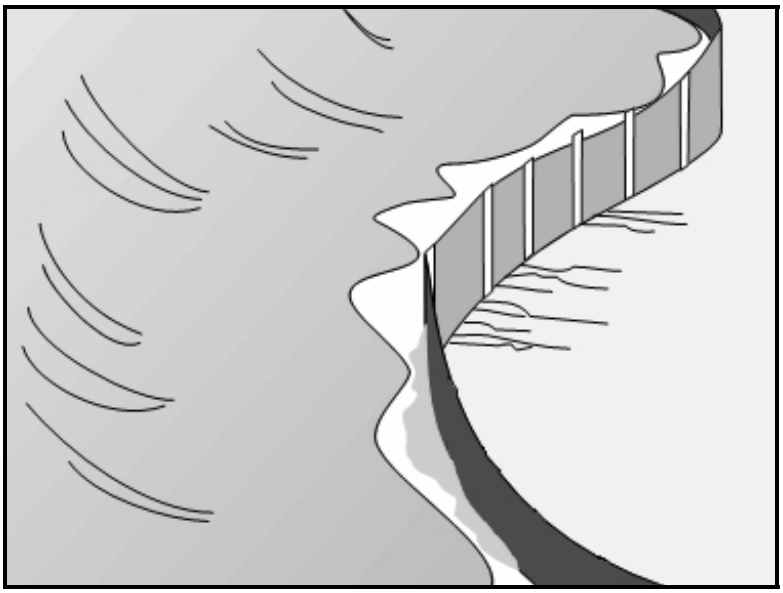
Truckee Meadows Construction Best Management Practices Handbook, 2003.

3.8 SEDIMENT CONTROL FACT SHEETS

SE-1 Silt Fence
SE-2 Sediment Basin
SE-3 Sediment Trap
SE-4 Check Dams
SE-5 Fiber Rolls
SE-6 Gravel Bag Berm
SE-7 Street Sweeping and Vacuuming
SE-8 Sandbag Barrier
SE-10 Storm Drain Inlet Protection
SE-11 Chemical Treatment
SE-12 Location of Potential Sources of Sediment
SE-13 Level Spreader
SE-14 Rip-Rap & Gabion Inflow Protection
SE-15 Vegetated Buffer Strips and Channels
SE-16 Compost Socks and Berms

E Mālama I Ka Wai Ola
Protect our waters...
FOR LIFE

Silt Fence SE-1



Objectives

EC – Erosion Control	
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

A silt fence is made of a filter fabric that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They should also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion. Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project. Consider embedding the perimeter dust screen fabric and jointly using it as the perimeter silt fence;
- Below the toe or down slope of exposed and erodible slopes;
- Along streams and channels;
- Around temporary spoil areas and stockpiles; and
- Below other small cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.

- Do not use in locations where ponded water may cause flooding.
- Do not place fence on a slope, or across any contour line. If not installed at the same elevation throughout, silt fences will create erosion.
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.
  - Not effective unless trenched and keyed in.
  - Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
  - Do not allow water depth to exceed 1.5 ft. at any point.

Implementation

General

A silt fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

Silt fences are preferable to straw bale barriers in many cases. Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. While the failure rate of silt fences is lower than that of straw bale barriers, there are many instances where silt fences have been improperly installed. The following layout and installation guidance can improve performance and should be followed:

- Use principally in areas where sheet flow occurs;
- Don't use in streams, channels, or anywhere flow is concentrated. Don’t use silt fences to divert flow;
- Don't use below slopes subject to creep, slumping, or landslides;
- Select filter fabric that retains 85% of soil by weight, based on sieve analysis, but that is not finer than an equivalent opening size of 70;
- Install along a level contour, so water does not pond more than 1.5 ft. at any point along the silt fence;
- The maximum length of slope draining to any point along the silt fence should be 200 ft. or less;
- The maximum slope perpendicular to the fence line should be 1:1;
- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence;
- Turn the ends of the filter fence uphill to prevent storm water from flowing around the fence;

- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible; and
- Silt fences should remain in place until the disturbed area is permanently stabilized.

Design and Layout

Selection of a filter fabric is based on soil conditions at the construction site (which affect the equivalent opening size (EOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer should specify a filter fabric that retains the soil found on the construction site yet that it has openings large enough to permit drainage and prevent clogging. The following criteria are recommended for selection of the equivalent opening size:

- If 50 percent or less of the soil, by weight, will pass the U.S. Standard Sieve No. 200, select the EOS to retain 85% of the soil. The EOS should not be finer than EOS 70; and
- For all other soil types, the EOS should be no larger than the openings in the U.S. Standard Sieve No. 70 except where direct discharge to a stream, lake, or wetland will occur, then the EOS should be no larger than Standard Sieve No. 100.

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with an EOS smaller than U.S. Standard Sieve No. 100. If 85% or more of a soil, by weight, passes through the openings in a No. 200 sieve, filter fabric should not be used. Most of the particles in such a soil would not be retained if the EOS was too large and they would clog the fabric quickly if the EOS were small enough to capture the soil.

The fence should be supported by a plastic or wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material should contain ultraviolet inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F to 120°F.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence. Additional protection may be a chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.

Materials

- Silt fence fabric should be composed of a permeable geotextile filter fabric with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D4632 and should have an integral reinforcement layer. The reinforcement layer should be a polypropylene, or equivalent, net provided by the manufacturer.
- Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of

the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.
- There are new products that may use prefabricated plastic or metal stakes with holders for the silt fence and use bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement.

Installation Guidelines

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line of the proposed silt fence.
- Bottom of the silt fence should be keyed-in a minimum of 12 in.
- Posts should be spaced a maximum of 6 ft. apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench. Fabric should be installed on the upslope face of the posts.
- When standard strength filter fabric is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy-duty wire staples at least 1 in. long. The mesh should extend into the trench.
- When extra-strength filter fabric and closer post spacing are used, the mesh support fence may be eliminated.
- Filter fabric should be purchased in a long roll, and then cut to the length of the barrier. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.
- The trench should be backfilled with compacted native material.
- Construct silt fences with a setback of at least 3 ft. from the toe of a slope. Where a silt fence is determined to be not practicable due to specific site conditions, the silt fence may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practicable. Silt fences close to the toe of the slope will be less effective and difficult to maintain.
- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.

Costs

- Average annual cost for installation and maintenance (assumes 6 month useful life) in California: $7 per lineal foot ($850 per drainage acre). Range of cost is $3.50 - $9.10 per lineal foot. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed of, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence should be inspected and maintained.
- Holes, depressions, or other ground disturbance caused by the removal of the silt fences should be backfilled and repaired.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

Sedimentation and Erosion Control Practices, and Inventory of Current Practices (Draft), UESPA, 1990.

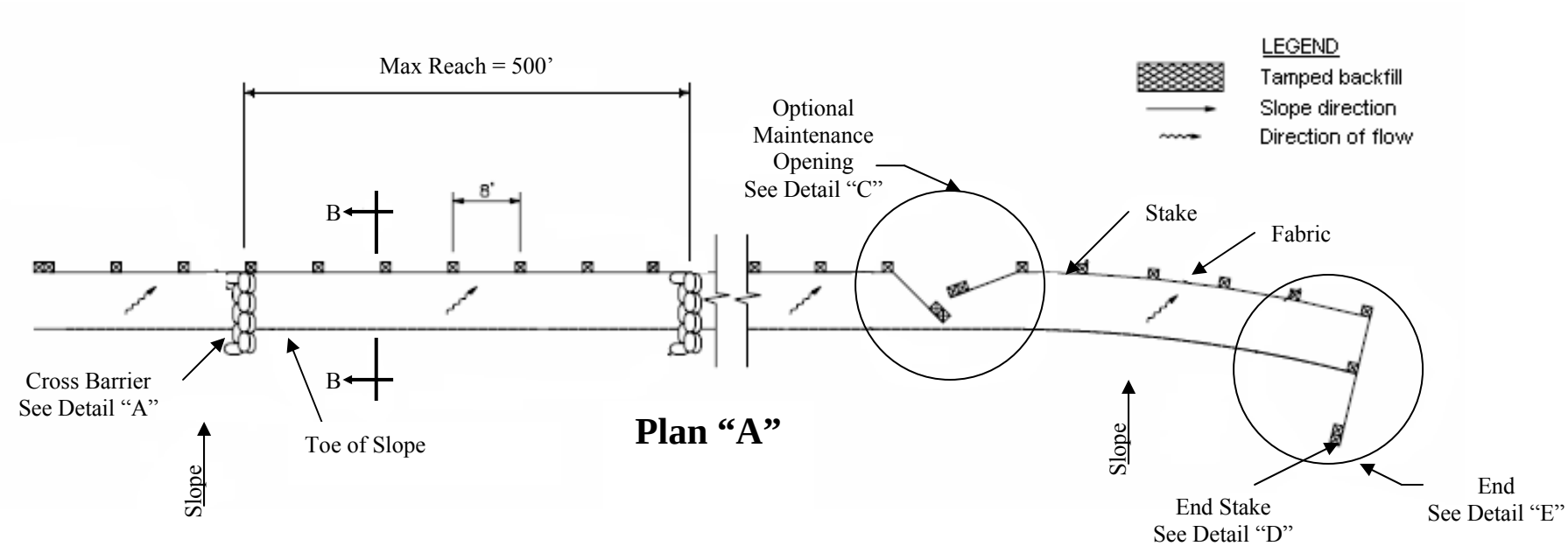
Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI, 1991.

Storm Water Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

U.S. Environmental Protection Agency (USEPA). Stormwater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1992.

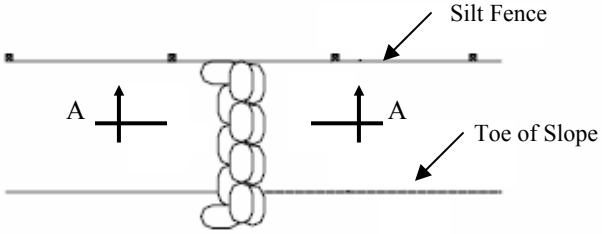
Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



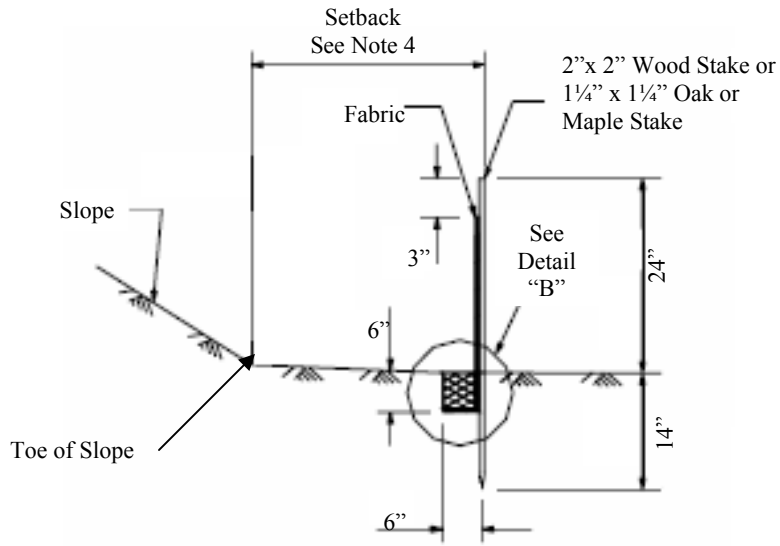
Notes:

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier, in no case shall the reach length exceed 500'.
2. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier.
3. Sandbag rows and layers shall be offset to eliminate gaps.
4. Setback dimension may vary to fit field condition. Typical 3' setback from top of slope.
5. Stakes shall be spaced at 8' maximum and shall be positioned on downstream side of fence, or as specified by the engineer.
6. Stake dimensions are nominal. Material as specified by engineer.
7. Stakes to overlap and fence fabric to fold around each stake one full turn. Secure fabric to stake with 4 staples or wire.
8. Stakes shall be driven tightly together to prevent potential flow-through of sediment at joint. The tops of the stakes shall be secured with wire.
9. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 stables or wire.
10. Minimum 4 staples or wire per stake. Dimensions shown are typical.
11. Joining sections shall not be placed at sump locations.
12. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence.
13. The last 8' of fence shall be turned up slope to reduce breakthrough of sediment.

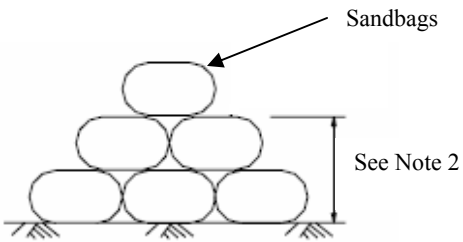
Silt Fence



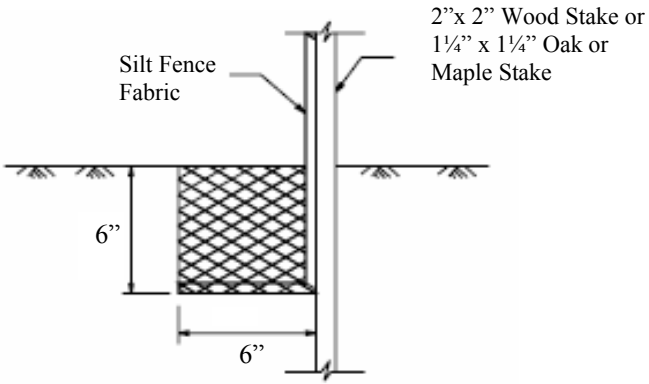
CROSS BARRIER DETAIL "A"



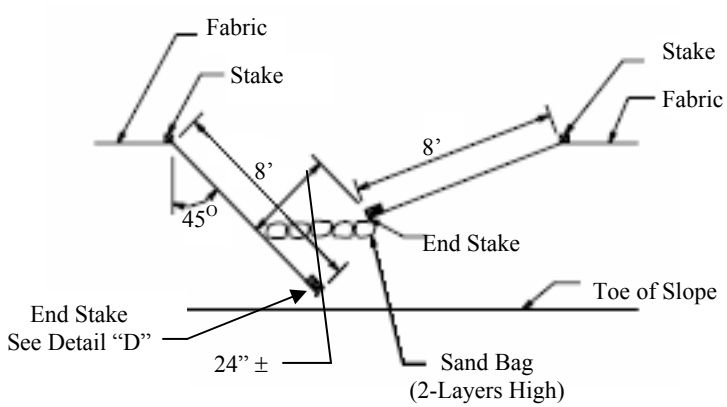
SECTION B-B



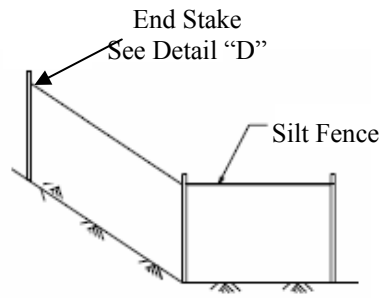
SECTION A-A



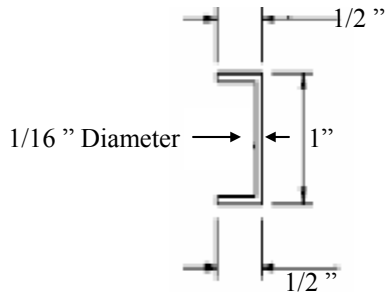
DETAIL "B"



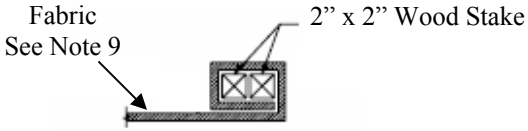
OPTIONAL MAINTENANCE OPENING DETAIL "C"
See note 12



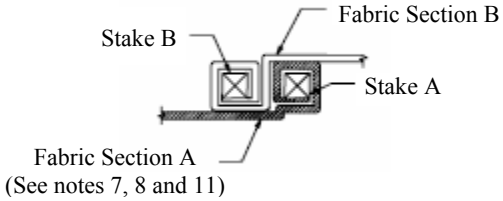
END DETAIL "E"
See note 2



STAPLE DETAIL
"F"

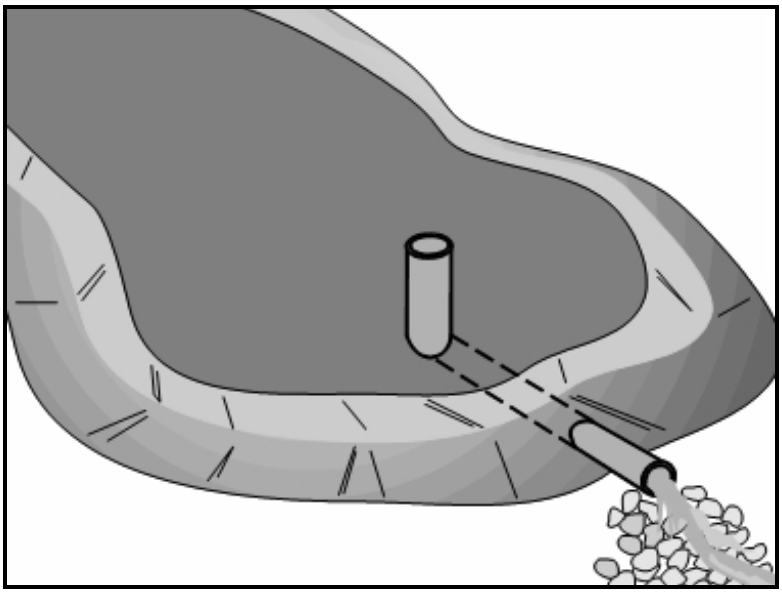


END STAKE DETAIL "D"
(TOP VIEW)



JOINING SECTION DETAIL "G"
TOP VIEW

Sediment Basin SE-2



Objectives

EC – Erosion Control	
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	√
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses;
- On construction projects with disturbed areas during the rainy season;
- At the outlet of disturbed watersheds between 5 acres and 75 acres;
- At the outlet of large disturbed watersheds, as necessary;
- Where post construction detention basins are required; or
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas.

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. State NPDES Notice of General Permit coverage (DOH NOI-C 8.b.iv. (1) (a)) regarding

health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the site-specific BMPs plan and in the construction specifications.

- Generally, sediment basins are limited to drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. Since safety is a concern, a basin may include protective fencing, lockable grates at top of riser inlets to restrict access in pipe.
- Sediment basins designed according to this manual are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical treatment is used in addition to the sediment basin.
- Sites with very fine sediments (fine silt and clay) may require longer detention times for effective sediment removal.
- Basins with a height of 25 ft. or more or an impounding capacity of 50 ac-ft or more must obtain approval from State of Hawaii Department of Land and Natural Resources (HAR 13-179 Dams & Reservoirs).
- Standing water may cause mosquitoes or other pests to breed.
- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.
- Basins in excess of certain depth and storage volume criteria must meet State Department of Land and Natural Resources (HAR 13-190 Dams and Reservoirs) safety requirements.

Implementation

General

A sediment basin is a controlled storm water release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure with a design life of 12 to 28 months in most cases and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the storm water outlet from the site but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to divert runoff to the basin inlet.

Many development projects in the City and County of Honolulu will be required by the Rules Relating to Storm Drainage Standards (2000) to provide a storm water detention basin for post-construction flood control, desilting, or storm water pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins trap 70-80% of the sediment that flows into them if designed according to this manual. Therefore, they should be used in conjunction with erosion control practices such as

temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. The best locations are generally low areas. Drainage into the basin can be improved by the use of earth dikes and drainage swales (EC-9). The basin must not be located in a stream but it should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

- Construct before clearing and grading work begins when feasible.
- Do not locate in a stream.
- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Large basins are subject to state and State DLNR dam safety requirements.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

Sediment basins must be designed in accordance with State of Hawaii Department of Health, Clean Water Branch (CWB) NPDES General Permit Coverage Notice of Intent (NOI) Form C Authorizing Discharge of Storm Water Associated with Construction Activities where sediment basins are the only control measure proposed for the site. If there is insufficient area to construct a sediment basin in accordance with the CWB NOI Form C requirements, then the alternate design standards specified herein may be used.

Sediment basins designed per CWB NOI Form C shall be designed as follows:

For Drainage Areas Greater than 10 Acres:

For common drainage locations that serve an area with 10 or more acres disturbed at one time, a temporary (or permanent) sediment basin that provides storage for a calculated volume of runoff from the drainage area from a 2-year, 24-hour storm, or equivalent control measures, must be provided where attainable until final stabilization of the site. This requirement is specified in both the City & County of Honolulu –Department of Planning and Permitting Rules Relating to Soil Erosion Standards and Guidelines (April 1999). When computing the number of acres draining into a common location, it is not necessary to include flows from offsite areas and flows from on-site areas that are either undisturbed or have undergone final stabilization where such flows are diverted around both the disturbed area and the sediment basin. In determining

whether installing a sediment basin is attainable, the operator may consider factors such as site soils, slope, available area on-site, etc. In any event, the operator must consider public safety, especially as it relates to children, as a design factor for the sediment basin, and alternative sediment controls must be used where site limitations would preclude a safe design.

For drainage locations which serve 10 or more disturbed acres at one time and where a temporary sediment basin or equivalent controls is not attainable, smaller sediment basins and/or sediment traps (SE-3) should be used. At a minimum, silt fences (SE-1), vegetative buffer strips (SE-15), or equivalent sediment controls are required for all down slope boundaries (and for those side slope boundaries deemed appropriate as dictated by individual site conditions).

For Drainage Areas Less than 10 Acres:

Smaller sediment basins and/or sediment traps (SE-3) should be used. At a minimum, silt fences (SE-1), vegetative buffer strips (SE-15), or equivalent sediment controls are required for all down slope boundaries (and for those side slope boundaries deemed appropriate as dictated by individual site conditions) of the construction area unless a sediment basin providing storage for a calculated volume of runoff from a 2-year, 24-hour storm is provided.

Other design considerations are:

- The draw-down (or draining) time for the detention volume, which is intended to drain down completely (vs. permanent wet volume), shall be between 48 and 72 hours. For bottom half of the detention volume, the draw-down time shall be greater than or equal to 36 to 72 hours. The 48 and 36 hour limit is specified to provide adequate settling time; the 72-hour limit is specified to mitigate vector control concerns.
- For detention based water quality controls with less than or equal to 20 acres of drainage area, the total draw-down time can be reduced to 36 hours, with the lower half of the detention volume draw-down time of 24 hours, if it can be demonstrated that the outlet sizing (e.g., outlet pipe diameter less than 4 inches) would not be practical.
- The detention system shall be designed to maximize the distance between the inlet and outlet, and to minimize “dead spaces” (areas where little or no exchange occurs during a storm event), there-by limiting short-circuiting. A minimum flow-path length to width ratio of 3 should be utilized.
- The outlet shall be sized to achieve the above required detention times. In addition, it shall be large enough that clogging is unlikely to occur. It should be 4 inches or larger in diameter. Alternative hydraulic structures can be accepted with computations and approval by the City DPP.
- Recommended maximum side slope of 3:1 (H:V).
- A detention time of 24 to 40 hours should allow 70 to 80% of sediment to settle.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 ft. deep, and
  - A settling zone at least 2 ft. deep.
- The depth must be no less than 3 ft.
- The length to settling depth ratio (L/SD) should be less than 200.

- Sediment basins are best used in conjunction with erosion controls. Sediment basins that will be used as the only means of treatment, without upstream erosion and sediment controls, must be designed to the satisfaction of CWB NOI Form C. Sediment basins that are used in conjunction with upstream erosion and sediment controls should be designed to have a capacity equivalent to 67 yd^3 of sediment storage per acre of contributory area.
- Basins with an impounding levee greater than 4.5 ft. tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,000 ft^3, should be designed by a Licensed Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.
- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.
  - Include an emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap.
  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft. in length.
- Rock or vegetation should be used to protect the basin inlet and slopes against erosion.
- A forebay, constructed upstream of the basin may be provided to remove debris and larger particles.
- Consider using biodegradeable flocculants (chitosan) to enhance sedimentation of finer suspended matters.
- The outflow from the sediment basin should be provided with velocity dissipation devices (EC-10) to prevent erosion and scouring of the embankment and channel.
- Basin inlets should be located to maximize travel distance to the basin outlet.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen; although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.

- The two most common outlet problems that occur are: (1) the capacity of the outlet is too great resulting in only partial filling of the basin and drawdown time less than designed for; and (2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, the following outlet types are recommended for use: (1) a single orifice outlet with or without the protection of a riser pipe, and (2) perforated riser. Design guidance for single orifice and perforated riser outlets follow:
  - Flow Control Using a Single Orifice At The Bottom Of The Basin (Figure 1): The outlet control orifice should be sized using the following equation:

$$a = \frac{2A(H-Ho)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7x10^{-5})A(H-Ho)^{0.5}}{CT} \qquad \text{(Eq. 2)}$$

where:

a = area of orifice (ft^2)

A = surface area of the basin at mid elevation (ft^2)

C = orifice coefficient

T = drawdown time of full basin (hrs.)

g = gravity (32.2 ft/s^2)

H = elevation when the basin is full (ft.)

Ho = final elevation when basin is empty (ft.)

With a drawdown time of 40 hours, the equation becomes:

$$a = \frac{(1.75x10^{-6})A(H-Ho)^{0.5}}{C} \qquad \text{(Eq. 3)}$$

  - Flow Control Using Multiple Orifices (see Figure 2):

$$a_t = \frac{2A(h_{max})}{3600CT(2g[h_{max} - h_{centroid\ of\ orifices}])^{0.5}} \qquad \text{(Eq. 4)}$$

With terms as described above except:

at = total area of orifices

hmax = maximum height from lowest orifice to the maximum water surface (ft.)

hcentroid of orifices = height from the lowest orifice to the centroid of the orifice configuration (ft.)

Allocate the orifices evenly on two rows; separate the holes by 3x hole diameter vertically, and by 120 degrees horizontally (refer to Figure 2).

Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

Care must be taken in the selection of "C"; 0.60 is most often recommended and used. However, based on actual tests, GKY (1989), "Outlet Hydraulics of Extended

Detention Facilities for Northern Virginia Planning District Commission", recommends the following:

C = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or

C = 0.80 when the material is thicker than the orifice diameter

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods.
- Areas under embankments must be cleared and stripped of vegetation.
- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

Costs

Average annual costs for installation and maintenance (2 year useful life) in California are:

- Basin less than 50,000 ft^3: Range, \$0.24 - \$1.58/ft^3. Average, \$0.73 per ft^3. \$400 - \$2,400, \$1,200 average per drainage acre; and
- Basin size greater than 50,000 ft^3: Range, \$0.12 - \$0.48/ft^3. Average, \$0.36 per ft^3. \$200 - \$800, \$600 average per drainage acre.

Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at appropriate locations.
- Remove standing water from basin within 72 hours after accumulation.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be implemented at all times during dewatering activities.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection; and
  - Remove excessive emergent and perimeter vegetation as needed or as advised by State Department of Agriculture.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

City & County of Honolulu, Rules Relating to Storm Drainage Standards, January 2000.

A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zones, Metropolitan Washington Council of Governments, March 1992.

Draft-Sedimentation and Erosion Control, an Inventory of Current Practices, USEPA. April 1990.

Guidelines for the Design and Construction of Small Embankment Dams, Division of Safety of Dams, California Department of Water Resources, March 1986.

Hawaii Administrative Rules, Chapter 11, Section 55, Water Pollution Control, October 2007.

Hawaii Revised Statutes, Chapter 179D, Dams and Reservoir.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

McLean, J., 2000. Mosquitoes in Constructed Wetlands: A Management Bugaboo? In T.R. Schueler and H.K. Holland [eds.], The Practice of Watershed Protection. pp. 29-33. Center for Watershed Protection, Ellicott City, MD, 2000.

Metzger, M.E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. The dark site of stormwater runoff management: disease vectors associated with structural BMPs, 2002.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Water, Work Group-Working Paper, USEPA, April 1992.

Hawaii Administrative Rules, Title 11, Chapter 55, Appendix C, State of Hawaii Department of Health, Clean Water Branch NPDES General Permit Coverage Notice of Intent (NOI) Form C Authorizing Discharge of Storm Water Associated with Construction Activities.

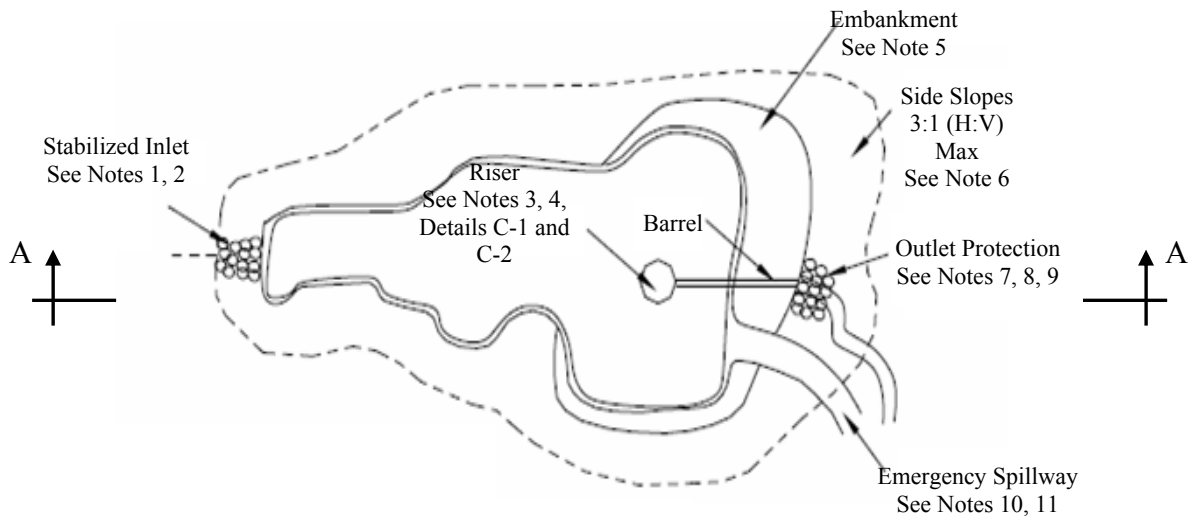
Hawaii Administrative Rules, Title 13, Subtitle 7, Chapter 190, Dams and Reservoirs.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

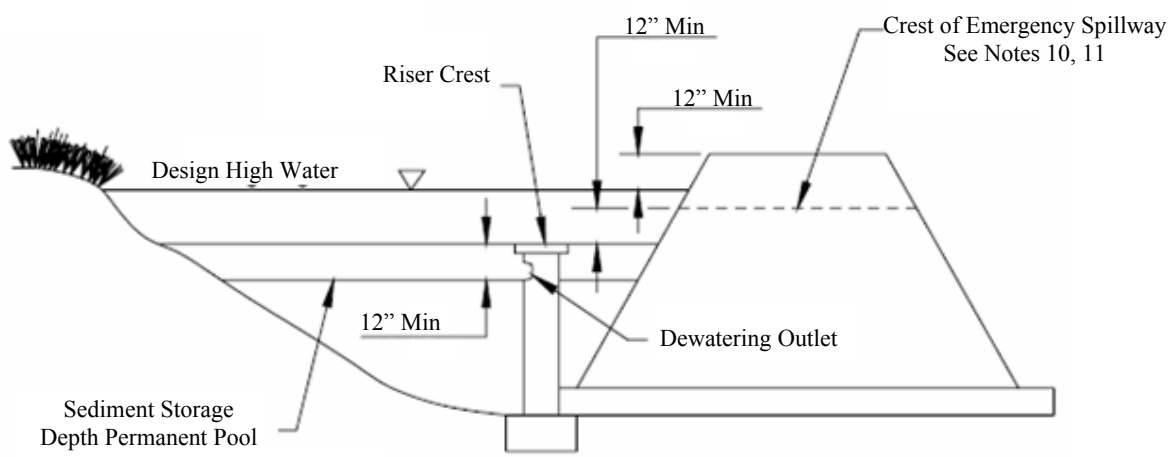
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

U.S. Environmental Protection Agency (USEPA). Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters. EPA 840-B-9-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1993.

Water Quality Management Plan for the Lake Tahoe Region, Volume II Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

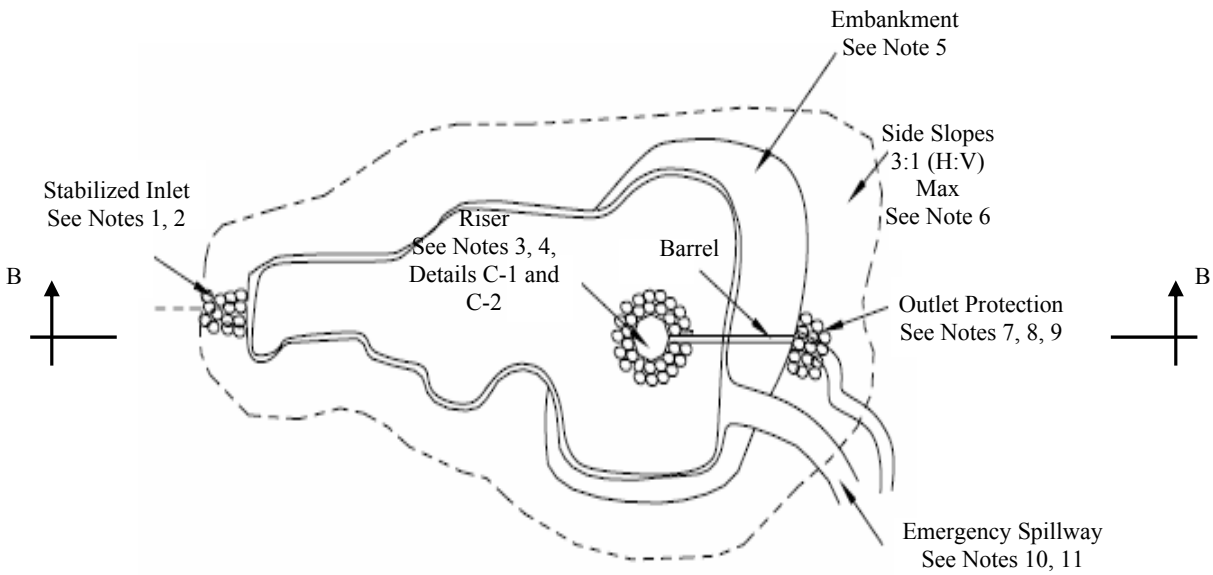


Plan "A"
Top View, Not to Scale



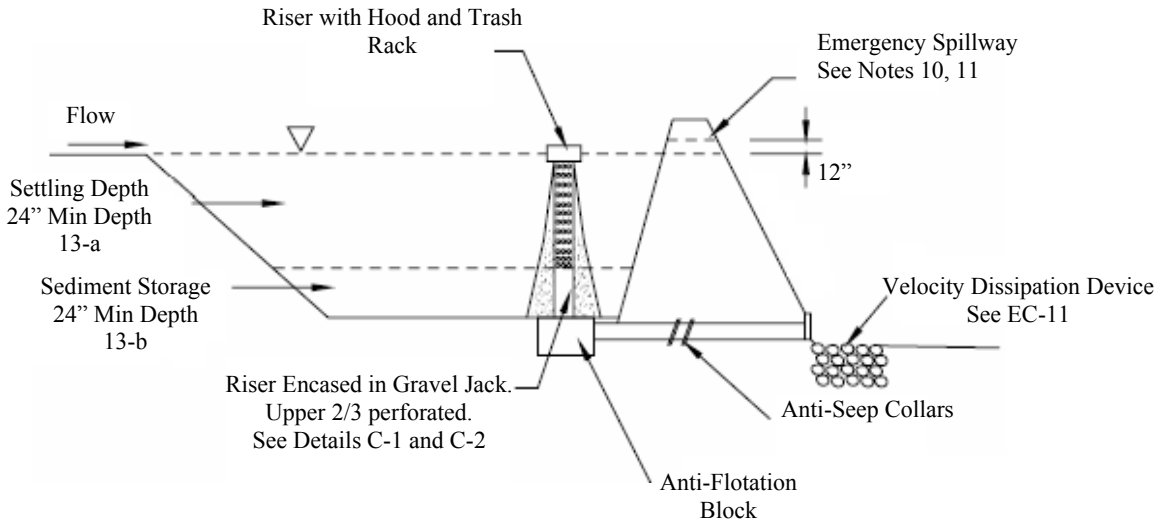
Section A-A
Not to Scale

Temporary Single Orifice Sediment Basin



Plan "B"

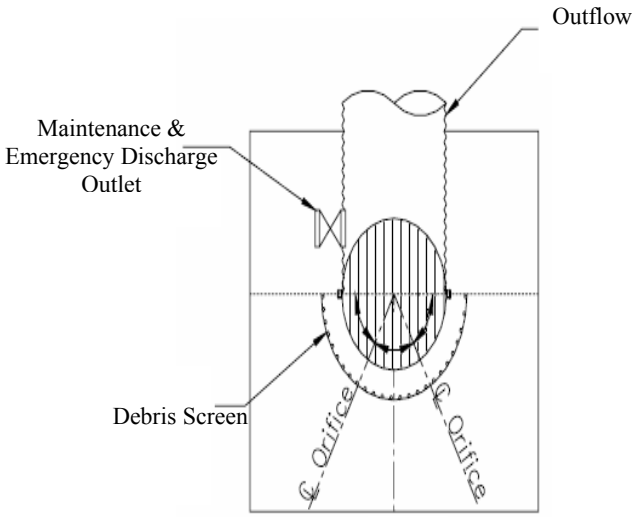
Top View, Not to Scale



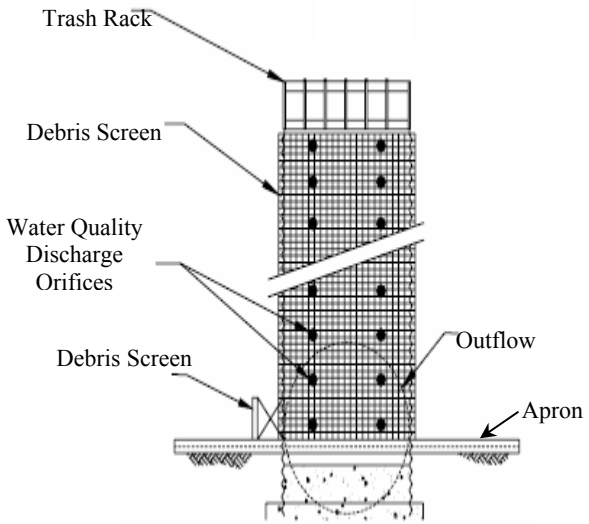
Section B-B

Not to Scale

Temporary Single Orifice Sediment Basin



Detail "C-1"
Plan View, Not to Scale

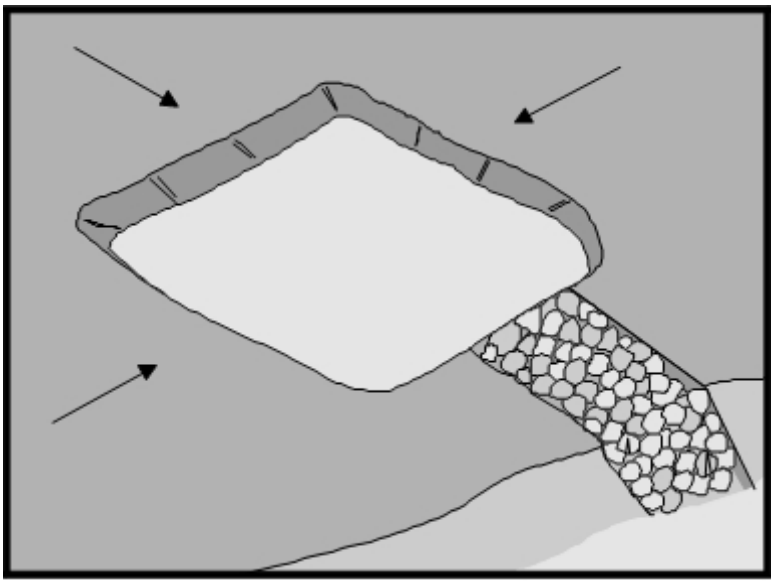


Detail "C-2"
Side View, Not to Scale

Notes:
1. Basin inlets should be located to maximize travel distance to the basin outlet.
2. Rock or vegetation should be used to protect the basin inlet and slopes against erosion.
3. Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
4. Cleanout level should be clearly marked on the riser pipe.
5. Areas under embankments must be cleared and stripped of vegetation.
6. *A maximum side slope of 3:1 (H:V).*
7. *The outlet shall be sized to achieve the above required detention times. See Rules Relating to Storm Drainage Standards. Jan, 2000. D. of §1-5.1 Part I- Water Quality Criteria).*
8. The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
9. The outflow from the sediment basin should be provided with velocity dissipation devices (EC-10) to prevent erosion and scouring of the embankment and channel.
10. The emergency spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap.
11. The spillway control section should be a minimum of 20 ft. in length.
12. The depth must be no less than 3 ft.
13. The basin volume consists of two zones:
    a. A sediment storage zone at least 1 ft. deep.
    b. A settling zone at least 2 ft. deep.
14. The length to settling depth ratio (L/SD) should be less than 200.
15. A forebay, constructed upstream of the basin may be provided to remove debris and larger particles.
16. Sediment basins that will be used as the only means of treatment, without upstream erosion and sediment controls, must be designed to the *satisfaction of CWB NOI Form C.*
17. Basins with a height of 25 ft. or more or an impounding capacity of 50 ac-ft or more must obtain approval from *State of Hawaii Department of Land and Natural Resources (HAR 13-190 Dams & Reservoirs).*
18. Fencing of basin is required.

Multiple Orifice Outlet Riser

Sediment Trap SE-3



Objectives

EC – Erosion Control	√
SE – Sediment Control	
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-2 Sediment Basin (for larger areas)

Description and Purpose

A sediment trap is a containment area where sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out or before the runoff is discharged. Sediment traps are formed by excavating or constructing an earthen embankment across a waterway or low drainage area.

Suitable Applications

Sediment traps should be considered for use:

- At the downslope project boundary at locations where sediment-laden runoff is discharged offsite;
- At multiple locations within the project site where sediment control is needed;
- Around or upslope from storm drain inlet protection measures;
- Sediment traps may be used on construction projects where the drainage area is less than 5 acres. Traps would be placed where sediment-laden storm water may enter a storm drain or watercourse. SE-2, Sediment Basins, should be used for drainage areas greater than 5 acres; and
- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Limitations

- Requires large surface areas to permit infiltration and settling of sediment.
- Not appropriate for drainage areas greater than 5 acres.
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, requiring protective fencing.
- Conducive to vector production.
- Should not be located in live streams.

Implementation

Design

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation or by construction of an earthen embankment. Its purpose is to collect and store sediment from sites cleared or graded during construction. It is intended for use on small drainage areas with no unusual drainage features and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately six months to one year and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to SE-2, Sediment Basins, or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The site-specific BMPs plan should detail how this sediment is to be disposed of, such as in fill areas onsite, or removal to an approved offsite dump. Sediment traps used as perimeter controls should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. However, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks:

- Recommend installing continuous fencing around the sediment trap or pond; and
- Restrict basin side slopes to 3:1 or flatter.

Sediment trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see SE-2, Sediment Basin). As a rule of thumb, the larger the basin volume the greater the sediment removal efficiency. Minimum sizing criteria have been established in the City's "Rules Relating to Soil Erosion Standards and Guidelines." The runoff volume from a 2-year, 24-hour duration storm or 3,600 ft^3 of storage per acre drained are common design criteria for a sediment trap. The sizing criteria below assume that this runoff intensity of 1.0 in. While the climatic, topographic, and soil type extremes make it difficult to establish a statewide standard, the following criteria should trap moderate to high amounts of sediment in most areas of Oahu:

- Locate sediment traps as near as practical to areas producing the sediment;
- Trap should be situated according to the following criteria: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where failure

would not cause loss of life or property damage, and (3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area;

- Trap should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 133 yd^3/acre and 66 yd^3/acre of contributing drainage area, respectively, based on 1.0 in. of runoff volume over a 24-hour period. In many cases, the size of an individual trap is limited by available space. Multiple traps or additional volume may be required to accommodate specific rainfall, soil, and site conditions;
- Traps with an impounding levee greater than 4.5 ft. tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 35,000 ft^3, should be designed by a Licensed Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the trap outlet and bypass structures;
- The outlet pipe or open spillway should be designed to convey anticipated peak flows;
- Use rock or vegetation to protect the trap outlets against erosion; and
- Fencing should be provided to prevent unauthorized entry.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a small embankment. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainage ways. The following steps should be followed during installation:

- The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared;
- The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed;
- All cut-and-fill slopes should be 3:1 or flatter;
- When a riser is used, all pipe joints must be watertight;
- When a riser is used, at least the top two-thirds of the riser should be perforated with 0.5 in. diameter holes spaced 8 in. vertically and 10 to 12 in. horizontally. See SE-2, Sediment Basin;
- When an earth or stone outlet is used, the outlet crest elevation should be at least 1 ft. below the top of the embankment; and
- When crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

Costs

Average annual cost per installation and maintenance (18 month useful life) is $0.73 per ft^3 ($1,300 per drainage acre) in California. Maintenance costs are approximately 20% of installation costs. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect outlet area for erosion and stabilize if required.
- Inspect trap banks for seepage and structural soundness, repair as needed.
- Inspect outlet structure and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Inspect fencing for damage and repair as needed.
- Inspect the sediment trap for area of standing water during every visit. Corrective measures should be taken if the BMP does not dewater completely in 72 hours or less to prevent vector production.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the trap capacity. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove vegetation from the sediment trap when first detected to prevent pools of standing water and subsequent vector production.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be implemented at all times during dewatering activities.

References

Brown, W., and T. Schueler. The Economics of Stormwater BMPs in the Mid-Atlantic Region. Prepared for Chesapeake Research Consortium, Edgewater, MD, by the Center for Watershed Protection, Ellicott City, MD, 1997.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Draft - Sedimentation and Erosion Control, an Inventory of Current Practices, USEPA, April 1990.

Hawaii Administrative Rules, Title 13, Subtitle 7, Chapter 190, Dams and Reservoirs.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Metzger, M.E., D.F. Messer, C.L. Beitia, C.M. Myers, and V.L. Kramer, The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with Structural BMPs, 2002.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

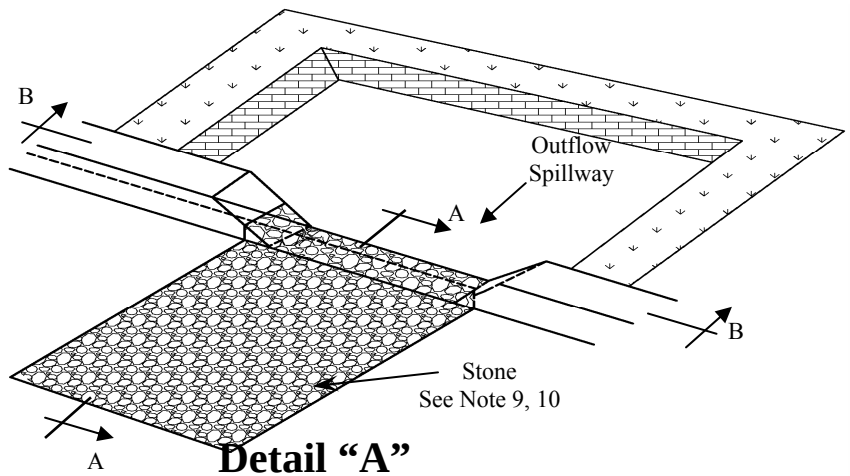
Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

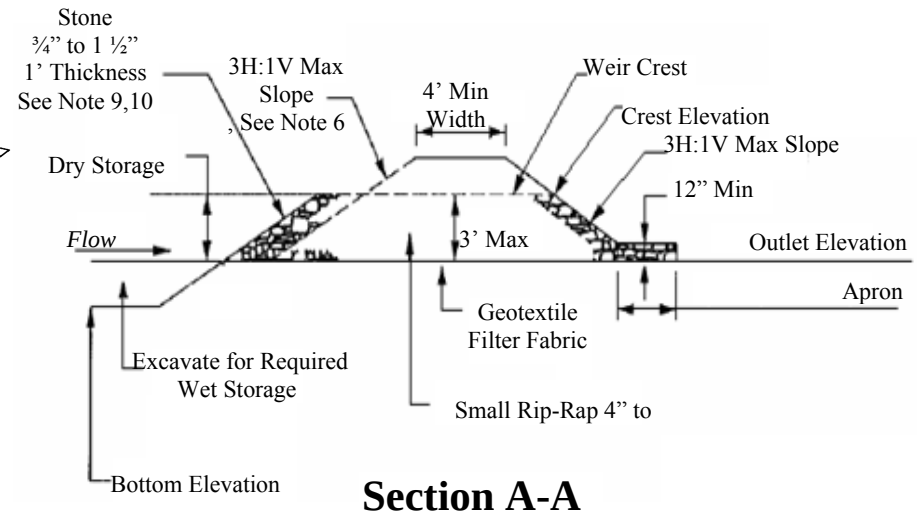
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

U.S. Environmental Protection Agency (USEPA). Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters. EPA 840-B-9-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1993.

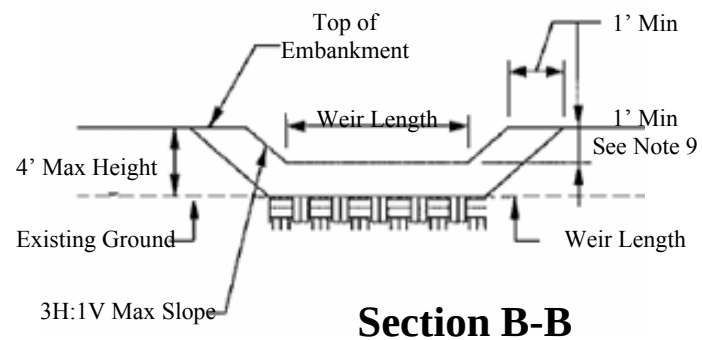
Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



Detail "A"
Not to Scale



Section A-A
Not to Scale

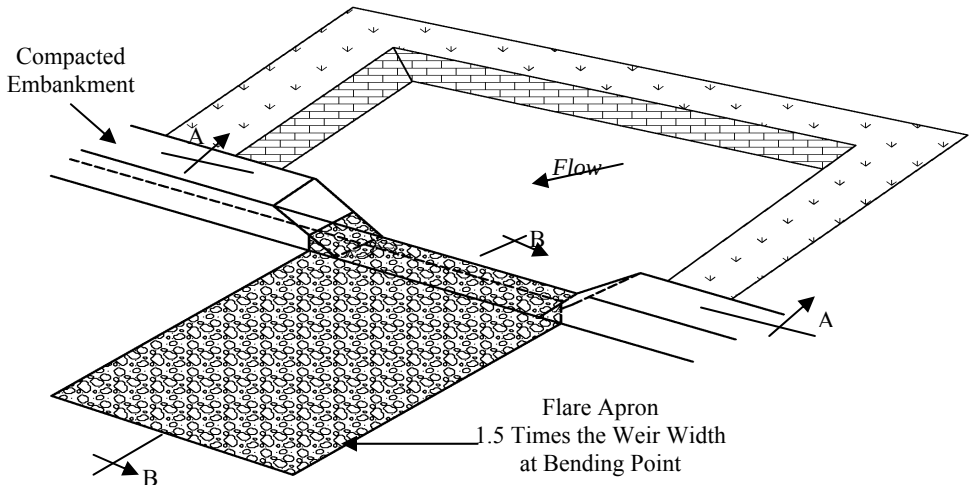


Section B-B
Not to Scale

1. Sediment traps may be used on construction projects where the drainage area is less than 5 acres.
2. Trap should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 133 yd^3/acre and 66 yd^3/acre of contributing drainage area, respectively, based on 1.0 in. of runoff volume over a 24-hour period.
3. Install continuous fencing around the sediment trap or pond. Consult City ordinances regarding requirements for maintaining health and safety.
4. The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
5. The embankment may be compacted by traversing with equipment while it is being constructed.
6. All cut-and-fill slopes should be 3:1 or flatter.
7. When a riser is used, all pipe joints must be watertight.
8. When a riser is used, at least the top two-thirds of the riser should be perforated with 0.5 in. diameter holes spaced 8 in. vertically and 10 to 12 in. horizontally. See SE-2, Sediment Basin.
9. When an earth or stone outlet is used, the outlet crest elevation should be at least 1 ft. below the top of the embankment.
10. When crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2.
11. Traps with an impounding levee greater than 4.5 ft. tall and traps capable of impounding more than 35,000 ft^3, should be designed by a Licensed Civil Engineer.

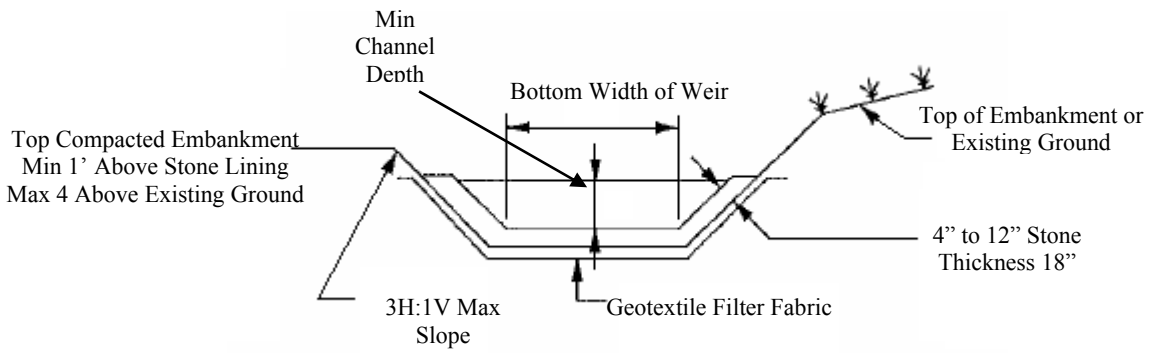
Stone Outlet Sediment Trap

Source: Modified from Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994



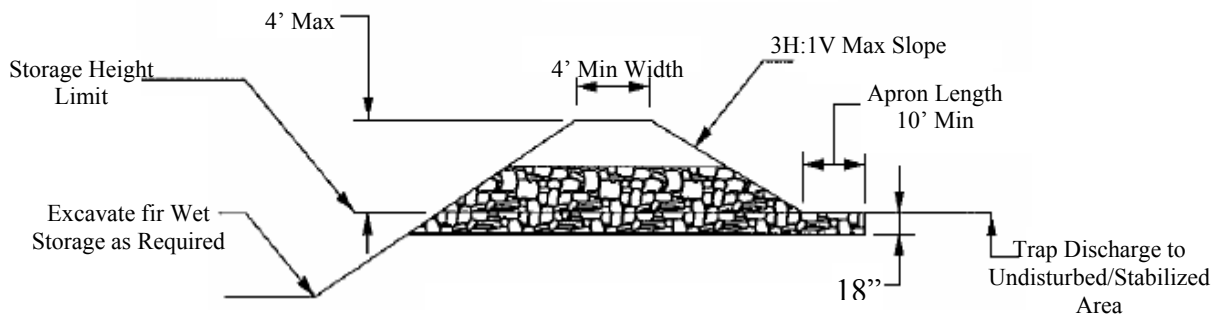
Detail "B"

Not to Scale



Section A-A

Not to Scale



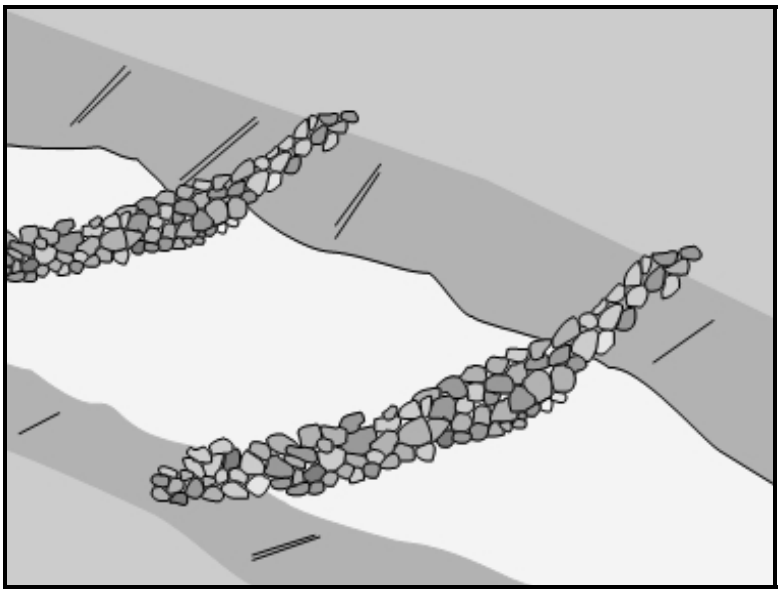
Section B-B

Not to Scale

Rip-Rap Outlet Sediment Trap

Source: Modified from Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994

Check Dams SE-4



Objectives

EC – Erosion Control	▲
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam;
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales;
- In small open channels that drain 10 acres or less;
- In steep channels where storm water runoff velocities exceed 5 ft/s;
- During the establishment of grass linings in drainage ditches or channels; and
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.

Limitations

- Not to be used in live streams or in channels with extended base flows.
- Not appropriate in channels that drain areas greater than 10 acres.

- Not appropriate in channels that are already grass-lined unless erosion is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Reduced slopes reduce the velocity of storm water flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Use of check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity should be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, there are several options:

- Do not use check dams. Consider alternative BMPs; or
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam. The center section of the dam should be lower than the edge sections so that the check dam will direct flows to the center of the ditch or swale.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products manufactured specifically for use as check dams are also being used, and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Straw bales can also be used for check dams and can work if correctly installed; but in practice, straw bale check dams have a high failure rate. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam must completely span the ditch or swale to prevent washout. The rock used should be large enough to stay in place given the expected design flow through the channel.

Log check dams are usually constructed of 4 to 6 in. diameter logs. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

Gravel bag and sandbag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet.

Manufactured products should be installed in accordance with the manufacturer's instructions.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft. from the outfall device and at regular intervals based on slope gradient and soil type;
- Check dams should be placed at a distance and height to allow small pools to form between each check dam;
- Backwater from a downstream check dam should reach the toes of the upstream check dam;
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap must be cleaned following each storm event;
- High flows (typically a 10-year, 1-hour duration storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam;
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale; and
- Gravel bags may be used as check dams with the following specifications:

Materials

Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms. Sandbags used for check dams should conform to SE-8, Sandbag Barrier.

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section. Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Fiber rolls should be trenched in and firmly staked in place.

Costs

Cost consists of only installation costs if materials are readily available. If material must be imported, costs may increase. For material costs, see SE-5, SE-6, and SE-8.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Replace missing rock, bags, etc. Replace bags that have degraded or have become damaged.
- If the check dam is used as a sediment capture device, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

References

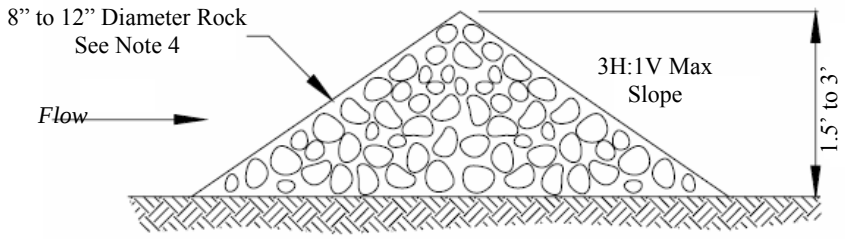
California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Draft - Sedimentation and Erosion Control, and Inventory of Current Practices, USEPA, April 1990.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

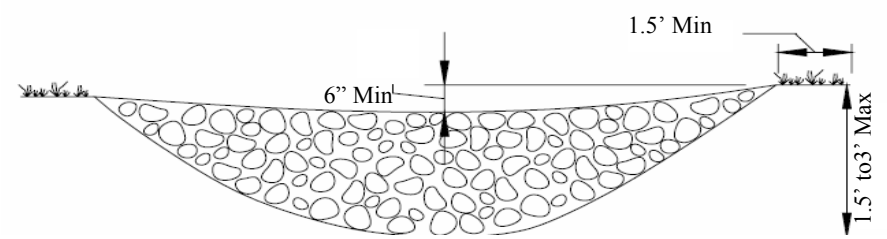
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



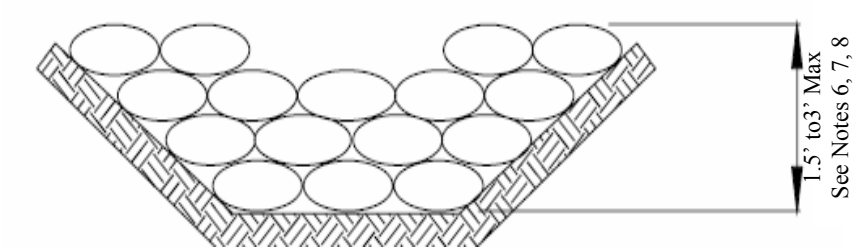
Type “A” Rock Check Dam

Not to Scale



Type “B” Rock Check Dam

Not to Scale



Gravel Bag Check Dam Elevation

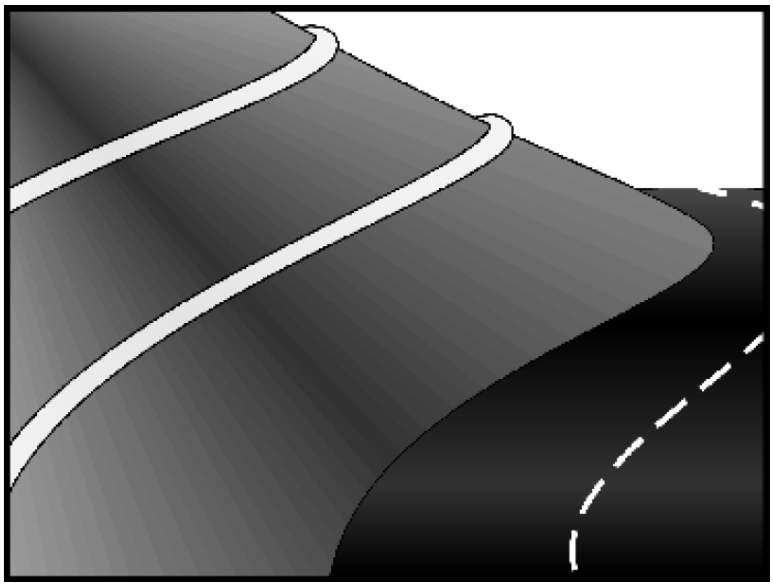
Not to Scale

Notes:

1. Install the first check dam approximately 16 ft. from the outfall device and at regular intervals based on slope gradient and soil type.
2. Check dams may be used in small open channels that drain 10 acres or less.
3. Check dams may be used in steep channels where storm water runoff velocities exceed 5 ft/s.
4. Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel.
5. Log check dams are usually constructed of 4 to 6 in. diameter logs. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.
6. Gravel bags and sandbags should not be stacked any higher than 3 ft.
7. Tightly abut bags.
8. Gravel bags used should conform to the requirements of SE-6. Sandbags used should conform to SE-8.
9. Fiber rolls should be trenched in and firmly staked in place.
10. Manufactured products should be installed in accordance with the manufacturer’s instructions. For Design and Layout see SE-4 Check Dams.

Check Dams

Fiber Rolls SE-5



Objectives

EC – Erosion Control	▲
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

A fiber roll consists of straw, flax, mulch, or other similar materials bound into a tight tubular roll. When fiber rolls are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, fiber rolls can also reduce erosion.

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow;
- At the end of a downward slope where it transitions to a steeper slope;
- Along the perimeter of a project;
- As check dams in unlined ditches;
- Down-slope of exposed soil areas; and/or
- Around temporary stockpiles.

Limitations

- Fiber rolls are not effective unless trenched.
- Fiber rolls at the toe of slopes greater than 5:1 (H:V) should be a minimum of 20 in. diameter or installations achieving the same protection (i.e. stacked smaller diameter fiber rolls, etc.).
- Difficult to move once saturated.

- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.

Implementation

Fiber Roll Materials

- Fiber rolls should be either prefabricated rolls or rolled tubes of erosion control blanket.

Assembly of Field Rolled Fiber Roll

- Roll length of erosion control blanket into a tube of minimum 8 in. diameter.
- Bind roll at each end and every 4 ft. along length of roll with jute-type twine.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.;
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective); and
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into a 2 to 4 in. deep trench with a width equal to the diameter of the fiber roll.
  - Drive stakes at the end of each fiber roll and spaced 4 ft. maximum on center.
  - Use stakes with a minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.

Removal

- Fiber rolls are typically left in place.
- If fiber rolls are removed, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

Costs

Material costs for fiber rolls range from $20 - $30 per 25 ft. roll in California. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP must be periodically

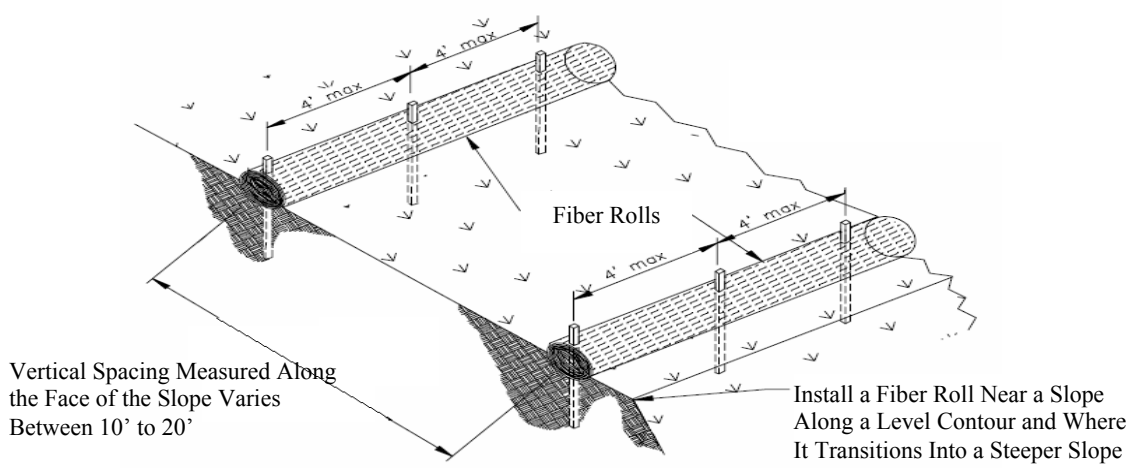
removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage depth, usually one-half the distance between the top of the fiber roll and the adjacent ground surface. Sediment removed during maintenance may be incorporated into earthwork on the site of disposed at an appropriate location.

- If fiber rolls are used for erosion control, such as in a mini check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.

References

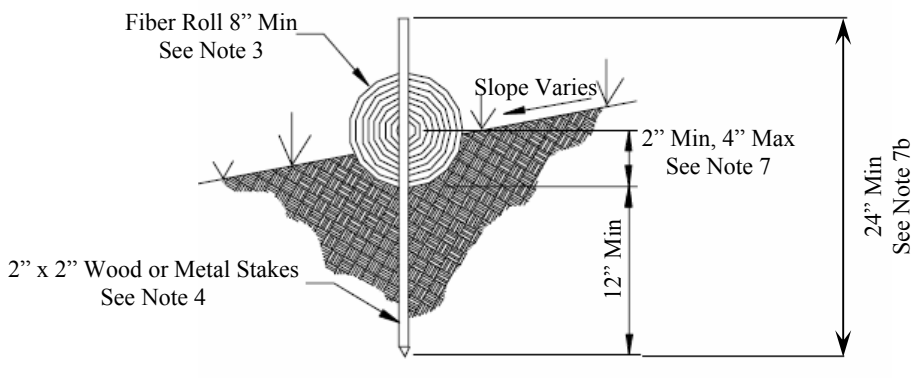
California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



Detail "A"

Not to Scale



Section A-A

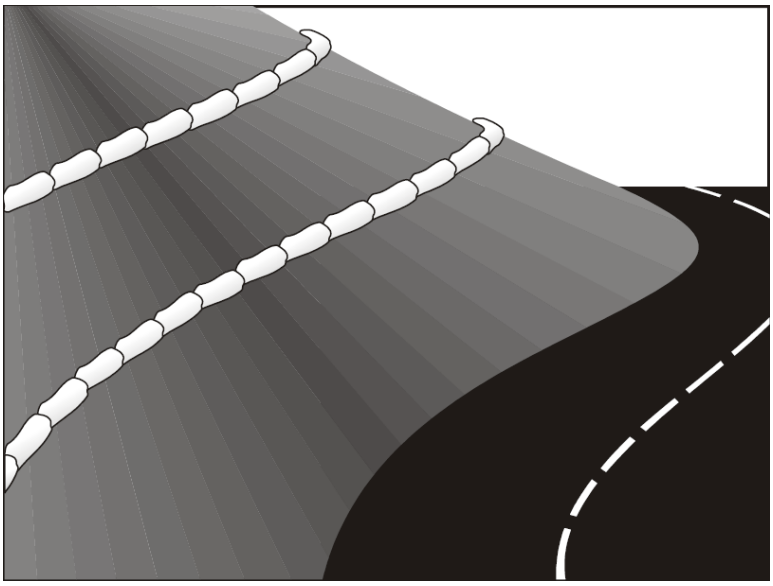
Not to Scale

Notes:

1. Fiber rolls at the toe of slopes greater than 5:1 (H:V) should be a minimum of 20 in. diameter or installations achieving the same protection.
2. Fiber rolls should be either prefabricated rolls or rolled tubes of erosion control blanket.
3. Roll length of erosion control blanket into a tube of minimum 8 in. diameter.
4. Bind roll at each end and every 4 ft. along length of roll with jute-type twine.
5. Locate fiber rolls on level contours spaced as follows:
   a. Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
   b. Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
   c. Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
6. Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
7. Stake fiber rolls into a 2 to 4 in. deep trench with a width equal to the diameter of the fiber roll.
   a. Drive stakes at the end of each fiber roll and spaced 4 ft. maximum on center.
   b. Use stakes with a minimum length of 24 in.
8. If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.

Fiber Rolls

Gravel Bag Berm SE-6



Objectives

EC – Erosion Control	▲
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-8 Sandbag Barrier

Description and Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flows, preventing erosion.

Suitable Applications

Gravel bag berms may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes;
  - As sediment traps at culvert/pipe outlets;
  - Below other small cleared areas;
  - Along the perimeter of a site;
  - Down slope of exposed soil areas;
  - Around temporary stockpiles and spoil areas;
  - Parallel to a roadway to keep sediment off paved areas; or
  - Along streams and channels.
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow;
  - At the top of slopes to divert runoff away from disturbed slopes; or
  - As check dams across mildly sloped construction roads.

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berm may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the filter, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Berms may have limited durability for long-term projects.
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

A gravel bag berm consists of a row of open graded gravel–filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sand bag barriers, but are more porous.

Design and Layout

- Locate gravel bag berms on level contours.
  - Slopes between 20:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 50 ft. (a closer spacing is more effective), with the first row near the slope toe.
  - Slopes 2:1 (H:V) or steeper: Gravel bags should be placed at a maximum interval of 25 ft. (a closer spacing is more effective), with the first row placed the slope toe.
- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the gravel bag barriers away from the slope toe to facilitate cleaning. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum,
  - Top width = 24 in. minimum for three or more layer construction,
  - Top width = 12 in. minimum for one or two layer construction, and
  - Side slopes = 2:1 or flatter.

- In Construction Traffic Areas:
  - Height = 12 in. maximum,
  - Top width = 24 in. minimum for three or more layer construction,
  - Top width = 12 in. minimum for one or two layer construction, and
  - Side slopes = 2:1 or flatter.
- Butt ends of bags tightly.
- On multiple row, or multiple layer construction, overlap butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.

Materials

- **Bag Material:** Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.
- **Bag Size:** Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.
- **Fill Material:** Fill material should be 0.5 to 1 in. Class 2 aggregate base, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel.

Costs

Gravel filter: Expensive, since off-site materials, hand construction, and demolition/removal are usually required. Material costs for gravel bags are average of $2.50 per empty gravel bag.

Gravel costs range from $20-$35 per yd^3 in California. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.
- Reshape or replace gravel bags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove gravel bag berms when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Handbook of Steel Drainage and Highway Construction, American Iron and Steel Institute, 1983.

Stormwater Pollution Plan Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials and Research, October 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Street Sweeping and Vacuuming SE-7

Objectives

EC – Erosion Control	
SE – Sediment Control	▲
TR – Tracking Control	√
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	√
Metals	
Bacteria	
Oil and Grease	√
Organics	

Potential Alternatives

None

Description and Purpose

Street sweeping, washing and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping, washing and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.
- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.

- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

NPDES Permit Background

NPDES Permit No. HI S000002 issued by the State Department of Health (DOH) to the City and County of Honolulu for its municipal separate storm sewer system provides in pertinent part as follows:

> "The following non-storm water discharges may be discharged into the Permittee's separate storm sewer system without an NPDES permit, provided that the Permittee determines that such discharges will not contain pollutants in amounts that will cause or contribute to a violation of an applicable water quality standard and the SWMP [Storm Water Management Plan] shall identify and ensure the implementation of appropriate pollution prevention measures for the non-storm water component(s) of the discharge."
>
> "Residual street wash water (water only), including wash water from sidewalks, plazas, and driveways, but excluding parking lots."
>
> "The discharge of pollutants from the Permittee's MS4 [Municipal Separate Storm Sewer Systems] and Small MS4 facilities shall be reduced to the Maximum Extent Practicable (MEP)."

Handling Procedure

The Department of Environmental Services (ENV) acknowledges that it may be necessary to wash streets to control dust, sediment, and other pollutants during construction. However, the discharger should use appropriate BMPs and be responsible for complying with the City, State and Federal rules and regulations. Other related BMPs include graveled entrances and, if necessary, tire washing.

The following handling procedures are listed for guidance purposes only where they are deemed applicable:

- The street should be swept (or alternative dry cleanup methods) before any washing takes place. Alternatively, washing may occur in the uphill direction and immediately followed by a vacuum truck;
- Drain inlet should be protected with a "Gutter Buddy," "True Dam," or other drain inlet protection device, or water should be directed away from drain inlets; and
- No chemicals or solvents may be used during washing.

For more information, please call the Storm Water Quality Branch of ENV at (808) 768-3242.

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental.

Expect rental rates from \$58/hour (3 yd^3 hopper) to \$88/hour (9 yd^3 hopper), plus operator costs in California. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

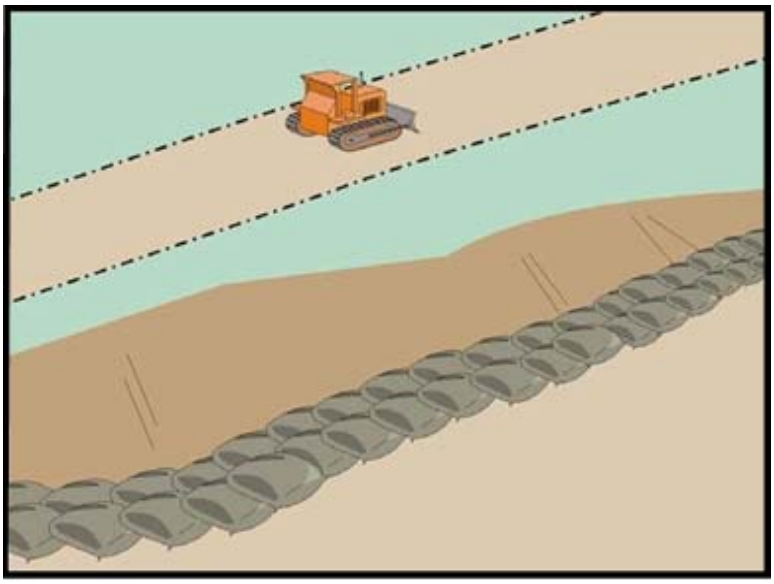
California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

State of Hawaii Department of Health Clean Water Branch NPDES Permit HIS000002 for City & County of Honolulu.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Sandbag Barrier SE-8



Objectives

EC – Erosion Control	▲
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

Description and Purpose

A sandbag barrier is a series of sand-filled bags placed on a level contour to intercept sheet flows. Sandbag barriers pond sheet flow runoff, allowing sediment to settle out.

Suitable Applications

Sandbag barriers may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes;
  - As sediment traps at culvert/pipe outlets;
  - Below other small cleared areas;
  - Along the perimeter of a site;
  - Down slope of exposed soil areas;
  - Around temporary stockpiles and spoil areas;
  - Parallel to a roadway to keep sediment off paved areas; or
  - Along streams and channels.
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow;
  - At the top of slopes to divert runoff away from disturbed slopes; or
  - As check dams across mildly sloped construction roads.

Limitations

- It is necessary to limit the drainage area upstream of the barrier to 5 acres.
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor intensive.
- Barriers may have limited durability for long-term projects.
- When used to detain concentrated flows, maintenance requirements increase.
- Burlap should not be used for sandbags.

Implementation

General

A sandbag barrier consists of a row of sand-filled bags placed on a level contour. When appropriately placed, a sandbag barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. While the sand-filled bags are porous, the fine sand tends to quickly plug with sediment, limiting the rate of flow through the barrier. If a porous barrier is desired, consider SE-1, Silt Fence, SE-5, Fiber Rolls, or SE-6, Gravel Bag Berms. Sandbag barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets which erode rills, and ultimately gullies, into disturbed, sloped soils. Sandbag barriers are similar to ground bag berms, but less porous.

Design and Layout

- Locate sandbag barriers on a level contour.
  - Slopes between 20:1 and 2:1 (H:V): Sandbags should be placed at a maximum interval of 50 ft. (a closer spacing is more effective), with the first row near the slope toe.
  - Slopes 2:1 (H:V) or steeper: Sandbags should be placed at a maximum interval of 25 ft. (a closer spacing is more effective), with the first row placed near the slope toe.
- Turn the ends of the sandbag barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the barrier away from the slope toe to facilitate cleaning. To prevent flow behind the barrier, sandbags can be placed perpendicular to the barrier to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- Stack sandbags at least three bags high with proper side slopes.
- Butt ends of bags tightly.
- Overlap butt joints of row beneath with each successive row.
- Use a pyramid approach when stacking bags.

- In non-traffic areas:
  - Height = 12 in. maximum,
  - Top width = 12 in. minimum for three or more layer construction, and
  - Side slope = 2:1 or flatter.
- In construction traffic areas:
  - Height = 12 in. maximum,
  - Top width = 24 in. minimum for three or more layer construction, and
  - Side slopes = 2:1 or flatter.

Materials

- **Sandbag Material:** Sandbag should be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. Use of burlap may not acceptable in some jurisdictions.
- **Sandbag Size:** Each sand-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.
- **Fill Material:** All sandbag fill material should be non-cohesive soil permeable material free from clay and deleterious material.

Costs

Sandbag barriers are more costly, but typically have a longer useful life than other barriers. Empty sandbags cost $0.25 - $0.75. Average cost of fill material is $8 per yd^3. Pre-filled sandbags are more expensive at $1.50 - $2.00 per bag in California. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

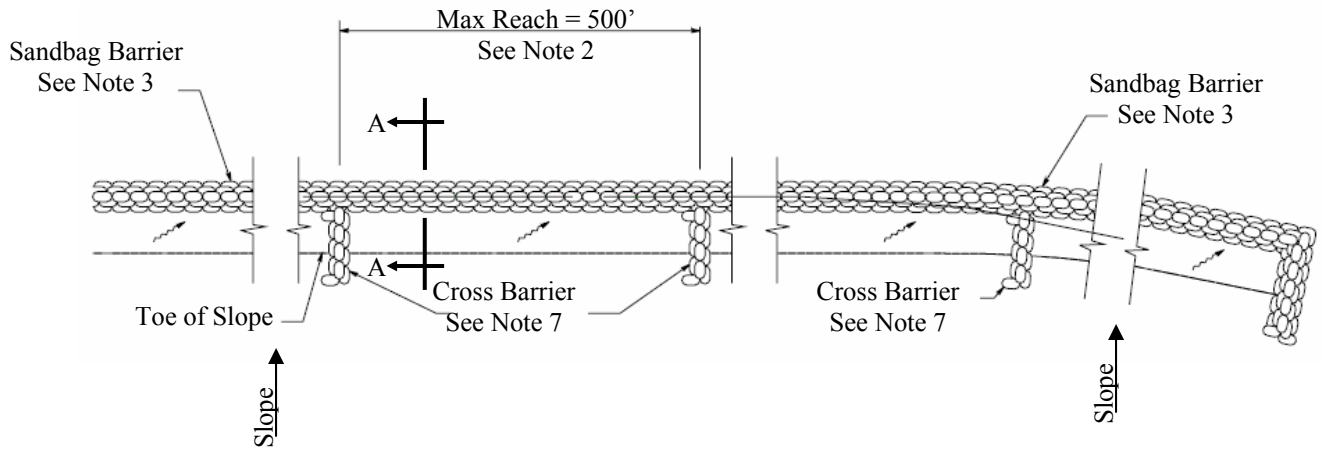
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Sandbags exposed to sunlight will need to be replaced every two to three months due to degradation of the bags.
- Reshape or replace sandbags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove sandbags when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

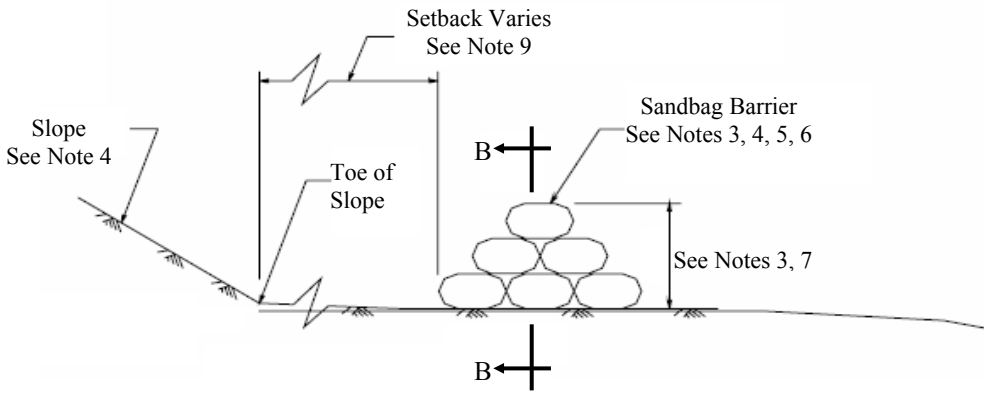
The Disaster Handbook 1998 National Edition, Institute of Food and Agricultural Sciences, University of Florida.



Detail "A"
Not to Scale

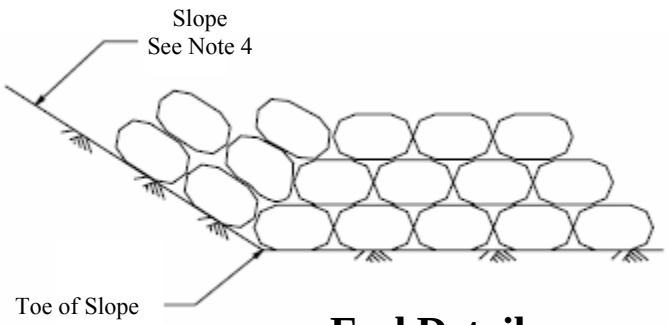
Notes:
1. Drainage area should not exceed 5 acres.
2. Construct the length of each reach so that the change in base elevation along the reach does not exceed ½ the height of the linear barrier. In no case shall the reach length exceed 500'.
3. Stack sandbags at least three bags high with proper side slopes using a pyramid approach.
4. Locate sandbag barriers on a level contour.
   a. Slopes between 20:1 and 2:1 (H:V): Sandbags should be placed at a maximum interval of 50 ft. (a closer spacing is more effective), with the first row near the slope toe.
   b. Slopes 2:1 (H:V) or steeper: Sandbags should be placed at a maximum interval of 25 ft. (a closer spacing is more effective), with the first row placed near the slope toe.
5. Overlap butt joints of row beneath with each successive row.
6. The end of the barrier shall be turned up slope.
7. Cross barriers shall be a min of ½ and a max of 2/3 of the height of the linear barrier.
8. Sandbag material must conform to ASTM designation D3786 and ASTM designation D4355.
9. Dimensions may vary to fit field condition.
10. For Sandbag and Fill Material Specifications see SE-8 Sandbag Barrier, Materials.

Sandbag Barrier

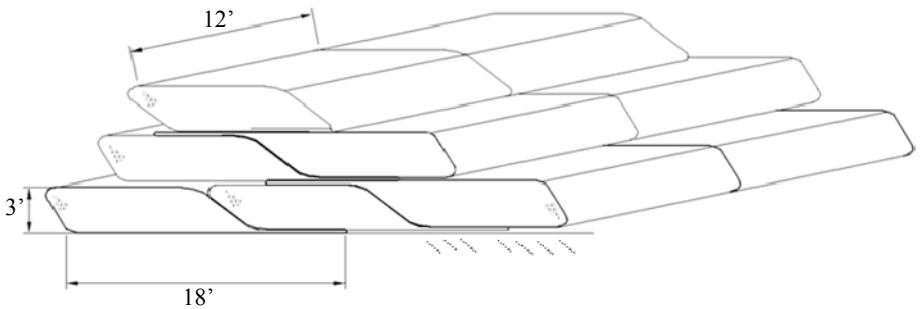


Section A-A
Not to Scale

Section B-B
See Note 5
Not to Scale



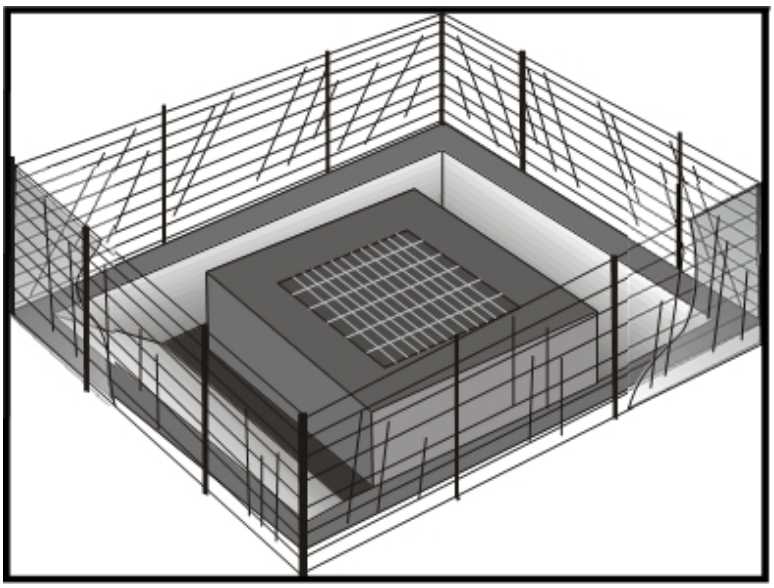
End Detail
See Note 6
Not to Scale



Stacked Sandbags
See Note 3
Not to Scale

Overlapping Sandbags
Not to Scale

Storm Drain Inlet Protection SE-10



Objectives

EC – Erosion Control

SE – Sediment Control √

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment √

Nutrients

Trash √

Metals

Bacteria

Oil and Grease

Organics

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area around or upstream of a storm drain, drop inlet, or curb inlet. Storm drain inlet protection measures temporarily pond runoff before it enters the storm drain, allowing sediment to settle. Some filter configurations also remove sediment by filtering, but usually the ponding action results in the greatest sediment reduction.

Suitable Applications

Every storm drain inlet receiving sediment-laden runoff should be protected.

Limitations

- Drainage area should not exceed 1 acre.
- Not applicable for inlets within pedestrian or vehicle travel ways.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.
- Inlet protection usually requires other methods of temporary protection to prevent sediment-laden storm water and non-storm water discharges from entering the storm drain system.
- Sediment removal may be difficult in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are expected, use other onsite sediment trapping techniques in conjunction with inlet protection.
- Frequent maintenance is required.

- For drainage areas larger than 1 acre, runoff should be routed to a sediment-trapping device designed for larger flows. See BMPs SE-2, Sediment Basin, and SE-3, Sediment Traps.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected, and overflow capability is needed.

Implementation

General

Large amounts of sediment may enter the storm drain system when storm drains are installed before the upslope drainage area is stabilized, or where construction is adjacent to an existing storm drain. In cases of extreme sediment loading, the storm drain itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Inlet control measures presented in this manual should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through SE-2, Sediment Basin or SE-3, Sediment Trap. Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Inlet protection methods not presented in this manual should be approved by the City DPP.

Design and Layout

Identify existing and planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed and which method to use.

- Limit upstream drainage area to 1 acre maximum. For larger drainage areas, use SE-2, Sediment Basin, or SE-3, Sediment Trap, upstream of the inlet protection device.
- The key to successful and safe use of storm drain inlet protection devices is to know where runoff will pond or be diverted.
  - Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm drain inlet protection device.
  - Determine the extent of potential runoff diversion caused by the storm drain inlet protection device. Runoff ponded by inlet protection devices may flow around the device and towards the next downstream inlet. In some cases, this is acceptable; in other cases, serious erosion or downstream property damage can be caused by these diversions. The possibility of runoff diversions will influence whether or not storm drain inlet protection is suitable; and, if suitable, the type and design of the device.
- The location and extent of ponding, and the extent of diversion, can usually be controlled through appropriate placement of the inlet protection device. In some cases, moving the inlet protection device a short distance upstream of the actual inlet can provide more efficient sediment control, limit ponding to desired areas, and prevent or control diversions.
- Five types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.
  - Filter Fabric Fence: Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5 cfs.

- Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (SE-3).
- Gravel bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets. Appropriate for sheet flow or when concentrated flow may exceed 0.5 cfs, and where overtopping is required to prevent flooding.
- Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
- Temporary Geotextile Insert: Application dependant on type and manufacturer.

- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Provide area around the inlet for water to pond without flooding structures and property.
- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.
- Excavate sediment sumps (where needed) 1 to 2 ft. with 2:1 side slopes around the inlet.

Installation

- **DI Protection Type 1 - Filter Fabric Fence -** The filter fabric fence (Type 1) protection is shown in the attached figure. Similar to constructing a silt fence; see BMP SE-1, Silt Fence. Do not place filter fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced.
  - Excavate a trench approximately 6 in. wide and 6 in. deep along the line of the silt fence inlet protection device.
  - Place 2 in. by 2 in. wooden stakes, metal stakes or #4 rebar with cap around the perimeter of the inlet a maximum of 3 ft. apart and drive them at least 18 in. into the ground or 12 in. below the bottom of the trench. The stakes should be at least 48 in.
  - Lay fabric along bottom of trench, up side of trench, and then up stakes. See SE-1, Silt Fence, for details. The maximum silt fence height around the inlet is 24 in.
  - Staple the filter fabric (for materials and specifications, see SE-1, Silt Fence) to stakes. Use heavy-duty wire staples or wire at least 1 in. in length.
  - Backfill the trench with gravel or compacted earth all the way around.
- **DI Protection Type 2 - Excavated Drop Inlet Sediment Trap -** The excavated drop inlet sediment trap (Type 2) is shown in the attached figures. Install filter fabric fence in accordance with DI Protection Type 1. Size excavated trap to provide a minimum storage capacity calculated at the rate 67 yd^3/acre of drainage area.
- **DI Protection Type 3 - Gravel bag -** The gravel bag barrier (Type 3) is shown in the figures. Flow from a severe storm should not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with SE-6, Gravel Bag Berm. Gravel bags should be used due to their high permeability.
  - Use sand bag made of geotextile fabric (not burlap) and fill with 0.75 in. rock or 0.25 in. pea gravel.
  - Construct on gently sloping street.
  - Leave room upstream of barrier for water to pond and sediment to settle.

- Place several layers of sand bags - overlapping the bags and packing them tightly together.
- Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10 year storm) should not overtop the curb.

- **DI Protection Type 4 - Gravel Filter** - The gravel filter (Type 4) is shown in the figures. Gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction.
  - Place hardware cloth or comparable wire mesh with 0.5 in. openings over the drop inlet so that the wire extends a minimum of 1 ft. beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place filter fabric over the wire mesh.
  - Place wire mesh over the outside vertical face (open end) of the inlet to prevent stone from being washed through. Use hardware cloth or comparable wire mesh with 0.5 in. opening.
  - Pile washed aggregate against the wire mesh to the top of the inlet. Use 0.75 to 3 in aggregate.
- **DI Protection Type 5** – Temporary Geotextile Insert (proprietary) – Many types of temporary inserts are available. Most inserts fit underneath the grate of a drop inlet or inside a curb inlet and are fastened to the outside of the grate or curb. These inserts are removable and many can be cleaned and reused. Installation of these inserts differs between products and manufactures. Please refer to manufacturer instruction for installation of proprietary devices.

Costs

Average annual cost for installation and maintenance (one year useful life) is $200 per inlet in California. Note that Hawaii's unit prices are higher than California's unit prices.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- During flash flood warning or advisories from the National Weather Service DOH-CWB recommends that the contractor perform maintenance on all site BMPs followed by removal of inlet protection. At these times, public (human) health and safety is paramount to control of pollutants entering the waterways. Reinstall all inlet protection when warning or advisories ended.
- Filter Fabric Fences. If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes. Check for gaps in the fabric, where the fabric overlaps, and if the posts need cross bracing due to high water levels.
- Gravel Filters. If the gravel becomes clogged with sediment, it shall be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment-laden stone as fill material

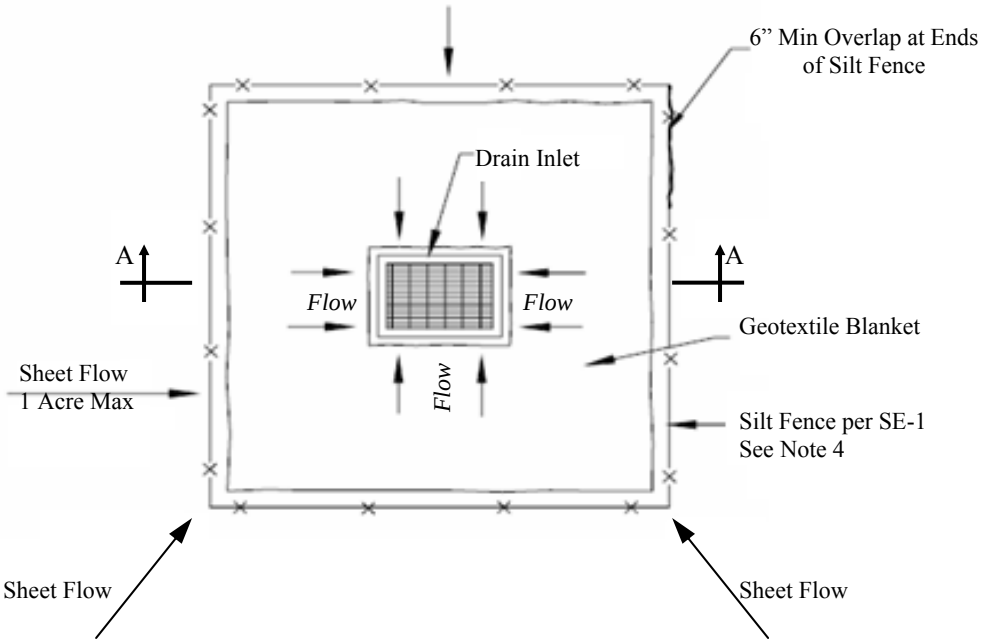
and put fresh stone around the inlet. Inspect bags for holes, gashes, and snags, and replace bags as needed. Check gravel bags for proper arrangement and displacement.

- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site ore disposed at an appropriate location.
- Remove storm drain inlet protection once the drainage area is stabilized. Clean and regrade area around the inlet and clean the inside of the storm drain inlet as it must be free of sediment and debris at the time of final inspection.

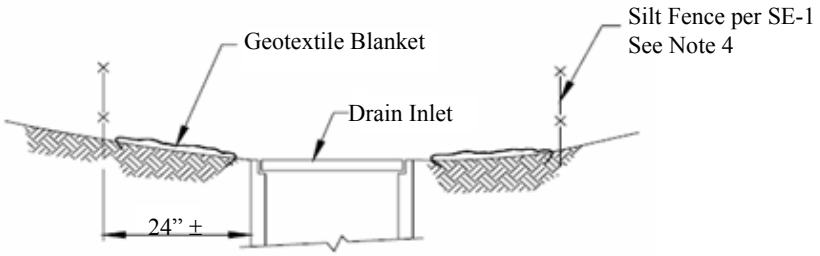
References

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



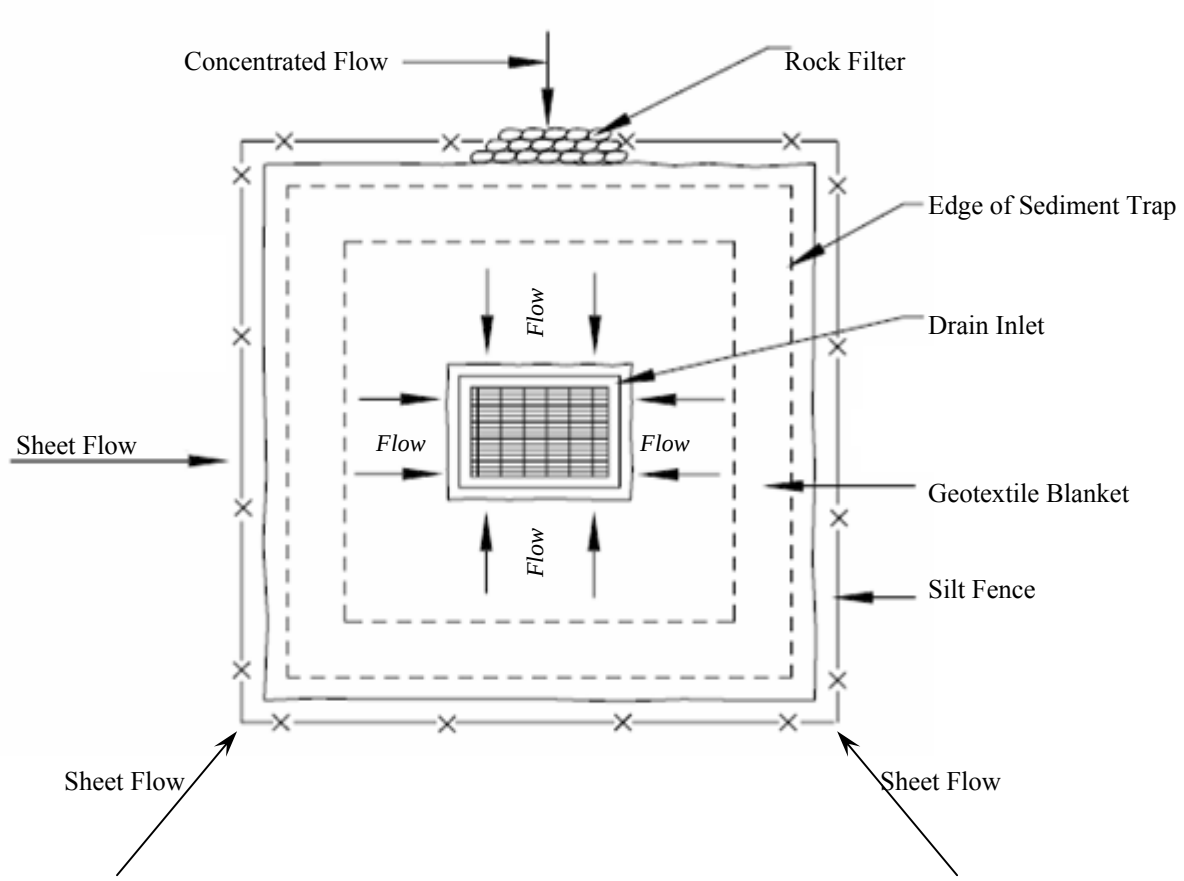
Detail “A”
Not to Scale



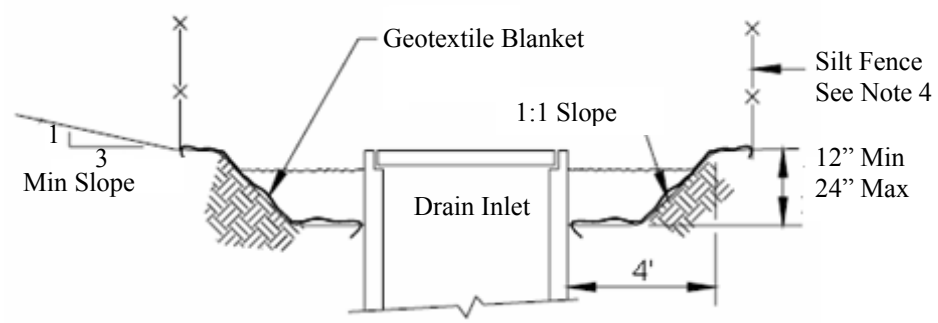
Section A-A
Not to Scale

Notes:
1. For use in areas where grading has been completed and final soil stabilization and seeding are pending.
2. Not applicable in paved areas.
3. Not applicable in concentrated flows.
4. Refer to BMP SE-1, Silt Fence for construction.

DI Protection Type 1, Filter Fabric Fence

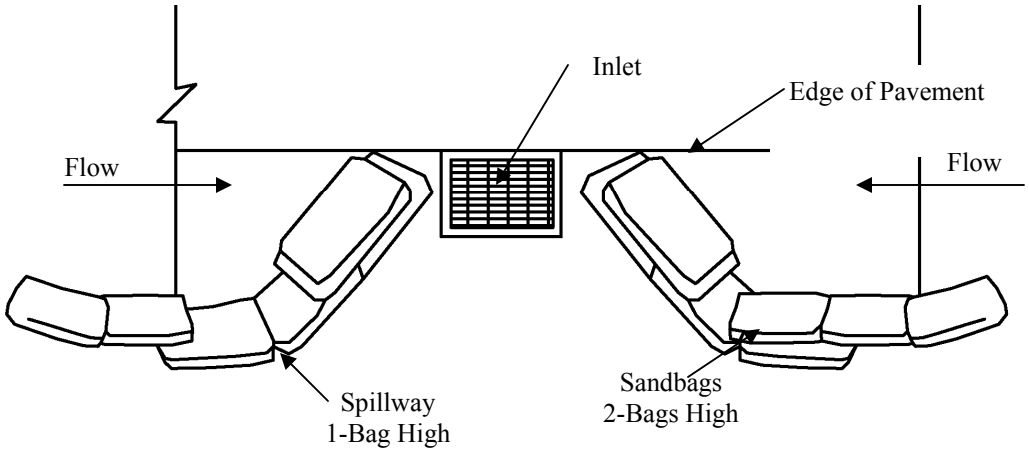


Detail "B"
Not to Scale

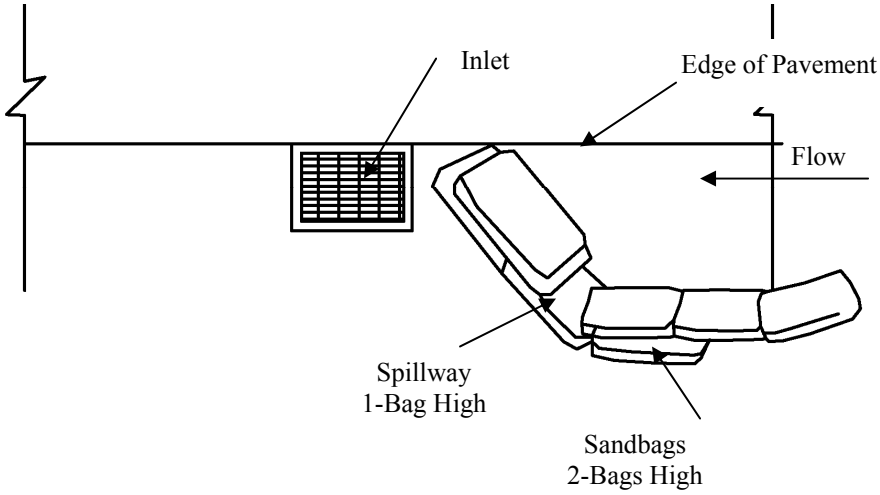


Notes:
1. For use in cleared and grubbed and in graded areas.
2. For concentrated flows, shape basin in 2:1 (L:W) ratio with length oriented towards direction of flow.
3. Size excavated trap to provide a minimum storage capacity calculated at the rate 67 yd^3/acre of drainage area.
4. Refer to BMP SE-1, Silt Fence for construction.

DI Protection Type 2, Excavated Drop Inlet Sediment Trap



Typical Protection for Inlet on Sump, Detail "C"
Not to Scale



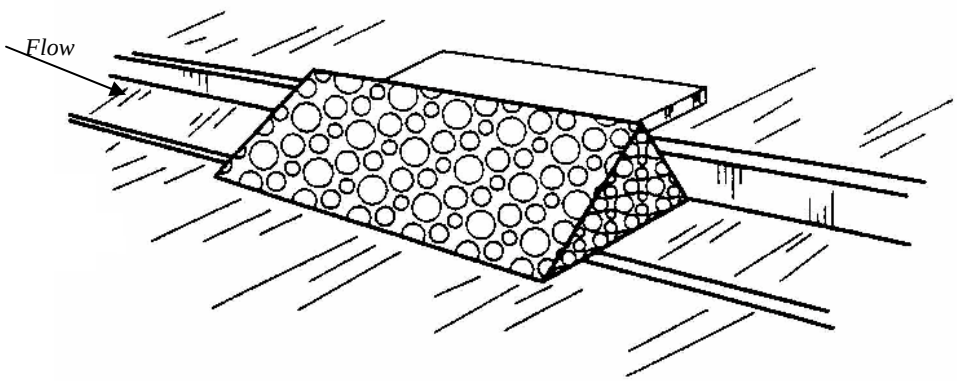
Typical Protection for Inlet on Grade, Detail "D"
Not to Scale

Notes:
1. Intended for short-term use. Not suitable for roads open to traffic.
2. Used to inhibit non-storm water flow.
3. Bags **should** be removed after adjacent operation is completed.
4. Not applicable in areas with high silts and clays without filter fabric.
5. Use sand bag made of geotextile fabric (not burlap) and fill with 0.75 in. rock or 0.25 in. pea gravel.
6. Construct on gently sloping street.
7. Leave room upstream of barrier for water to pond and sediment to settle.
8. Place several layers of sand bags - overlapping the bags and packing them tightly together.
9. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10 year storm) should not overtop the curb.
10. Do not use sandbags for roadways subject to traffic.
11. For traffic area, insert geotextile filter inserts instead of sandbags.

DI Protection Type 3, Gravel Bag

Detail "E"

Not to Scale



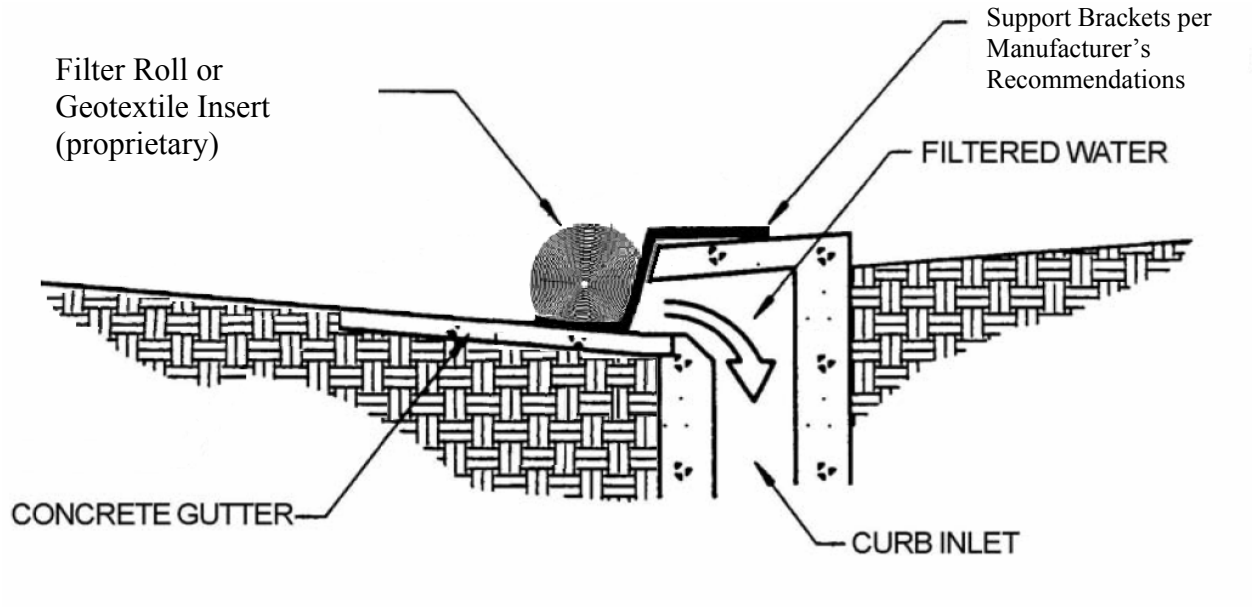
Section E-E

Not to Scale

Notes:

1. Place hardware cloth or comparable wire mesh with 0.5 in. openings over the drop inlet so that the wire extends a minimum of 1 ft. beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips.
2. Place filter fabric over the wire mesh.
3. Place wire mesh over the outside vertical face (open end) of the inlet to prevent stone from being washed through. Use hardware cloth or comparable wire mesh with 0.5 in. opening.
4. Pile washed stone against the wire mesh to the top of the inlet. Use 0.75 to 3 in stones.
5. Do not use gravel within vehicle and pedestrian traffic areas.
6. For traffic areas, insert geotextile filter inserts instead of gravel filters.

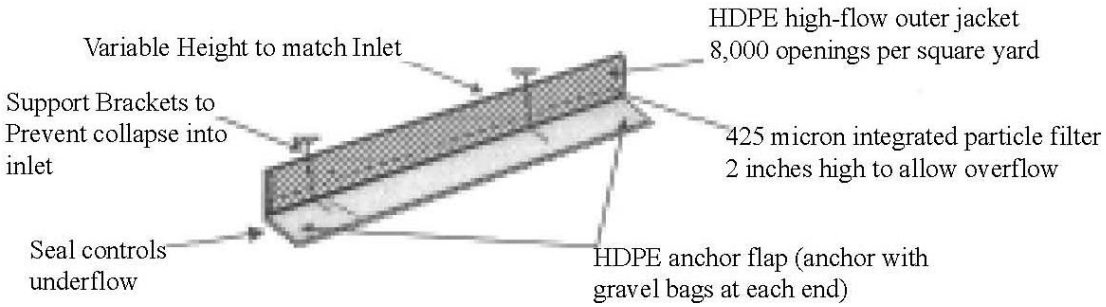
DI Protection Type 4, Gravel and Wire Mesh Filter for Curb Inlet



Detail "F"

Not to Scale and May Use Various Types of Geotextile Inserts

DI Protection Type 5, Filter Roll or Geotextile Insert with Supports for Curb Inlet

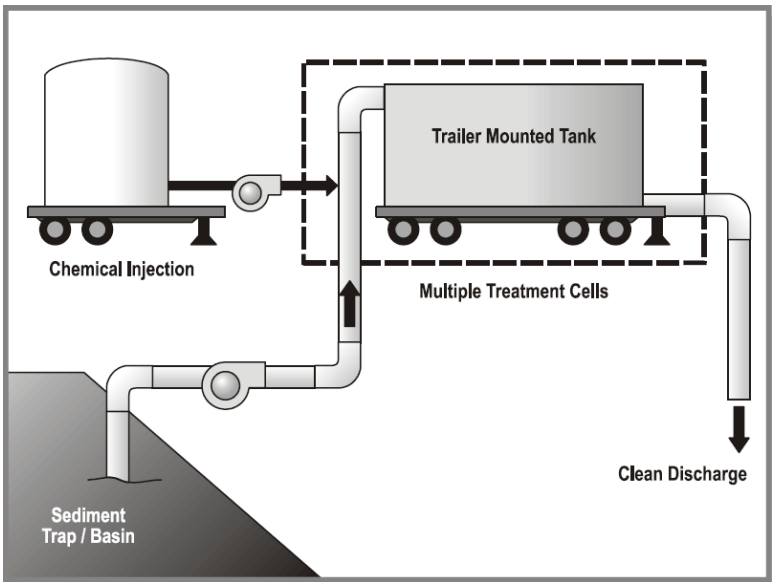


Detail "G"

Not to Scale and May Use Various Types and Styles of Geotextile Inserts

DI Protection Type 5, Geotextile Insert with Supports for Curb Inlet

Chemical Treatment SE-11



Objectives

EC – Erosion Control

SE – Sediment Control √

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment √

Nutrients

Trash

Metals

Bacteria

Oil and Grease

Organics

Potential Alternatives

None

Description and Purpose

Chemical treatment includes the application of chemicals to storm water to aid in the reduction of turbidity caused by fine suspended sediment.

Suitable Applications

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants and should be considered where turbid discharges to sensitive wastes cannot be avoided using other BMPs. Typically, chemical use is limited to waters with numeric turbidity standards.

Limitations

The use of chemical treatment should have the advanced approval of the State of Hawaii Department of Health, Clean Water Branch (CWB).

- Chemical Treatment of storm water is relatively new and unproven technology in California or Hawaii;
- BMP has not been used often in California or Hawaii;
- Petroleum based polymers should not be used;
- Requires sediment basin or trailer mounted unit for chemical application;
- Batch treatment required, flow through continuous treatment not allowed;
- Requires large area;
- Limited discharge rates depending on receiving water body;

- Labor intensive operation and maintenance; and
- Requires monitoring for non-visible pollutants.

Implementation

Turbidity is difficult to control once fine particles are suspended in storm water runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling, but are ineffective at removing smaller particulates such as clay and fine silt. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Chemical treatment may be used to reduce the turbidity of storm water runoff. Very high turbidities can be reduced to levels comparable to what is found in streams during dry weather.

Criteria for Chemical Treatment Product Use

Chemically treated storm water discharged from construction sites must be non-toxic to aquatic organisms. The following protocol should be used to evaluate chemicals proposed for storm water treatment at construction sites. Authorization to use a chemical in the field based on this protocol does not relieve the applicant from responsibility for meeting all discharge and receiving water criteria applicable to a site.

- Treatment chemicals must be approved by USEPA for potable water use.
- Petroleum-based polymers are prohibited.
- Prior to authorization for field use, jar tests should be conducted to demonstrate that turbidity reduction necessary to meet the receiving water criteria could be achieved. Test conditions, including but not limited to raw water quality and jar test procedures, should be indicative of field conditions. Although these small-scale tests cannot be expected to reproduce performance under field conditions, they are indicative of treatment capability.
- Prior to authorization for field use, the chemically treated storm water should be tested for aquatic toxicity. Applicable state Whole Effluent Toxicity Testing and Limits, should be used. Testing should use storm water from the construction site at which the treatment chemical is proposed for use or a water solution using soil from the proposed site.
- The proposed maximum dosage should be at least a factor of five lower than the no observed effects concentration (NOEC).
- The approval of a proposed treatment chemical should be conditional, subject to full-scale bioassay monitoring of treated storm water at the construction site where the proposed treatment chemical is to be used.
- Treatment chemicals that have already passed the above testing protocol do not need to be reevaluated. Contact the CWB for a list of treatment chemicals that may be approved for use.

Treatment System Design Considerations

The design and operation of a chemical treatment system should take into consideration the factors that determine optimum, cost-effective performance. It may not be possible to fully incorporate all of the classic concepts into the design because of practical limitations at construction sites. Nonetheless, it is important to recognize the following:

- The right chemical must be used at the right dosage. A dosage that is either too low or too high will not produce the lowest turbidity. There is an optimum dosage rate. This is a situation where the adage "adding more is always better" is not the case;
- The coagulant must be mixed rapidly into the water to insure proper dispersion;
- Experience has found that sufficient flocculation occurs in the pipe leading from the point of chemical addition to the settling or sediment basin;
- Since the volume of the basin is a determinant in the amount of energy per unit volume, the size of the energy input system can be too small relative to the volume of the basin;
- Care must be taken in the design of the withdrawal system to minimize outflow velocities and to prevent floc discharge. The discharge should be directed through a physical filter such as vegetated swale that would catch any unintended floc discharge; and
- A pH-adjusting chemical should be added into the sediment basin to control pH. Experience shows that the most common problem is low pH.

Treatment System Design

Chemical treatment systems should be designed as batch treatment systems using either ponds or portable trailer-mounted tanks. Flow-through continuous treatment systems are not allowed at this time.

A chemical treatment system consists of the storm water collection system (either temporary diversion or the permanent site drainage system), a sediment basin or sediment trap, pumps, a chemical feed system, treatment cells, and interconnecting piping.

The treatment system should use a minimum of two lined treatment cells. Multiple treatment cells allow for clarification of treated water while other cells are being filled or emptied. Treatment cells may be basins, traps or tanks. Portable tanks may also be suitable for some sites.

The following equipment should be located in an operation shed:

- The chemical injector;
- Secondary contaminant for acid, caustic, buffering compound, and treatment chemical;
- Emergency shower and eyewash; and
- Monitoring equipment which consists of a pH meter and a turbidimeter.

Sizing Criteria

The combination of the sediment basin or other holding area and treatment capacity should be large enough to treat storm water during multiple day storm events. See SE-2, Sediment Basin, for design criteria. Bypass should be provided around the chemical treatment system to accommodate extreme storm events. Runoff volume should be calculated using the Rational Method. Primary settling should be encouraged in the sediment basin/storage pond. A forebay with access for maintenance may be beneficial.

There are two opposing considerations in sizing the treatment cells. A larger cell is able to treat a larger volume of water each time a batch is processed. However, the larger the cell the longer the time required to empty the cell. A larger cell may also be less effective at flocculation and therefore require a longer settling time. The simplest approach to sizing the treatment cell is to multiply the allowable discharge flow rate times the desired drawdown time. A 4-hour

drawdown time allows one batch per cell per 8-hour work period, given 1 hour of flocculation followed by 2 hours of settling.

The permissible discharge rate governed by potential downstream effect can be used to calculate the recommended size of the treatment cells. The following discharge flow rate limits apply absent any State Department of Agriculture requirements:

- If the discharge is direct or indirect to a stream, the discharge flow rate should not exceed 50 percent of the peak flow rate for all events between the 2-year and the 10-year, 1-hour event;
- If discharge is occurring during a storm event equal to or greater than the 10-year storm the allowable discharge rate is the peak flow rate of the 10-year, 1-hour event;
- Discharge to a stream should not increase the stream flow rate by more than 10 percent;
- If the discharge is directly to a lake or major receiving water there is no discharge flow limit;
- If the discharge is to a municipal storm drainage system, the allowable discharge rate may be limited by the capacity of the public system. It may be necessary to clean the municipal storm drainage system prior to the start of the discharge to prevent scouring solids from the drainage system; and
- Runoff rates may be calculated using the Rational Method, unless another method is required by the City.

Costs

Costs for chemical treatment may be significant due to equipment required and cost of chemicals. The cost is offset by the ability to reduce some use of other onsite erosion control BMPs and the reuse of equipment (e.g., pumps and dosing equipment). The incremental cost is generally less than 1% of the total construction costs.

Inspection and Maintenance

Chemical treatment systems must be operated and maintained by individuals with expertise in their use. Chemical treatment systems should be monitored continuously while in use.

The following monitoring should be conducted. Test results should be recorded on a daily log kept on site.

Operational Monitoring

- pH conductivity (as a surrogate for alkalinity), turbidity, and temperature of the untreated storm water;
- Total volume treated and discharged;
- Discharge time and flow rate;
- Type and amount of chemical used for pH adjustment;
- Amount of polymer used for treatment; and
- Settling time.

Compliance Monitoring

- pH and turbidity of the treated storm water; and
- pH and turbidity of the receiving water.

Bio-monitoring

Treated storm water should be tested for acute (lethal) toxicity. Bioassays should be conducted by a laboratory accredited by the State of Hawaii. The performance standard for acute toxicity is no statistically significant difference in survival between the control and 100 percent chemically treated storm water.

Acute toxicity tests should be conducted with the approved species and protocols by the CWB.

All toxicity tests should meet quality assurance criteria and test conditions accepted by CWB.

Bioassays should be performed on the first five batches and on every tenth batch thereafter or as otherwise approved by the CWB. Failure to meet the performance standard should be immediately reported to the CWB.

Discharge Compliance:

Prior to discharge, each batch of treated storm water should be sampled and tested for compliance with pH and turbidity limits. These limits may be established by the water quality standards or a site-specific discharge permit. Sampling and testing for other pollutants may also be necessary at some sites. Turbidity should be within 5 NTUs of the background turbidity. Background is measured in the receiving water, upstream from the treatment process discharge point. pH should be within the range of 6.5 to 8.5 standard units and not cause a change in the pH of the receiving water of more than 0.2 standard units. It is often possible to discharge treated storm water that has a lower turbidity than the receiving water and that matches the pH.

Treated storm water samples and measurements should be taken from the discharge pipe or another location representative of the nature of the treated storm water discharge. Samples used for determining compliance with the water quality standards in the receiving water should not be taken from the treatment pond to decanting. Compliance with the water quality standards is determined in the receiving water.

Operator Training:

Each contractor who intends to use chemical treatment should be trained by an experienced contractor on an active site for at least 40 hours.

Standard BMPs:

Erosion and sediment control BMPs should be implemented throughout the site to prevent erosion and discharge of sediment.

Sediment Removal and Disposal

- Sediment should be removed from the storage or treatment cells as necessary. Typically, sediment removal is required at least once during a wet season and at the decommissioning of the cells. Sediment remaining in the cells between batches may enhance the settling process and reduce the required chemical dosage.
- Sediment may be incorporated into the site away from drainages.

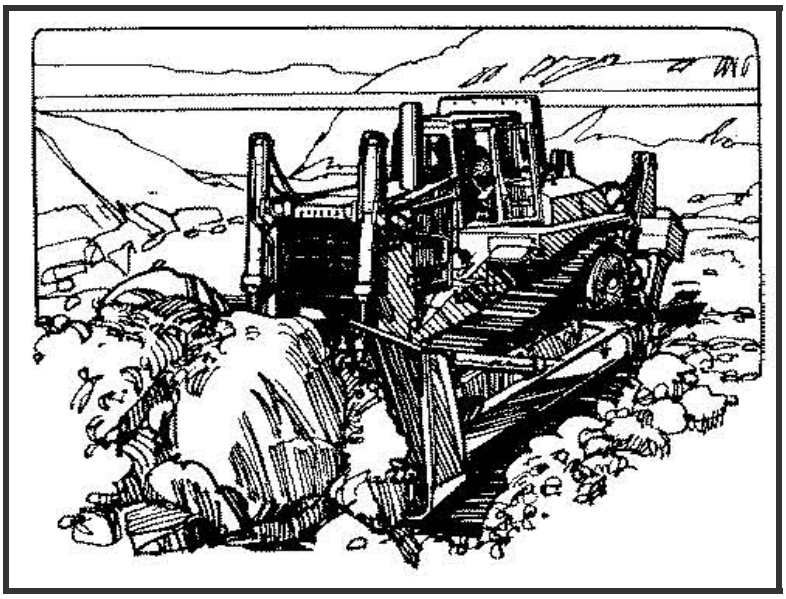
References

Hawaii Administrative Rules 11-54 Water Quality Standards.

Stormwater Management Manual for Western Washington, Volume II – Construction Stormwater Pollution Prevention, Washington State Department of Ecology, August 2001.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Location of Potential Sources of Sediment SE-12



Objectives

EC – Erosion Control	▲
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	√

Potential Alternatives

None

Description and Purpose

Proper location of potential sources of sediment can reduce the generation of erosion and sediment from construction sites.

Suitable Applications

Locating potential sources of sediment to minimize the discharge of pollutants should be considered on all projects. This is especially true where runoff goes either directly or indirectly to Class 1 or Class AA waters.

Approach

- Sequence construction so that haul roads and stockpiles are buffered with planted areas prior to discharging offsite.
- Separate/Divert offsite runoff where possible, flowing through the construction site without going over bare ground.
- Locate stockpiles away from waterways or low spots.
- Maintain swales and natural drainage ways in vegetated condition.
- Preserve trees and other existing vegetation. Vegetation along the perimeter of the site provides an effective buffer against sediment leaving the construction site.
- Use naturally level area for parking during construction.

Requirements

- Maintenance:
  - Inspect regularly and after rain for damage; and
  - Provide mulching, grassing other ground cover to reduce bare areas.

Limitations

Prevention should be supplemented with mulching, planting and structural controls such as berms, silt fences, and silt basins.

References

California Storm Water Best Management Practices Handbooks, Construction Activity Best Management Practice Handbook, March 1993, Camp Dresser & McKee, et al. For the California Storm Water Quality Task Force.

City & County of Honolulu, Best Management Practices Manual for Construction Sites in Honolulu, Department of Environmental Services, May 1999.

Erosion and Sediment Control Guide for Hawaii, Marc h1981, USDA Soil Conservation Service.

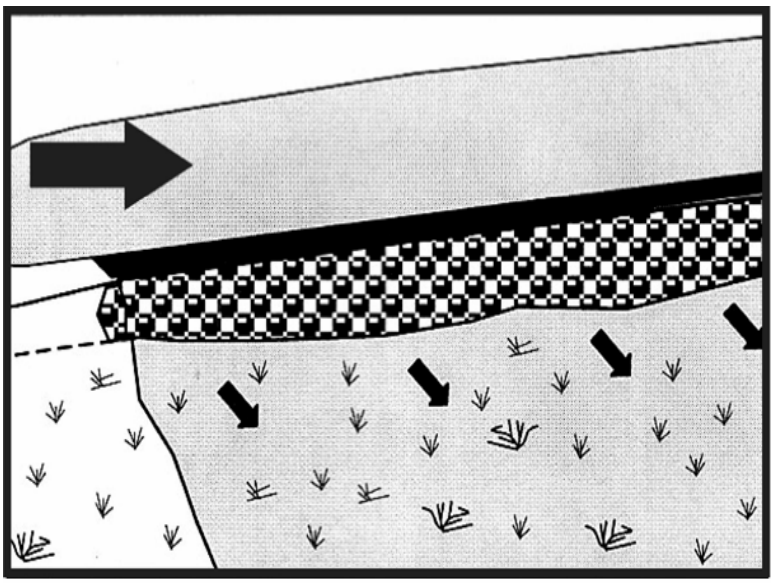
Hawaii Administrative Rules, Title 11, Chapter 54, Water Quality Standards.

Planning and Design Manual for the Control and Erosion, Sediment, and Stormwater; A Cooperative Effort by: USDA Natural Resources Conservation Service, Mississippi Department of Environmental Quality, and the Mississippi Soil & Water Conservation Commission.

Rules Relating to Soil Erosion Standards and Guidelines, April 1999, Department of Planning and Permitting, City and County of Honolulu.

Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices, September 1992, U.S. Environmental Protection Agency.

Level Spreader SE-13



Objectives

EC – Erosion Control	▲
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	√

Potential Alternatives

None

Description and Purpose

A device used at outlets that converts concentrated flow to sheet flow preventing erosion of the receiving area. Tops of channels, earthen berms, or rigid weir-like structures may function as level spreaders.

Suitable Applications

- Flat or gentle sloping areas.
- Outlets for dikes and diversions.

Installation & Implementation

- Construct on undisturbed soil.
- Do not construct on fill material.
- Locate where re-concentration of water will not occur.
- A stabilized and well vegetated slope of less than 10% should be located below the level spreader.
- Filter runoff containing high sediment loads through a sediment-trapping device prior to release to the level spreader.
- Incorporate a rigid outlet lip design for high discharge flows.
- Zero percent grade on the spreader lip is necessary for uniform sheet flow.
- Avoid operating vehicles and heavy equipment on the level spreader to maintain a smooth level surface for the overflow weir.

Requirements

- Maintenance & Inspection:
  - Conduct inspections of the level spreaders prior to the rainy season and after rain events exceeding the design storm intensity (2-year recurrence interval, 1 hour duration, unless otherwise directed.
  - Inspect level spreader channel for accumulation of debris and sediment regularly and remove debris and sediment.
  - Verify a slope of zero percent along the spreader lip.
  - Inspect the discharge area for signs of erosion or concentrated flow.

Limitations

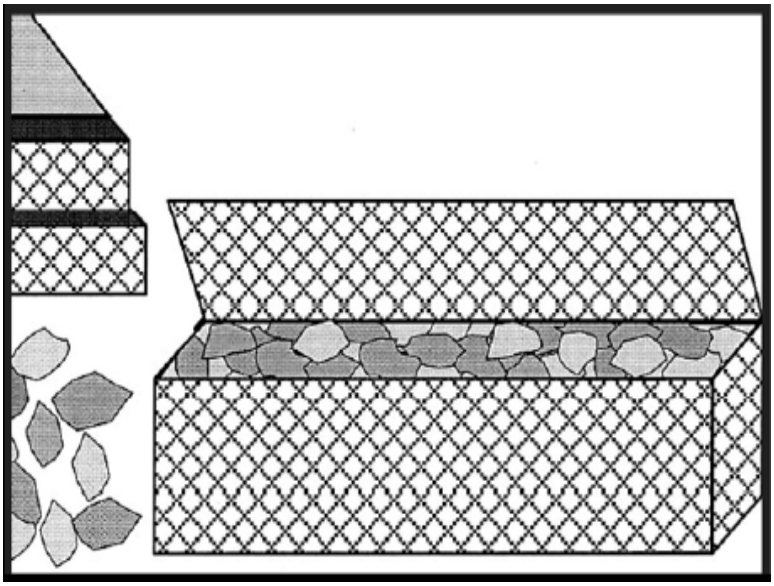
Not applicable to sediment laden runoff.

References

Knoxville BMP Manual, 2003.

State of Hawaii DOT Highway Division, Construction BMP Field Manual, February 2007.

Rip-Rap Gabion Inflow Protection SE-14



Objectives

EC – Erosion Control	▲
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Lined drainageway to stabilize the flow channel along steep slopes.

Suitable Applications

- Use of rip-rap inflow protection applies to slopes between 10:1 and 4:1 (H:V).
- Use of gabion inflow protection applies to slopes exceeding 4:1 (H:V).

Limitations

- None identified.

Implementation

Rip-Rap

- 2:1 (H:V) side slopes, 3 foot minimum bottom width, and 1 foot minimum depth.
- Line channel with 4 to 12 inch rip-rap at a depth of 18 inches.
- Install geotextile filter fabric under all rip-rap.
- Gabion inflow protection may be used in lieu of rip-rap inflow protection.
- Blend rip-rap into existing ground.

Gabion

- Construct 2:1 (H:V) side slopes, 3 foot bottom width, and 1 foot deep from 9’ x 3’ x 9” gabion baskets.
- Install geotextile filter fabric under all gabion baskets.

- Fill gabion baskets with 4” to 7” stone.
- Install gabions in accordance with manufacturer’s recommendations.

Inspection and Maintenance

- Inspect periodically and after significant rain events.
- Remove accumulated sediment at inlet structure.

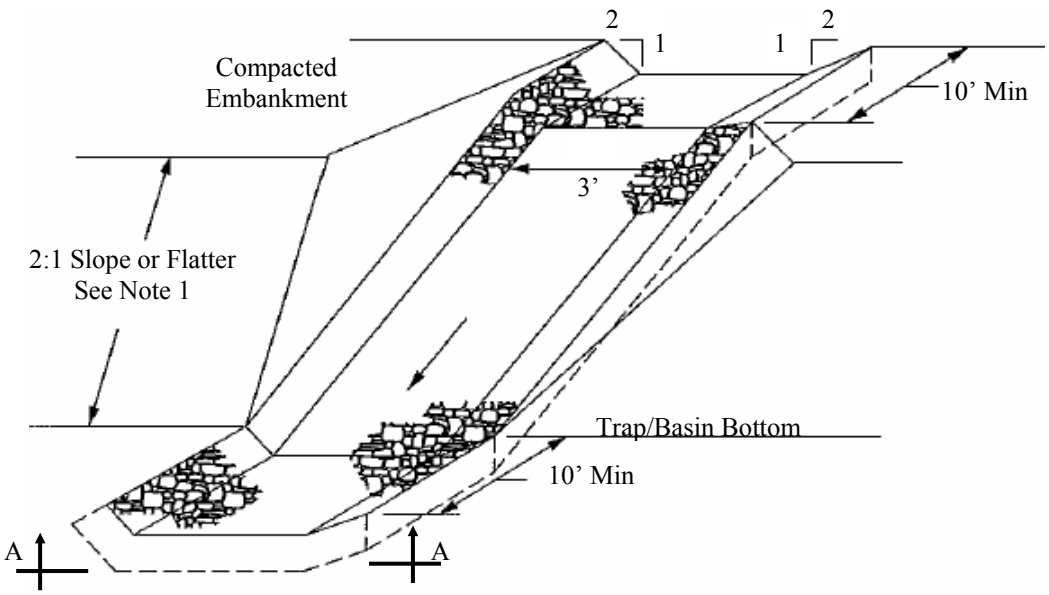
Costs

All of the above are low cost measures.

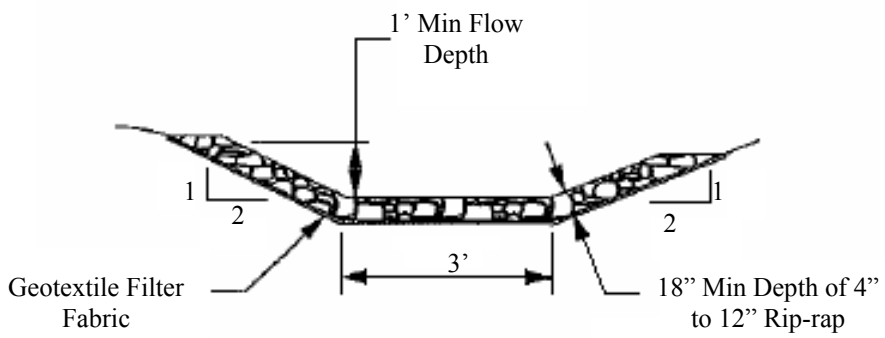
References

Knoxville BMP Manual, 2003.

State of Hawaii DOT, Highways Division Construction BMP Field Manual, September 2006.



Detail "A"
Not to Scale

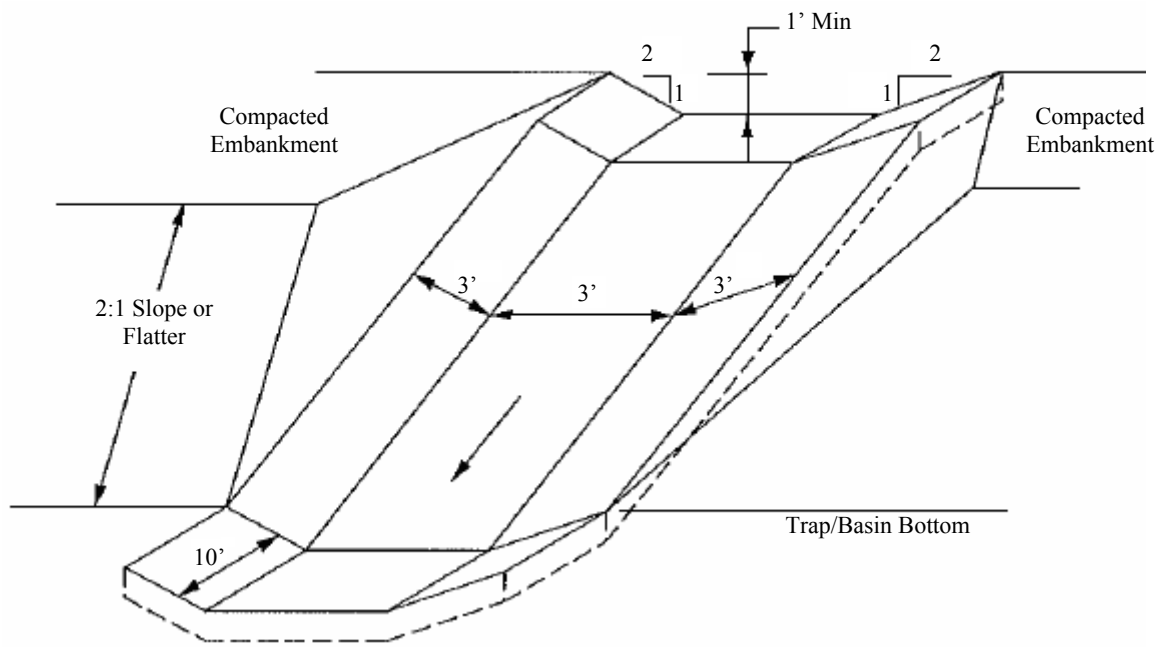


Section A-A
Not to Scale

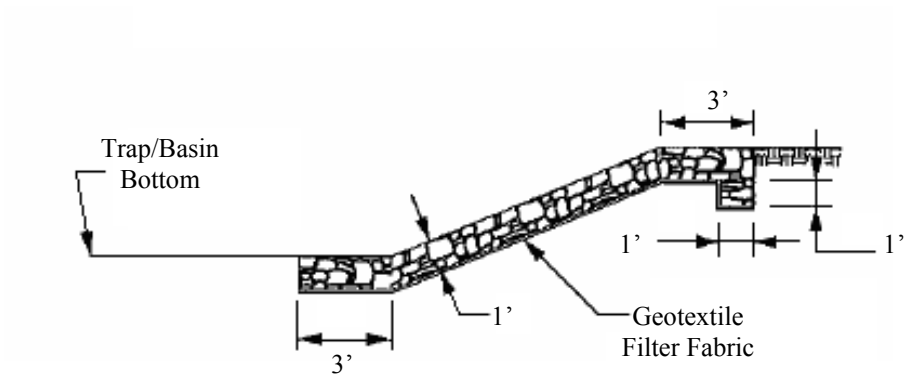
Notes:
1. 2:1 (H:V) side slopes, 3 foot minimum bottom width, and 1 foot minimum depth.
2. Line channel with 4 to 12 inch rip-rap at a depth of 18 inches.
3. Install geotextile filter fabric under all rip-rap.
4. Gabion inflow protection may be used in lieu of rip-rap inflow protection.
5. Blend rip-rap into existing ground.

Rip-Rap Inflow Protection

Source: Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994



Detail "B"
Not to Scale



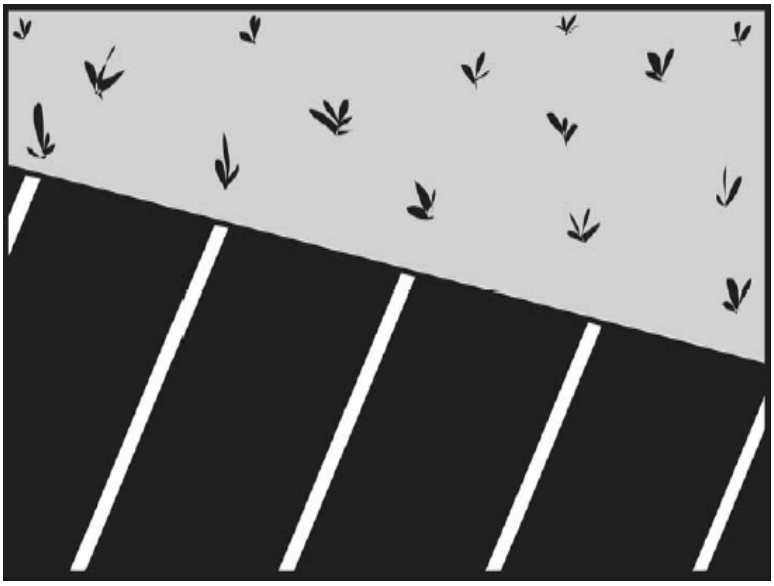
Centerline Profile View
Not to Scale

Notes:
1. Construct 2:1 (H:V) side slopes, 3 foot bottom width, and 1 foot deep from 9' x 3' x 9" gabion baskets.
2. Install geotextile filter fabric under all gabion baskets.
3. Fill gabion baskets with 4" to 7" stone.
4. Install gabions in accordance with manufacturer's recommendations.

Gabion Inflow Protection

Source: Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1994

Vegetated Buffer Strips and Channels SE-15



Objectives

EC – Erosion Control	
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	√
Bacteria	
Oil and Grease	√
Organics	

Potential Alternatives

None

Description and Purpose

Vegetative buffer strips and channels protect soil from erosion, increase infiltration, and remove sediment from surface runoff. Located adjacent to pollutant sources such as construction sites, vegetated buffer strips also provide protection to downstream receiving inlets or water bodies.

Suitable Applications

- Any site which is suitable for establishment of vegetation.
- Vegetated buffer strips are appropriate for uncurbed, paved areas; steep and potentially unstable slopes; and areas adjacent to sensitive water bodies.
- Vegetated channels are appropriate for surface runoff conveyed by channels to downstream inlets or receiving waters.

Limitations

- Site conditions such as availability of land.
- Flow depth and vegetative condition determine BMP effectiveness.
- May require irrigation to maintain vegetation.
- High maintenance requirements may exist depending on the design condition of the vegetation.
- Unless existing vegetation is used as a buffer strip, an area will need to be provided specifically for a buffer strip and vegetation will need to be established.
- Maintaining sheet flow in buffer strips may be difficult.

- Vegetated channels require a larger area than lined channels.
- Vegetated channels require gradual slopes since runoff with high flow velocity may flow over grass rather than through it.

Implementation

Refer to EC-3 (Preservation of Existing Vegetation) in this manual if existing vegetation will be used as a buffer strip.

Installation of a buffer strip with new vegetation should comply with the following:

- Prior to cultivation of the designated buffer strip area, remove and dispose of all weeds and debris in accordance with contract documents;
- During construction, strip and stockpile good topsoil for surface preparation purposes prior to planting activities;
- Plant the area upon completion of grading in the area;
- Fine grade and roll areas to be planted after cultivating soil and, if applicable, installing the irrigation system;
- Provide additional watering or irrigation of vegetation to supplement rainfall until vegetation has been established;
- Fertilize vegetation in accordance with manufacturers' instructions and grass/soil requirements determined by testing of the soil;
- Vehicular traffic passing through vegetated buffer strips or channels should be avoided to protect vegetation from damage and maximize its effectiveness;
- Applicable regulations and manufacturers' instructions when applying fertilizers, pesticides, soil amendments, or chemicals;
- During seeding activities:
  - Add soil amendments such as fertilizer when preparing seedbed. Apply mulch after seeding to protect vegetation during establishment. Select an appropriate seed mixture based on site conditions. Dense grasses are more effective in reducing flow velocities and removing sediment. Thick root structures are necessary for erosion control;
  - Use proper equipment and methods to ensure uniform distribution and appropriate seed placement; and
  - Overseed, repair bare spots, and apply additional mulch as necessary.
- During sodding activities:
  - Protect sod with tarps or other types of protective covering during delivery and do not allow sow to dry between harvesting and placement;
  - Any irregular or uneven areas observed prior to or during the plant establishment period should be restored to a smooth and even appearance;
  - Prior to placing sod, ground surface should be smooth and uniform;
  - Areas, which will be planted with sod and are adjacent to paved surfaces such as sidewalks and concrete headers, should be 1.5±0.25 inches below the top grade of the paved surface after fine grading, rolling, and settlement of the soil;

- Ends of adjacent strips of sod should be staggered a minimum of 24 inches;
- Edges and ends of sod should be placed firmly against paved borders;
- After placement of the sod, lightly roll sodded area to eliminate air pockets and ensure close contact with the soil;
- After rolling, water the sodded area to moisten the soil to a depth of 4 inches;
- Do not allow sod to dry;
- Avoid planting sod during extremely hot or wet weather; and
- Sod should not be placed on slopes steeper than 3:1 (H:V) if the area will be mowed.

Costs

All of the above are low cost measures.

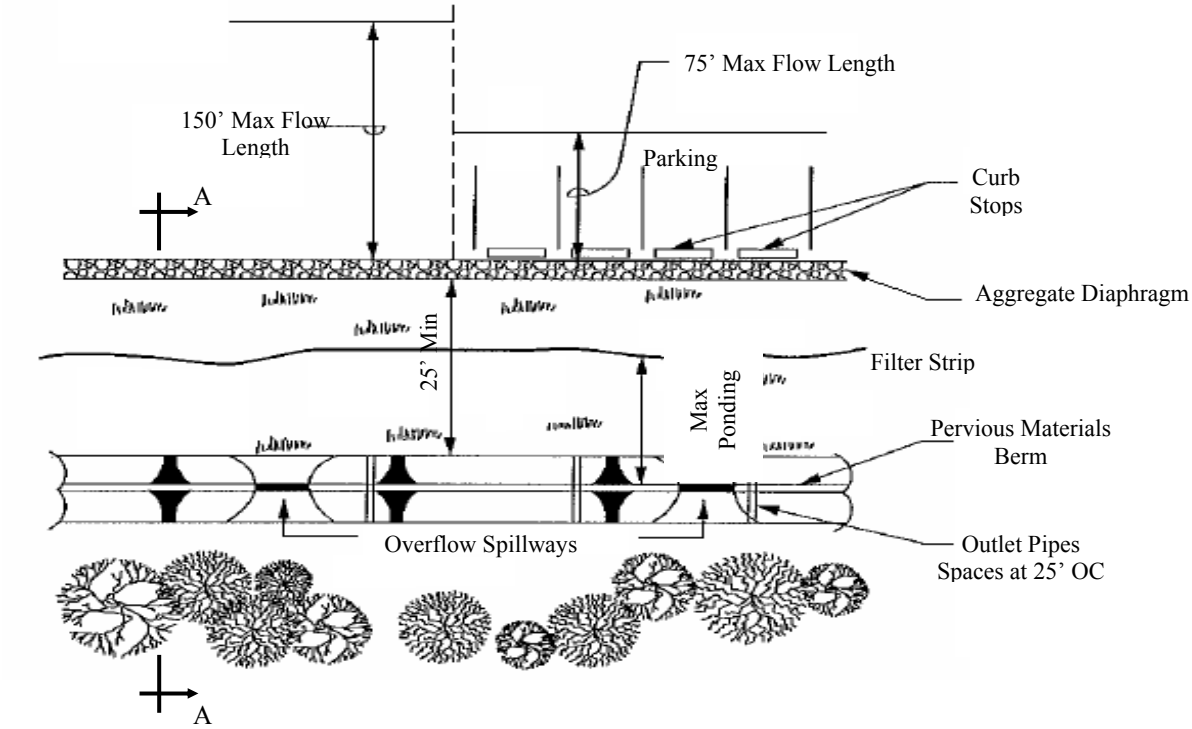
Inspection and Maintenance

- Inspect weekly and after significant rain events until vegetation is established. Repair eroded or damaged areas as necessary.
- Maintenance activities include mowing, weeding, and verification of a properly operating irrigation system, if applicable.
- Properly remove and dispose of clippings from mowing and trimming.

References

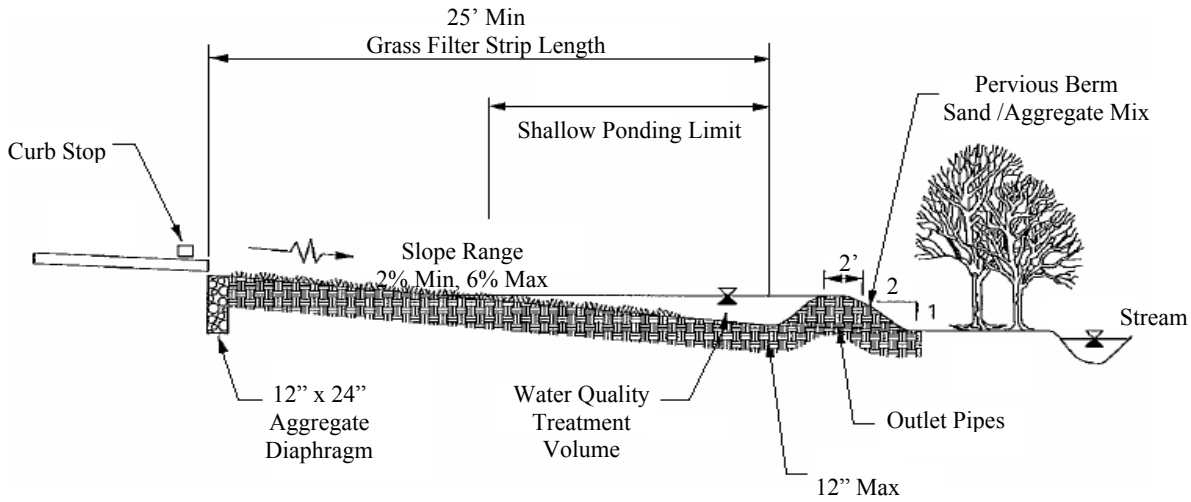
Knoxville BMP Manual, 2003.

State of Hawaii DOT, Highways Division Construction BMP Field Manual, September 2006.



Detail "A"

Plan View, Not to Scale



Section A-A

Not to Scale

Notes:

1. For Implementation see City and County of Honolulu Storm Water Construction BMP Details SE-14 (Vegetated Buffer Strips and Channels).
2. If existing vegetation will be used as a buffer strip, EC-2 (Preservation of Existing Vegetation).

Typical Vegetated Buffer Strip

Source: Prince George's County, Low-Impact Development Design Strategies: An Integrated Environmental Design Approach, 1999

Compost Socks and Berms SE-16

Objectives

EC – Erosion Control	▲
SE – Sediment Control	√
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	▲
Bacteria	▲
Oil and Grease	▲
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

Composite socks and berms act as three-dimensional biodegradable filtering structures to intercept runoff where sheet flow occurs and are generally placed at the perimeter or at intervals on sloped areas. Compost socks are generally a mesh sock containing compost and a compost berm is a dike of compost, trapezoidal in cross section. When employed to intercept sheet flow, both BMPs are placed perpendicular to the flow of the runoff allowing filtered runoff to pass through the compost and retaining sediment (and potentially other pollutants in runoff). A compost sock can be assembled on site by filling a mesh sock with compost (i.e. using a pneumatic blower or similar) or they can be manufactured off site and delivered to the site for installation. The compost berm should be constructed using a backhoe or equivalent and/or a pneumatic delivery (blower) system and should be properly compacted after placement. Compost socks and berms act as filters, reduce runoff velocities, and in some cases, aid in future establishment of vegetation.

Compost is organic, biodegradable, and renewable. Compost provides soil structure that allows water to infiltrate the compost medium which helps reduce rill erosion and the retained moisture promotes seed germination and vegetation growth, in addition to providing organic matter and nutrients important for fostering vegetation. Compost improves soil quality and productivity. The compost of the compost sock or berm can be selected to target site-specific objectives in capturing sediment and other pollutants, supporting certain vegetation, or additional erosion controls.

Compost is typically derived from leaf/yard trimmings, or wood. The primary targeted sources of compost are products of the City green waste programs. Compost is organic and biodegradable and in most cases can be left onsite once construction activity is completed. There are many types of compost with a variety of properties with specific functions, and accordingly compost selection is an important design consideration in the application of this type of erosion and sediment control.

Suitable Applications

- Along toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow (compost berms should only be used at the top of slopes or on slopes 4:1 (H:V) or less, all other slopes applications should use compost socks or other BMPs);
- Along perimeter of project;
- As check dams in unlined ditches (socks only);
- Down-slope of exposed soil areas; and
- Around temporary stockpiles.

Compost socks and berms do not require special trenching or BMP removal as compared to other sediment control methods (e.g. silt fences or fiber rolls). Since installing compost socks does not require trenching or disturbing the earth, compost socks can be effectively installed during a rain event if immediate sediment and erosion control is required. Compost socks and berms can remain in place after earth disturbing activities are completed or the compost components can be spread over the site providing nutrients for plant growth and augmenting soil structure. BMPs that remain in place are particularly advantageous below embankments, especially adjacent to streams, by limiting re-entry and the continued disturbance to sensitive areas.

Compost socks can be manufactured in 20’ coils, similar to other sediment retention fiber roll (SRFR) devices (straw wattles, etc.) and placed on a pallet for easy storage, transportation, and installation. Pre-made compost sock coils can be stored on the site in preparation for BMP maintenance activities and rain events.

Compost can be pre-seeded prior to application (recommended by EPA for construction site storm water runoff control, USEPA Website-Compost Filter Socks) or seeded after installation (primarily for compost berms).

Limitations

- Compost can potentially leach nutrients (dissolved phosphorous and nitrogen) into runoff and potentially impact water quality. Compost should not be used directly upstream from nutrient impaired waterbodies;
- Compost may also contain other undesirable constituents that are detrimental to water quality choose source of compost selectively;
- Application by hand is time intensive and potentially costly. Using a pneumatic blower truck is the recommended cost effective method of distribution;
- Heavy vegetation should be removed to ensure close contact of compost with the existing ground surface;

- Compost socks and berms should not be employed at the base of slopes greater than 2:1. They can be employed in combination with other erosion control methods for steeper slopes;
- Difficult to move once saturated;
- Compost berms should not be applied in areas of concentrated flows;
- Compost socks and berms are easy to fix; however they are susceptible to damage by frequent traffic. Compost socks can be used around heavy machinery, but regular disturbance decreases sock performance; and
- Different strength socks are available by compost sock manufacturers, select sock which is of sufficient strength to handle anticipated disturbances.

Implementation

Compost Materials

- Compost should meet or exceed AASHTO R 51-10, Standard Specification for Compost for Erosion/Sediment Control (Filter Berms and Filter Socks);
- Compost quality shall comply with all local, state, and Federal requirements;
- Particle size is an important parameter for selecting compost. Well consolidated coarser grades of compost (e.g. mixture of small and larger pieces) perform better for filtration objectives, while finer grades support vegetation better. Particle size of the compost should be selected based on site conditions, such as expected participation rates, filtration goals, and/or long term plant nutrient requirements;
- Compost moisture should be considered for composition quality and application purposes. A range of 30-50% is typical. Compost that is too dry is hard to apply and compost that is too wet is more difficult (and more expensive) to transport. For arid or semi-arid areas, or for application during the dry season, use compost with greater moisture content than areas with wetter climates. For wetter or more humid climates or for application during the wet season, drier composts can be used as the compost will absorb moisture from the ambient air;
- If vegetation establishment is a desired function of the compost, a compost sample should be inspected by a qualified individual;
- Organic content of the compost is also important and should range from 30-65% depending on site conditions and uses for vegetation establishment;
- Compost should not be derived from mixed municipal solid waste or biosolids and should be free of visible contaminants;
- Compost used should not emit objectionable odors; and
- Compost should be weed and alien plant free.

Installation

- Prior to application, prepare locations for socks and/or berms by removing brush and thick vegetation. The compost of the sock and/or berm should be allowed to come in full contact with the ground surface;
- If manufacturing on site select method to apply the compost berm or fill sock. A pneumatic blower is most cost effective and most adaptive in applying compost to steep, rough terrain, and hard to reach locations;
- If compost sock has been manufactured off site, the sock shall be manufactured in pre-made lengths that are easily, safely, and efficiently handled by construction laborers;
- Overlap the ends of adjoining sock lengths by a minimum of 6";
- The compost of the berm should be distributed evenly to the surface, compacted, and shaped trapezoidal (refer to AASHTO Specification R 51-10);
- Compost socks can be assembled on site by filling mesh socks with selected compost. Mesh socks can be tied at one end, filled, and then tied at the other end. The ends of socks can be interlocked until the desired length is achieved. Alternatively, use a filter sock equivalent to length of slope if practicable. The sock diameter is a function of slope steepness and length (refer to AASHTO Specification R 51-10) – typically 8" to 18" in diameter;
- Compost socks are typically placed in contours perpendicular to sheet flow. They can also be placed in V formation on a slope. Compost socks must be anchored, typically stakes, through center of the sock although alternative anchor methods may be prescribed by the compost sock manufacturer;
- Turn ends of socks up slope to prevent flow around ends;
- When used as a Slope Interruption Device (SID) locate compost socks and berms on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Socks and/or berms should be place at a maximum interval of 35-40 ft.;
  - Slope inclination between 4:1 and 2:1 (H:V): Socks (use of berms not recommended) should be placed at a maximum interval of 25-30 ft. (a closer spacing is more effective); and
  - Slope inclination of 2:1 (H:V) or greater: Socks should be placed at maximum interval of 15-20 ft.
- If used at toe of slopes, the compost sock or berm should at minimum of 5 to 10 feet away from toe;
- Compost socks and berms can be effective over rocky ground if secured properly;
- It is recommended that the drainage areas of these compost BMPS do not exceed 0.25 acre/100 foot placement interval and runoff does not exceed 1 CFS; and
- Layout in accordance with attached details or as specified in SWPPP.

Other Materials

- Wood stakes should be commercial quality lumber with nominal size of ¾" by ¾" and minimum length of 16 inches designed for the staking of compost socks and/or sediment retention fiber rolls (SRFRs). Each stake should be free from decay, splits or cracks longer than the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable. Larger sized wood anchor stakes may be installed at the discretion of the installer, or as specified by the Project Engineer. Rebar or other metal rods are not recommended.
- Typical sock materials are; 1) high density polyethylene (HDPE) expandable, tubular, biodegradable or photodegradable, 2) polyester knitted mesh netting fabric sock, and 3) composite two-layered compost sock can be constructed using a polyester knitted mesh netting fabric sock as the outermost layer (outer filtration mesh) and a high density polyethylene (HDPE) expandable, tubular, biodegradable or photodegradable netting as the innermost layer (inner confinement netting). Sock materials shall be of sufficient diameter to allow the compost sock to be manufactured to the desired finished size. Aperture size (apparent opening of tubular net and knitted mesh netting) can range in size based on desired performance and intended function, but in no case shall outermost layer have an apparent size greater than 3/8".

Costs

Recently obtained Hawaii vendor cost indicated $6.50 per linear foot for compost berm application and $3.50 per linear foot for 10" (8.5" effective height) socks. Costs do not include final compost sock and berm functions at the end of construction activities, including spreading or removal, if required.

Inspection and Maintenance

- Inspect BMPs prior to forecasted rain, daily during extended rain events, after rain events 0.5" or greater which occurs in a 24-hour period, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Remove sediment which has accumulated to within 1/3 of the sock or berm height.
- Once damage is identified mend or reapply sock or berm as needed. Washed out areas should be replaced. If the sock or berm height is breached during a storm, an additional sock can be stacked to increase the sock height and similarly the berm dimensions can be increased, as applicable. An additional sock or berm may be installed upslope, as needed.
- Limit traffic to minimize damage to BMPs or impede vegetation establishment.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, November 2009.

Hawaii Department of Transportation (HDOT) Best Management Practices Field Manual Construction, January 2008.

http://stormwaterhawaii.com/program_plan/pdfs/app_e6.pdf.

National Pollutant Discharge Elimination System (NPDES), Compost Filter Socks, U.S. Environmental Protection Agency (USEPA).

http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=120.

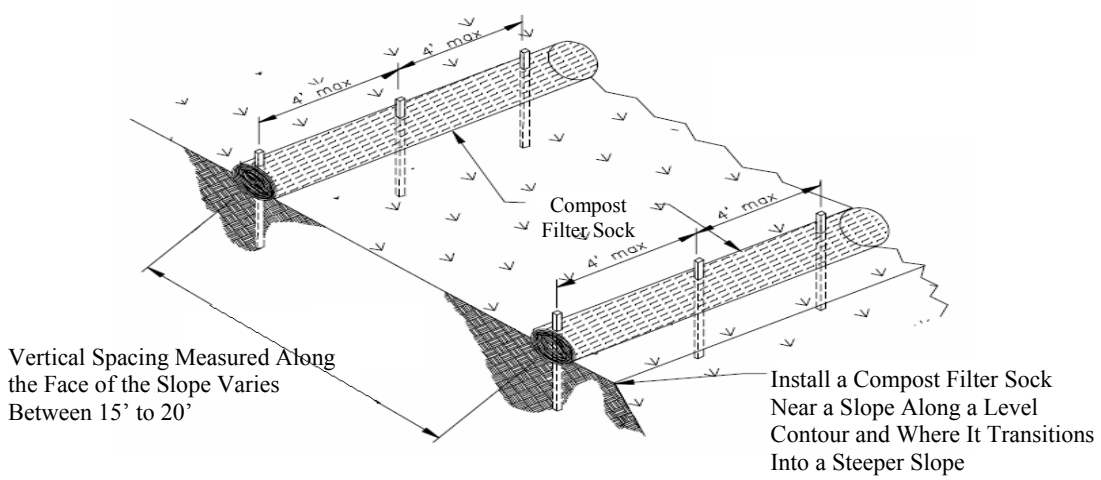
National Pollutant Discharge Elimination System (NPDES), Compost Filter Berms, U.S. Environmental Protection Agency (USEPA).

http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=119&minmeasure=4.

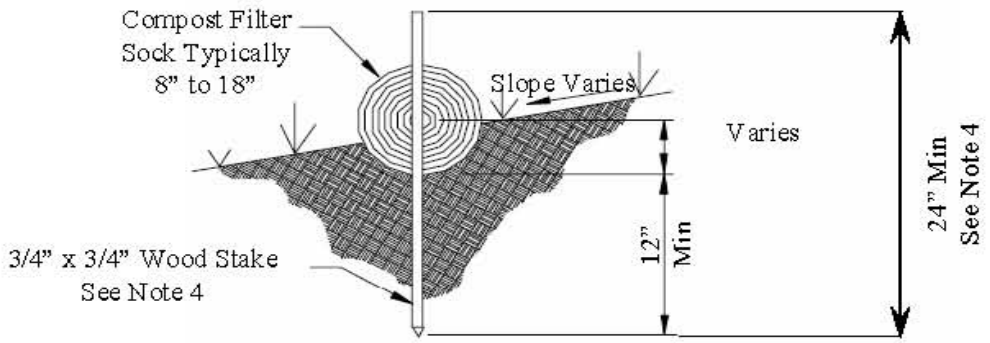
AASHTO. 2010 Standard Practice for Transportation Materials and Methods of Sampling and Testing, Designation R 51-10, Compost for Erosion/Sediment Control (Filter Berms and Filter Socks), American Association of State Highway Officials, Washington, D.C.

Faucette, et al. 2005. Evaluation of Stormwater from Compost and Conventional Erosion Control Practices in Construction Activities, Journal of Soil and Water Conservation, 60:6, 288-297.

USEPA. 1998. An Analysis of Composting as an Environmental Remediation Technology. U.S. Environmental Protection Agency, Solid Waste and Emergency Response (5305W), EPA530-R-98-008, April 1998.



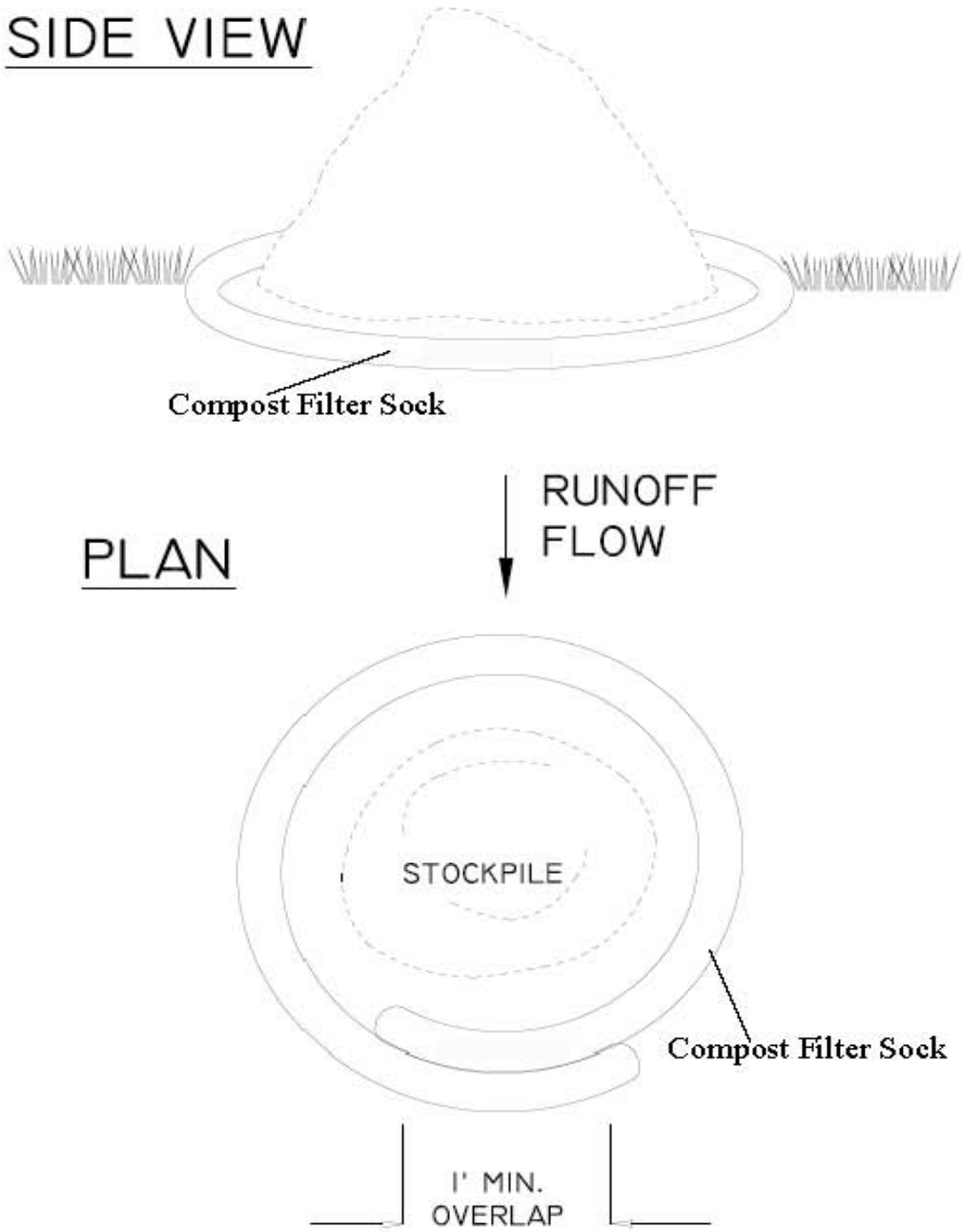
Detail "A"
Not to Scale



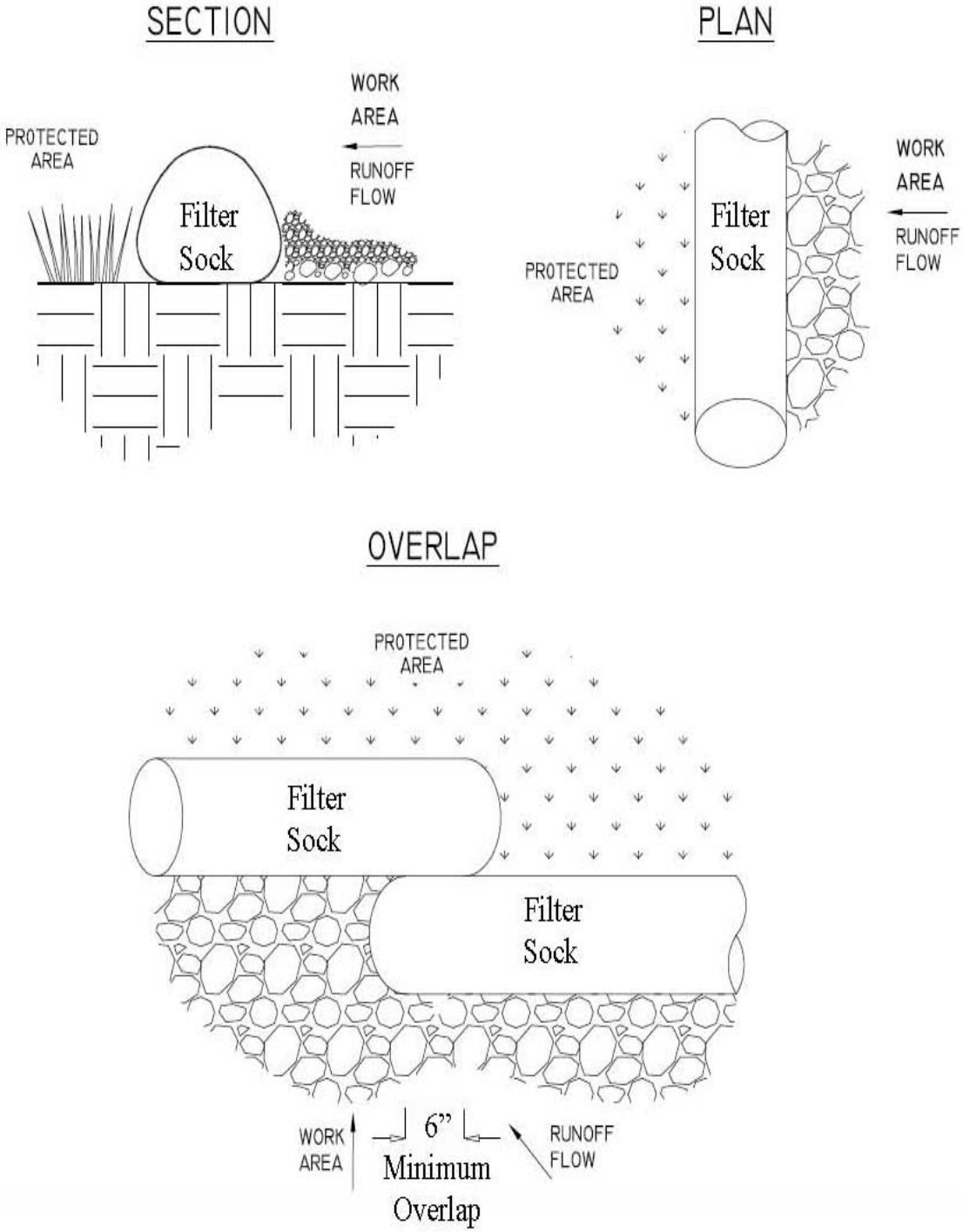
Section A-A
Not to Scale

Notes:
1. Compost Filter Socks should be either prefabricated or assembled at site.
2. Locate Compost Filter Socks on level contours spaced as follows:
   a. Slope inclination of 4:1 (H:V) or flatter: Compost Filter Socks and/or berms should be place at a maximum interval of 20 ft.
   b. Slope inclination between 4:1 and 2:1 (H:V): Compost Filter Socks (use of berms not recommended) should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
   c. Slope inclination of 2:1 (H:V) or greater: Compost Filter Socks should be placed at maximum interval of 10 ft.
3. Turn the ends of the Compost Filter Socks up slope to prevent runoff from going around the roll.
4. Stake Compost Filter Socks with stakes with a minimum length of 14 in and spaced 4 ft. on center.
5. If more than one Compost Filter Socks is placed in a row, the rolls should be overlapped, not abutted.

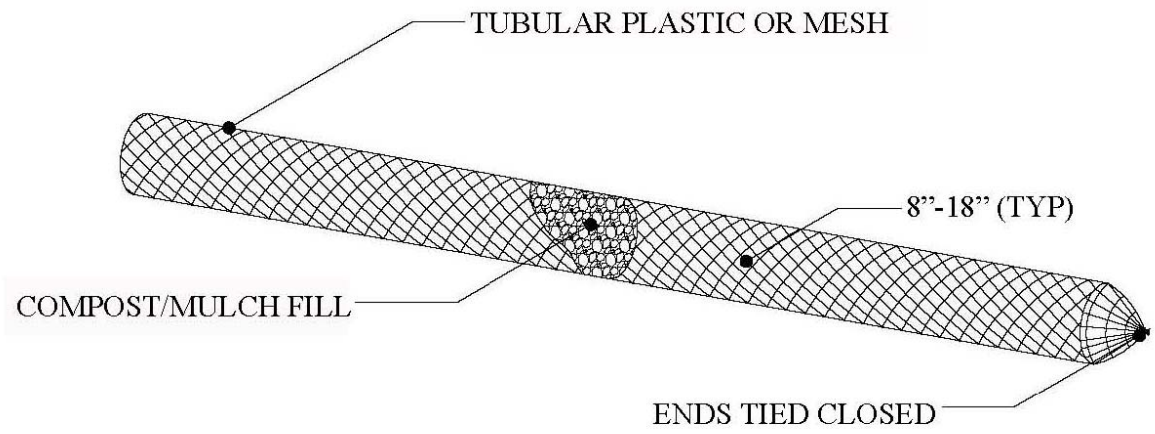
COMPOST FILTER SOCK (Slope Interruption Device)



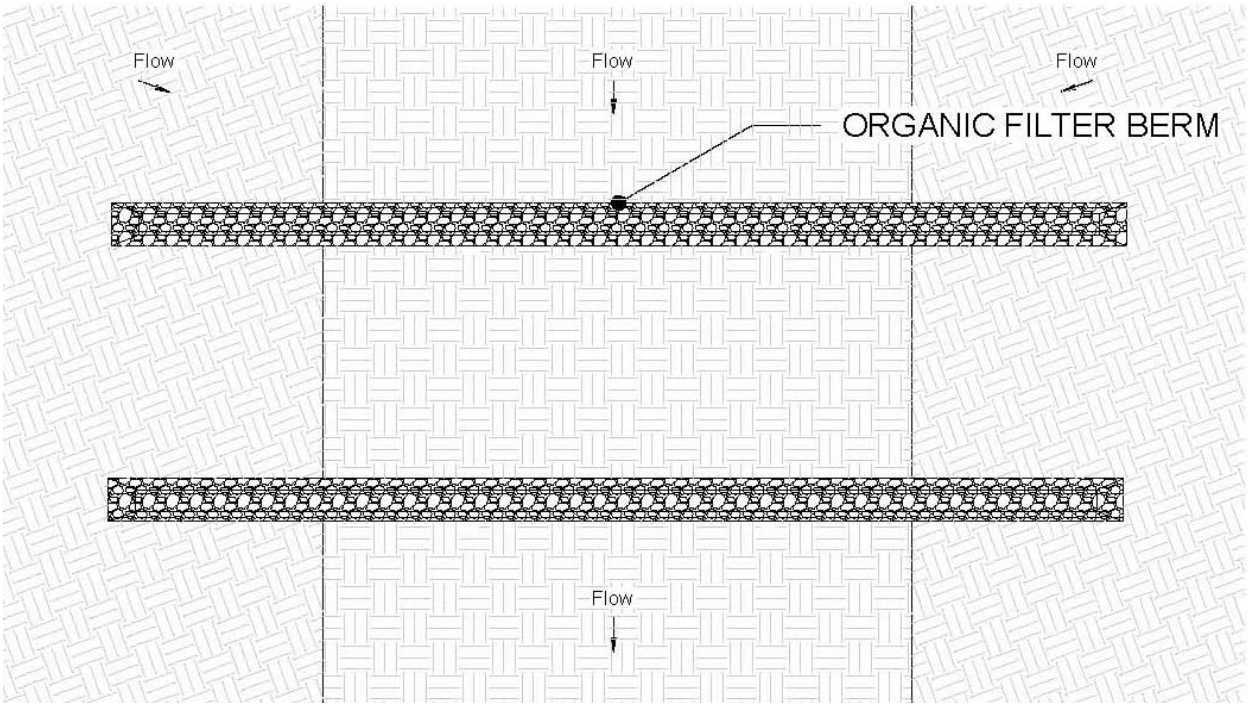
COMPOST FILTER SOCK (Stockpile Protection)



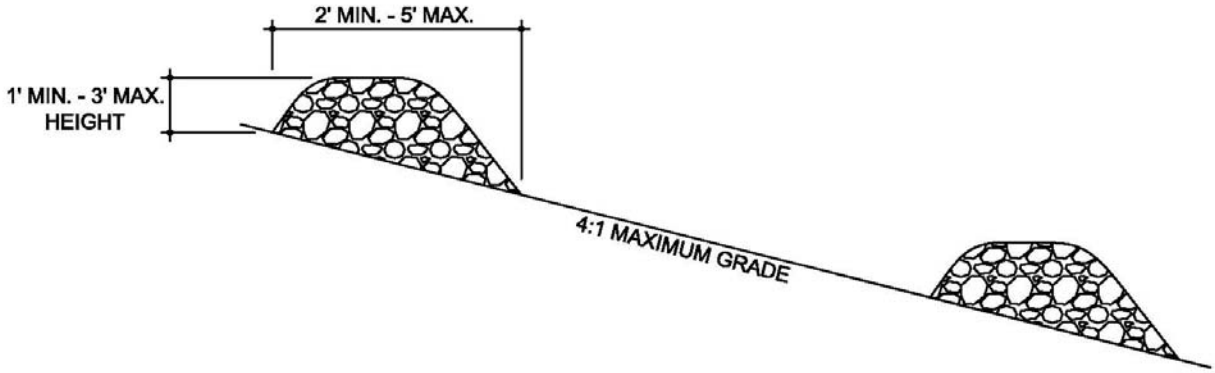
COMPOST FILTER SOCK (Perimeter Control)



COMPOST FILTER SOCK



Plan "B"
Not to Scale



Section "B-B"
Not to Scale

COMPOST FILTER BERM

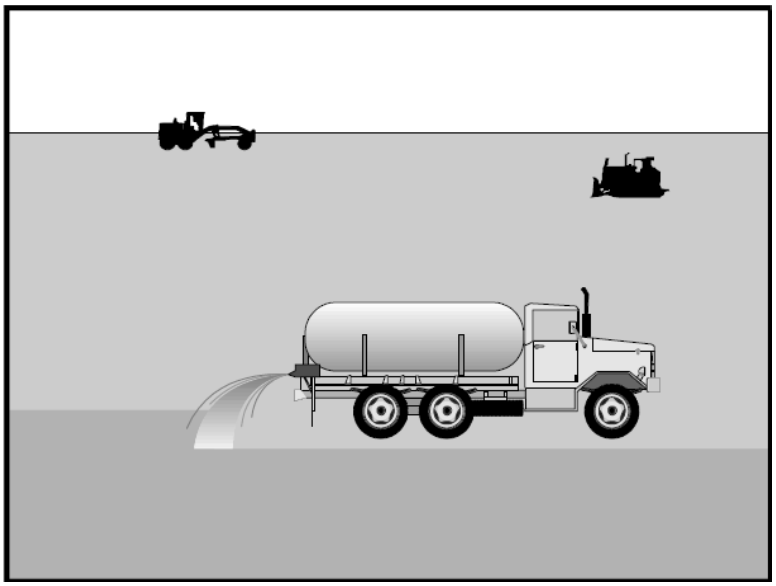
3.9 WIND EROSION CONTROL FACT SHEETS

WE-1 Wind Erosion Control

E Mālama I Ka Wai Ola

Protect our waters...
FOR LIFE

Wind Erosion Control WE-1



Objectives

EC – Erosion Control

SE – Sediment Control ▲

TR – Tracking Control

WE – Wind Erosion Control √

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment √

Nutrients

Trash

Metals

Bacteria

Oil and Grease

Organics

Potential Alternatives

None

Description and Purpose

Wind erosion or dust control consists of applying water or other dust palliatives as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

Suitable Applications

Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads,
- Drilling and blasting activities,
- Sediment tracking onto paved roads,
- Soils and debris storage piles,
- Batch drop from front-end loaders,
- Areas with unstabilized soil, and/or
- Final grading/site stabilization.

Limitations

- Watering prevents dust only for a short period and should be applied daily (or more often) to be effective.
- Over watering may cause erosion.
- Oil or oil-treated subgrade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.
- Effectiveness depends on soil, temperature, humidity, and wind velocity.

- Chemically treated subgrades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation of the site.
- Asphalt, as a mulch tack or chemical mulch, requires a 24-hour curing time to avoid adherence to equipment, worker shoes, etc. Application should be limited because asphalt surfacing may eventually migrate into the drainage system.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.

Implementation

General

During these dry seasons, construction activities are at their peak, and disturbed and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment.

Dust control, as a BMP, is a practice that is already in place for many construction activities.

City and County of Honolulu has enacted dust control in the grading permit that cause dust to be transported beyond the construction project property line.

The following are measures that the City may have already implemented as requirements for dust control from contractors:

- Construction and Grading Permits: Require provisions for dust control (ROH Section 14-15.1 (k), 14-15.2 (e)).
- DOH NOI-C for projects greater than 1-acre. Site-specific BMPs Plan: Integrate dust control measures into the plan.

Dust Control Practices

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table shows dust control practices that can be applied to site conditions that cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no construction traffic. Preventive measures would include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph, and controlling the number and activity of vehicles on a site at any given time.

Dust Control Practices

Site Condition	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt	Silt Fences	Temporary Gravel Construction Entrances/ Equipment Wash Down	Haul Truck Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	x	x	x	x	x				x
Disturbed Areas Subjected to Traffic			x	x	x		x		x
Material Stock Pile Stabilization			x	x		x			x
Demolition			x				x	x	
Clearing/ Excavation			x	x		x			x
Truck Traffic on Unpaved Roads			x						
Mud/Dirt Carry Out					x		x		

Additional preventive measures include:

- Schedule construction activities to minimize exposed area (EC-2, Scheduling);
- Quickly stabilize exposed soils using vegetation, mulching, spray-on adhesives, calcium chloride, sprinkling, and stone/gravel layering;
- Identify and stabilize key access points prior to commencement of construction;
- Minimize the impact of dust by anticipating the direction of prevailing winds;
- Direct most construction traffic to stabilized roadways within the project site;
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution;
- All distribution equipment should be equipped with a positive means of shutoff;
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project;
- If reclaimed waste water is used, the sources and discharge must meet Hawaii Department of Health Wastewater Branch, Guidelines for the Treatment and Use of Recycled Water (2002) water reclamation criteria. Non-potable water should not be conveyed in tanks or drain pipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes, and other conveyances should be marked, “NON-POTABLE WATER - DO NOT DRINK.”;

- Materials applied as temporary soil stabilizers and soil binders also generally provide wind erosion control benefits;
- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads;
- Provide covers for haul trucks transporting materials that contribute to dust;
- Provide for wet suppression or chemical stabilization of exposed soils;
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and vehicle wash down areas;
- Stabilize inactive construction sites using vegetation or chemical stabilization methods; and
- Limit the amount of areas disturbed by clearing and earth moving operations by scheduling these activities in phases.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on storm water, plant life, or groundwater.

Costs

Installation costs for water and chemical dust suppression are low, but annual costs may be quite high since these measures are effective for only a few hours to a few days.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Check areas protected to ensure coverage.
- Most dust control measures require frequent, often daily, or multiple times per day attention.

References

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

California Air Pollution Control Laws, California Air Resources Board, 1992.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Caltrans, Standard Specifications, Sections 10, “Dust Control”; Section 17, “Watering”; and Section 18, “Dust Palliative.”

Hawaii Administrative Rules 11-60.1-33 Air Pollution Control.

Hawaii Department of Health Wastewater Branch, Guidelines for the Treatment and Use of Recycled Water, May 2002.

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Revised Ordinances of Honolulu Article 15 Grading, Grubbing and Stockpiling.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Revised Ordinances of Honolulu Article 14 Permits, Bonds and Inspection for Grading, Soil Erosion and Sediment Control, 1990 as Amended.

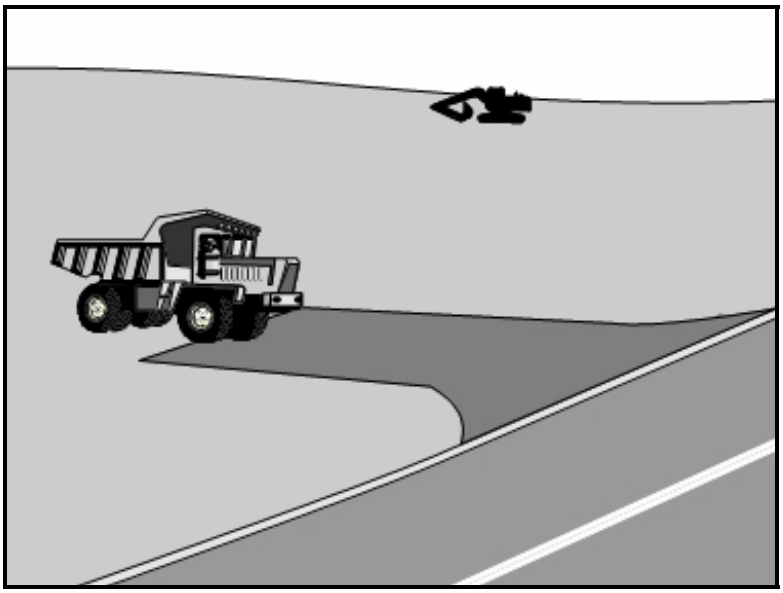
3.10 TRACKING CONTROL FACT SHEETS

TR-1 Stabilized Construction Entrance/Exit
TR-2 Stabilized Construction Roadway
TR-3 Entrance/Outlet Tire Wash

E Mālama I Ka Wai Ola

Protect our waters...
FOR LIFE

Stabilized Construction Entrance/Exit TR-1



Objectives	
EC – Erosion Control	▲
SE – Sediment Control	▲
TR – Tracking Control	√
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents	
Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives
None

Description and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Suitable Applications

Use at construction sites:

- Where dirt or mud can be tracked onto public roads,
- Adjacent to water bodies,
- Where poor soils are encountered, and/or
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right of way.
- Entrances and exits should be constructed on level ground only.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.

Implementation

General

A stabilized construction entrance is a pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right of way, street, alley, sidewalk, or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights of way or streets. Reducing tracking of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving the construction site, a stabilized construction entrance should be used. NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be built on level ground. Advantages of the Stabilized Construction Entrance/Exit are that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance/exit.

See the City and County of Honolulu's "Rules Relating to Soil Erosion Standards and Guidelines," for additional information.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones.
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft. minimum, and 30 ft. minimum width.
- Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove additional sediment and to keep adjacent streets clean.
- Provide ample turning radii as part of the entrance.
- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphalt concrete (AC) grindings for stabilized construction access/roadway.

- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but not exceeding 6 in. should be used.
- Designate combination or single purpose entrances and exits to the construction site.
- Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.
- Implement SE-7, Street Sweeping and Vacuuming, as needed.
- All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect local roads adjacent to the site daily. Sweep or vacuum to remove visible accumulated sediment.
- Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment.
- Keep all temporary roadway ditches clear.
- Check for damage and repair as needed.
- Replace gravel material when surface voids are visible.
- Remove all sediment deposited on paved roadways within 24 hours.
- Remove gravel and filter fabric at completion of construction.

Costs

In California, average annual cost for installation and maintenance may vary from $1,200 to $4,800 each, averaging $2,400 per entrance. Costs will increase with addition of washing rack, and sediment trap. With wash rack, costs range from $1,200 - $6,000 each, averaging $3,600 per entrance. Note that Hawaii's unit prices are higher than California's unit prices.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters, EPA 840-B-9-002, USEPA, Office of Water, Washington, DC, 1993.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, USEPA Agency, 2002.

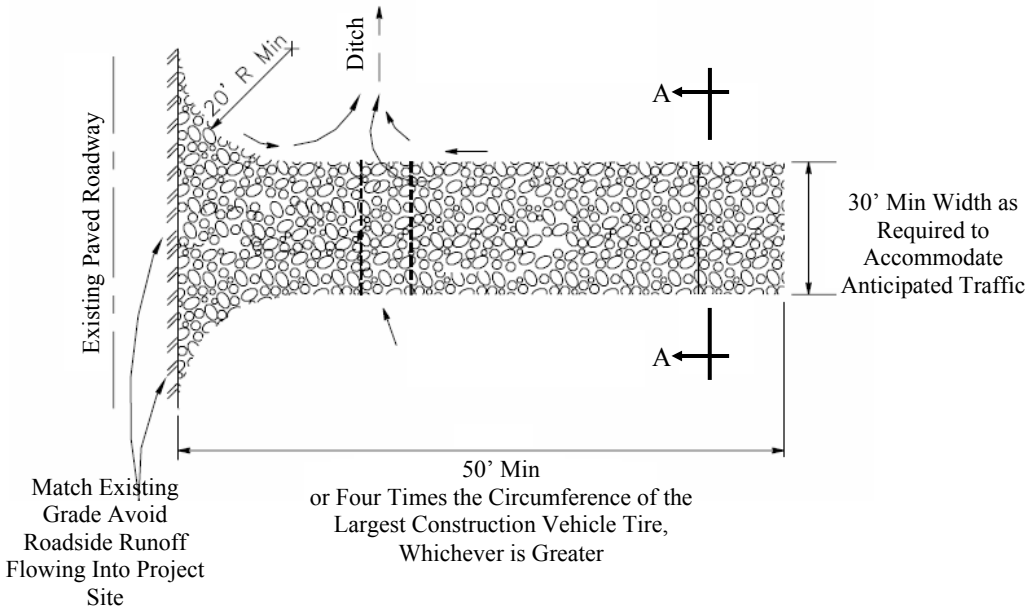
Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

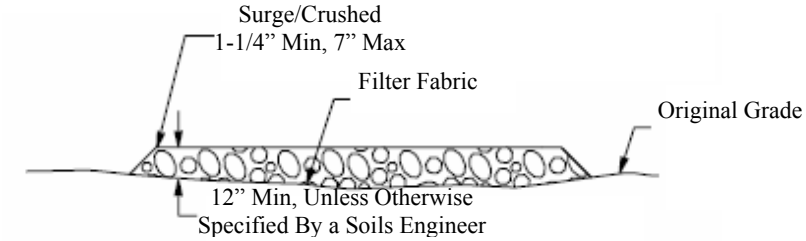
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

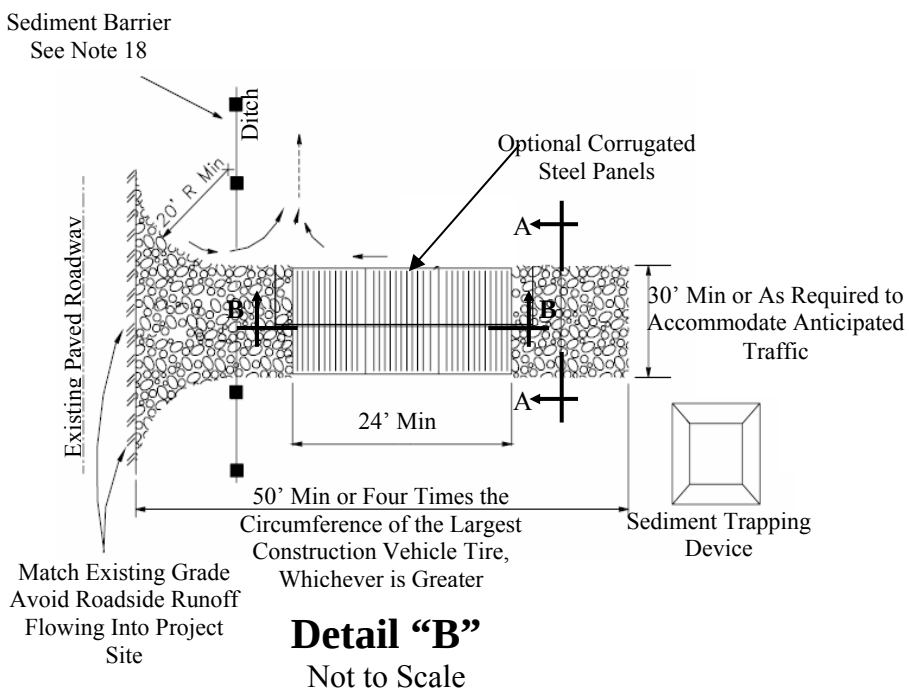


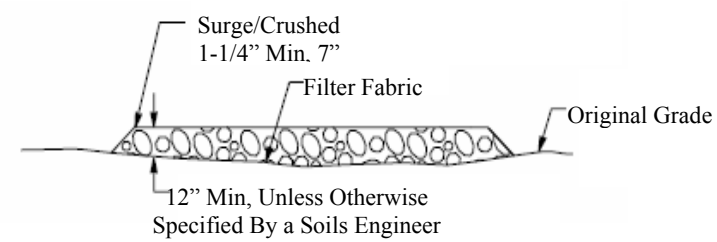
Detail "A"
Not to Scale



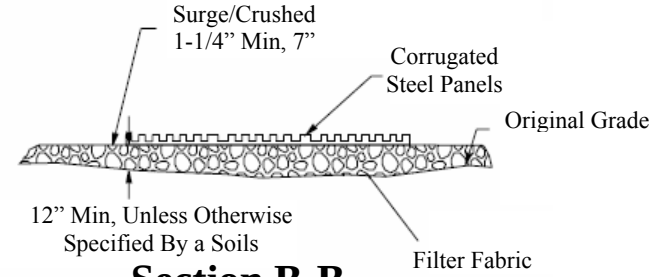
Section A-A
Not to Scale

Stabilized Construction Entrance/Exit





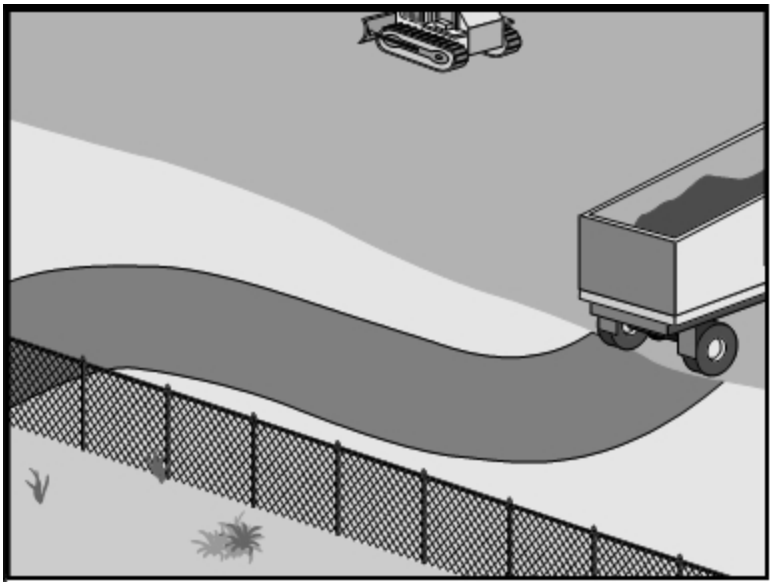
Section A-A
Not to Scale



Section B-B
Not to Scale

Notes:
1. Construct on level ground where possible.
2. Select 3 to 6 in. diameter stones.
3. Use minimum depth of stones of 12 in. or as recommended by soils engineer.
4. Construct length of 50 ft. minimum, and 30 ft. minimum width.
5. Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove additional sediment and to keep adjacent streets clean.
6. Provide ample turning radii as part of the entrance.
7. Limit the points of entrance/exit to the construction site.
8. Limit speed of vehicles to control dust.
9. Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
10. Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
11. Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.
12. Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphalt concrete (AC) grindings for stabilized construction access/roadway.
13. Place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but not exceeding 6 in. should be used.
14. Designate combination or single purpose entrances and exits to the construction site.
15. Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.
16. Implement SE-7, Street Sweeping and Vacuuming, as needed.
17. All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.
18. Construct sediment Barrier and channel runoff to sediment trapping device as appropriate.

Stabilized Construction Roadway TR-2



Objectives

EC – Erosion Control	▲
SE – Sediment Control	▲
TR – Tracking Control	√
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Access roads, subdivision roads, parking areas, and other onsite vehicle transportation routes should be stabilized immediately after grading, and frequently maintained to prevent erosion and control dust.

Suitable Applications

This BMP should be applied for the following conditions:

- Temporary Construction Traffic:
  - Phased construction projects and offsite road access, or
  - Construction during wet weather.
- Construction roadways and detour roads:
  - Where mud tracking is a problem during wet weather,
  - Where dust is a problem during dry weather,
  - Adjacent to water bodies, or
  - Where poor soils are encountered.

Limitations

- The roadway must be removed or paved when construction is complete.
- Certain chemical stabilization methods may cause storm water or soil pollution and should not be used. See WE-1, Wind Erosion Control.
- Management of construction traffic is subject to air quality control measures. Contact the local air quality management agency.

- Materials will likely need to be removed prior to final project grading and stabilization.
- Use of this BMP may not be applicable to very short duration projects.

Implementation

General

Areas that are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires that generate significant quantities of sediment that may pollute nearby streams or are transported offsite on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces onsite erosion but also can significantly speed onsite work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather.

Installation/Application Criteria

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadway should be considered during the rainy season and on slopes greater than 5%.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15%. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section or one side in the case of a super elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment laden water from entering the storm sewer system (SE-9, Storm Drain Inlet Protection). In addition, the following criteria should be considered.

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15%.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust (WE-1, Wind Erosion Control).
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support heaviest vehicles and equipment that will use it.
- Stabilize roadway using aggregate, asphalt concrete, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or asphalt concrete (AC) grindings for stabilized construction roadway is not allowed.
- Coordinate materials with those used for stabilized construction entrance/exit points.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Keep all temporary roadway ditches clear.
- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.
- Periodically apply additional aggregate on gravel roads.
- Active dirt construction roads are commonly watered three or more times per day during the dry season.

Costs

Gravel construction roads are moderately expensive, but cost is often balanced by reductions in construction delay. No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

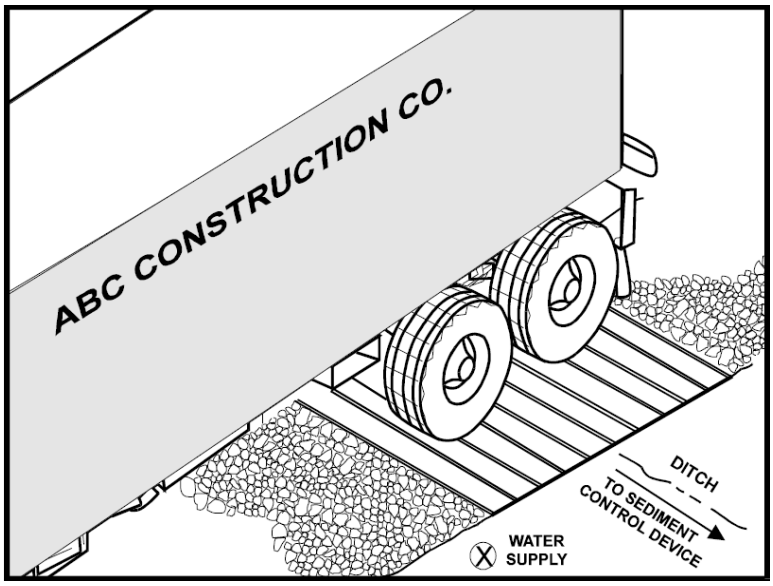
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Entrance/Outlet Tire Wash TR-3



Objectives

EC – Erosion Control	
SE – Sediment Control	▲
TR – Tracking Control	√
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

TR-1 Stabilized Construction Entrance/Exit

Description and Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and under carriages and to prevent sediment from being transported onto public roadways.

Suitable Applications

Tire washes may be used on construction sites where dirt and mud tracking onto public roads by construction vehicles may occur.

Soil erosion control designer to exercise professional judgment on its application to a project.

Limitations

- The tire wash requires a supply of wash water.
- A turnout or doublewide exit is required to avoid having entering vehicles drive through the wash area.
- Do not use where wet tire trucks leaving the site leave the road dangerously slick.

Implementation

- Incorporate with a stabilized construction entrance/exit. See TR-1, Stabilized Construction Entrance/Exit.
- Construct on level ground when possible, on a pad of coarse aggregate greater than 3 in. but not exceeding 6 in. A geotextile fabric should be placed below the aggregate.
- Wash rack should be designed and constructed/manufactured for anticipated traffic loads.

- Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device sized for the anticipated amount of vehicle washing and rainfall. The drainage ditch should be of sufficient grade, width, and depth to carry the wash runoff.
- Use hoses with automatic shutoff nozzles to prevent hoses from being left on.
- Require that all employees, subcontractors, and others that leave the site with mud caked tires and undercarriages to use the wash facility.
- Implement SE-7, Street Sweeping and Vacuuming, as needed.

Costs

Costs are low for installation of wash rack.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharge daily while non-storm water discharges occur.
- Remove accumulated sediment in wash rack and/or sediment trap to maintain system performance.
- Inspect routinely for damage and repair as needed.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

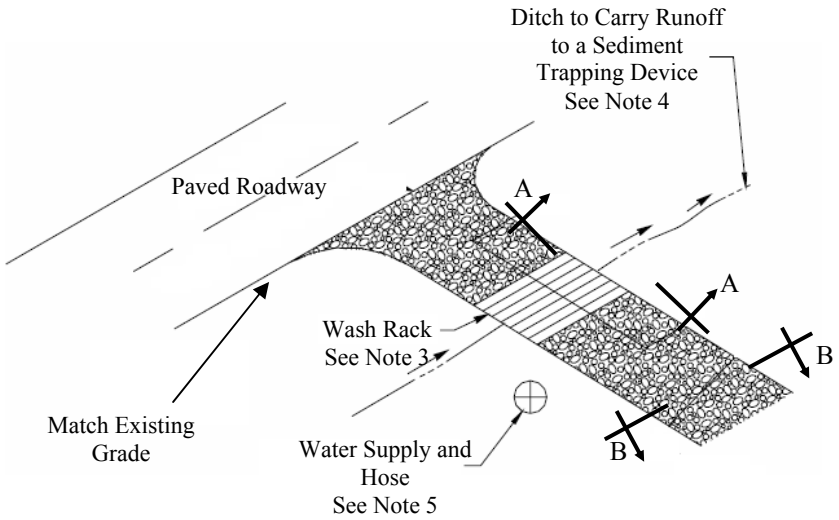
California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

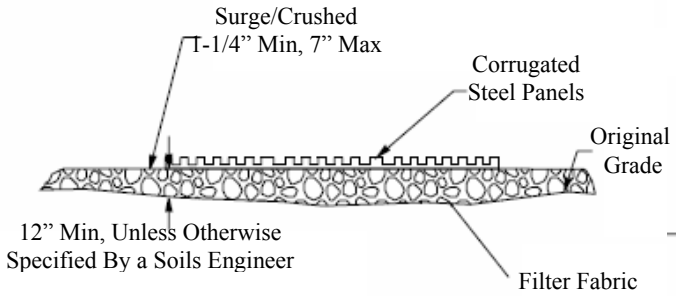
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

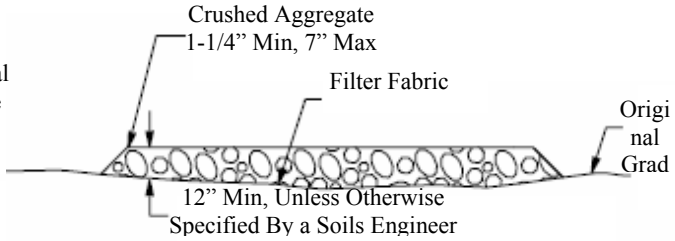
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



Plan "A"
Not to Scale



Section A-A
Not to Scale



Section B-B
Not to Scale

Notes:
1. Incorporate with a stabilized construction entrance/exit. See TC-1, Stabilized Construction Entrance/Exit.
2. Construct on level ground when possible, on a pad of coarse aggregate greater than 3 in. but not exceeding 6 in. A geotextile fabric should be placed below the aggregate.
3. Wash rack should be designed and constructed/manufactured for anticipated traffic loads.
4. Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device sized for the anticipated amount of vehicle washing and rainfall. The drainage ditch should be of sufficient grade, width, and depth to carry the wash runoff.
5. Use hoses with automatic shutoff nozzles to prevent hoses from being left on.
6. Require that all employees, subcontractors, and others that leave the site with mud caked tires and undercarriages to use the wash facility.
7. Implement SE-7, Street Sweeping and Vacuuming, as needed.

Typical Tire Wash

SECTION 4: NON-STORM WATER MANAGEMENT AND MATERIAL MANAGEMENT BMPS

4.1 NON-STORM WATER MANAGEMENT BMPS

The construction general permit prohibits the discharge of materials other than storm water and authorized non-storm water discharges. It is recognized that certain non-storm water discharges may be necessary for the completion of construction projects. Such discharges include but are not limited to irrigation of vegetative erosion control measures, pipe flushing and testing, and street cleaning.

Table 4-1: Non-Storm Water Management BMP

BMP#	BMP Name
NS-1	Water Conservation Practices
NS-2	Dewatering Operations
NS-3	Paving and Grinding Operations
NS-4	Temporary Stream Crossing
NS-5	Clear Water Diversion
NS-6	Illicit Connection/Discharge
NS-7	Potable Water/Irrigation
NS-8	Vehicle and Equipment Cleaning
NS-9	Vehicle and Equipment Fueling
NS-10	Vehicle and Equipment Maintenance
NS-11	Pile Driving Operations
NS-12	Concrete Curing
NS-13	Concrete Finishing
NS-14	Material over Water
NS-15	Demolition Adjacent to Water
NS-16	Temporary Batch Plants

Non-storm water management BMPs are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source or eliminating off-site discharge. These practices involve day-to-day operations of the construction site and are usually under the control of the contractor. These BMPs are also referred to as "good housekeeping practices" which involve keeping a clean, orderly construction site.

Non-storm water management BMPs also include procedures and practices designed to minimize or eliminate the discharge of pollutants from vehicle and equipment cleaning, fueling, and maintenance operations to storm water drainage systems or to watercourses.

Table 4-1 lists the non-storm water management BMPs. All these BMPs should be implemented depending on the conditions and applicability of deployment described as part of the BMP.

It is recommended that owners and contractors be vigilant regarding implementation of these BMPs, including making their implementation a condition of continued employment, and part of all prime and subcontract agreements. By doing so, the chance of inadvertent violation by an uncaring individual can be prevented, potentially saving thousands of dollars in fines and project delays. Also, if procedures are not properly implemented and/or if BMPs are compromised then the discharge is subject to sampling and analysis requirements contained in the general permit.

4.2 WASTE MANAGEMENT & MATERIALS POLLUTION CONTROL BMPS

Waste management and materials pollution control BMPs, like non-storm water management BMPs, are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source before they come in contact with storm water. These BMPs also involve day-to-day operations of the construction site, are under the control of the contractor, and are additional "good housekeeping practices" which involve keeping a clean, orderly construction site.

Waste management consists of implementing procedural and structural BMPs for handling, storing, and disposing of wastes generated by a construction project. The objective is to prevent the release of waste materials into storm water runoff or discharges through proper management of the following types of wastes:

- Solid,
- Sanitary,
- Concrete,
- Hazardous, and
- Equipment – related wastes.

Materials pollution control (also called materials handling) consists of implementing procedural and structural BMPs in the handling, storing, and the use of construction materials. The BMPs are intended to prevent the release of pollutants during storm water and non-storm water discharges. The objective is to prevent or reduce the opportunity for contamination of storm water runoff from construction materials by covering and/or providing secondary containment of storage areas, and by taking adequate precautions when handling materials. These controls must be implemented for all applicable activities, material usage, and site conditions.

Table 4-2 lists the waste management and materials pollution control BMPs. It is important to note that these BMPs should be implemented depending on the conditions/applicability of deployment described as part of the BMP.

Table 4-2: Waste Management & Materials Pollution Control BMP

BMP#	BMP Name
WM-1	Material Delivery and Storage
WM-2	Material Use
WM-3	Stockpile Management
WM-4	Spill Prevention and Control
WM-5	Solid Waste Management
WM-6	Hazardous Waste Management
WM-7	Contaminated Soil Management
WM-8	Concrete Waste Management
WM-9	Sanitary/Septic Waste Management
WM-10	Liquid Waste Management

Table 4-3 Quick Reference - Disposal Alternatives lists general discharge/activities and suggests disposal methods as well as any necessary approval.

4.3 FACT SHEET FORMAT

The BMP face sheet is a short document that gives all the information about a particular BMP. Typically, each fact sheet contains the information outlined in Figure 4-1. Completed fact sheets for each of the above activities are provided in Section 4.4.

Figure 4-1: Example of Fact Sheet

NS-xx-Example of Fact Sheet

Description and Purpose

Suitable Applications

Limitations

Implementation

Cost

Inspection and Maintenance

The fact sheets also contain side bar presentations with information on BMP objectives, targeted constituents, removal effectiveness, and potential alternatives.

4.4 BMP FACT SHEETS

BMP Fact Sheets for non-storm water management and waste management and materials pollution control follow. The BMP fact sheets are individually page numbered and are suitable for photocopying and inclusion into SSBMPPs.

Table 4-3: Quick Reference – Disposal Alternatives

(Adopted from Santa Clara County Nonpoint Source Pollution Control Program - December, 1992)

All of the waste products on this chart are prohibited from discharge to the storm drain system. Use this matrix to decide which alternative disposal strategies to use.

ALTERNATIVES ARE LISTED IN PRIORITY ORDER

KEY:

POTW - Publicly Owned Treatment Plant, which in most areas is the City & County of Honolulu, Department of Environmental Services.

"Dispose to sanitary sewer" means dispose into sink, toilet, or sanitary sewer clean-out connection.

"Dispose as trash" means dispose in dumpsters or trash containers for pickup and/or eventual disposal in landfill.

"Dispose as hazardous waste" for business/commercial means contract with a hazardous waste hauler to remove and dispose.

Table 4-3: Quick Reference – Disposal Alternatives (Cont'd)

Discharge/Activity	Business/Commercial	
	Disposal	**Approval**
General Construction and Painting, Street and Utility Maintenance		
Excess Paint (oil- based)	▪ Recycle/reuse. ▪ If volume is too much to dry, solidify with absorbent material, dispose as solid waste.	
Excess Paint (water-based)	▪ Recycle/reuse. ▪ Dry by leaving cans in open air, dispose as solid waste. ▪ If volume is too much to dry, solidify with absorbent material, dispose as solid waste.	
Paint cleanup (oil-based)	▪ Wipe paint out of brushes, then: • Filter & reuse thinners, solvents; and • Dispose as hazardous waste.	
Paint cleanup (water-based)	▪ Wipe paint out of brushes, then: • Rinse to sanitary sewer.	
Empty paint cans (dry) (See WM-5)	▪ Remove lids, dispose as solid waste.	
Paint Stripping (with solvent)	▪ Use it up/give it to someone to use for original intended purpose. ▪ Separate from non-hazardous wastes (to prevent commingling with recyclable materials). ▪ Dispose as hazardous waste.	
Building exterior cleaning (high pressure water)	▪ Prevent entry into storm drain and remove offsite. ▪ Wash onto dirt area, spade in. ▪ Collect (e.g. mop up) and discharge to sanitary sewer.	POTW
Cleaning of building exteriors which have HAZARDOUS MATERIALS (e.g. mercury, lead) in paints (See WM-6)	▪ Use dry clean methods. ▪ Contain and dispose washwater as hazardous waste (suggestion: dry material first to reduce volume).	Site permitted to handle HW [#] [#]Corrected 05/23/2012
Non-hazardous paint scraping/sand blasting (See WM-6)	▪ Dry sweep, dispose as solid waste.	MSW Landfill[#]

Discharge/Activity	Business/Commercial	
	Disposal	**Approval**
HAZARDOUS paint scraping/sand blasting (e.g. marine paints or paints containing lead or tributyl tin)	▪ Dry sweep, dispose as hazardous waste.	
Cleaning streets in construction areas	▪ Dry sweep and minimize tracking of mud, then wash street with water, filter prior to discharging to storm drain. ▪ Use silt ponds, gravel filters, and/or similar pollutant reduction techniques when flushing pavement.	
Fresh cement, grout, mortar (See WM-8)	▪ Use/reuse excess for original intended purpose. ▪ Dispose separately from recyclable materials as solid waste (take to C&D Landfill.)	C&D Landfill
Washwater from concrete/motor (etc.) cleanup	▪ Wash onto dirt area, spade in. ▪ Pump and remove to appropriate disposal facility. ▪ Settle, pump water to sanitary sewer.	
Aggregate wash from driveway/patio construction	▪ Wash onto dirt area, spade in. ▪ Pump and remove to appropriate disposal facility. ▪ Settle, pump water to sanitary sewer.	POTW
Rinsewater from concrete trucks	▪ Return truck to yard for rinsing into pond or dirt area. ▪ At construction site, wash into pond or dirt area.	

Discharge/Activity	Business/Commercial	
	Disposal	**Approval**
Non-hazardous construction and demolition debris	▪ Separate debris (e.g., pressure-treated lumber, coated or partially coated with lead-based paint (LBP), adhesives, asbestos) from recyclable materials (e.g., untreated wood, non-ferrous metals), to the extent feasible at each stage of the construction, or demolition process. ▪ Recycle/reuse (e.g., concrete clean of LBP, untreated wood). ▪ Dispose non-recyclables as solid waste (take to C&D Landfill).	C&D Landfill
Hazardous demolition and construction debris (e.g. asbestos) (See WM-5, WM-6)	▪ Separate from recyclable materials (to prevent commingling different waste types) to the extent feasible each stage of the construction, demolition process. ▪ Dispose as hazardous waste.	
Saw-cut slurry	▪ Use dry cutting technique and sweep up residue. ▪ Vacuum slurry and dispose off-site.	
Construction dewatering (See NS-2)	▪ Recycle/reuse. ▪ Discharge to sanitary sewer. ▪ As appropriate, treat prior to discharge to storm drain.	POTW, DOH, DPP
Portable toilet waste	▪ Leasing company shall dispose to sanitary sewer at POTW.	
Leaks from garbage dumpsters (See WM-10)	▪ Collect, contain leaking material. Eliminate leak, keep covered, return to leasing company for immediate repair. ▪ If dumpster is used for liquid waste, use plastic liner.	
Leaks from construction debris bins (See WM-10)	▪ Insure that bins are used for dry nonhazardous materials only. (Suggestion: Fencing, covering help prevent misuse.)	

Discharge/Activity	Business/Commercial	
	Disposal	**Approval**
Dumpster cleaning water (See WM-10)	▪ Clean at dumpster's own facility and discharge waste through grease interceptor to sanitary sewer. ▪ Clean on site and discharge through grease interceptor to sanitary sewer.	POTW POTW
Cleaning driveways, paved areas (Special Focus = Restaurant alleys, Grocery dumpster areas)	▪ Sweep and dispose as trash (Dry cleaning only). ▪ For vehicle leaks, restaurant/ grocery alleys, follow this 3-step process: • Clean up leaks with rags or absorbents. • Sweep, use granular absorbent material (cat litter). • Mop and dispose of mopwater to sanitary sewer (or collect rinsewater and pump to sanitary sewer).	
Steam cleaning of sidewalks, plazas	▪ Collect all water and pump to sanitary sewer. ▪ Follow this 3-step process: • Clean oil leaks with rages or absorbents. • Sweep, using granular absorbent material (cat litter). • Mop and dispose of mopwater to sanitary sewer (or collect rinsewater and pump to the sanitary sewer).	
Potable water/line flushing. Hydrant testing (See NS-7)	▪ Deactivate chlorine by maximizing time water will travel before reaching streams or the ocean. ▪ Discharge to sanitary sewer. ▪ Complete dechlorination required before discharge to storm drain. Permits are required from the City's Environmental Services Department and the State DOH.	ENV, SWQ Branch DOH

Discharge/Activity	Business/Commercial	
	Disposal	**Approval**
Landscape/Garden Maintenance		
Pesticides (See NS-8)	▪ Use up. Rinse containers use rinsewater as product. Dispose rinsed containers as trash. ▪ Dispose unused pesticide as hazardous waste.	
Garden Clippings	▪ Separate from "inert fill material," solid waste and recyclable materials to the extent feasible at each stage of the construction or demolition process. ▪ Take to permitted commercial composters (for recycling).	
Swimming pool, spa, fountain water (emptying)	▪ Do not use metal-based algicides (i.e. Copper Sulfate). ▪ Recycle/reuse (e.g. irrigation). ▪ Dechlorinate, check if pH is acceptable, discharge to storm drain (permit required).	ENV, SWQ Branch
Swimming pool, spa filter backwash	▪ Reuse for irrigation. ▪ Dispose on dirt area. ▪ Settle, dispose to sanitary sewer.	
Vehicle Wastes		
Used motor oil (See NS-10)	▪ Store in tanks, containers, or other containers that are in good condition and compatible with the oil, send to permitted recycler via a DOH-permitted transporter.	
Antifreeze (See NS-10)	▪ DO NOT MIX with other hazardous wastes (solvents, pesticides. used oil). ▪ Store in tanks, containers, or other containers that are in good condition and compatible with the antifreeze, send to permitted recycler. ▪ Dispose as hazardous waste.	

Discharge/Activity	Business/Commercial	
	Disposal	**Approval**
Other vehicle fluids and solvents (See NS-10)	▪ DO NOT MIX with hazardous wastes. ▪ Store in tanks, containers, or other containers that are in good condition and compatible with the fluid, send to permitted recycler.	
Automobile batteries	▪ Send to auto battery recyclers.	
Refrigerant	▪ Send to an EPA-certified technician who uses EPA-approved recycling/recovery equipment.	
Motor home/construction trailer waste	▪ Use holding tank. Dispose to sanitary sewer.	
Vehicle Washing(See NS-8)	▪ Recycle. ▪ Discharge to sanitary sewer.	POTW
Mobile Vehicle Washing (See NS-8)	▪ Collect washwater and discharge to sanitary sewer.	
Vehicle leaks at Vehicle Repair Facilities	▪ Follow this 3-step process: • Clean up leaks with rags and absorbents. • Sweep, using granular absorbent material (cat litter). • Mop and dispose of mop water to sanitary sewer.	
Other Wastes		
Carpet cleaning solutions & other mobile washing services	▪ Dispose to sanitary sewer	POTW
Roof Drains	▪ If roof is contaminated with industrial waste products, discharge to sanitary sewer. ▪ If no contamination is present, discharge to storm drain.	
Cooling water, except for once through cooling water	▪ Recycle/reuse. ▪ Discharge to sanitary sewer.	POTW
Pumped groundwater, infiltration/foundation drainage (contaminated)	▪ Recycle/reuse (landscaping, etc.). ▪ Treat if necessary; discharge to sanitary sewer. ▪ Treat and discharge to storm drain.	POTW ENV, SWQ Branch

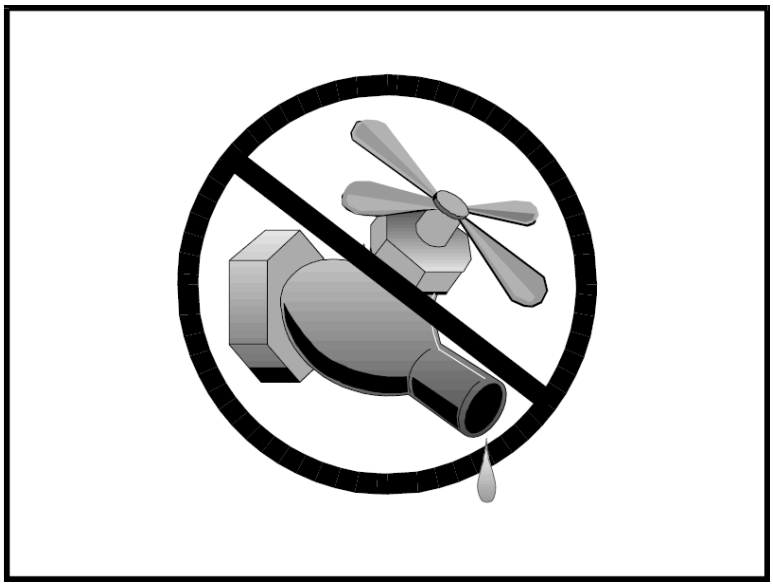
Discharge/Activity	Business/Commercial	
	Disposal	**Approval**
Kitchen Grease	▪ Provide secondary containment, collect, and send to DOH-permitted processor or recycler. NOTE: prior to transport, check with the City and County if POTW is an option, as they may not accept untreated grease.	POTW
Other vehicle fluids and solvents	▪ DO NOT MIX with hazardous wastes ▪ Store in tanks, containers, or other containers that are in good condition and compatible with the fluid, send to permitted recycler.	
Restaurant cleaning of floor mats, exhaust filters, etc.	▪ Clean inside building with discharge through grease trap to sanitary sewer. ▪ Clean outside in container or bermed area with discharge to sanitary sewer.	
Clean-up wastewater from sewer backup	▪ Follow this procedure: • Block storm drain, contain, collect, and return spilled material to the sanitary sewer. • Block storm drain, rinse remaining material to collection point and pump to sanitary sewer (No rinsewater may flow to storm drain).	

4.5 NON-STORM WATER MANAGEMENT FACT SHEETS

NS-1 Water Conservation Practices
NS-2 Dewatering Operations
NS-3 Paving and Grinding Operations
NS-4 Temporary Stream Crossing
NS-5 Clear Water Diversion
NS-6 Illicit Connection/Discharge
NS-7 Potable Water/Irrigation
NS-8 Vehicle and Equipment Cleaning
NS-9 Vehicle and Equipment Fueling
NS-10 Vehicle and Equipment Maintenance
NS-11 Pile Driving Operations
NS-12 Concrete Curing
NS-13 Concrete Finishing
NS-14 Material Over Water
NS-15 Demolition Adjacent to Water
NS-16 Temporary Batch Plants

E Mālama I Ka Wai Ola
Protect our waters...
FOR LIFE

Water Conservation Practices NS-1



Objectives

EC – Erosion Control	▲
SE – Sediment Control	▲
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	√
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Water conservation practices are activities that use water during the construction of a project in a manner that avoids causing erosion and the transport of pollutants offsite. These practices can reduce or eliminate non-storm water discharges.

Suitable Applications

Water conservation practices are suitable for all construction sites where water is used, including piped water, metered water, trucked water, and water from a reservoir.

Limitations

- None identified.

Implementation

- Keep water equipment in good working condition.
- Stabilize water truck filling area.
- Repair water leaks promptly.
- Washing of vehicles and equipment on the construction site is discouraged.
- Avoid using water to clean construction areas. If water must be used for cleaning or surface preparation, surface should be swept and vacuumed first to remove dirt. This will minimize amount of water required.
- Direct construction water runoff to areas where it can soak into the ground or be collected and reused.

- Large dewatering operations have the potential to cause localized ground water gradients to change and may alter the direction of nearby contaminants.
- Authorized non-storm water discharges to the storm drain system, channels, or receiving waters are acceptable with the implementation of appropriate BMPs.
- Lock water tank valves to prevent unauthorized use.

Costs

The cost is small to none compared to the benefits of conserving water.

Inspection and Maintenance

- Inspect and verify that activity based BMPs are in place prior to the commencement of authorized non-storm water discharges.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges are occurring.
- Repair water equipment as needed to prevent unintended discharges:
  - Water trucks,
  - Water reservoirs (water buffalos),
  - Irrigation systems, and
  - Hydrant connections.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Dewatering Operations NS-2

Objectives

EC – Erosion Control	
SE – Sediment Control	▲
TR – Tracking Control	
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	√
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	√
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

Description and Purpose

Dewatering operations are practices that manage the discharge of pollutants when non-storm water and accumulated precipitation must be removed from a work location so that construction work may be accomplished.

Suitable Applications

These practices are implemented for discharges of non-storm water from construction sites. Non-storm waters include, but are not limited to, groundwater, water from cofferdams, water diversions, and waters used during construction activities that must be removed from a work area.

Practices identified in this section are also appropriate for implementation when managing the removal of accumulated precipitation (storm water) from depressed areas at a construction site.

Limitations

- Site conditions will dictate design and use of dewatering operations.
- The controls discussed in this best management practice (BMP) address sediment only.
- The controls detailed in this BMP only allow for minimal settling time for sediment particles. Use only when site conditions restrict the use of the other control methods.
- Dewatering operations will require, and must comply with, applicable local permits.

- Dewatered sludge effluent shall not discharge into the storm drain system.
- Avoid dewatering discharges where possible by using the water for dust control, by infiltration, etc.

Implementation

- Dewatering non-storm water cannot be discharged without prior notice to and approval from the State of Hawaii Department of Health, Clean Water Branch (CWB) and City and County of Honolulu Planning and Permitting (DPP). This includes storm water that is co-mingled with groundwater or other non-storm water sources. Once the discharge is allowed, appropriate BMPs must be implemented to ensure the discharge complies with all permit requirements and regional and watershed-specific requirements.
- CWB may require a separate NPDES permit prior to the dewatering discharge of non-storm water. These permits will have specific testing, monitoring, and discharge requirements and can take significant time to obtain.
- The flow chart shown in the figure at the end of this BMP should be utilized to guide dewatering operations.
- The owner will coordinate monitoring and permit compliance.
- Additional permits or permissions from other agencies may be required for dewatering cofferdams or diversions.
- Dewatering discharges must not cause erosion at the discharge point.
- A variety of methods can be used to treat water during dewatering operations. Several devices are presented below and provide options to achieve sediment removal. The size of particles present in the sediment and Permit or receiving water limitations on sediment are key considerations for selecting sediment treatment option(s); in some cases, the use of multiple devices may be appropriate.

Toxics and Petroleum Products

- In areas suspected of having groundwater pollution, sample the groundwater near the excavation site and have the water tested for known or suspected pollutants at a certified laboratory. Check with CWB and City DPP for their requirements for dewatering, additional water quality tests, and disposal options.
- With permits from CWB and City DPP, discharge to the storm drainage system is allowed. With a permit from a publicly owned treatment works (POTW), contaminated groundwater can be treated and discharged to the POTW via sanitary sewer.

Sediment Basin (See also SE-2)

Description:

- A sediment basin is a temporary basin with a controlled release structure that is formed by excavation or construction of an embankment to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment basins are generally larger than Sediment Traps (SE-3).

Appropriate Applications:

- Effective for the removal of gravel, sand, silt, some metals that settle out with the sediment, and trash.

Implementation:

- Excavation and construction of related facilities is required.
- Temporary sediment basins must be fenced if safety is a concern.
- Outlet protection is required to prevent erosion at the outfall location.

Maintenance:

- Maintenance is required for safety fencing, vegetation, embankment, inlet and outfall structures, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-half.

Sediment Trap (See also SE-3)

Description:

A sediment trap is a temporary basin formed by excavation and/or construction of an earthen embankment across a waterway or low drainage area to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment traps are generally smaller than Sediment Basins (SE-2).

Appropriate Applications:

Effective for the removal of large and medium sized particles (sand and gravel) and some metals that settle out with the sediment.

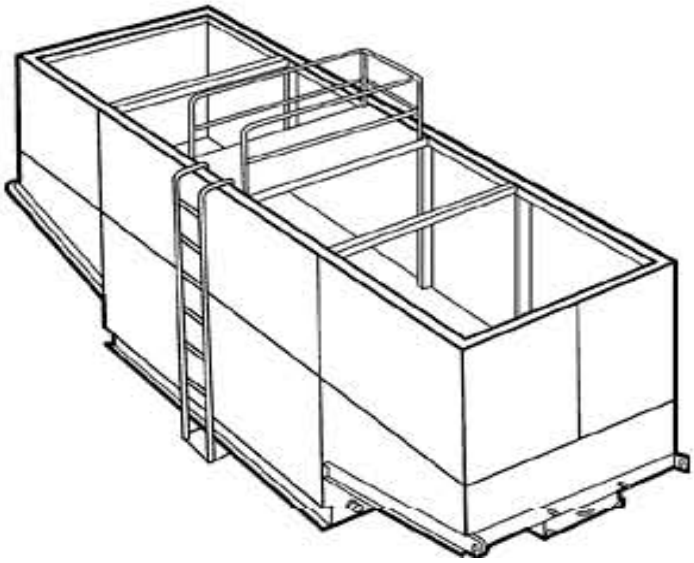
Implementation:

- Excavation and construction of related facilities is required.
- Trap inlets should be located to maximize the travel distance to the trap outlet.
- Use rock or vegetation to protect the trap outlets against erosion.

Maintenance:

- Maintenance is required for vegetation, embankment, inlet and outfall structures, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-third.

Weir Tanks



Description:

- A weir tank separates water and waste by using weirs. The configuration of the weirs (over and under weirs) maximizes the residence time in the tank and determines the waste to be removed from the water, such as oil, grease, and sediments.

Appropriate Applications:

- The tank removes trash, some settleable solids (gravel, sand, and silt), some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

Implementation:

- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.

Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.
- Oil and grease disposal must be by professional waste disposal company.

Dewatering Tanks

Description:

- A dewatering tank removes debris and sediment. Flow enters the tank through the top, passes through a fabric filter, and is discharged through the bottom of the tank. The filter separates the solids from the liquids.

Appropriate Applications:

- The tank removes trash, gravel, sand, and silt, some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

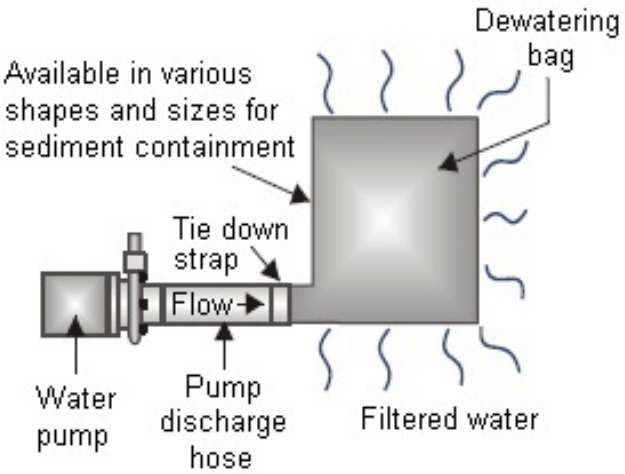
Implementation:

- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.

Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.
- Oil and grease disposal must be by professional waste disposal company.

Gravity Bag Filter



Description:

- A gravity bag filter, also referred to as a dewatering bag, is a square or rectangular bag made of non-woven geotextile fabric that collects sand, silt, and fines.

Appropriate Applications:

- Effective for the removal of sediments (gravel, sand, and silt). Some metals are removed with the sediment.

Implementation:

- Water is pumped into one side of the bag and seeps through the bottom and sides of the bag.
- A secondary barrier, such as a rock filter bed or straw/hay bale barrier, is placed beneath and beyond the edges of the bag to capture sediments that escape the bag.

Maintenance:

- Inspection of the flow conditions, bag condition, bag capacity, and the secondary barrier is required.
- Replace the bag when it no longer filters sediment or passes water at a reasonable rate.
- The bag is disposed of offsite.

Sand Media Particulate Filter

Description:

- Water is treated by passing it through canisters filled with sand media. Generally, sand filters provide a final level of treatment. They are often used as a secondary or higher level of treatment after a significant amount of sediment and other pollutants have been removed using other methods.

Appropriate Applications:

- Effective for the removal of trash, gravel, sand, and silt and some metals, as well as the reduction of biochemical oxygen demand (BOD) and turbidity.
- Sand filters can be used for stand-alone treatment or in conjunction with bag and cartridge filtration if further treatment is required.
- Sand filters can also be used to provide additional treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.

Maintenance:

- The filters require regular service to monitor and maintain the level of the sand media. If subjected to high loading rates, filters can plug quickly.
- Vendors generally provide data on maximum head loss through the filter. The filter should be monitored daily while in use, and cleaned when head loss reaches target levels.
- If cleaned by backwashing, the backwash water may need to be hauled away for disposal, or returned to the upper end of the treatment train for another pass through the series of dewatering BMPs.

Pressurized Bag Filter

Description:

- A pressurized bag filter is a unit composed of single filter bags made from polyester felt material. The water filters through the unit and is discharged through a header. Vendors provide bag filters in a variety of configurations. Some units include a combination of bag filters and cartridge filters for enhanced contaminant removal.

Appropriate Applications:

- Effective for the removal of sediment (sand and silt) and some metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Oil absorbent bags are available for hydrocarbon removal.
- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.

Maintenance:

- The filter bags require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

Cartridge Filter

Description:

- Cartridge filters provide a high degree of pollutant removal by utilizing a number of individual cartridges as part of a larger filtering unit. They are often used as a secondary or higher polishing) level of treatment after a significant amount of sediment and other pollutants are removed. Units come with various cartridge configurations (for use in series with bag filters) or with a larger single cartridge filtration unit (with multiple filters within).

Appropriate Applications:

- Effective for the removal of sediment (sand, silt, and some clays) and metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Hydrocarbons can effectively be removed with special resin cartridges.
- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance.

Maintenance:

- The cartridges require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

Costs

Sediment controls are low to high cost measures depending on the dewatering system that is selected. Pressurized filters tend to be more expensive than gravity settling, but are often more effective. Simple tanks are generally rented on a long-term basis (one or more months) and can range from $360 per month for a 1,000 gallon tank to $2,660 per month for a 10,000 gallon tank in California. Mobilization and demobilization costs vary considerably. Note that Hawaii's rental fees are higher than California's unit prices.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharges daily where non-storm water discharges occur.
- Unit-specific maintenance requirements are included with the description of each unit.
- Sediment removed during the maintenance of a dewatering device may be either spread onsite and stabilized, or disposed of at a disposal site as approved by the owner.
- Sediment that is commingled with other pollutants must be disposed of in accordance with all applicable laws and regulations and as approved by the owner.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

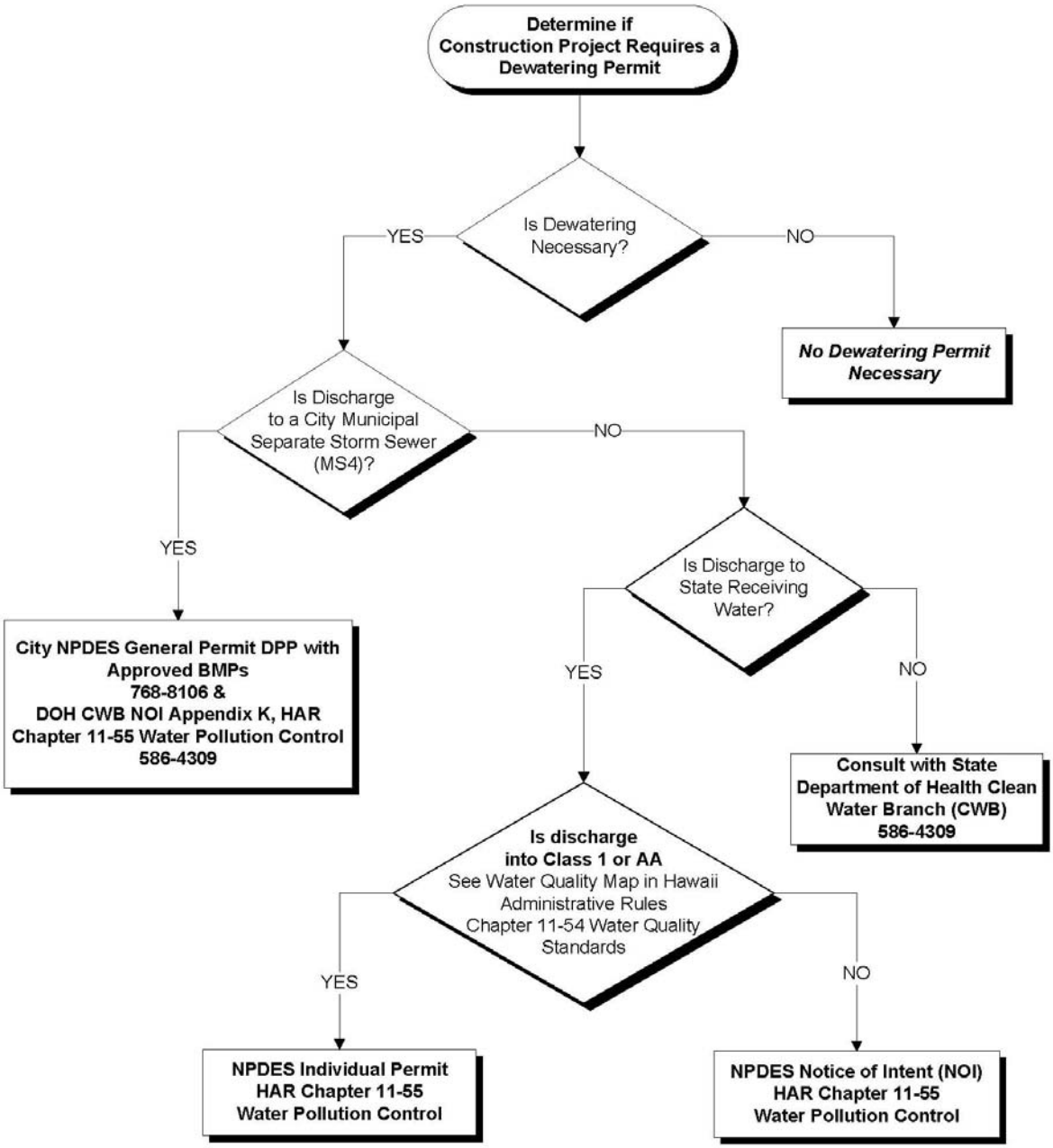
Hawaii Administrative Rules 11-55 CWB NOI Form G Construction Activity Dewatering Effluent.

Labor Surcharge & Equipment Rental Rates, April 1, 2002 through March 31, 2003, California Department of Transportation (Caltrans).

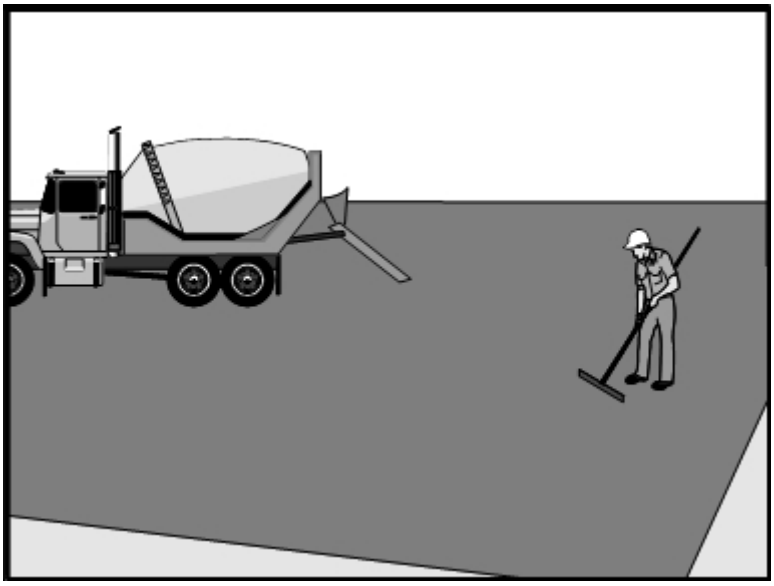
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Dewatering Permit Flow Chart



Paving and Grinding Operations NS-3



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control ▲

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	√
Organics	

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

Suitable Applications

These procedures are implemented where paving, surfacing, resurfacing, or sawcutting, may pollute storm water runoff or discharge to the storm drain system or watercourses.

Limitations

- Finer solids are not effectively removed by filtration systems.
- Paving opportunities may be limited during wet weather.

Implementation

General

- Avoid paving during the wet season when feasible.
- Reschedule paving and grinding activities if rain is in the forecast.
- Train employees and sub-contractors in pollution prevention and reduction.
- Store materials away from drainage courses to prevent storm water runon (see WM-1, Material Delivery and Storage).

- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or to trap and filter sediment.
- Avoid applying tack or prime coats if rain is expected. Place BMPs to trap and filter oil sheen. Use multiple lines of BMPs to protect drain inlets.
- If paving involves an onsite mixing plant, follow the storm water permitting requirements for industrial activities.
- Stockpile material removed from roadways away from drain inlets, drainage ditches, and watercourses. These materials should be stored consistent with WM-3, Stockpile Management.
- Disposal of PCC and AC waste should be in conformance with WM-8, Concrete Waste Management.

Saw Cutting, Grinding, and Pavement Removal

- Shovel or vacuum saw-cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- When paving involves AC, the following steps should be implemented to prevent the discharge of grinding residue, uncompacted or loose AC, tack coats, equipment cleaners, or unrelated paving materials:
  - AC grindings, pieces, or chunks used in embankments or shoulder backing must not be allowed to enter any storm drains or watercourses. Install silt fence until structure is stabilized or permanent controls are in place. Examples of temporary perimeter controls can be found in EC-10, Earth Dikes and Drainage Swales; SE-1, Silt Fence; or SE-5, Fiber Rolls;
  - Collect and remove all broken asphalt and recycle when practical. Old or spilled asphalt must be recycled or disposed; and
  - Any AC chunks and pieces used in embankments must be placed above the water table and covered by at least 1 ft. of material.
- Do not allow saw-cut slurry to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine, should not be allowed to flow across the pavement, and should not be left on the surface of the pavement. See also WM-8, Concrete Waste Management, and WM-10, Liquid Waste Management.
- Dig out activities should not be conducted in the rain.
- Collect dig out material by mechanical or manual methods. This material may be recycled for use as shoulder backing or base material.
- If dig out material cannot be recycled, transport the material back to an approved storage site.

Asphaltic Concrete Paving

- If paving involves asphaltic cement concrete, follow these steps:
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or streams. Vacuum or sweep loose sand and gravel and properly dispose of this waste by referring to WM-5, Solid Waste Management;

- Old asphalt must be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible; and
- Use of asphalt concrete as fill shall meet inert fill definition given by Hawaii Revised Statutes (HRS) Chapter 342H Solid Waste Pollution.

Portland Cement Concrete Paving

- Do not wash sweepings from exposed aggregate concrete into a storm drain system. Collect and return to aggregate base stockpile or dispose of properly.
- Allow aggregate rinse to settle. Then, either allow rinse water to dry in a lined temporary pit as described in WM-8, Concrete Waste Management, or pump the water to the sanitary sewer if allowed by the local (Federal, City or private) wastewater authority.

Sealing Operations

- During chip seal application and sweeping operations, petroleum or petroleum covered aggregate must not be allowed to enter any storm drain or water courses. Apply temporary perimeter controls until structure is stabilized.
- Drainage inlet structures and manholes should be covered with filter fabric during application of seal coat, tack coat, slurry seal, and fog seal.
- Seal coat, tack coat, slurry seal, or fog seal should not be applied if rainfall is predicted to occur during the application or curing period.

Paving Equipment

- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials rather than burying. See NS-10, Vehicle and Equipment Maintenance, WM-4, Spill Prevention and Control, and WM-10, Liquid Waste Management.
- Substances used to coat asphalt transport trucks, and asphalt spreading equipment should not contain soap and should be non-foaming and non-toxic.
- Use only non-toxic substances to coat asphalt transport trucks and asphalt spreading equipment.
- Paving equipment parked onsite should be parked over plastic to prevent soil contamination.
- Clean asphalt coated equipment offsite whenever possible. When cleaning dry, hardened asphalt from equipment, manage hardened asphalt debris as described in WM-5, Solid Waste Management. Any cleaning onsite should follow NS-8, Vehicle and Equipment Cleaning.

Thermoplastic Striping

- Thermoplastic striper and pre-heater equipment shutoff valves should be inspected to ensure that they are working properly to prevent leaking thermoplastic from entering drain inlets, the storm water drainage system, or watercourses.
- Pre-heaters should be filled carefully to prevent splashing or spilling of hot thermoplastic. Leave six inches of space at the top of the pre-heater container when filling thermoplastic to allow room for material to move when the vehicle is deadheaded.

- Do not pre-heat, transfer, or load thermoplastic near drain inlets or watercourses.
- Clean truck beds daily of loose debris and melted thermoplastic. When possible, recycle thermoplastic material.

Raised/Recessed Pavement Marker Application and Removal

- Do not transfer or load bituminous material near drain inlets, the storm water drainage system, or watercourses.
- Melting tanks should be loaded with care and not filled to beyond six inches from the top to leave room for splashing when vehicle is deadheaded.
- When servicing or filling melting tanks, ensure all pressure is released before removing lids to avoid spills.
- On large-scale projects, use mechanical or manual methods to collect excess bituminous material from the roadway after removal of markers.

Costs

- All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Keep ample supplies of drip pans or absorbent materials onsite.
- Inspect and maintain machinery regularly to minimize leaks and drips.

References

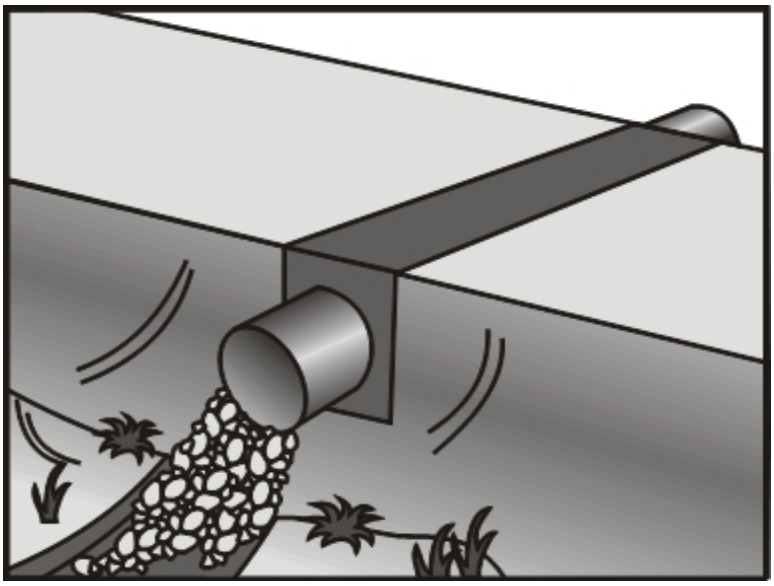
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Hot Mix Asphalt-Paving Handbook AC 150/5370-14, Appendix I, U.S. Army Corps of Engineers, July 1991.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Temporary Stream Crossing NS-4



Objectives

EC – Erosion Control	▲
SE – Sediment Control	▲
TR – Tracking Control	▲
WE – Wind Erosion Control	
NS – Non-Storm Water Management Control	√
WM – Waste Management & Materials Pollution Control	

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

A temporary stream crossing is a temporary culvert, ford or bridge placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings are not intended to maintain traffic for the public. The temporary access will eliminate erosion and downstream sedimentation caused by vehicles.

Suitable Applications

Temporary stream crossings should be installed at all designated crossings of perennial and intermittent streams on the construction site, as well as for dry channels that may be significantly eroded by construction traffic.

Temporary streams crossings are installed at sites:

- Where appropriate permits have been secured (U.S. Army Corps of Engineers 404 Permits, and State of Hawaii Department of Health, Clean Water Branch (CWB) 401 Certifications), State Department of Land and Natural Resources (DLNR), Commission on Water Resource Management (CWRM), and Stream Channel Alteration Permit (HAR Title 13, Chapter 169-50, Protection of Instream Uses);
- Where construction equipment or vehicles need to frequently cross a waterway;
- When alternate access routes impose significant constraints;
- When crossing perennial streams or waterways causes significant erosion;

- Where construction activities will not last longer than one year; and/or
- Where appropriate permits have been obtained for the stream crossing.

Limitations

The following limitations may apply:

- Installation and removal will usually disturb the waterway;
- Installation may require CWB 401 Certification, and U.S. Army Corps of Engineers 404 permit. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required;
- Installation may require dewatering or temporary diversion of the stream. See NS-2, Dewatering Operations and NS-5, Clear Water Diversion;
- Installation may cause a constriction in the waterway, which can obstruct flood flow and cause flow backups or washouts. If improperly designed, flow backups can increase the pollutant load through washouts and scouring;
- Use of natural or other gravel in the stream for construction of Cellular Confinement System (CCS) ford crossing will be contingent upon approval by fisheries agencies;
- Ford crossings may degrade water quality due to contact with vehicles and equipment;
- May be expensive for a temporary improvement;
- Requires other BMPs to minimize soil disturbance during installation and removal;
- Fords should only be used in dry weather; and/or
- Liability for damage resulting from the culvert is with the design engineer/contractor. It should be designed so it will not create flooding problems.

Implementation

General

The purpose of this BMP is to provide a safe, erosion-free access across a stream for construction equipment. Minimum standards and specifications for the design, construction, maintenance, and removal of the structure should be established by an engineer registered in Hawaii. Temporary stream crossings may be necessary to prevent construction equipment from causing erosion of the stream and tracking sediment and other pollutants into the stream.

Temporary stream crossings are used as access points to construction sites when other detour routes may be too long or burdensome for the construction equipment. Often heavy construction equipment must cross streams or creeks, and detour routes may impose too many constraints such as being too narrow or poor soil strength for the equipment loadings. Additionally, the contractor may find a temporary stream crossing more economical for light-duty vehicles to use for frequent crossings, and may have less environmental impact than construction of a temporary access road.

Location of the temporary stream crossing should address:

- Site selection where erosion potential is low; and
- Areas where the side slopes from site runoff will not spill into the side slopes of the crossing.

The following types of temporary stream crossings should be considered:

- **Culverts** - A temporary culvert is effective in controlling erosion but will cause erosion during installation and removal. A temporary culvert can be easily constructed and allows for heavy equipment loads;
- **Fords** - Appropriate during the dry season in arid areas. Used on dry washes and ephemeral streams, and low-flow perennial streams. CCS, a type of ford crossing, is also appropriate for use in streams that would benefit from an influx of gravels. A temporary ford provides little sediment and erosion control and is ineffective in controlling erosion in the stream channel. A temporary ford is the least expensive stream crossing and allows for maximum load limits. It also offers very low maintenance. Fords are more appropriate during the dry season and in arid areas; and
- **Bridges** - Appropriate for streams with high flow velocities, steep gradients and where temporary restrictions in the channel are not allowed.

Design

During the summer construction season, rainfall is infrequent and many streams are dry. Under these conditions, a temporary ford may be sufficient. A ford is not appropriate if construction will continue through the winter rainy season, if summer thunderstorms are likely, or if the stream flows during most of the year. Temporary culverts and bridges should then be considered and, if used, should be sized to pass a significant design storm (i.e., at least a 10-year storm). The temporary stream crossing should be protected against erosion, both to prevent excessive sedimentation in the stream and to prevent washout of the crossing.

Design and installation requires knowledge of stream flows and soil strength. Designs should be prepared under direction of, and approved by, a registered civil engineer and for bridges, a registered structural engineer. Both hydraulic and construction loading requirements should be considered with the following:

- Comply with any special requirements for culvert and bridge crossings, particularly if the temporary stream crossing will remain through the rainy season;
- Provide stability in the crossing and adjacent areas to withstand the design flow. The design flow and safety factor should be selected based on careful evaluation of the risks due to over topping, flow backups, or washout;
- Install sediment traps immediately downstream of crossings to capture sediments. See SE-3, Sediment Trap;
- Avoid oil or other potentially hazardous materials for surface treatment;
- Culverts are relatively easy to construct and able to support heavy equipment loads;
- Fords are the least expensive of the crossings, with maximum load limits;
- CCS crossing structures consist of clean, washed gravel and cellular confinement system blocks. CCS is appropriate for streams that would benefit from an influx of gravel; for example: streams or rivers below reservoirs, and urban, channelized streams. Many urban stream systems are gravel-deprived due to human influences, such as dams, gravel quarries, and concrete channels;
- CCS allows designers to use either angular or naturally occurring rounded gravel, because the cells provide the necessary structure and stability. In fact, natural gravel is

optimal for this technique, because of the habitat improvement it will provide after removal of the CCS;

- A gravel depth of 6 to 12 in. for a CCS structure is sufficient to support most construction equipment;
- An advantage of a CCS crossing structure is that relatively little rock or gravel is needed, because the CCS provides the stability; and
- Bridges are generally more expensive to design and construct, but provide the least disturbance of the streambed and constriction of the waterway flows.

Construction and Use

- Stabilize construction roadways, adjacent work area, and stream bottom against erosion.
- Construct during dry periods to minimize stream disturbance and reduce costs.
- Construct at or near the natural elevation of the streambed to prevent potential flooding upstream of the crossing.
- Install temporary erosion control BMPs in accordance with erosion control BMP fact sheets to minimize erosion of embankment into flow lines.
- Any temporary artificial obstruction placed within flowing water should only be built from material, such as clean gravel or sandbags, that will not introduce sediment or silt into the watercourse.
- Temporary water body crossings and encroachments should be constructed to minimize scour. Cobbles used for temporary water body crossings or encroachments should be clean, rounded stream cobble.
- Vehicles and equipment should not be driven, operated, fueled, cleaned, maintained, or stored in the wet or dry portions of a water body where wetland vegetation, riparian vegetation, or aquatic organisms may be destroyed.
- The exterior of vehicles and equipment that will encroach on the water body within the project should be maintained free of grease, oil, fuel, and residues.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than one hour.
- Disturbance or removal of vegetation should not exceed the minimum necessary to complete operations. Precautions should be taken to avoid damage to vegetation by people or equipment. Disturbed vegetation should be replaced with the appropriate soil stabilization measures.
- Riparian vegetation, when removed pursuant to the provisions of the work, should be cut off no lower than ground level to promote rapid re-growth. Access roads and work areas built over riparian vegetation should be covered by a sufficient layer of clean river run cobble to prevent damage to the underlying soil and root structure. The cobble must be removed upon completion of project activities.
- Conceptual temporary stream crossings are shown in the attached figures.
- Construction in waterways is subject to additional permit requirements. Contact the US Army Corps of Engineers and State Department of Land and Natural Resources for additional information.

Costs

Caltrans Construction Cost index for temporary bridge crossings is \$45-\$95/ft^2. Note that Hawaii's unit prices are higher than California's unit prices and cost of regulatory permits not included in estimated unit cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two week intervals in the non-rainy season to verify continued BMP implementation.
- Check for blockage in the channel, sediment buildup or trapped debris in culverts, blockage behind fords or under bridges.
- Check for erosion of abutments, channel scour, riprap displacement, or piping in the soil.
- Check for structural weakening of the temporary crossings, such as cracks, and undermining of foundations and abutments.
- Remove sediment that collects behind fords, in culverts, and under bridges periodically.
- Replace lost or displaced aggregate from inlets and outlets of culverts and cellular confinement systems.
- Remove temporary crossing promptly when it is no longer needed.

References

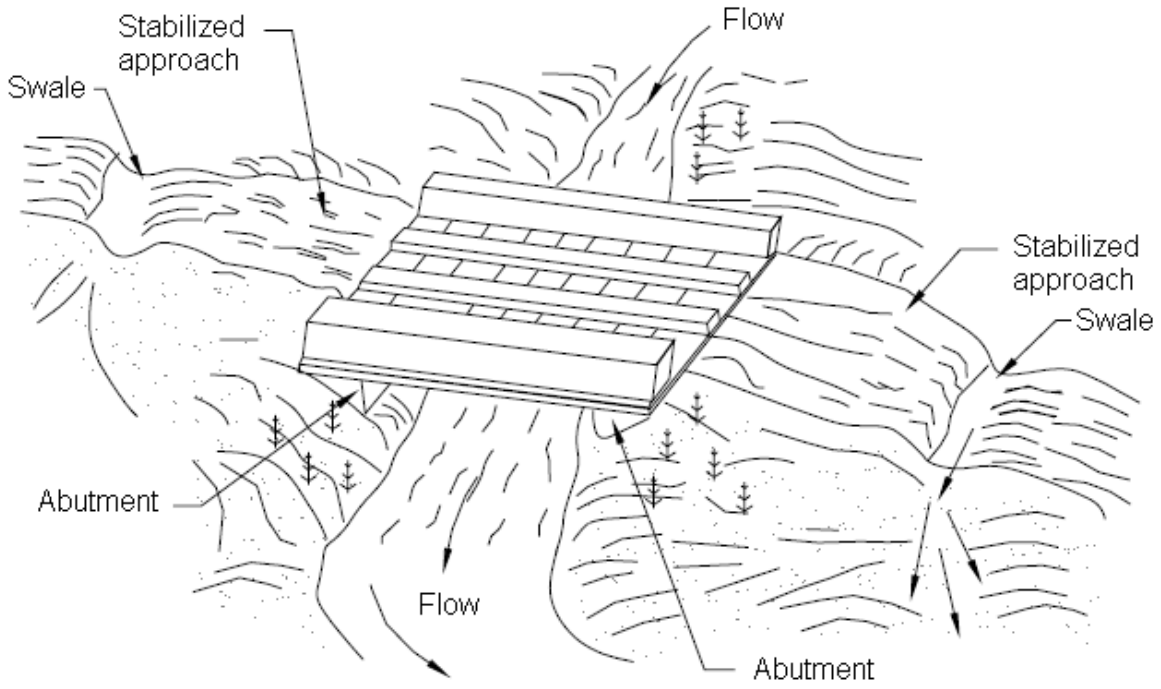
California Bank and Shore Rock Slope Protection Design - Practitioners Guide and Field Evaluations of Riprap Methods, Caltrans Study No. F90TL03, October 2000.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Hawaii Administrative Rules, Title 11, Chapter 54, Water Quality Standards Section 404 of the Clean Water Act.

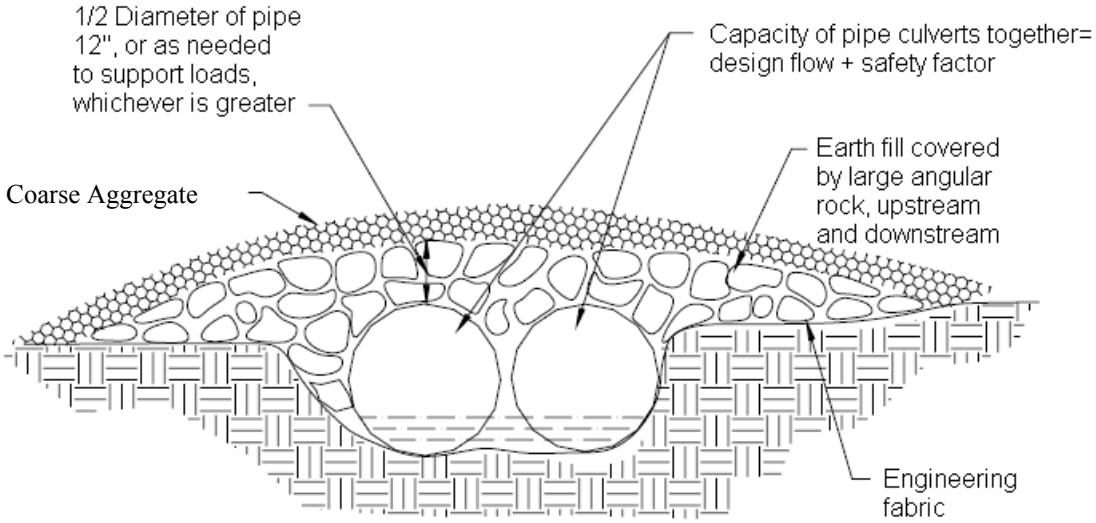
Hawaii Administrative Rules, Title 13, Chapter 169-50, Protection of Instream Uses of Water.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

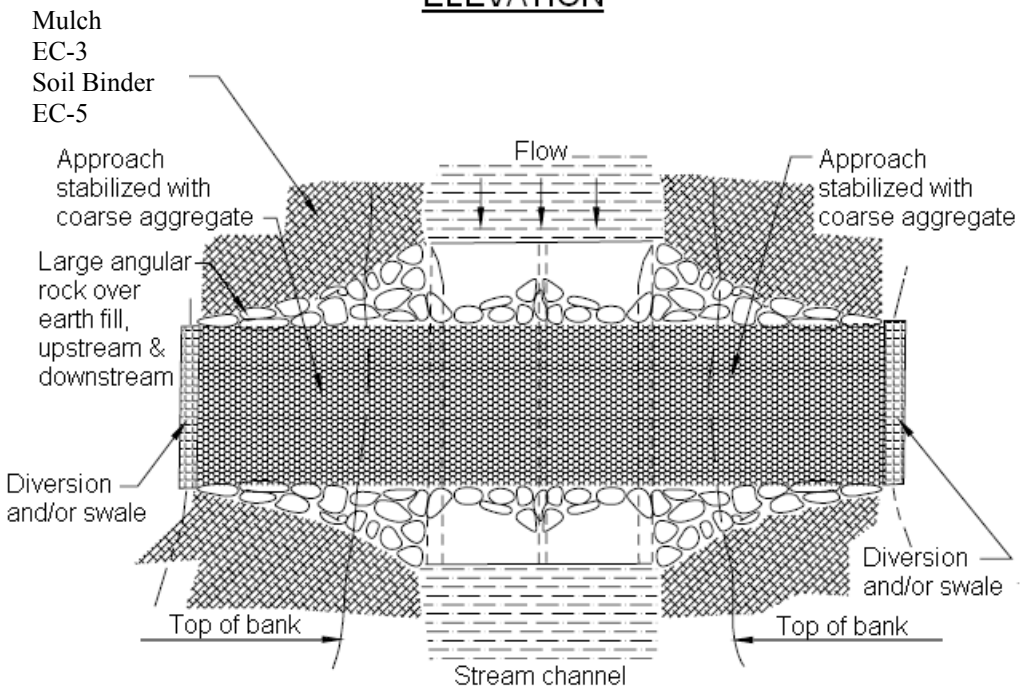


NOTE:
Surface flow of road diverted by swale and/or dike.

TYPICAL BRIDGE CROSSING
NOT TO SCALE



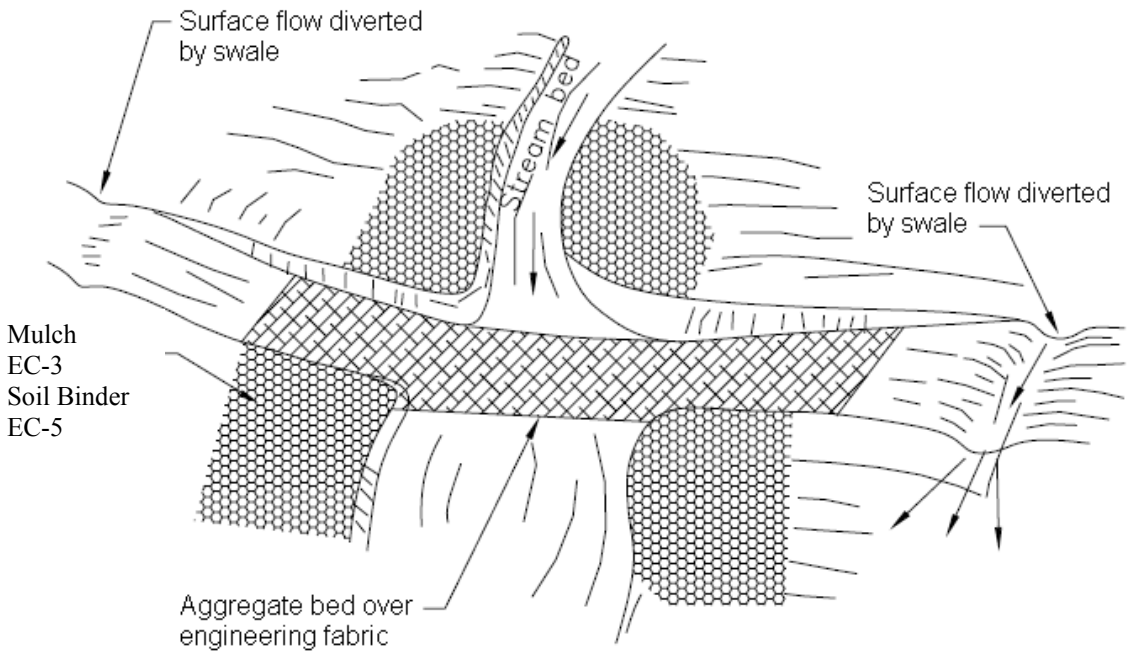
ELEVATION



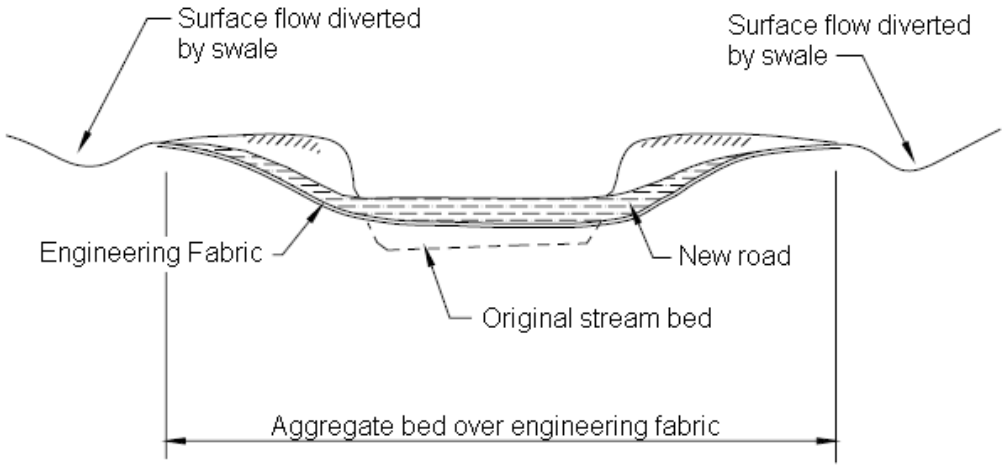
PLAN

TYPICAL CULVERT CROSSING

NOT TO SCALE

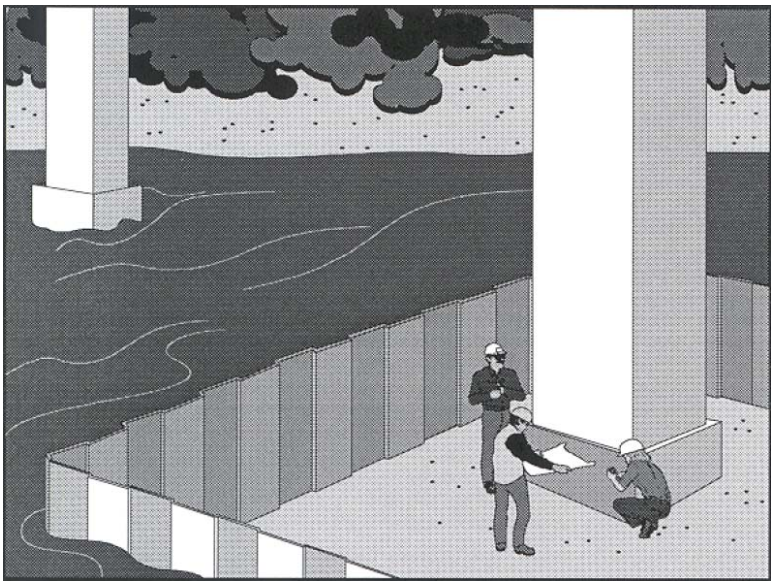


Aggregate approach
1:5 (V:H) Maximum slope of road



TYPICAL FORD CROSSING
NOT TO SCALE

Clear Water Diversion NS-5



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Clear water diversion consists of a system of structures and measures that intercept clear surface water runoff upstream of a project, transport it around the work area, and discharge it downstream with minimal water quality degradation from either the project construction operations or the construction if the diversion. Clear water diversions are used in a waterway to enclose a construction area and reduce sediment pollution from construction work occurring in or adjacent to water. Structures commonly used as part of this system include diversion ditches, berms, dikes, slope drains, rock, gravel bags, wood, aqua barriers, cofferdams, filter fabric or turbidity curtains, drainage and interceptor swales, pipes, or flumes.

Suitable Applications

A clear water diversion is typically implemented where appropriate permits have been secured and work must be performed in a flowing stream or water body.

- Clear water diversions are appropriate for isolating construction activities occurring within or near a water body such as streambank stabilization, or culvert, bridge, pier or abutment installation. They may also be used in combination with other methods, such as clear water bypasses and/or pumps.
- Pumped diversions are suitable for intermittent and low flow streams.

- Excavation of a temporary bypass channel, or passing the flow through a heavy pipe (called a "flume") with a trench excavated under it, is appropriate for the diversion of streams less than 20 ft. wide, with flow rates less than 100 cfs.

Limitations

- Diversion and encroachment activities will usually disturb the waterway during installation and removal of diversion structures.
- Installation may require State of Hawaii Department of Health, Clean Water Branch (CWB) 401 Certification, State Department of Land and Natural Resources (DLNR), Commission on Water Resource Management (CWRM), Stream Channel Alteration Permit (HAR Title 13, Chapter 169-50, Protection of Instream Uses of Water), and U.S. Army Corps of Engineers 404 permit. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.
- Diversion and encroachment activities may constrict the waterway, which can obstruct flood flows and cause flooding or washouts. Diversion structures should not be installed without identifying potential impacts to the stream channel.
- Diversion or isolation activities are not appropriate in channels where there is insufficient stream flow to support aquatic species in the area dewatered as a result of the diversion.
- Diversion or isolation activities are inappropriate in deep water unless designed or reviewed by an engineer registered in Hawaii.
- Diversion or isolation activities should not completely dam stream flow.
- Dewatering and removal may require additional sediment control or water treatment. See NS-2, Dewatering Operations.
- Not appropriate if installation, maintenance, and removal of the structures will disturb sensitive aquatic species of concern.

Implementation

General

- Implement guidelines presented in EC-12, Streambank Stabilization to minimize impacts to streambanks.
- Where working areas encroach on flowing streams, barriers adequate to prevent the flow of muddy water into streams should be constructed and maintained between working areas and streams. During construction of the barriers, muddying of streams should be held to a minimum.
- Diversion structures must be adequately designed to accommodate fluctuations in water depth or flow volume due to tides, storms, flash floods, etc.
- Heavy equipment driven in wet portions of a water body to accomplish work should be completely clean of petroleum residue, and water levels should be below the fuel tanks, gearboxes, and axles of the equipment unless lubricants and fuels are sealed such that inundation by water will not result in discharges of fuels, oils, greases, or hydraulic fluids.
- If one portion of the stream is pumped it may trigger a Stream Diversion Works Permit (HAR Title 13, Chapter 168-32 to 35: Water Use, Wells, and Stream Diversion Works).

- Excavation equipment buckets may reach out into the water for the purpose of removing or placing fill materials. Only the bucket of the crane/ excavator/backhoe may operate in a water body. The main body of the crane/excavator/backhoe should not enter the water body except as necessary to cross the stream to access the work site.
- Stationary equipment such as motors and pumps located within or adjacent to a water body should be positioned over drip pans.
- When any artificial obstruction is being constructed, maintained, or placed in operation, sufficient water should, at all times, be allowed to pass downstream to maintain aquatic life.
- Equipment should not be parked below the high water mark unless allowed by a permit.
- Disturbance or removal of vegetation should not exceed the minimum necessary to complete operations. Precautions should be taken to avoid damage to vegetation by people or equipment. Disturbed vegetation should be replaced with the appropriate erosion control measures.
- Riparian vegetation approved for trimming as part of the project should be cut off no lower than ground level to promote rapid re-growth. Access roads and work areas built over riparian vegetation should be covered by a sufficient layer of clean river run cobble to prevent damage to the underlying soil and root structure. The cobble should be removed upon completion of project activities.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- Where possible, avoid or minimize diversion and encroachment impacts by scheduling construction during periods of low flow or when the stream is dry. Scheduling should also consider seasonal releases of water from dams, fish migration and spawning seasons, and water demands due to crop irrigation.
- Construct diversion structures with materials free of potential pollutants such as soil, silt, sand, clay, grease, or oil.

Temporary Diversions and Encroachments

- Construct diversion channels in accordance with EC-9, Earth Dikes and Drainage Swales.
- In high flow velocity areas, stabilize slopes of embankments and diversion ditches using an appropriate liner, in accordance with EC-7, Geotextiles and Mats, or use rock slope protection.
- Where appropriate, use natural streambed materials such as large cobbles and boulders for temporary embankment and slope protection, or other temporary soil stabilization methods.
- Provide for velocity dissipation at transitions in the diversion, such as the point where the stream is diverted to the channel and the point where the diverted stream is returned to its natural channel. See also EC-10, Velocity Dissipation Devices.

Temporary Dry Construction Areas

- When dewatering behind temporary structures to create a temporary dry construction area, such as cofferdams, pass pumped water through a sediment-settling device, such as a portable tank or settling basin, before returning water to the water body. See also NS-2, Dewatering Operations.
- Any substance used to assemble or maintain diversion structures, such as form oil, should be non-toxic and non-hazardous.
- Any material used to minimize seepage underneath diversion structures, such as grout, should be non-toxic, non-hazardous, and as close to a neutral pH as possible.

Comparison of Diversion and Isolation Techniques:

- Gravel bags are relatively inexpensive, but installation and removal can be labor intensive. It is also difficult to dewater the isolated area. Sandbags should not be used for this technique in rivers or streams, as sand should never be put into or adjacent to a stream, even if encapsulated in geotextile.
- Gravel Bag Berms (SE-6) used in conjunction with an impermeable membrane are cost effective, and can be dewatered relatively easily. Only clean, washed gravel should be used for both the gravel bag and gravel berm techniques.
- Cofferdams are relatively expensive, but frequently allow full dewatering. Also, many options now available are relatively easy to install.
- Sheet pile enclosures are a much more expensive solution, but do allow full dewatering. This technique is not well suited to small streams, but can be effective on large rivers or lakes, and where staging and heavy equipment access areas are available.
- K-rails are an isolation method that does not allow full dewatering, but can be used in small to large watercourses, and in fast-water situations.
- A relatively inexpensive isolation method is filter fabric isolation. This method involves placement of gravel bags or continuous berms to 'key-in' the fabric, and subsequently staking the fabric in place. This method should be used in relatively calm water, and can be used in smaller streams. Note that this is not a dewatering method, but rather a sediment isolation method.
- Turbidity curtains should be used where sediment discharge to a stream is unavoidable. They can also be used for in-stream construction, when dewatering an area is not required.
- When used in watercourses or streams, cofferdams must be used in accordance with permit requirements.
- Manufactured diversion structures should be installed following manufacturer's specifications.
- Filter fabric and turbidity curtain isolation installation methods can be found in the specific technique descriptions that follow.

Filter Fabric Isolation Technique

Definition and Purpose

A filter fabric isolation structure is a temporary structure built into a waterway to enclose a construction area and reduce sediment pollution from construction work in or adjacent to water. This structure is composed of filter fabric, gravel bags, and steel t-posts.

Appropriate Applications

- Filter fabric may be used for construction activities such as streambank stabilization, or culvert, bridge, pier or abutment installation. It may also be used in combination with other methods, such as clean water bypasses and/or pumps.
- Filter fabric isolation is relatively inexpensive. This method involves placement of gravel bags or continuous berms to 'key-in' the fabric, and subsequently staking the fabric in place.
- This method should be used in relatively calm water, and can be used in smaller streams. This is not a dewatering method, but rather a sediment isolation method.
- Water levels inside and outside the fabric curtain must be about the same, as differential heads will cause the curtain to collapse.

Limitations

- Do not use if the installation, maintenance and removal of the structures will disturb sensitive aquatic species of concern.
- Filter fabrics are not appropriate for projects where dewatering is necessary.
- Filter fabrics are not appropriate to completely dam stream flow.

Design and Installation

- For the filter fabric isolation method, a non-woven or heavy-duty fabric is recommended over standard silt fence. Using rolled geotextiles allows non-standard widths to be used.
- Anchor filter fabric with gravel bags filled with clean, washed gravel. Do not use sand. If a bag should split open, the gravel can be left in the stream, where it can provide aquatic habitat benefits. If a sandbag splits open in a watercourse, the sand could cause a decrease in water quality, and could bury sensitive aquatic habitat.
- Another anchor alternative is a continuous berm, made with the Continuous Berm Machine. This is a gravel-filled bag that can be made in very long segments. The length of the berms is usually limited to 18 ft. for ease of handling (otherwise, it gets too heavy to move).
- Place the fabric on the bottom of the stream, and place either a bag of clean, washed gravel or a continuous berm over the bottom of the silt fence fabric, such that a bag-width of fabric lies on the stream bottom. The bag should be placed on what will be the outside of the isolation area.
- Pull the fabric up, and place a metal t-post immediately behind the fabric, on the inside of the isolation area; attach the silt fence to the post with three diagonal nylon ties.
- Continue placing fabric as described above until the entire work area has been isolated, staking the fabric at least every 6 ft.

Inspection and Maintenance

- Immediately repair any gaps, holes or scour.
- Remove and properly dispose of sediment buildup.
- Remove BMP upon completion of construction activity. Recycle or reuse if applicable.
- Revegetate areas disturbed by BMP removal if needed.

Turbidity Curtain Isolation Technique

Definition and Purpose

A turbidity curtain is a fabric barrier used to isolate the near shore work area. The barriers are intended to confine the suspended sediment. The curtain is a floating barrier, and thus does not prevent water from entering the isolated area; rather, it prevents suspended sediment from getting out.

Appropriate Applications

Turbidity curtains should be used where sediment discharge to a stream is unavoidable. They are used when construction activities adjoin quiescent waters, such as lakes, ponds, and slow flowing streams. The curtains are designed to deflect and contain sediment within a limited area and provide sufficient retention time so that the sediment particles will fall out of suspension.

Limitations

- Turbidity curtains should not be used in flowing water; they are best suited for use in ponds, lakes, and very slow-moving streams.
- Turbidity curtains should not be placed across the width of a channel.
- Removing sediment that has been deflected and settled out by the curtain may create a discharge problem through the resuspension of particles and by accidental dumping by the removal equipment.

Design and Installation

- Turbidity curtains should be oriented parallel to the direction of flow.
- The curtain should extend the entire depth of the watercourse in calm-water situations.
- In wave conditions, the curtain should extend to within 1 ft. of the bottom of the watercourse, such that the curtain does not stir up sediment by hitting the bottom repeatedly. If it is desirable for the curtain to reach the bottom in an active-water situation, a pervious filter fabric may be used for the bottom 1 ft.
- The top of the curtain should consist of flexible flotation buoys, and the bottom should be held down by a load line incorporated into the curtain fabric. The fabric should be a brightly colored impervious mesh.
- The curtain should be held in place by anchors placed at least every 100 ft.
- First, place the anchors, then tow the fabric out in a furled condition, and connect to the anchors. The anchors should be connected to the flotation devices, and not to the bottom of the curtain. Once in place, cut the furling lines, and allow the bottom of the curtain to sink.
- Consideration must be given to the probable outcome of the removal procedure. It must be determined if it will create more of a sediment problem through re-suspension of the

particles or by accidental dumping of material during removal. It is recommended that the soil particles trapped by the turbidity curtain only be removed if there has been a significant change in the original contours of the affected area in the watercourse.

- Particles should always be allowed to settle for a minimum of 6 to 12 hours prior to their removal or prior to removal of the turbidity curtain.

Maintenance and Inspection

- The curtain should be inspected for holes or other problems, and any repairs needed should be made promptly.
- Allow sediment to settle for 6 to 12 hours prior to removal of sediment or curtain. This means that after removing sediment, wait an additional 6 to 12 hours before removing the curtain.
- To remove, install furling lines along the curtain, detach from anchors, and tow out of the water.

K-rail River Isolation

Definition and Purpose

This temporary sediment control or stream isolation method uses K-rails (or Jersey barriers) to form the sediment deposition area, or to isolate the in-stream or near-bank construction area.

Barriers are placed end-to-end in a pre-designed configuration and gravel-filled bags are used at the toe of the barrier and at their abutting ends to seal and prevent movement of sediment beneath or through the barrier walls.

Appropriate Applications

The K-rail isolation can be used in streams with higher water velocities than many other isolation techniques.

- This technique is also useful at the toe of embankments, and cut or fill slopes.

Limitations

- The K-rail method should not be used to dewater a project site, as the barrier is not watertight.

Design and Installation

- To create a floor for the K-rail, move large rocks and obstructions. Place washed gravel and gravel-filled bags to create a level surface for K-rails to sit. Washed gravel should always be used.
- Place the bottom two K-rails adjacent to each other, and parallel to the direction of flow; fill the center portion with gravel bags. Then place the third K-rail on top of the bottom two. There should be sufficient gravel bags between the bottom K-rails such that the top rail is supported by the gravel. Place plastic sheeting around the K-rails, and secure at the bottom with gravel bags.
- Further support can be added by pinning and cabling the K-rails together. Also, large riprap and boulders can be used to support either side of the K-rail, especially where there is strong current.

Inspection and Maintenance:

- The barrier should be inspected and any leaks, holes, or other problems should be addressed immediately.
- Sediment should be allowed to settle for at least 6 to 12 hours prior to removal of sediment, and for 6 to 12 hours prior to removal of the barrier.

Stream Diversions

The selection of which stream diversion technique to use will depend upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project.

Advantages of a Pumped Diversion

- Downstream sediment transport can be nearly eliminated.
- Dewatering of the work area is possible.
- Pipes can be moved around to allow construction operations.
- The dams can serve as temporary access to the site.
- Increased flows can be managed by adding more pumping capacity.

Disadvantages of a Pumped Diversion

- Flow volume is limited by pump capacity.
- A pumped diversion requires 24 hour monitoring of pumps.
- Sudden rain could overtop dams.
- Erosion at the outlet.
- Minor in-stream disturbance is required to install and remove dams.

Advantages of Excavated Channels and Flumes

- Excavated channels isolate work from water flow and allow dewatering.
- Excavated channels can handle larger flows than pumps.

Disadvantages of Excavated Channels and Flumes

- Bypass channel or flume must be sized to handle flows, including possible floods.
- Channels must be protected from erosion.
- Flow diversion and re-direction with small dams involves in-stream disturbance and mobilization of sediment.

Design and Installation

- Installation guidelines will vary based on existing site conditions and type of diversion used.
- Pump capacity must be sufficient for design flow.
- A standby pump is required in case a primary pump fails.
- Dam materials used to create dams upstream and downstream of diversion should be erosion resistant; materials such as steel plate, sheet pile, sandbags, continuous berms, inflatable water bladders, etc., would be acceptable.

When constructing a diversion channel, begin excavation of the channel at the proposed downstream end, and work upstream. Once the watercourse to be diverted is reached and the excavated channel is stable, breach the upstream end and allow water to flow down the new channel. Once flow has been established in the diversion channel, install the diversion weir in the main channel; this will force all water to be diverted from the main channel.

Inspection and Maintenance

- Pumped diversions require 24 hour monitoring of pumps.
- Inspect embankments and diversion channels for damage to the linings, accumulating debris, sediment buildup, and adequacy of the slope protection. Remove debris and repair linings and slope protection as required. Remove holes, gaps, or scour.
- Upon completion of work, the diversion or isolation structure should be removed and flow should be redirected through the new culvert or back into the original stream channel. Recycle or reuse if applicable.
- Revegetate areas disturbed by BMP removal if needed.

Costs

Costs of clear water diversion vary considerably and can be very high.

Inspection and Maintenance

Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.

Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.

Refer to BMP-specific inspection and maintenance requirements.

References

California Bank and Shore Rock Slope Protection Design – Practitioners Guide and Field Evaluations of Riprap Methods, Caltrans Study No. F90TL03, October, 2000.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

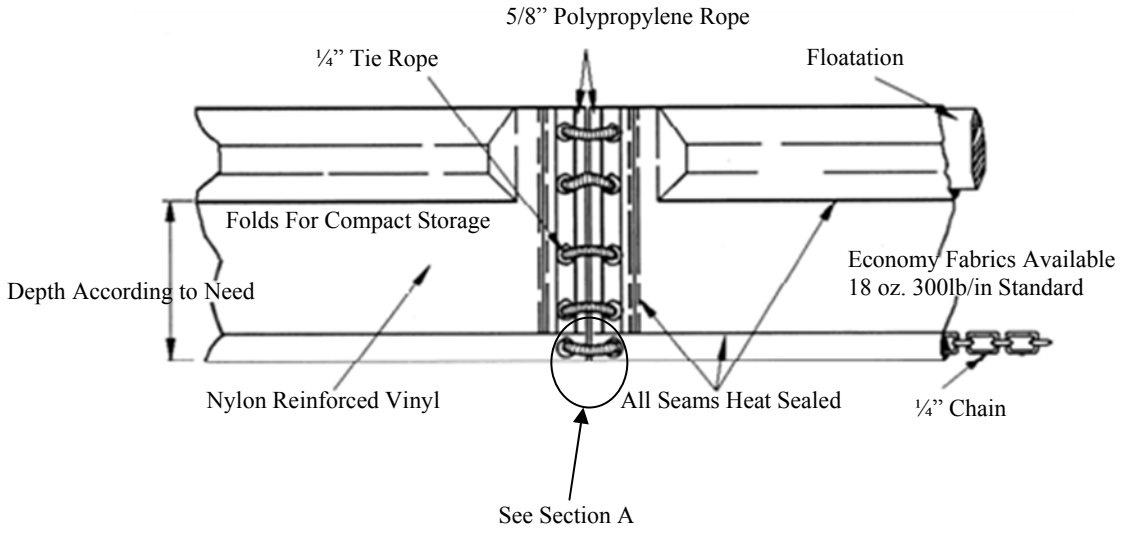
Hawaii Administrative Rules, Title 11, Chapter 54, Water Quality Standards.

Hawaii Administrative Rules, Title 13, Chapter 169-50, Protection of Instream Uses of Water.

Hawaii Administrative Rules, Title 13, Chapter 168-32 to 35, Water Use, Wells, and Stream Diversion Works.

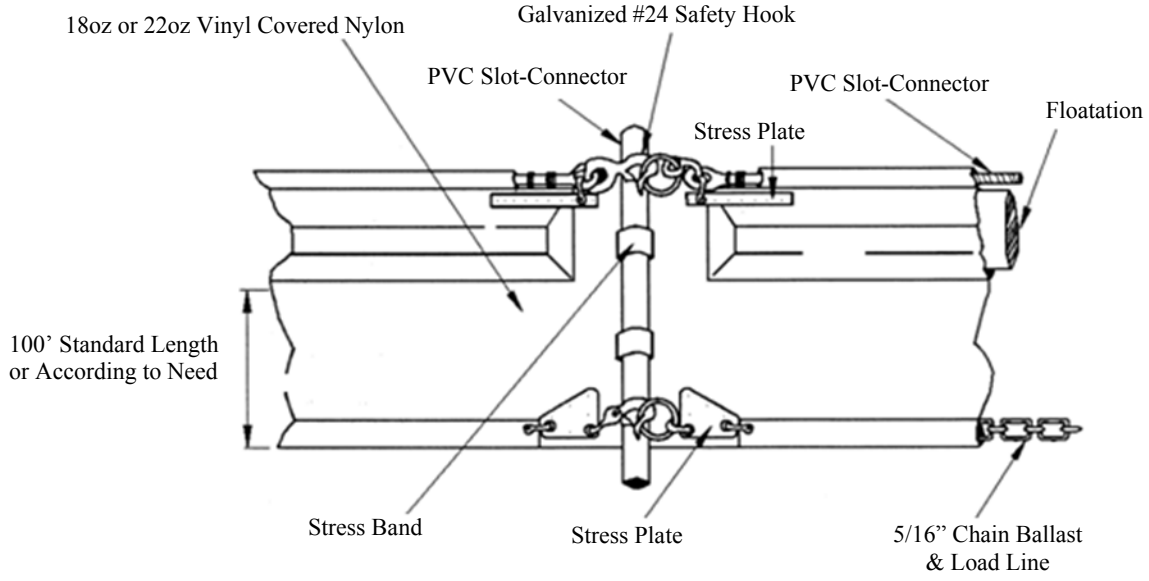
Section 404 of the Clean Water Act.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



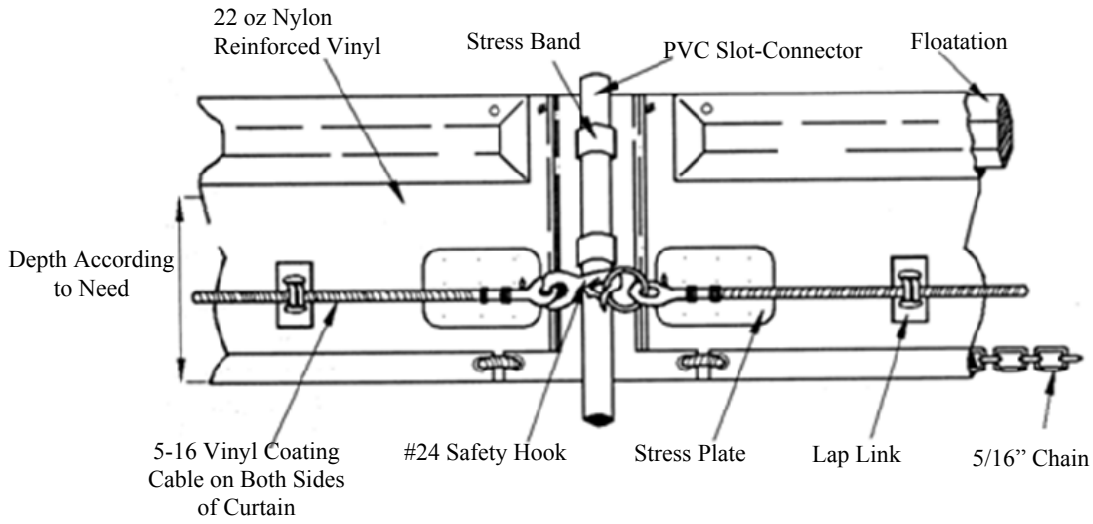
Section A
Shackle Connection

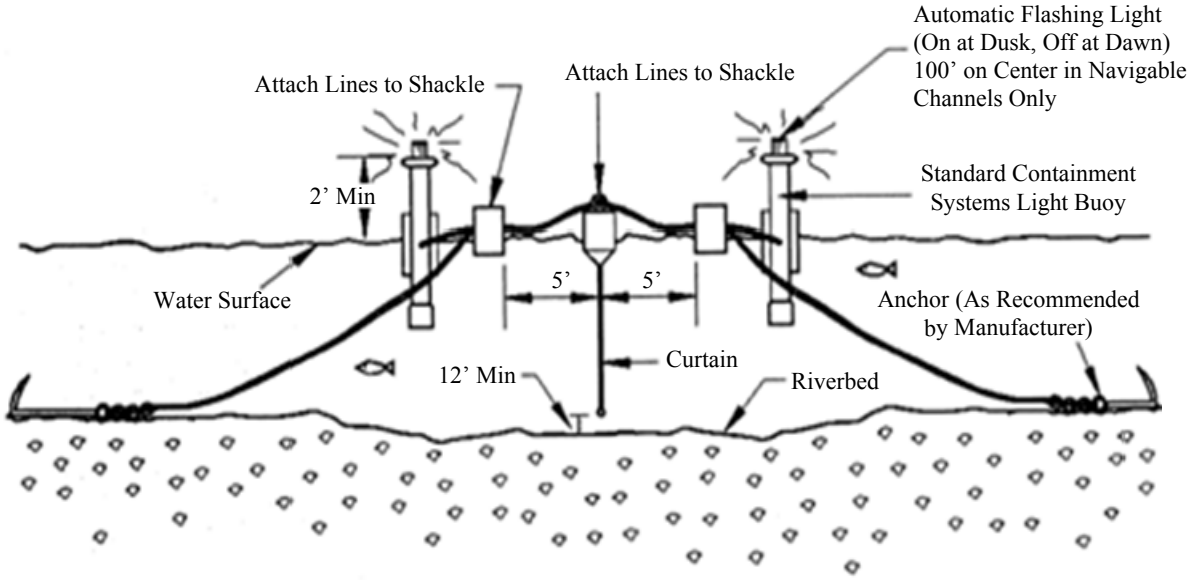
Type 1 Turbidity Curtain



Type 2 Turbidity Curtain

Source: American Boom and Barrier Corp. product literature

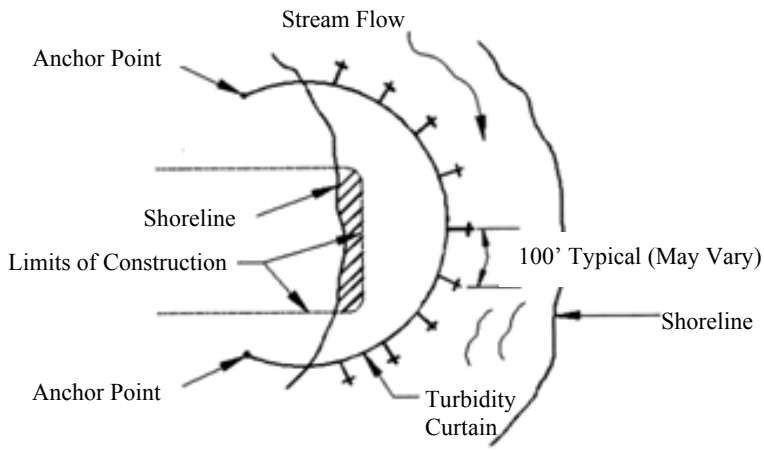




Tidal Situation Orientation

Type 3 Turbidity Curtain

Source: Adapted from American Boom and Barrier Corp. and VDOT Standard Sheets

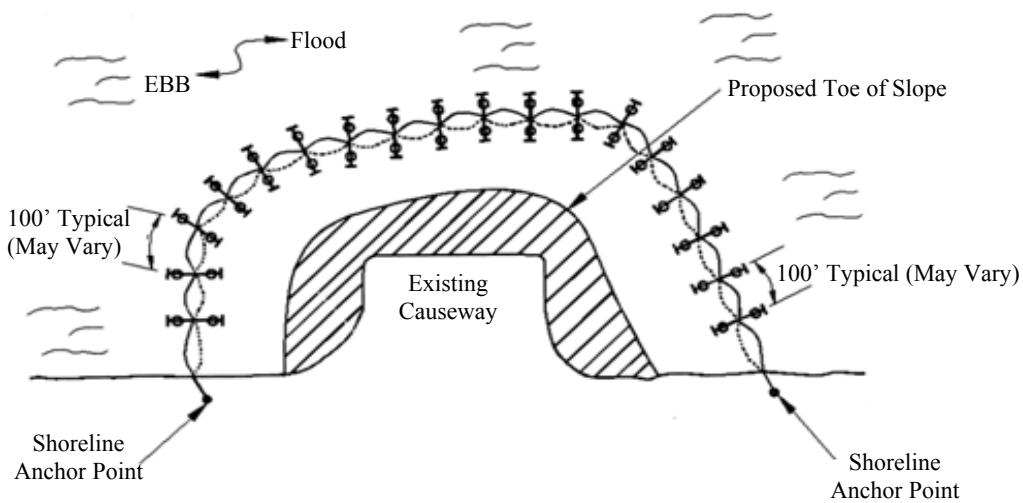


Legend

Stake or Anchor

Fill Area

Streams, Ponds & Lakes (Protected & Non-Tidal)



Legend

Anchor & Anchor Buoy

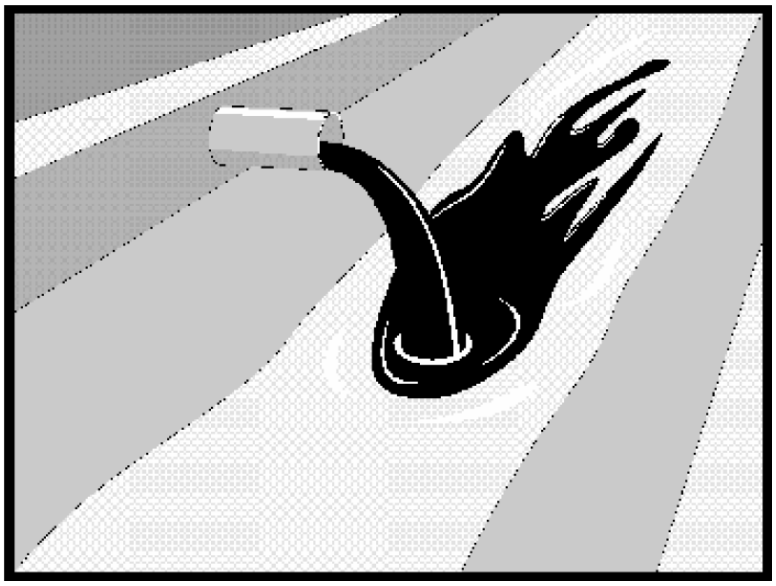
Barrier Movement due to Tidal Change

Barrier Movement due to Tidal Change

Tidal Waters and/or Heavy Wind & Wave Action

<u>Turbidity Curtain Typical Layouts</u>

Illicit Connection/Discharge NS-6



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	
Nutrients	√
Trash	√
Metals	√
Bacteria	√
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Procedures and practices designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Illicit connection/discharge and reporting is applicable anytime an illicit connection or discharge is discovered or illegally dumped material is found on the construction site.

Limitations

Illicit connections and illegal discharges or dumping, for the purposes of this BMP, refer to discharges and dumping caused by parties other than the contractor. If pre-existing hazardous materials or wastes are known to exist onsite, they should be identified in the site-specific BMPs plan and handled as set forth in the site-specific BMPs plan.

Implementation

Planning

- Review the site-specific BMPs plan. Pre-existing areas of contamination should be identified and documented in the site-specific BMPs plan.
- Inspect site before beginning the job for evidence of illicit connections, illegal dumping or discharges. Document any pre-existing conditions and notify the owner.

- Inspect site regularly during project execution for evidence of illicit connections, illegal dumping or discharges.
- Observe site perimeter for evidence for potential of illicitly discharged or illegally dumped material, which may enter the job site.

Identification of Illicit Connections and Illegal Dumping or Discharges

- **General** – unlabeled and unidentifiable material should be treated as hazardous.
- **Solids** – Look for debris, or rubbish piles. Solid waste dumping often occurs on roadways with light traffic loads or in areas not easily visible from the traveled way.
- **Liquids** – signs of illegal liquid dumping or discharge can include:
  - Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils;
  - Pungent odors coming from the drainage systems;
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes; and/or
  - Abnormal water flow during the dry weather season.
- **Urban Areas** – Evidence of illicit connections or illegal discharges is typically detected at storm drain outfall locations or at manholes. Signs of an illicit connection or illegal discharge can include:
  - Abnormal water flow during the dry weather season;
  - Unusual flows in sub drain systems used for dewatering;
  - Pungent odors coming from the drainage systems;
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes; and/or
  - Excessive sediment deposits, particularly adjacent to or near active offsite construction projects.
- **Rural Areas** – Illicit connections or illegal discharges involving irrigation drainage ditches are detected by visual inspections. Signs of an illicit discharge can include:
  - Abnormal water flow during the non-irrigation season;
  - Non-standard junction structures; and/or
  - Broken concrete or other disturbances at or near junction structures.

Reporting

Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery. For illicit connections or discharges to the storm drain system, notify the local storm water management agency. For illegal dumping, notify the local law enforcement agency.

Cleanup and Removal

The responsibility for cleanup and removal of illicit or illegal dumping or discharges will vary by location. Contact the local storm water management agency for further information.

Costs

Costs to look for and report illicit connections and illegal discharges and dumping are low. The best way to avoid costs associated with illicit connections and illegal discharges and dumping is to keep the project perimeters secure to prevent access to the site, to observe the site for vehicles that should not be there, and to document any waste or hazardous materials that exist onsite before taking possession of the site.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect the site regularly to check for any illegal dumping or discharge.
- Prohibit employees and subcontractors from disposing of non-job related debris or materials at the construction site.
- Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery.

References

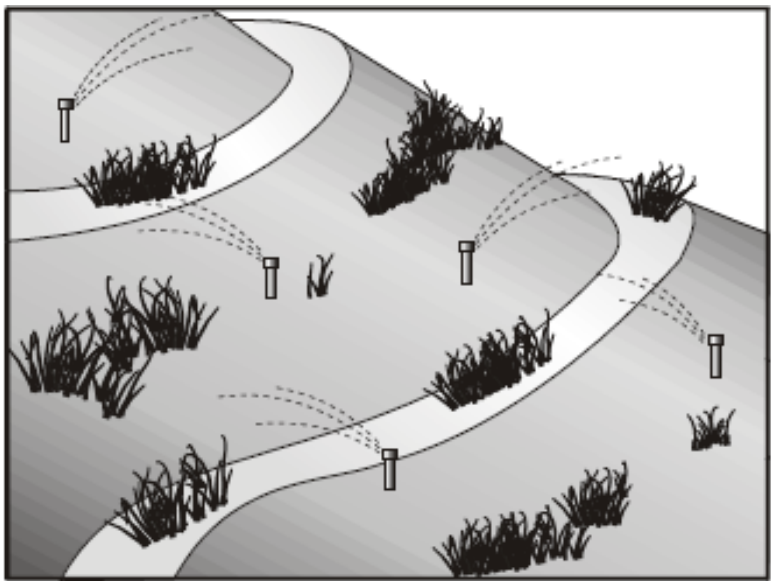
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Potable Water/Irrigation NS-7



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	
Metals	√
Bacteria	
Oil and Grease	
Organics	√

Potential Alternatives

None

Description and Purpose

Potable Water/Irrigation consists of practices and procedures to manage the discharge of potential pollutants generated during discharges from irrigation water lines, landscape irrigation, lawn or garden watering, planned and unplanned discharges from potable water sources, water line flushing, and hydrant flushing.

Suitable Applications

Implement this BMP whenever potable water or irrigation water discharges occur at or enter a construction site.

Limitations

None identified.

Implementation

- Direct water from offsite sources around or through a construction site, where feasible, in a way that minimizes contact with the construction site.
- Discharges from water line flushing should be reused for landscaping purposes where feasible.
- Shut off the water source to broken lines, sprinklers, or valves as soon as possible to prevent excess water flow.
- Recommend installation of rain shut-off devices and precision sprinkler heads for irrigation systems.
- Protect downstream storm water drainage systems and watercourses from water pumped or bailed from trenches excavated to repair water lines.

- Inspect irrigated areas within the construction limits for excess watering. Adjust watering times and schedules to ensure that the appropriate amount of water is being used and to minimize runoff. Consider factors such as soil structure, grade, time of year, and type of plant material in determining the proper amounts of water for a specific area.

Costs

Cost to manage potable water and irrigation are low and generally considered to be a normal part of related activities.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Repair broken water lines as soon as possible.
- Inspect irrigated areas regularly for signs of erosion and/or discharge.

References

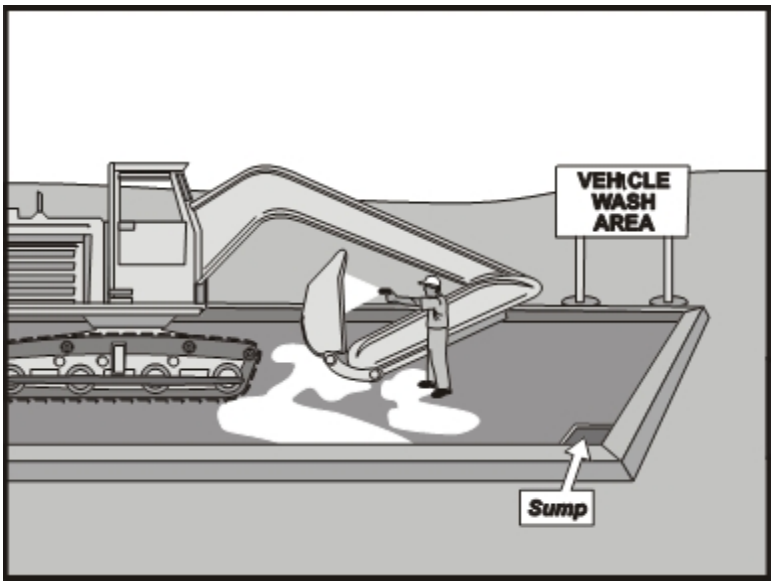
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Vehicle and Equipment Cleaning NS-8



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	
Metals	
Bacteria	
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Vehicle and equipment cleaning procedures and practices eliminate or reduce the discharge of pollutants to storm water from vehicle and equipment cleaning operations. Procedures and practices include but are not limited to: using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors in proper cleaning procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Implementation

Other options to washing equipment onsite include contracting with either an offsite or mobile commercial washing business. These businesses may be better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

If washing operations are to take place onsite, then:

- Use phosphate-free, biodegradable soaps;
- Educate employees and subcontractors on pollution prevention measures;
- Do not permit steam cleaning onsite. Steam cleaning can generate significant pollutant concentrates;
- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless resulting wastes are fully contained and disposed of. Resulting wastes should not be discharged or buried, and must be captured and recycled or disposed according to the requirements of WM-10, Liquid Waste Management or WM-6, Hazardous Waste Management, depending on the waste characteristics. Minimize use of solvents. Use of diesel for vehicle and equipment cleaning is prohibited;
- All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite;
- When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should have the following characteristics:
  - Located away from storm drain inlets, drainage facilities, or watercourses;
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent runon and runoff;
  - Configured with a sump to allow collection and disposal of wash water;
  - No discharge of wash waters to storm drains or watercourses; and
  - Used only when necessary.
- When cleaning vehicles and equipment with water:
  - Install high-efficiency water fixtures. Use as little water as possible. High-pressure sprayers may use less water than a hose and should be considered;
  - Use positive shutoff valve to minimize water usage; and
  - Facility wash racks should discharge to a sanitary sewer, recycle system or other approved discharge system and must not discharge to the storm drainage system, watercourses, or to groundwater.

Costs

Cleaning vehicles and equipment at an offsite facility may reduce overall costs for vehicle and equipment cleaning by eliminating the need to provide similar services onsite. When onsite cleaning is needed, the cost to establish appropriate facilities is relatively low on larger, long-duration projects, and moderate to high on small, short-duration projects.

Inspection and Maintenance

Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.

- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Inspection and maintenance is minimal, although some berm repair may be necessary.
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.
- Inspect sump regularly and remove liquids and sediment as needed.
- Prohibit employees and subcontractors from washing personal vehicles and equipment on the construction site.

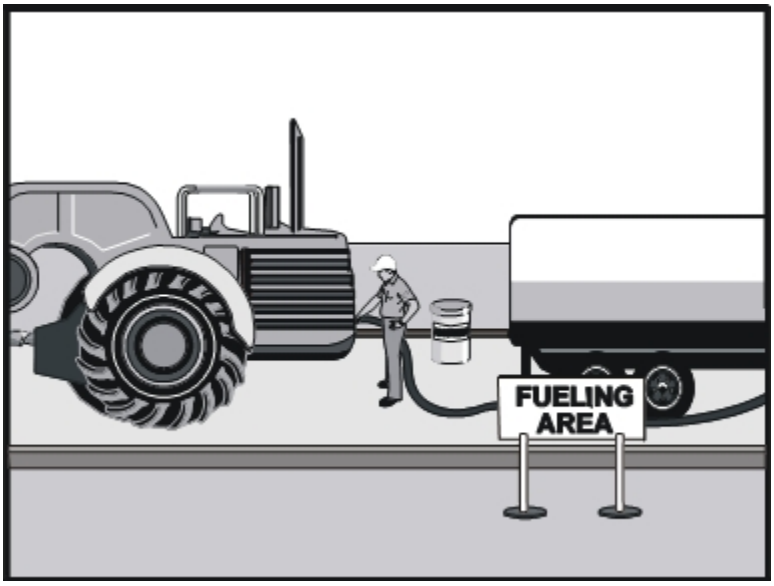
References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Swisher, R.D. Surfactant Biodegradation, Marcel Decker Corporation, 1987.

Vehicle and Equipment Fueling NS-9



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment

Nutrients

Trash

Metals

Bacteria

Oil and Grease √

Organics

Potential Alternatives

None

Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of storm water. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage "topping-off" of fuel tanks.
- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should be disposed of properly after use.

- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and large excavators, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the site-specific BMPs plan.
- Dedicated fueling areas should be protected from storm water runon and runoff, and should be located at least 50 ft. away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.
- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- Use vapor recovery nozzles to help control drips as well as air pollution.
- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

Costs

- All of the above measures are low cost except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.

Inspection and Maintenance

- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately or problem vehicles or equipment should be removed from the project site.
- Keep ample supplies of spill cleanup materials onsite.
- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

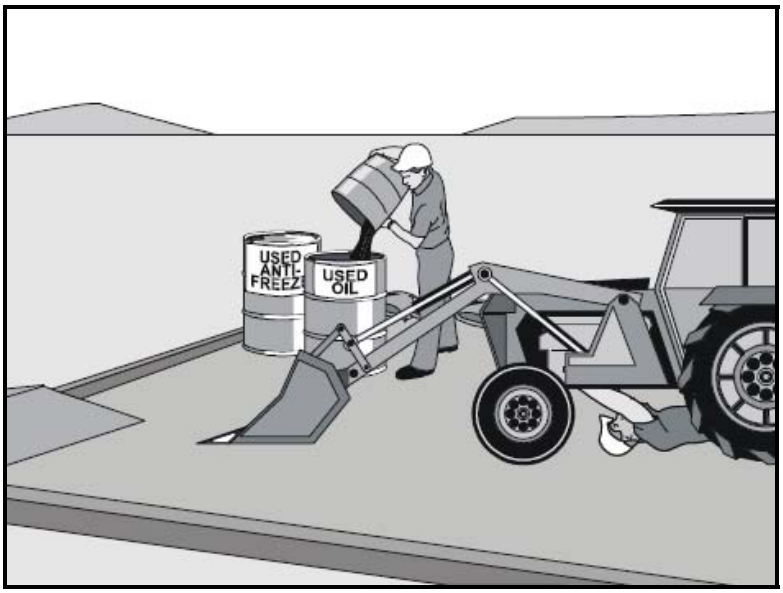
California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Vehicle and Equipment Maintenance NS-10



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	
Nutrients	√
Trash	√
Metals	
Bacteria	
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Prevent or reduce the contamination of storm water resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of storm water pollution. Activities that can contaminate storm water include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8, Vehicle and Equipment Cleaning, and NS-9, Vehicle and Equipment Fueling.

Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from storm water runon and runoff, and should be located at least 50 ft. from downstream drainage facilities and watercourses.
- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.
- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.
- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.
- Properly dispose of or recycle used batteries.
- Do not bury used tires.
- Repair leaks of fluids and oil immediately.

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an “environmentally friendly” label.
- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.

- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in HAR, Title 11, Chapter 261, Hazardous Waste Management Identification and Listing of Hazardous Waste as pollutants. These materials are harmful and must not contaminate storm water. They must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Costs

All of the above are low cost measures. Higher costs are incurred to setup and maintain onsite maintenance areas.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Keep ample supplies of spill cleanup materials onsite.
- Maintain waste fluid containers in leak proof condition.

- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

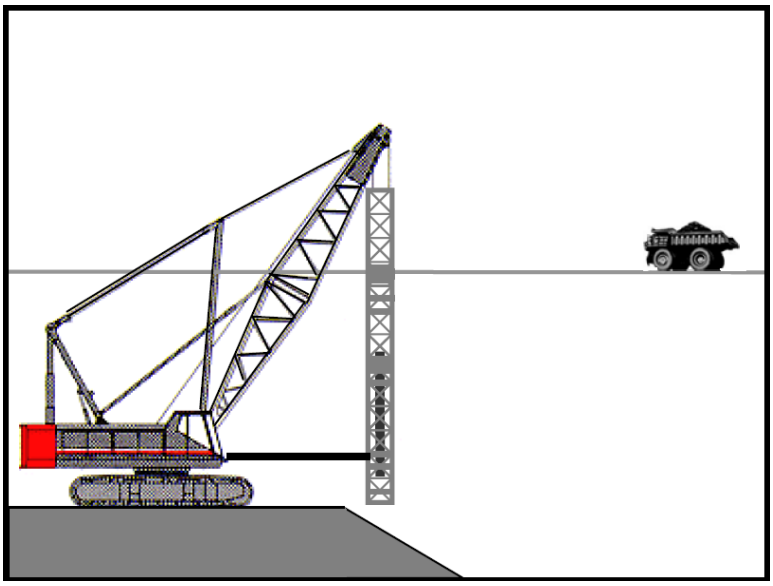
Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Hawaii Administrative Rules, Title 11, Chapter 54, Water Quality Standards.

Hawaii Administrative Rules, Title 11, Chapter 261, Hazardous Waste management Identification and Listing of Hazardous Waste.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Pile Driving Operations NS-11



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	√
Organics	

Potential Alternatives

None

Description and Purpose

The construction and retrofit of bridges and retaining walls often include driving piles for foundation support and shoring operations. Driven piles are typically constructed of precast concrete, steel, or timber. Driven sheet piles are also used for shoring and cofferdam construction. Proper control and use of equipment, materials, and waste products from pile driving operations will reduce or eliminate the discharge of potential pollutants to the storm drain system, watercourses, and waters of the United States.

Suitable Applications

These procedures apply to all construction sites near or adjacent to a watercourse or groundwater where permanent and temporary pile driving (impact and vibratory) takes place, including operations using pile shells as well as construction of cast-in-steel-shell and cast-in-drilled-hole piles.

Limitations

None identified.

Implementation

- Use drip pans or absorbent pads during vehicle and equipment operation, maintenance, cleaning, fueling, and storage. Refer to NS-8, Vehicle and Equipment Cleaning, NS-9, Vehicle and Equipment Fueling, and NS-10, Vehicle and Equipment Maintenance.

- Have spill kits and cleanup materials available at all locations of pile driving. Refer to WM-4, Spill Prevention and Control.
- Have spill kits and cleanup materials available at all locations of pile driving. Refer to WM- 4, Spill Prevention and Control.
- Equipment that is stored or in use in streambeds, or on docks, barges, or other structures over water bodies should be kept leak free.
- Park equipment over plastic sheeting or equivalent where possible. Plastic is not a substitute for drip pans or absorbent pads. The storage or use of equipment in streambeds or other bodies of water must comply with all applicable permits.
- Implement other BMPs as applicable, such as NS-2, Dewatering Operations, WM-5, Solid Waste Management, WM-6, Hazardous Waste Management, and WM-10, Liquid Waste Management.
- When not in use, store pile-driving equipment away from concentrated flows of storm water, drainage courses, and inlets. Protect hammers and other hydraulic attachments from runon and runoff by placing them on plywood and covering them with plastic or a comparable material prior to the onset of rain.
- Use less hazardous products, e.g., vegetable oil, when practicable.

Costs

All of the above measures can be low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Inspect equipment every day at startup and repair equipment as needed (i.e., worn or damaged hoses, fittings, and gaskets). Recheck equipment at shift changes or at the end of the day and scheduled repairs as needed.

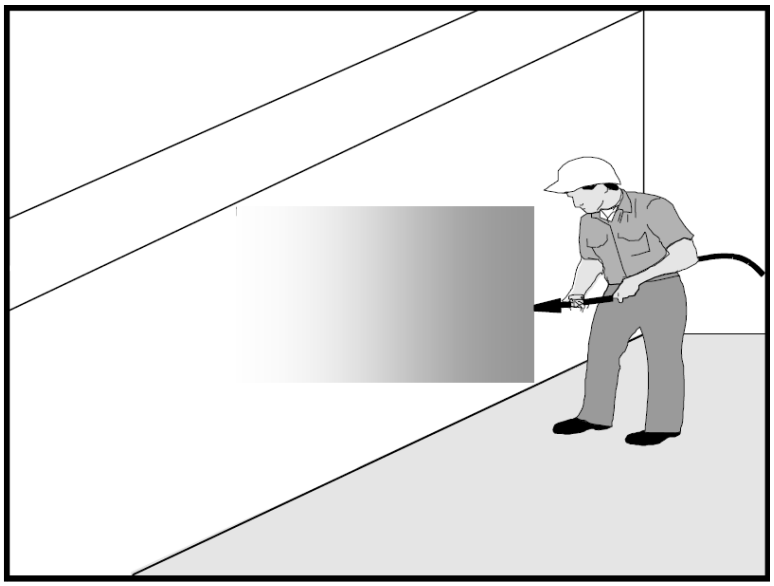
References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Concrete Curing NS-12



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	
Nutrients	√
Trash	
Metals	√
Bacteria	
Oil and Grease	√
Organics	

Potential Alternatives

None

Description and Purpose

Concrete curing is used in the construction of structures such as bridges, retaining walls, pump houses, large slabs, and structured foundations. Concrete curing includes the use of both chemical and water methods. Discharges of storm water and non-storm water exposed to concrete during curing may have a high pH and may contain chemicals, metals, and fines. Proper procedures reduce or eliminate the contamination of storm water runoff during concrete curing.

Suitable Applications

Suitable applications include all projects where Portland Cement Concrete (PCC) and concrete curing chemicals are placed where they can be exposed to rainfall, runoff from other areas, or where runoff from the PCC will leave the site.

Limitations

None identified.

Implementation

Chemical Curing

- Avoid over spray of curing compounds.
- Minimize the drift of chemical cure as much as possible by applying the curing compound close to the concrete surface. Apply an amount of compound that covers the surface, but does not allow any runoff of the compound.
- Use proper storage and handling techniques for concrete curing compounds. Refer to WM-1, Material Delivery and Storage.

- Protect drain inlets prior to the application of curing compounds.
- Refer to WM-4, Spill Prevention and Control.

Water Curing for Bridge Decks, Retaining Walls, and other Structures

- Direct cure water away from inlets and watercourses to collection areas for infiltration or other means of removal in accordance with all applicable permits.
- Collect cure water at the top of slopes and transport or dispose of water in a non-erodible manner. See EC-9 Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.
- Utilize wet blankets or a similar method that maintains moisture while minimizing the use and possible discharge of water.

Costs

All of the above measures are generally low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Ensure that employees and subcontractors implement appropriate measures for storage, handling, and use of curing compounds.
- Inspect cure containers and spraying equipment for leaks.

References

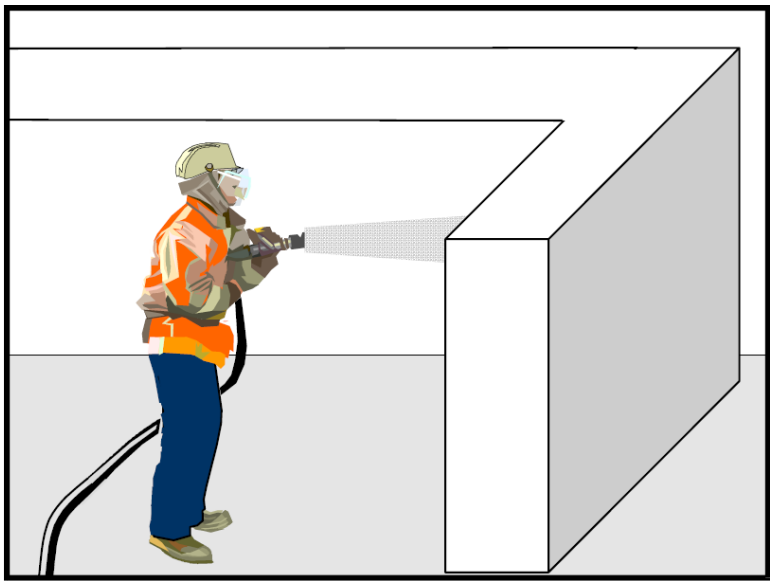
Blue Print for a Clean Bay-Construction-Related Industries: Best Management Practices for Stormwater Pollution Prevention; Santa Clara Valley Non Point Source Pollution Control Program, 1992.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Concrete Finishing NS-13



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	
Nutrients	√
Trash	
Metals	√
Bacteria	
Oil and Grease	
Organics	√

Potential Alternatives

None

Description and Purpose

Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances. Methods include sand blasting, shot blasting, grinding, or high pressure water blasting. Storm water and non-storm water exposed to concrete finishing by-products may have a high pH and may contain chemicals, metals, and fines. Proper procedures and implementation of appropriate BMPs can minimize the impact that concrete-finishing methods may have on storm water and non-storm water discharges.

Suitable Applications

These procedures apply to all construction locations where concrete finishing operations are performed.

Limitations

None identified.

Implementation

Collect and properly dispose of water from high-pressure water blasting operations.

Collect contaminated water from blasting operations at the top of slopes. Transport or dispose of contaminated water while using BMPs such as those for erosion control. Refer to EC-9, Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.

- Direct water from blasting operations away from inlets and watercourses to collection areas for infiltration or other means of removal (dewatering). Refer to NS-2 Dewatering Operations.
- Protect inlets during sandblasting operations. Refer to SE-10, Storm Drain Inlet Protection.
- Refer to WM-8, Concrete Waste Management for disposal of concrete based debris.
- Minimize the drift of dust and blast material as much as possible by keeping the blasting nozzle close to the surface.
- When blast residue contains a potentially hazardous waste, refer to WM-6, Hazardous Waste Management.

Costs

These measures are generally of low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharges daily while non-storm water discharges occur.
- Sweep or vacuum up debris from sandblasting at the end of each shift.
- At the end of each work shift, remove and contain liquid and solid waste from containment structures, if any, and from the general work area.

References

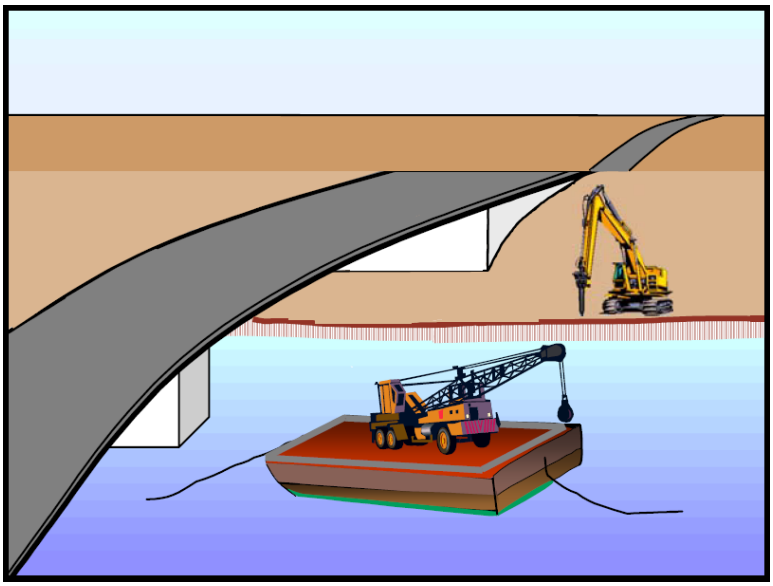
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Material over Water NS-14



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	√
Metals	√
Bacteria	√
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Procedures for the proper use, storage, and disposal of materials and equipment on barges, boats, temporary construction pads, or similar locations, that minimize or eliminate the discharge of potential pollutants to a watercourse.

Suitable Applications

Applies where materials and equipment are used on barges, boats, docks, and other platforms over or adjacent to a watercourse including waters of the United States. These procedures should be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may cause or contribute to exceedences of water quality standards.

Limitations

Dredge and fill activities are regulated by the US Army Corps of Engineers and State of Hawaii Department of Health, Clean Water Branch (CWB) under Section 404/401 of the Clean Water Act.

Implementation

- Refer to WM-1, Material Delivery and Storage and WM-4, Spill Prevention and Control.
- Use drip pans and absorbent materials for equipment and vehicles and ensure that an adequate supply of spill cleanup materials is available.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is expected to be idle for more than 1 hour.

- Maintain equipment in accordance with NS-10, Vehicle and Equipment Maintenance. If a leaking line cannot be repaired, remove equipment from over the water.
- Provide watertight curbs or toe boards to contain spills and prevent materials, tools, and debris from leaving the barge, platform, dock, etc.
- Provide sediment control BMPs for openings on top of bridges.
- Secure all materials to prevent discharges to receiving waters via wind.
- Identify types of spill control measures to be employed, including the storage of such materials and equipment. Ensure that staff is trained regarding the use of the materials, deployment and access of control measures, and reporting measures.
- In case of spills, contact the local emergency response by dialing 911 as soon as possible but within 48 hours. See WM-4 Spill Prevention and Control for more information.
- Refer to WM-5, Solid Waste Management (non-hazardous) and WM-6, Hazardous Waste Management. Ensure the timely and proper removal of accumulated wastes.
- Comply with all necessary permits required for construction within or near the watercourse, such as CWB and U.S. Army Corps of Engineers.
- Discharges to waterways should be reported to the CWB immediately upon discovery. A written discharge notification must follow within 7 days. Follow the spill reporting procedures contained in site-specific BMPs plan.

Costs

These measures are generally of low to moderate cost. Exceptions are areas for temporary storage of materials, engine fluids, or wastewater pump out.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharge daily while non-storm water discharges occur.
- Ensure that employees and subcontractors implement the appropriate measures for storage and use of materials and equipment.
- Inspect and maintain all associated BMPs and perimeter controls to ensure continuous protection of the water courses, including waters of the United States.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

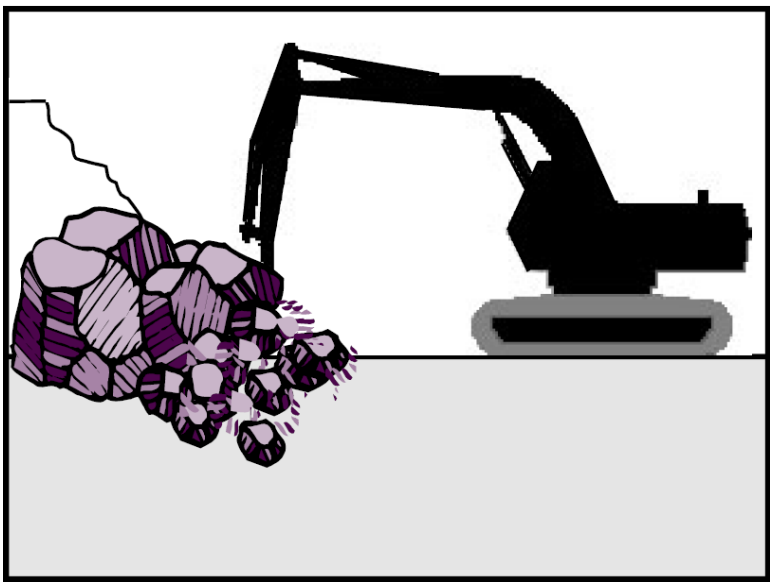
Hawaii Administrative Rules, Title 11, Chapter 54, Water Quality Standards.

Section 404 of the Clean Water Act.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Demolition Adjacent to Water NS-15



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	√
Metals	√
Bacteria	√
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Procedures to protect water bodies from debris and wastes associated with structure demolition or removal over or adjacent to watercourses.

Suitable Applications

Full bridge demolition and removal, partial bridge removal (barrier rail, edge of deck) associated with bridge widening projects, concrete channel removal, or any other structure removal that could potentially affect water quality.

Limitations

None identified.

Implementation

- Provide sediment control BMPs for the upland construction activities at bridges.
- Refer to NS-5, Clear Water Diversion, to direct water away from work areas.
- Use attachments on construction equipment such as backhoes to catch debris from small demolition operations.
- Use covers or platforms to collect debris.
- Platforms and covers are to be approved by the owner.
- Stockpile accumulated debris and waste generated during demolition away from watercourses and in accordance with WM-3, Stockpile Management.
- Ensure safe passage of wildlife, as necessary.

- Discharges to waterways shall be reported to the State of Hawaii Department of Health, Clean Water Branch (CWB) immediately upon discovery. A written discharge notification must follow within 7 days. Follow the spill reporting procedures in the site-specific BMPs plan.
- For structures containing hazardous materials, i.e., lead paint or asbestos, refer to BMP WM-6, Hazardous Waste Management. For demolition work involving soil excavation around lead-painted structures, refer to WM-7, Contaminated Soil Management.

Costs

Cost may vary according to the combination of practices implemented.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharge daily while non-storm water discharges occur.
- Any debris-catching devices shall be emptied regularly. Collected debris shall be removed and stored away from the watercourse and protected from runon and runoff.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Hawaii Administrative Rules, Title 11, Chapter 54, Water Quality Standards.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Temporary Batch Plants NS-16

Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	√
Metals	√
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

The construction of roads, bridges, retaining walls, and other large structures in remote areas, often requires temporary batch plant facilities to manufacture Portland Cement Concrete (PCC) or asphalt cement (AC). Temporary batch plant facilities typically consist of silos containing fly ash, lime, and cement; heated tanks of liquid asphalt; sand and gravel material storage areas; mixing equipment; above ground storage tanks containing concrete additives and water; and designated areas for sand and gravel truck unloading, concrete truck loading, and concrete truck washout. Proper control and use of equipment, materials, and waste products from temporary batch plant facilities will reduce the discharge of potential pollutants to the storm drain system or watercourses, reduce air emissions, and mitigate noise impacts.

Suitable Applications

These procedures typically apply to construction sites where temporary batch plant facilities are used.

Limitations

The General Permit for discharges of storm water associated with industrial activities may be applicable to temporary batch plants. Rock crushing activities require an individual industrial activities NPDES permit for the State of Hawaii.

Specific permit requirements or mitigation measures such as State of Hawaii Department of Health, Clean Air Branch (CAB), State of Hawaii Department of Health, Clean Water Branch (CWB), county ordinances and city ordinances may require alternative mitigation measures for temporary batch plants.

Implementation

Planning

Implementation steps are as follows:

- Large scale temporary batch plants may be subject to the General Industrial NPDES permit – contact CWB for determination. If batch plant is classified as an industrial facility by CWB, a Notice of Intent (NOI) Form B must be submitted to the CWB;
- Proper planning, design, and construction of temporary batch plants should be implemented to minimize potential water quality, air pollution, and noise impacts associated with temporary batch plants;
- BMPs and a Sampling and Analysis Plan (SAP) must be included in the project site-specific BMPs plan. BMPs must be implemented, inspected, and maintained;
- Temporary batch plants should be managed to comply with CWB requirements;
- Construct temporary batch plants down-wind of existing developments whenever possible; and
- Placement of access roads should be planned to mitigate water and air quality impacts.

Layout and Design

- Temporary batch plants should be properly located and designed to mitigate water quality impacts to receiving water bodies. Batch plants should be located away from watercourses, drainage courses, and drain inlets. Batch plants should be located to minimize the potential for storm water runon onto the site.
- Temporary batch plant facilities (including associated stationary equipment and stockpiles) should be located at least 300 ft. from any recreational area, school, residence, or other structure not associated with the construction project.
- Construct continuous interior AC or PCC berms around batch plant equipment (mixing equipment, silos, concrete drop points, conveyor belts, admixture tanks, etc.) to facilitate proper containment and cleanup of releases. Rollover or flip top curb or dikes should be placed at ingress and egress points.
- Direct runoff from the paved or unpaved portion of the batch plant into a sump and pipe to a lined washout area or dewatering tank.
- Direct storm water and non-storm water runoff from unpaved portions of batch plant facility to catchment ponds or tanks.
- Construct and remove concrete washout facilities in accordance with WM-8, Concrete Waste Management.
- Layout of a typical batch plant and associated BMP is located at the end of this BMP fact sheet.

Operational Procedures

- Washout of concrete trucks should be conducted in a designated area in accordance with WM-8, Concrete Waste Management.
- Do not dispose of concrete into drain inlets, the storm water drainage system, or watercourses.

- Equipment washing should occur in a designated area in accordance with WM-8, Concrete Waste Management. Washing equipment, tools, or vehicles to remove PCC shall be conducted in accordance with NS-7, Potable Water/Irrigation, and NS-8, Vehicle and Equipment Cleaning.
- All dry material transfer points should be ducted through a fabric or cartridge type filter unless there are no visible emissions from the transfer point.
- Equip all bulk storage silos, including auxiliary bulk storage trailers, with fabric or cartridge type filter(s).
- Maintain silo vent filters in proper operating condition.
- Equip silos and auxiliary bulk storage trailers with dust-tight service hatches.
- Fabric dust collection system should be capable of controlling 99 percent of the particulate matter.
- Fabric dust collectors (except for vent filters) should be equipped with an operational pressure differential gauge to measure the pressure drop across the filters.
- All transfer points should be equipped with a wet suppression system to control fugitive particulate emissions unless there are no visible emissions.
- All conveyors should be covered, unless the material being transferred results in no visible emissions.
- There should be no visible emissions beyond the property line, while the equipment is being operated.
- Collect dust emissions from the loading of open-bodied trucks at the drip point of dry batch plants, or dust emissions from the drum feed for central mix plants.
- Equip silos and auxiliary bulk storage trailers with a visible and/or audible warning mechanism to warn operators that the silo or trailer is full.
- All open-bodied vehicles transporting material should be loaded with a final layer of wet sand and the truck shall be covered with a tarp to reduce emissions.

Tracking Control

- Plant roads (batch truck and material delivery truck roads) and areas between stockpiles and conveyor hoppers should be stabilized (TR-2, Stabilized Construction Roadway), watered (WE-1, Wind Erosion Control), treated with dust-suppressant chemicals, or paved with a cohesive hard surface that can be repeatedly swept, maintained intact, and cleaned as necessary to control dust emissions.
- Trucks should not track PCC from plants onto public roads. Use appropriate practices from TR-1, Stabilized Construction Entrance/Exit to prevent tracking.

Materials Storage

- WM-1, Material Delivery and Storage, should be implemented at all batch plants using concrete components or compounds. An effective strategy is to cover and contain materials.
- WM-2, Material Use should be conducted in a way to minimize or eliminate the discharge of materials to storm drain system or watercourse.

- Ensure that finer materials are not dispersed into the air during operations, such as unloading of cement delivery trucks.
- Stockpiles should be covered and enclosed with perimeter sediment barriers per WM-3, Stockpile Management. Uncovered stockpiles should be sprinkled with water and/or dust suppressant chemicals as necessary to control dust emissions, unless the stockpiled material results in no visible emissions. An operable stockpile watering system should be onsite at all times.
- Store bagged and boxed materials on pallets and cover on non-working days prior to rain.
- Minimize stockpiles of demolished PCC by recycling them in a timely manner.
- Provide secondary containment for liquid materials (WM-1). Containment should provide sufficient volume to contain precipitation from a 25-year storm plus 10% of the aggregate volume of all containers or plus 100% of the largest container, whichever is greater.
- Handle solid and liquid waste in accordance with WM-5, Solid Waste Management, WM-10, Liquid Waste Management, and WM-8, Concrete Waste Management.
- Maintain adequate supplies of spill cleanup materials and train staff to respond to spills per WM-4, Spill Prevention and Control.
- Immediately clean up spilled cement and fly ash and contain or dampen so that dust or emissions from wind erosion or vehicle traffic are minimized.

Equipment Maintenance

- Equipment should be maintained to prevent fluid leaks and spills per NS-9, Vehicle and Equipment Fueling, and NS-10, Vehicle and Equipment Maintenance.
- Maintain adequate supplies of spill cleanup materials and train staff to respond to spills per WM-4, Spill Prevention and Control.
- Incorporate other BMPs such as WM-5, Solid Waste Management, WM-6, Hazardous Waste Management, and WM-10, Liquid Waste Management.

Costs

Costs will vary depending on the size of the facility and combination of BMPs implemented.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharge daily while non-storm water discharges occur.
- Inspect and repair equipment (for damaged hoses, fittings, and gaskets).
- Inspect and maintain Stabilized Construction Entrance/Exit (TR-1) as needed.
- Inspect and maintain stabilized haul roads as needed.
- Inspect and maintain materials and waste storage areas as needed.

References

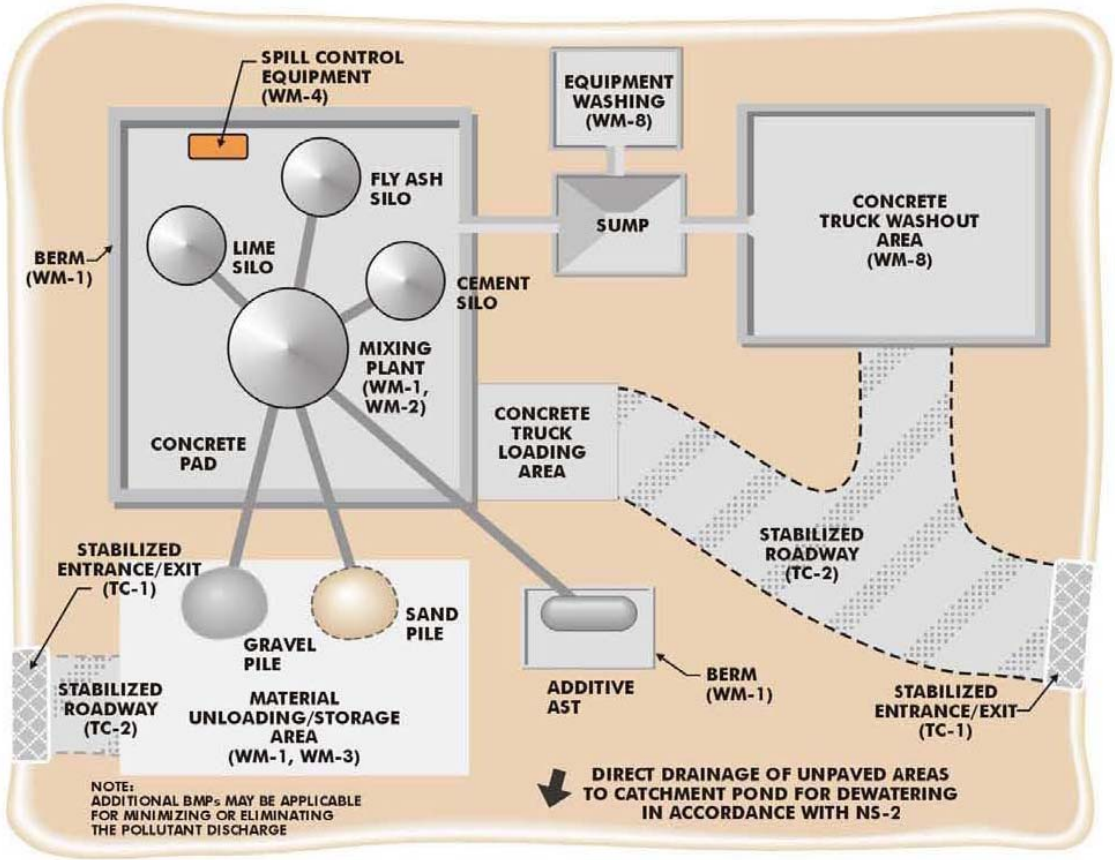
California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Hawaii Administrative Rules, Title 11, Chapter 55, Water Pollution Control.

Hawaii Administrative Rules, Title 11, Chapter 60.1, Air Pollution Control.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



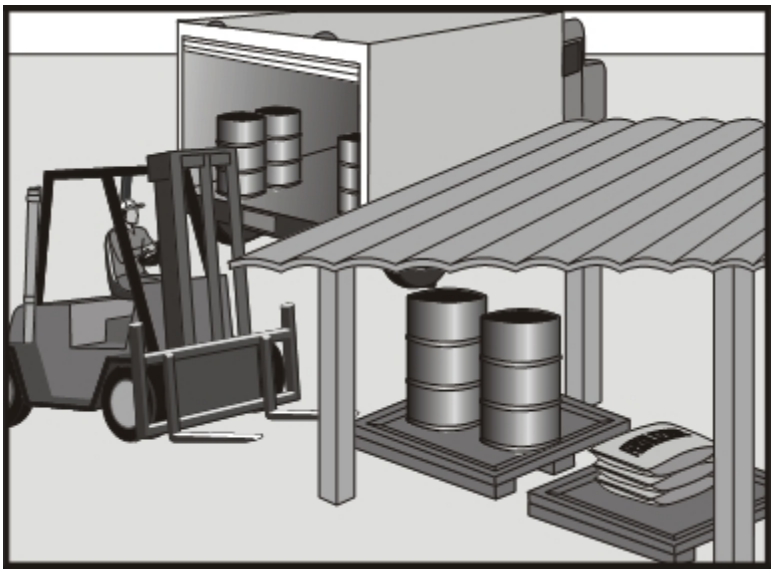
Typical Temporary Batch

4.6 WASTE MANAGEMENT AND MATERIALS POLLUTION CONTROL FACT SHEETS

WM-1 Material Delivery and Storage
WM-2 Material Use
WM-3 Stockpile Management
WM-4 Spill Prevention and Control
WM-5 Solid Waste Management
WM-6 Hazardous Waste Management
WM-7 Contaminated Soil Management
WM-8 Concrete Waste Management
WM-9 Sanitary/Septic Waste Management
WM-10 Liquid Waste Management

E Mālama I Ka Wai Ola
Protect our waters...
FOR LIFE

Material Delivery and Storage WM-1



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control √

WM – Waste Management & Materials Pollution Control

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	√
Metals	√
Bacteria	
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the storm water system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see WM-2 Material Use, or WM-4 Spill Prevention and Control. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Soil stabilizers and binders;
- Pesticides and herbicides;
- Fertilizers;
- Detergents;
- Plaster;
- Petroleum products such as fuel, oil, and grease. Note that spill prevention, control, and countermeasure (SPCC) plan are necessary if total above ground storage (AST) volume is equal to or greater than 1320 gallons (40 CFR 112.1 (d)(2)(ii)). See WM-4;
- Asphalt and concrete components;

- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds;
- Concrete compounds; and/or
- Other materials that may be detrimental if released to the environment.

Limitations

- Space limitation may preclude indoor storage.
- Storage sheds often must meet building and fire code requirements.

Implementation

The following steps should be taken to minimize risk:

- Temporary storage area should be located away from vehicular traffic;
- Material Safety Data Sheets (MSDS) should be supplied for all materials stored;
- Construction site areas should be designated for material delivery and storage;
- Material delivery and storage areas should be located near the construction entrances, away from waterways, if possible:
  - Avoid transport near drainage paths or waterways;
  - Surround with earth berms (See EC-9, Earth Dikes and Drainage Swales) or approved containment device; and
  - Place in an area which will be paved.
- Storage of reactive, ignitable, or flammable liquids must comply with the City and County of Honolulu fire codes. Contact the Honolulu Fire Department (HFD) to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30;
- An up to date inventory of materials delivered and stored onsite should be kept;
- Hazardous materials storage onsite should be minimized;
- Hazardous materials should be handled as infrequently as possible;
- During the rainy season, consider storing materials in a covered area. Store materials in secondary containments such as earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays;
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment;
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting;
- Chemicals should be kept in their original labeled containers;
- Employees and subcontractors should be trained on the proper material delivery and storage practices;
- Employees trained in emergency spill cleanup procedures must be present when dangerous materials or liquid chemicals are unloaded;

- If significant residual materials remain on the ground after construction is complete, properly remove materials and any contaminated soil. See WM-7, Contaminated Soil Management. If the area is to be paved, pave as soon as materials are removed to stabilize the soil; and
- Maintain a complete set of material safety data sheets at the project site.

Material Storage Areas and Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 should be stored in approved containers and drums and should not be overfilled. Containers and drums should be placed in temporary containment facilities for storage.
- A temporary containment facility should provide for a spill containment volume able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest container within its boundary, whichever is greater.
- A temporary containment facility should be impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be collected and placed into drums. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids should be sent to an approved disposal site.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Throughout the rainy season, each temporary containment facility should be covered during non-working days, prior to, and during rain events.
- Materials should be stored in their original containers and the original product labels should be maintained in place in a legible condition. Damaged or otherwise illegible labels should be replaced immediately.
- Bagged and boxed materials should be stored on pallets and should not be allowed to accumulate on the ground. To provide protection from wind and rain throughout the rainy season, bagged and boxed materials should be covered during non-working days and prior to and during rain events.
- Stockpiles should be protected in accordance with WM-3, Stockpile Management.
- Materials should be stored indoors within existing structures or sheds when available.
- Proper storage instructions should be posted at all times in an open and conspicuous location.
- An ample supply of appropriate spill cleanup material should be kept near storage areas.
- Also see WM-6, Hazardous Waste Management, for storing of hazardous materials.

Material Delivery Practices

- Keep an accurate, up-to-date inventory of material delivered and stored onsite.
- Arrange for employees trained in emergency spill cleanup procedures to be present when dangerous materials or liquid chemicals are unloaded.

Spill Cleanup

- Contain and clean up any spill immediately.
- Properly remove and dispose of any hazardous materials or contaminated soil if significant residual materials remain on the ground after construction is complete. See WM-7, Contaminated Soil Management.
- See WM-4, Spill Prevention and Control, for spills of chemicals and/or hazardous materials.

Cost

The largest cost of implementation may be in the construction of a material's storage area that is covered and provides secondary containment.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Keep an ample supply of spill cleanup materials near the storage area.
- Keep storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

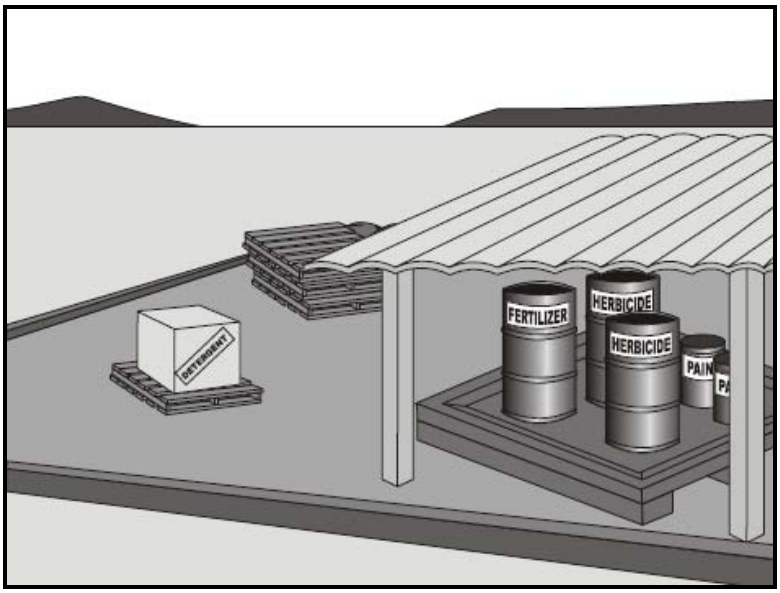
Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Revised Ordinances of Honolulu Chapter 20 Fire Code of the City & County of Honolulu.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Material Use WM-2



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	√
Metals	√
Bacteria	
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to the storm drain system or watercourses from material use by using alternative products, minimizing hazardous material use onsite, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for use at all construction projects. These procedures apply when the following materials are used or prepared onsite:

- Pesticides and herbicides;
- Fertilizers;
- Detergents;
- Plaster;
- Petroleum products such as fuel, oil, and grease;
- Asphalt and other concrete components;
- Other hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds;
- Concrete compounds; and/or
- Other materials that may be detrimental if released to the environment.

Limitations

Safer alternative building and construction products may not be available or suitable in every instance.

Implementation

The following steps should be taken to minimize risk:

- Minimize use of hazardous materials onsite;
- Follow manufacturer instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals;
- Train employees and subcontractors in proper material use;
- Supply Material Safety Data Sheets (MSDS) for all materials;
- Use recycled and less hazardous products when practical. Recycle residual paints, solvents, non-treated lumber, and other materials;
- Use materials only where and when needed to complete the construction activity. Use safer alternative materials as much as possible. Reduce or eliminate use of hazardous materials onsite when practical;
- Train personnel who use pesticides. The State Department of Agriculture (DOA), Pesticides Branch, licensed pesticide dealers, certifies pesticides applicators, and conducts on-site inspections;
- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydro seeding. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains;
- Do not remove the original product label; it contains important safety and disposal information. Use the entire product before disposing of the container;
- Use temporary scaffolding to hang drop cloths or draperies to prevent drift during painting work. Application equipment that minimizes overspray also helps. When using sealants on woods, pavement, roofs, etc., quickly clean up spills. Remove excess liquid with absorbent material or rags;
- If painting requires scraping or sand blasting of the existing surface, use a drop cloth to collect most of the chips. Dispose the residue properly. If the paint contains lead or tributyl tin, it is considered a hazardous waste. Refer to the waste management BMPs;
- Dispose of sand blasted material properly. Chips and dust from marine paints or paints containing lead should be disposed of as hazardous waste. Paint chips and dust from non-hazardous dry stripping and sand blasting may be swept up and disposed of as trash;
- Dispose of latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, with other construction debris;
- Mix paint indoors or in a containment area. Never clean paintbrushes or rinse paint containers into a street, gutter, storm drain, or watercourse. Dispose of any paint thinners, residue, and sludge(s) that cannot be recycled, as hazardous waste;
- For water-based paint, clean brushes to the extent practicable, and rinse to a drain leading to a sanitary sewer where permitted, or into a concrete washout pit or temporary sediment trap. For oil-based paints, clean brushes to the extent practicable, and filter and reuse thinners and solvents;

- When working on roofs, if small particles have accumulated in the gutter, either sweep out the gutter or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is lined tight, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vacuum (vactor) truck, and clean the catch basin sump and plug;
- Keep an ample supply of spill cleanup material near use areas. Train employees in spill cleanup procedures; and
- Avoid exposing applied materials to rainfall and runoff unless sufficient time has been allowed for them to dry.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Maintenance of this best management practice is minimal.
- Spot check employees and subcontractors throughout the job to ensure appropriate practices are being employed.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Hawaii Administrative Rules, Title 4, Chapter 66, Pesticides.

Hawaii Administrative Rules, Title 149, Hawaii Pesticides Law.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stockpile Management WM-3

Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	√
Metals	√
Bacteria	
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Stockpiles can be a significant source of erosion and sediment, and measures should be taken to mitigate the potential for nonpoint source pollution. Information to be provided to the City and County of Honolulu, Department of Planning and Permitting, when applying for a stockpiling permit include "a plot plan showing the property lines, easements and setbacks, topography, and the location of the proposed stockpile, quantities, height of stockpile, life of stockpile and source of the material to be stockpiled," and other information as may be required to "control the emission of air-borne dust, drainage runoff or erosion problems."

Stockpile Management procedures and practices are designed to reduce or eliminate air and storm water pollution from stockpiles of soil, paving materials such as portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate sub base or pre-mixed aggregate, temporary asphalt (so called "cold mix" asphalt), and pressure treated wood.

Suitable Applications

- Stockpiles for gravel or topsoil in roadway areas.
- Stockpiles for excavated material to be moved to off-site locations.
- Stockpiles of imported material.
- Stockpiles for surcharging to stabilize or consolidate an area.

Limitations

Stockpiles are for temporary storage of materials. Provisions should be made for permanent movement of stockpiled material. Failure to contain stockpiled material may cause downstream erosion or flood damage. Stockpiles not properly stabilized may cause fugitive dust problems.

Keep maximum height of stockpiles no greater than 15 feet high. Anything greater than 15 feet requires 8-foot wide benching (ROH Article 15).

Implementation

- Provide adequate setback from waterways.
- Provide earth dikes or other diversion to keep runoff away from stockpiles.
- Provide silt fences at the toe of the stockpile to mitigate runoff during rain events.
- Cover, grass or provide other stabilization measures.
- Provide adequate setback distance from lot lines.
- Provide silt basins where required.

Protection of stockpiles is a year-round requirement. To properly manage stockpiles:

- Locate stockpiles a minimum of 50 ft. away from concentrated flows of storm water, drainage courses, and inlets.
- Protect all stockpiles from storm water runon using a temporary perimeter sediment barrier such as berms, dikes, fiber rolls, silt fences, sandbag, gravel bags, or straw bale barriers.
- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information, see WE-1, Wind Erosion Control.
- Manage stockpiles of contaminated soil in accordance with WM-7, Contaminated Soil Management.
- Place bagged materials on pallets and under cover.

Protection of Non-Active Stockpiles

Non-active stockpiles of the identified materials should be protected further as follows:

Soil stockpiles

- During the rainy season, soil stockpiles should be covered or protected with soil stabilization measures and a temporary perimeter sediment barrier at all times.
- During the non-rainy season, soil stockpiles should be covered or protected with a temporary perimeter sediment barrier prior to the onset of precipitation.

Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate sub base

- During the rainy season, the stockpiles should be covered or protected with a temporary perimeter sediment barrier at all times.
- During the non-rainy season, the stockpiles should be covered or protected with a temporary perimeter sediment barrier prior to the onset of precipitation.

Stockpiles of "cold mix"

- During the rainy season, cold mix stockpiles should be placed on and covered with plastic or comparable material at all times.
- During the non-rainy season, cold mix stockpiles should be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Stockpiles/Storage of pressure treated wood with chromate copper arsenate or ammoniacal copper zinc arsenate

- During the rainy season, treated wood should be covered with plastic or comparable material at all times.
- During the non-rainy season, treated wood should be covered with plastic or comparable material at all times and cold mix stockpiles should be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Protection of Active Stockpiles

Active stockpiles of the identified materials should be protected further as follows:

- All stockpiles should be protected with a temporary linear sediment barrier prior to the onset of precipitation.
- Stockpiles of "cold mix" should be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Repair and/or replace perimeter controls and covers as needed to keep them functioning properly.

References

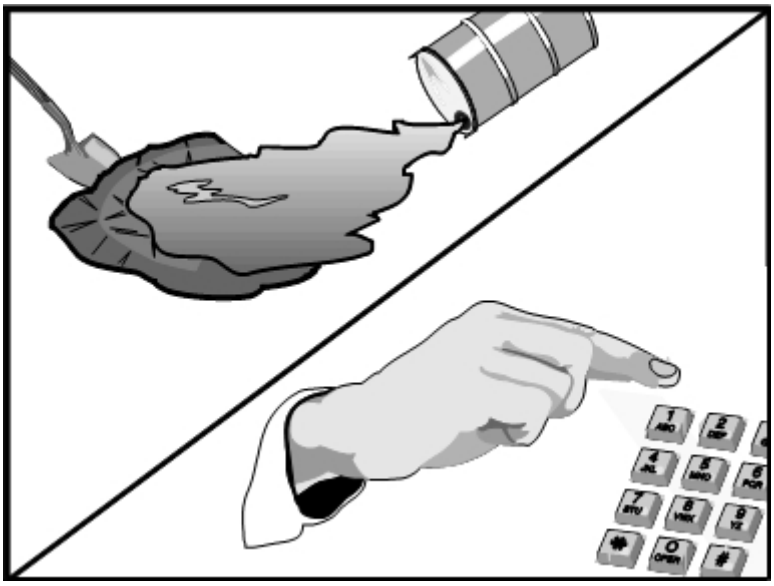
California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Revised Ordinances of Honolulu Chapter 14, Article 14 Permits, Bonds and Inspection for Grading, Soil Erosion and Sediment Control, 1990 as amended.

Revised Ordinances of Honolulu Article 15 Grading, Grubbing and Stockpiling. Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Spill Prevention and Control WM-4



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	√
Metals	√
Bacteria	
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to drainage systems or watercourses from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, WM-1 Materials Delivery and Storage, and WM-2 Material Use, also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

This BMP is suitable for all construction projects. Spill control procedures are implemented anytime chemicals or hazardous substances are stored on the construction site, including the following materials:

- Soil stabilizers/binders,
- Dust palliatives,
- Herbicides,
- Growth inhibitors,
- Fertilizers,
- Deicing/anti-icing chemicals,
- Fuels,
- Lubricants, and/or
- Other petroleum distillates.

Limitations

- In some cases it may be necessary to use a private spill cleanup company.
- This BMP applies to spills caused by the contractor and subcontractors.
- Procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite.

Implementation

The following steps will help reduce the storm water impacts of leaks and spills:

Education

- Be aware that different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Have contractor's superintendent or representative oversee and enforce proper spill prevention and control measures.

General Measures

- Provide a spill prevention control and countermeasure (SPCC) plan when the above ground storage volume is equal to or greater than 1320 gallons (40 CFR 112.1 (d)(2)(ii)).
- To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110,117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.
- Store hazardous materials and wastes in covered containers and protect from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals to oversee and enforce control measures.
- Prepare and maintain a spill response plan at the project site.
- Spills should be covered and protected from storm water runon during rainfall to the extent that it doesn't compromise cleanup activities.
- Do not bury or wash spills with water.
- Store and dispose of used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose in conformance with the provisions in applicable BMPs.
- Do not allow water used for cleaning and decontamination to enter storm drains or watercourses. Collect and dispose of contaminated water in accordance with WM-10 Liquid Waste Management.
- Contain water overflow or minor water spillage and do not allow it to discharge into drainage facilities or watercourses.

- Place proper storage, cleanup, and spill reporting instructions for hazardous materials stored or used on the project site in an open, conspicuous, and accessible location.
- Keep waste storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

Cleanup

- Clean up leaks and spills immediately.
- Use a rag for small spills on paved surfaces, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill,
  - Recover spilled materials, and
  - Clean the contaminated area and properly dispose of contaminated materials.

Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.
- Spills should be cleaned up immediately:
  - Contain spread of the spill;
  - Notify the project foreman immediately;
  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely;
  - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil; and
  - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:
  - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper City and County officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site;
  - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center at (800) 424-8802;
  - Notification should first be made by telephone and followed up with a written report;
  - The services of a spills contractor or a HazMat team should be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staffs have arrived at the job site; and
  - Other agencies which may need to be consulted include, but are not limited to Hawaii State Department of Health Hazard Evaluation and Emergency Response Office, Honolulu Local Emergency Planning Committee, Honolulu Fire Department, the Coast Guard, Hawaii National Guard, the Department of Transportation, the City and County Police Department, Department of Health Solid Waste & Hazardous Waste Branch, Department of Health Clean Water Branch, Department of Labor & Industrial Relations Hawaii Occupational Safety and Health Administration (HIOSH), etc.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hours).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur onsite, use a designated area and a secondary containment, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Regularly inspect onsite vehicles and equipment for leaks and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.

- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute storm water. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask the oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur onsite, use designate areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Discourage "topping off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/leaks.

Costs

Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharge daily while non-storm water discharges occur.
- Keep ample supplies of spill control and cleanup materials onsite, near storage, unloading, and maintenance areas.
- Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals onsite.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

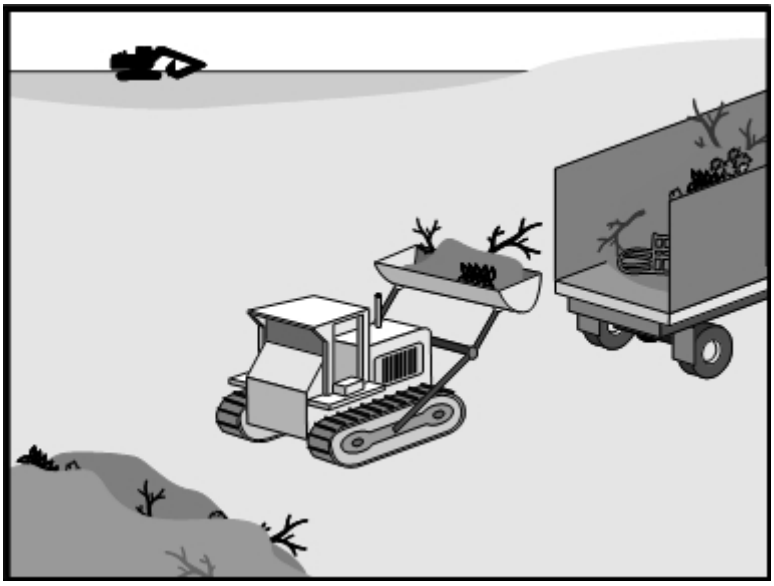
California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Hawaii Administrative Rules 11-262 Hazardous Waste Management Standards Applicable to Generators of Hazardous Waste.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Solid Waste Management WM-5



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	√
Metals	√
Bacteria	
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Prevent or reduce discharge of pollutants to the land, groundwater, in storm water from solid waste or construction and demolition (C&D) waste by providing designated waste collection areas, separate containers for recyclable waste materials, timing collection of waste and recyclable materials with each stage of the construction or demolition project, and properly training subcontractors and employees.

Table 4-3 Quick Reference – Disposal Alternatives include guidance on solid waste reuse, recycling, and disposal by select activities.

Suitable Applications

Solid waste is one of the major pollutants resulting from both construction and demolition activities that also contribute to illegal dumping.

Construction and demolition (C&D) waste is defined as solid, largely inert waste, resulting from the demolition or razing of buildings, of roads, or other structures, such as concrete, brick, bituminous concrete, wood, and masonry, composition roofing, and roofing paper, steel, plaster, and minor amount of other metals such as copper. Cleanup materials contaminated with hazardous substances, friable asbestos, waste paint, solvents, sealers, adhesives, or similar materials are not acceptable at C&D disposal sites.

One "subset" of C&D waste deserves special mention, because large volumes of these wastes are generated on construction

demolition sites. Inert fill materials should not be commingled with other C&D waste, especially if intended for reuse.

Inert fill material is defined as earth, soil, rock, rock-like material such as cured asphalt, brick, and clean concrete (with no exposed steel-reinforcing rod) less than eight inches in its greatest dimension, except as specified by a registered soils engineer. The fill material shall not contain vegetation or organic material, or other solid waste.

Inert fill materials are wastes that essentially will not decompose or produce leachate or other releases of environmental concern, nor be contaminated with items of concern like asbestos, and lead-based paint (LBP). Place qualifying as inert fill material according to both City and County and State DOH regulations have reuse potential. County and State laws prohibit other types and volumes of solid waste from job-sites from being used as fill material; instead, we must transport for disposal to a DOH-permitted landfill.

Recycling, Reuse Encouraged Over Disposal

Some C&D waste generated on-site should be recycled or reused whenever and wherever possible. These wastes include but are not limited to:

- Recycling:
  - Asphalt pavement,
  - Cardboard,
  - Concrete aggregate (no LBP, asbestos-free),
  - Electronic equipment – wiring, fluorescent light ballasts and tubes,
  - Excavated rock,
  - Excavated soil (uncontaminated),
  - Freon from appliances – air conditioners and refrigerators,
  - Glass,
  - Green waste – yard and tree trimmings, trunks, limbs,
  - Metals, ferrous – steel from appliances, concrete rebar,
  - Metals, non-ferrous – aluminum brass, copper, stainless-steel,
  - Used tires, and/or
  - Wood and lumber (untreated, no LBP, asbestos-free) – esp. pallets.
- Reuse:
  - Reusable building materials for self-help housing projects,
  - Small appliances and other used household items (e.g., fixtures), and/or
  - Used furniture.

The State DOH, Office of Solid Waste Management has developed a guide, "Minimizing Construction and Demolition Waste," especially for contractors, architects, builders, and design professionals. The DOH guide features:

- A checklist on how to start managing C&D waste,
- A list of available and DOH-permitted recycling and disposal facilities which can handle or process recyclable and reusable materials, and

- A brief regulatory overview of C&D waste and how important it is to recycle.

Free copies of the DOH guide can be obtained by calling 586-4226.

In addition, the State Department of Business and Economic Development & Tourism (DBEDT), Clean Hawaii Center has a specialized waste management guide for contractors supervising construction and demolition activities. "A Contractor's Waste Management Guide: Best management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii" features a Solid Waste Management Checklist offering practical tips on:

- How to build with used building materials,
- What recycled-content materials to consider in the design phase,
- Deciding where best to use recycled-content materials (e.g., use cold-formed steel framing with a minimum of 25 percent recycle content, and assemble with good quality connectors to prevent corrosion),
- Choosing the most helpful suppliers,
- Training subcontractors to reduce waste,
- What job-site operations most effectively reduced job-site waste volumes,
- Specific, environmentally-friendly ways on controlling termites, and
- How to reduce framing waste using advanced-framing techniques.

The DBEDT manual also offers detailed, helpful tips on managing hazardous wastes (see page 1–17) and a "General Practices Checklist" for training subcontractors and employees how to maximize opportunities for on-site waste reduction recycling. For a free copy of the guide, contact DBEDT at 587-3802.

The DBEDT emphasizes recycling and waste reduction as environmentally-responsible job-site waste management practices. And depending upon the type and scale of your project, implementing sound solid waste reduction practices may reduce your overall disposal costs. Other best management practices related to solid waste include: on-site separation of recyclable C&D materials from wastes intended for disposal; minimizing drive-by contamination of recycling bins, and shielding them from the weather; ensuring all refuse is promptly removed; ascertaining waste types generated at various stages of the project, and scheduling timed, specialized pickups for those recyclable materials. These solid waste management practices will mitigate health and safety hazards, enhance the appearance of the construction area, and help reduce waste management costs.

Limitations

Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

Implementation

The following steps will help keep a clean site and reduce pollution to storm water, to the land and protect groundwater resources:

- Select designated waste collection areas onsite;
- Inform trash-hauling contractors that you will accept only watertight dumpsters for onsite use. Inspect dumpsters for leaks and repair any dumpster that is not watertight;

- Locate containers in a covered area or in a secondary containment;
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it is windy;
- Plan for additional containers and more frequent pickup during the demolition phase of construction;
- Collect site trash daily, especially during rainy and windy conditions;
- Remove this solid waste promptly since erosion and sediment control devices tend to collect litter;
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris;
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash hauling contractor;
- Arrange for regular waste collection before containers overflow;
- Clean up immediately if a container does spill; and
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.

Education

- Have the contractor's superintendent or representative oversee and enforce proper solid waste management procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.
- Minimize production of solid waste materials wherever possible.

Collection, Storage, and Disposal

- Littering on the project site should be prohibited.
- To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines should be a priority.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly, regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, storm water drainage systems, or watercourses.

- Dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project.
- Full dumpsters should be removed from the project site and the contents should be disposed of by the trash hauling contractor.
- Construction debris and waste should be removed from the site biweekly or more frequently as needed.
- Construction material visible to the public should be stored or stacked in an orderly manner.
- Storm water runon should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Solid waste storage areas should be located at least 50 ft. from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters should be securely covered from wind and rain by covering the waste with tarps or plastic.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- For disposal of hazardous waste, see WM-6, Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
- Salvage or recycle useful vegetation debris, packaging and surplus building materials when practical. For example, trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharge daily while non-storm water discharges occur.
- Inspect construction waste area regularly.
- Arrange for regular waste collection.
- Inspect construction waste and recycling areas regularly for signs of contamination.
- State collection of recycled materials according to each phase of the construction/demolition project.
- Also, refer to DBEDT's BMP guide outlined in this section.

References

A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii, DBEDT, January 1999.

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Minimizing Construction and Demolition Waste: A C&D Waste Management Guide, First Edition, DOH, February 1998.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Residential Construction Waste Management: A Builder's Field Guide (How to Save Money and Landfill Space), NAHB Research Center, 1997.

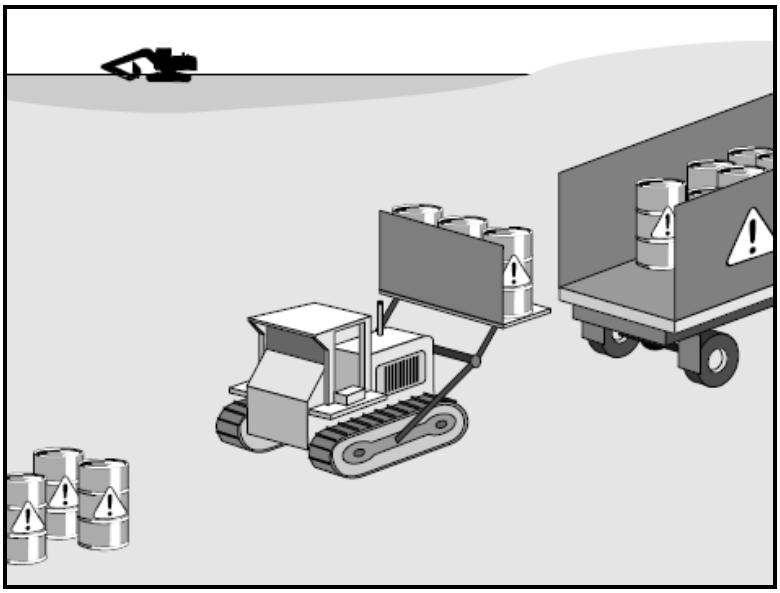
State of Hawaii Department of Business and Economic Development & Tourism http://www.hawaii.gov/dbedt.

State of Hawaii Department of Health Office of Solid Waste Management Branch http://www.hawaii.gov/health/about/environmental/waste/SW/index.html.

Storm Water Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Hazardous Waste Management WM-6



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	
Nutrients	√
Trash	√
Metals	√
Bacteria	√
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to storm water from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products,
- Concrete Curing Compounds,
- Palliatives,
- Septic Wastes,
- Stains,
- Wood Preservatives,
- Asphalt Products,
- Pesticides,
- Acids,
- Paints,
- Solvents,
- Roofing Tar, and/or
- C&D Wastes, including clean-up materials, contaminated with hazardous substances (for more information on C&D wastes, see WM-5 Solid Waste Management).

In addition, sites with existing structures may contain wastes, which must be disposed of in accordance with Federal and State regulations. These wastes include:

- Sandblasting grit or chips contaminated with lead-, cadmium-, or chromium-based paints, as regulated under the State of Hawaii Department of Health Noise Radiation and Indoor Air Quality Branch (NRIAQ) and Federal Clean Air Act;
- Asbestos as regulated under the State of Hawaii Department of Health Noise Radiation and Indoor Air Quality Branch (NRIAQ) and Federal Clean Air Act; and
- PCBs (particularly in older transformers) as regulated under the Federal Toxic Substances Control Act (TSCA).

To determine if a material or item is potentially hazardous waste:

- Check label and shipping papers;
- Look for words such as hazardous, danger, caustic or corrosive (dissolves skin, metal or other materials); flammable or ignitable (catches fire easily); carcinogenic (causes cancer); and toxic or poisonous (harms people and animals). A list of hazardous waste and criteria are found in Hawaii Administrative Rules (HAR) Title 11, Chapter 261 Hazardous Waste Management Identification and Listing of Hazardous Waste;
- Check the material safety data sheet (MSDS) the manufacturer must prepare for the product. Ask your supplier for a copy; and/or
- For questions and additional information including fact sheets and flyers, call the DOH, Hazardous Waste Program Office at 586-4226.

Limitations

- Hazardous waste that cannot be reused or recycled must be disposed of by a professional hazardous waste hauler.
- Nothing in this BMP relieves the contractor from responsibility for compliance with federal and state laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to WM-7, Contaminated Soil Management.

Implementation

The following steps will help reduce storm water and land pollution concerns resulting from hazardous wastes:

Material Use

- Wastes should be stored in sealed containers constructed of a suitable material.
- All hazardous waste should be stored, transported, and disposed as required.
- Waste containers should be stored in temporary containment facilities that should comply with the following requirements:
    - Temporary containment facility should provide for a spill containment volume equal to 1.5 times the volume of all containers able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater;

  - Temporary containment facility should be impervious to the materials stored there for a minimum contact time of 72 hours;
  - Temporary containment facilities should be maintained free of accumulated rain water and spills. In the event of spills or leaks, accumulated rain water and spills should be placed into drums after each rainfall. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids should be sent to an approved disposal site;
  - Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access;
  - Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility; and
  - Throughout the rainy season, temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs.
- Drums should not be overfilled and wastes should not be mixed.
- Unless watertight, containers of dry waste should be stored on pallets.
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application. Allow time for infiltration and avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains. People applying restricted-use pesticides must be certified in accordance with federal and state (HAR 4-6-66 Pesticide, section 4-66-32 restricted use pesticides) regulations.
- Paint brushes and equipment for water and oil based paints should be cleaned within a contained area and should not be allowed to contaminate site soils, watercourses, or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused should be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths should be disposed of as solid waste.
- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and reuse thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.
- Consult the "Hazardous Waste management Checklist" within the State Department of Business and Economic Development and Tourism (DBEDT's) "A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii" for additional tips and BMPs on selecting and purchasing lesser-toxic building products.

The DBEDT manual also offers detailed, helpful tips on solid waste management (see WM-5) and a "General Practices Checklist" for training subcontractors and employees how to maximize opportunities for on-site waste reduction and recycling. For a free copy of the guide, contact DBEDT at 587-3802.

- The following actions should be taken with respect to temporary contaminant:
  - Ensure that adequate hazardous waste storage volume is available;
  - Ensure that hazardous waste collection containers are conveniently located;
  - Designate hazardous waste storage areas onsite away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills;
  - Minimize production or generation of hazardous materials and hazardous waste on the job site;
  - Use containment berms in fueling and maintenance areas and where the potential for spills is high;
  - Segregate potentially hazardous waste from non-hazardous construction site debris;
  - Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover;
  - Clearly label all hazardous waste containers with the waste being stored and the date of accumulation;
  - Place hazardous waste containers in secondary containment;
  - Do not allow potentially hazardous waste materials to accumulate on the ground;
  - Do not mix wastes;
  - Use all of the product before disposing of the container; and
  - Do not remove the original product label; it contains important safety and disposal information.

Waste Recycling Disposal

- Select designated hazardous waste collection areas onsite.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, making recycling impossible and complicating disposal.
- Recycle any useful materials such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g., excess oil-based paint and sludge) is collected, removed, and disposed of only at authorized disposal areas.
- Consult the "Hazardous Waste Management Checklist" within the State DBEDT's "A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii" for additional tips and BMPs on how to reduce hazardous waste volumes, and how to best determine if a material or item is a potentially hazardous waste.

Disposal Procedures

- Waste should be disposed of by a professional hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A laboratory following EPA methods and standards should sample waste to determine the appropriate disposal facility.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.

Education

- Train employees and subcontractors in proper hazardous waste management. Consult the "Hazardous Waste management Checklist" within the State DBEDT's "A Contractor's Waste Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii" for tips and other useful resources available to help you train your employees and subcontractors.
- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).
- The contractor's superintendent or representative should oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharge daily while non-storm water discharges occur.
- Hazardous waste should be regularly collected.

- A foreman or construction supervisor should monitor onsite hazardous waste storage and disposal procedures.
- Waste storage areas should be kept clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.
- Hazardous spills should be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.
- The National Response Center, at (800) 424-8802, should be notified of spills of federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302.
- A copy of the hazardous waste manifests should be provided.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Hawaii Administrative Rules, Title 4, Chapter 66, Pesticides.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

State of Hawaii Department of Business and Economic Development & Tourism *http://www.hawaii.gov/dbedt*.

State of Hawaii Department of Health Office of Solid Waste Management Branch *http://www.hawaii.gov/health/about/environmental/waste/SW/index.html*.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Contaminated Soil Management WM-7

Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	
Nutrients	√
Trash	√
Metals	√
Bacteria	√
Oil and Grease	√
Organics	√

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to storm water from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

Suitable Applications

Contaminated soil management is implemented on construction projects in highly urbanized or industrial areas where soil contamination may have occurred due to spills, illicit discharges, aerial deposition, past use and leaks from underground storage tanks.

Limitations

Contaminated soils that are hazardous and cannot be treated onsite must be disposed of offsite by a State of Hawaii Department of Health approved hazardous waste transporter. NOTE: If transporting petroleum-contaminated soil (PCS) loads off-site to other than permitted remediation facilities, use transporters approved by the DOH, Office of Solid Waste Management (OSWM). Any PCS loads to be taken to DOH-permitted remediation facilities must notify OSWM 48 hours prior (refer to Hawaii Revised Statues). The presence of contaminated soil may indicate contaminated water as well. See NS-2, Dewatering Operations, for more information.

The procedures and practices presented in this BMP are general. The contractor should identify appropriate practices and procedures for the specific contaminants known to exist or discovered onsite.

Implementation

Most owners and developers conduct pre-construction environmental assessments as a matter of routine. Contaminated soils are often identified during project planning and development with known locations identified in the plans, specifications and in the site-specific BMPs plan. The contractor should review applicable reports and investigate appropriate call-outs in the plans, specifications, and site-specific BMPs plan. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil highlight the need for contractors to confirm a site assessment is completed before earth moving begins.

The following steps will help reduce storm water and land pollution concerns resulting from contaminated soil:

- Conduct thorough, pre-construction inspections of the site and review documents related to the site. If inspection or reviews indicated presence of contaminated soils, develop a plan before starting work.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills. Contaminated soil can be expensive to treat and dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- The contractor may further identify contaminated soils by investigating:
  - Past site uses and activities;
  - Detected or undetected spills and leaks;
  - Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements;
  - Contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris; and/or
  - Suspected soils should be tested at a certified laboratory.
- Determine if level of contamination is considered hazardous, as defined by the Hawaii Administrative Rules Title 11, Chapter 261 (HAR 11-261) Hazardous Waste Management Identification and Listing of Hazardous Waste; and DOH policy "Technical Guidance Manual for Underground Storage Tank Closure and Release Responses-Reporting, Remediation, and Management of Petroleum Contaminated Soil" dated January 4, 1996.
- If the soil is contaminated and hazardous, work with the State DOH Solid and Hazardous Waste Branch (586-4226) to develop options for treatment and/or disposal. Tier 1 action levels are found in HAR Title 11 Chapter 281 Underground Storage Tanks, DOH Environmental management Division Solid and Hazardous Waste Branch Policy Update "Technical Guidance Manual for Underground Storage Tank Closure and Release Responses-Reporting, Remediation, and Management of Petroleum Contaminated Soil" dated January 4, 1996.
- Secure required State DOH permits such as Transportation of Petroleum-contaminated Soil (PCS).

Education

- Have employees and subcontractors complete a safety training program which meets 29 CFR 1910.120 covering the potential hazards as identified, prior to performing any excavation work at the locations containing material classified as hazardous.
- Educate employees and subcontractors in identification of contaminated soil and on contaminated soil handling and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

Handling Procedures for Material with Aerially Deposited Lead (ADL)

- Materials from areas designated as containing (ADL) may, if allowed by the contract special provisions, be excavated, transported, and used in the construction of embankments and/or backfill.
- Excavation, transportation, and placement operations should result in no visible dust.
- Caution should be exercised to prevent spillage of lead containing material during transport.
- Quality should be monitored during excavation of soils contaminated with lead.

Handling Procedures for Contaminated Soils

- Minimize onsite storage. Contaminated soil should be disposed of properly in accordance with all applicable regulations.
- Guidance documents by local government provide by the State of Hawaii Department of Health Solid and Hazardous Waste Branch, Underground Storage Tank Section.
- Test suspected soils at an approved certified laboratory.
- Work with the state regulatory agencies to develop options for treatment or disposal if the soil is contaminated.
- Avoid temporary stockpiling of contaminated soils or hazardous material.
- Take the following precautions if temporary stockpiling is necessary:
  - Cover the stockpile with plastic sheeting or tarps;
  - Install a berm around the stockpile to prevent runoff from leaving the area;
  - Do not stockpile in or near storm drains or watercourses; and
  - Remove contaminated material and hazardous material on exteriors of transport vehicles and place either into the current transport vehicle or into the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality continuously during excavation operations at all locations containing hazardous material.
- Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including registration for transporting vehicles carrying the contaminated material and the hazardous material.
- Collect water from decontamination procedures and treat or dispose of it at an appropriate disposal site.

- Collect non-reusable protective equipment, once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.
- Excavate, transport, and dispose of contaminated material and hazardous material in accordance with the rules and regulations of the following agencies (the specifications of these agencies supersede the procedures outlined in this BMP):
  - United States Department of Transportation (USDOT),
  - United States Environmental Protection Agency (USEPA),
  - State of Hawaii Department of Health Solid Waste and Hazardous Waste Branch,
  - State of Hawaii Department of Labor & Industrial Relations, and
  - Hawaii Occupational Safety and Health Administration (HIOSH).

Procedures for Underground Storage Tank Removals

- Refer to the Technical Guidance Manual for UST Close & Release Response, by the State of Hawaii Department of Health Solid and Hazardous Waste Branch, Underground Storage Tank Section.
- Prior to commencing tank removal operations, obtain the required underground storage tank removal permits and approval from the federal and state agencies that have jurisdiction over such work.
- To determine if it contains hazardous substances, arrange to have tested, any liquid or sludge found in the underground tank prior to its removal.
- Following the tank removal, take soil samples beneath the excavated tank and perform analysis as required by the state agency representative(s).
- The underground storage tank, any liquid or sludge found within the tank, and all contaminated substances and hazardous substances removed during the tank removal and transported to disposal facilities permitted to accept such waste.

Water Control

- All necessary precautions and preventive measures should be taken to prevent the flow of water, including ground water, from mixing with hazardous substances or underground storage tank excavations. Such preventative measures may consist of, but are not limited to, berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, such water, when necessary to proceed with the work, should be discharged to clean, closed top, watertight transportable holding tanks, treated, and disposed of in accordance with federal and state laws.

Costs

Prevention of leaks and spills is inexpensive. Treatment or disposal of contaminated soil can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Arrange for contractor's Water Pollution Control Manager, foreman, and/or construction supervisor to monitor onsite contaminated soil storage and disposal procedures.
- Monitor air quality continuously during excavation operations at all locations containing hazardous material.
- Coordinate contaminated soils and hazardous substances/waste management with the appropriate federal and state agencies.
- Implement WM-4, Spill Prevention and Control, to prevent leaks and spills as much as possible.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Hawaii Administrative Rules, Title 11, Chapter 261, Hazardous Waste Management Identification and Listing of Hazardous Waste.

Hawaii Administrative Rules, Title 11, Chapter 281, Underground Storage Tanks.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

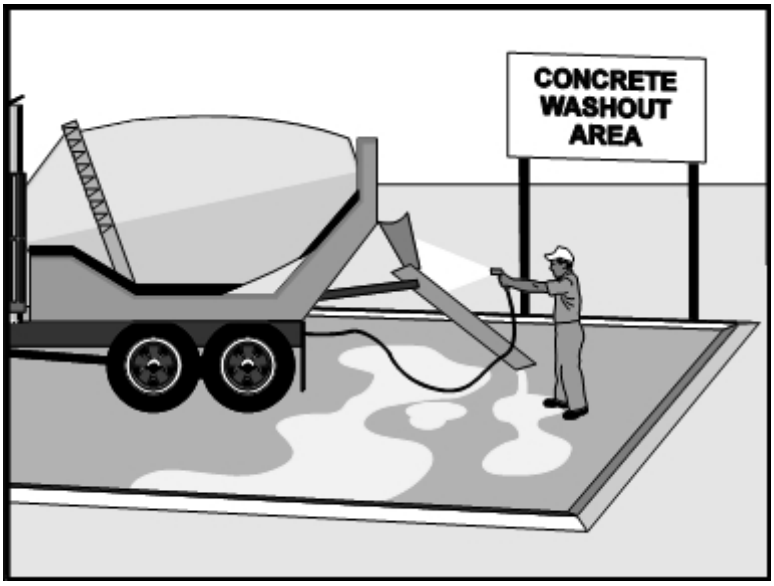
State of Hawaii Department of Health, Solid and Hazardous Waste Branch Policy Update "Technical Guidance Manual for Underground Storage Tank Closure and Release Responses-Reporting, Remediation, and Management of Petroleum-Contaminated Soil," 04 January, 1996.

State of Hawaii Department of Health, Solid and Hazardous Waste Branch Underground Storage Tank Section.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Concrete Waste Management WM-8



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	
Trash	
Metals	
Bacteria	√
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to storm water from concrete waste by conducting washout offsite, performing onsite washout in a designated area, and training employee and subcontractors.

Suitable Applications

Concrete waste management procedures and practices are implemented on construction projects where:

- Concrete is used as a construction material or where concrete dust and debris result from demolition activities;
- Slurries containing portland cement concrete (PCC) or asphalt concrete (AC) are generated, such as from saw cutting, coring, grinding, grooving, and hydro-concrete demolition;
- Concrete trucks and other concrete-coated equipment are washed onsite;
- Mortar-mixing stations exist; and/or
- See also NS-8, Vehicle and Equipment Cleaning.

Limitations

Offsite washout of concrete wastes may not always be possible.

Implementation

The following steps will help reduce storm water pollution from concrete wastes:

- Discuss the concrete management techniques described in this BMP (such as handling of concrete waste and washout) with the ready-mix concrete supplier before any deliveries are made;
- Incorporate requirements for concrete waste management into material supplier and subcontractor agreements;
- Store dry and wet materials under cover, away from drainage areas;
- Avoid mixing excess amounts of fresh concrete;
- Perform washout of concrete trucks offsite or in designated areas only;
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams;
- Do not allow excess concrete to be dumped onsite, except in designated areas;
- For onsite washout:
  - Locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary lined pit or bermed area large enough for liquid and solid waste; and
  - Wash out wastes into the temporary lined pit where the concrete can set, be broken up, and then disposed properly.
- Avoid creating runoff by draining water to a bermed or level area when washing concrete to remove fine particles and expose the aggregate; and
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile or dispose in the trash.

Education

- Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.
- Arrange for contractor's superintendent or representative to oversee and enforce concrete waste management procedures.

Concrete Slurry Wastes

- PCC and AC waste should not be allowed to enter storm drains or watercourses.
- PCC and AC waste should be collected and disposed of or placed in a temporary concrete washout facility.
- A sign should be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.
- Below grade concrete washout facilities are typical. Above grade facilities are used if excavation is not practical.
- A foreman or construction supervisor should monitor onsite concrete working tasks, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.

- Saw-cut PCC slurry should not be allowed to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine. Saw cutting residue should not be allowed to flow across the pavement and should not be left on the surface of the pavement. See also NS-3, Paving and Grinding Operations; and WM-10, Liquid Waste Management.
- Slurry residue should be vacuumed and disposed in a temporary pit (as described in Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below) and allowed to dry. Dispose of dry slurry residue in accordance with WM-5, Solid Waste Management.

Onsite Temporary Concrete Washout Facility, Transit Truck Washout Procedures

- Temporary concrete washout facilities should be located a minimum of 50 ft. from storm drain inlets, open drainage facilities, and watercourses. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.
- A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.
- Temporary concrete washout facilities should be constructed above grade or below grade at the option of the contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.
- Temporary washout facilities should have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.
- Washout of concrete trucks should be performed in designated areas only.
- Only concrete from mixer truck chutes should be washed into concrete wash out.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of offsite.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per WM-5, Solid Waste Management. Dispose of hardened concrete on a regular basis.
- Temporary Concrete Washout Facility (Type Above Grade):
  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft., but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations; and
  - Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
- Temporary Concrete Washout Facility (Type Below Grade):
  - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations;

- Lath and flagging should be commercial type; and
- Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and disposed of. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and disposed of.
- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4 in. for above grade facilities and 12 in. for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials should be removed and disposed of.
- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.

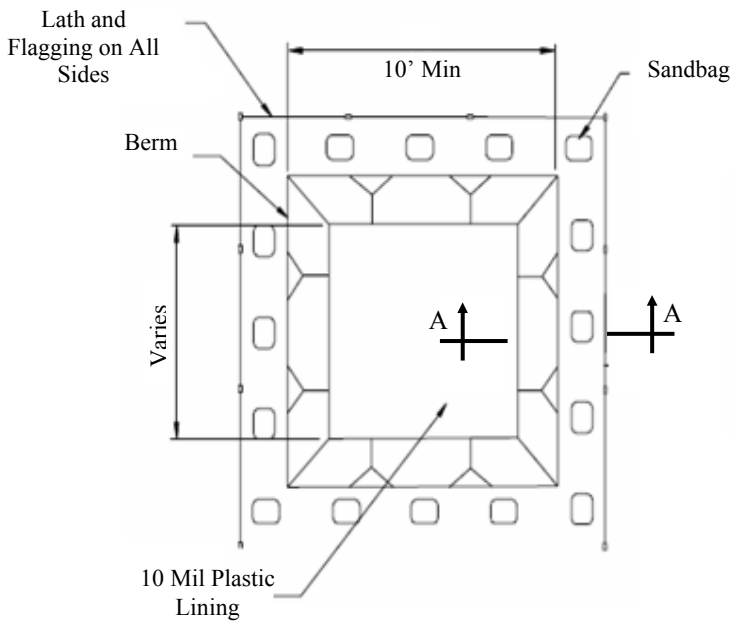
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

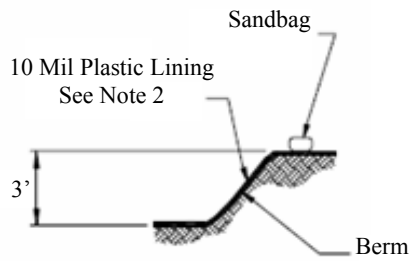
California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



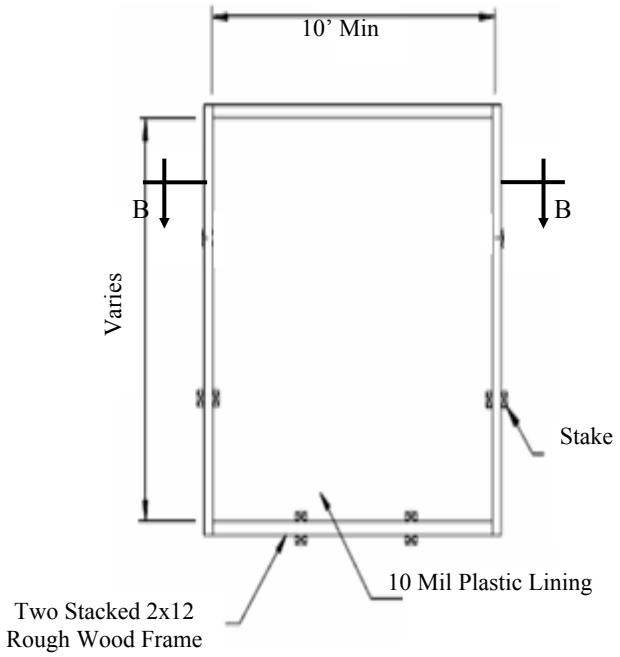
Plan "A"
Not to Scale



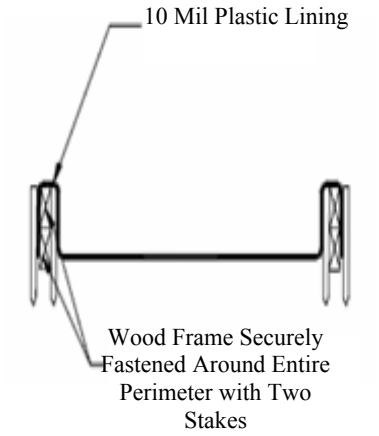
Section A-A
Not to Scale

Notes:
1. Temporary concrete washout facility (Below Grade) should be constructed with a minimum length and width of 10 ft., but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
2. Lath and flagging should be commercial type.
3. Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears or other defects that compromise the impermeability of the material.

Below Grade Concrete Washout



Plan "B"
Not to Scale

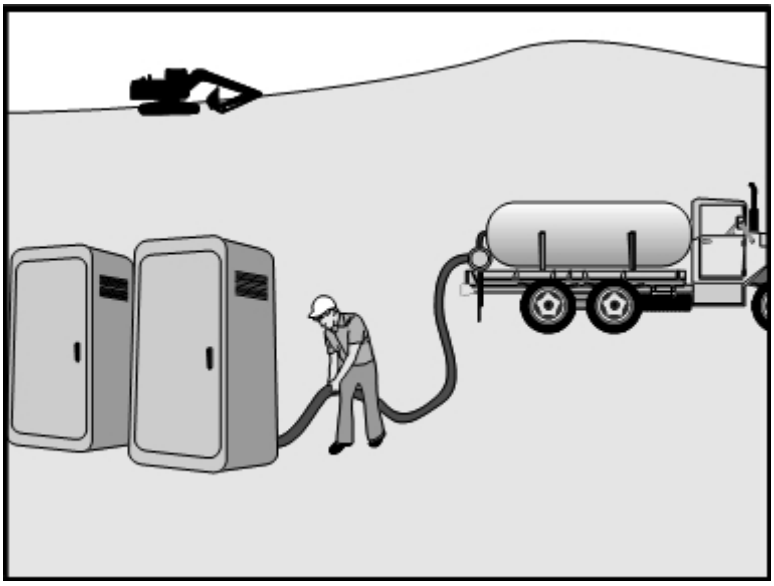


Section B-B
Not to Scale

Notes:
1. Temporary concrete washout facility (Above Grade) should be constructed with a minimum length and width of 10 ft., but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
2. Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears or other defects that compromise the impermeability of the material.

Above Grade Concrete Washout

Sanitary/Septic Waste Management WM-9



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	
Nutrients	√
Trash	√
Metals	
Bacteria	√
Oil and Grease	
Organics	√

Potential Alternatives

None

Description and Purpose

Proper sanitary and septic waste management prevent the discharge of pollutants to storm water from sanitary and septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

Suitable Applications

Sanitary septic waste management practices are suitable for use at all construction sites that use temporary or portable sanitary and septic waste systems.

Limitations

None identified.

Implementation

Sanitary or septic wastes should be treated or disposed of in accordance with State and City requirements. In many cases, one contract with a local facility supplier will be all that it takes to make sure sanitary wastes are properly disposed.

Storage and Disposal Procedures

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation. When subjected to high winds or risk of high winds, temporary sanitary facilities should be secured to prevent overturning.
- Wastewater should not be discharged or buried within the project site.
- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the State of Hawaii

Department of Health Wastewater Branch, and City and County Department of Planning & Permitting requirements.

- Only reputable, professional sanitary and septic waste haulers should be used.
- Sanitary facilities should be located in a convenient location.
- Untreated raw wastewater should never be discharged or buried.
- If using an onsite disposal system (OSDS), such as a septic system, State of Hawaii Department of Health Wastewater Branch requirements must be followed.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- Sanitary and septic facilities should be maintained in good working order by a professional service.
- Regular waste collection by a professional hauler should be arranged before facilities overflow.

Education

- Educate employees, subcontractors, and suppliers on sanitary and septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary and septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary and septic waste.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Arrange for regular waste collection.
- If high winds are expected, portable sanitary facilities must be secured with spikes or weighed down to prevent over turning.

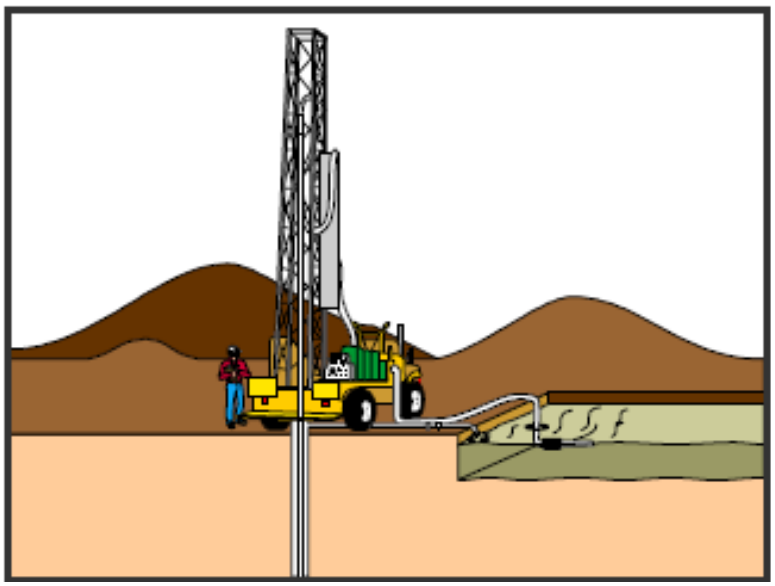
References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Liquid Waste Management WM-10



Objectives

EC – Erosion Control

SE – Sediment Control

TR – Tracking Control

WE – Wind Erosion Control

NS – Non-Storm Water Management Control

WM – Waste Management & Materials Pollution Control √

Legend:

√ Primary Objective

▲ Secondary Objective

Targeted Constituents

Sediment	√
Nutrients	√
Trash	√
Metals	√
Bacteria	
Oil and Grease	√
Organics	

Potential Alternatives

None

Description and Purpose

Liquid waste management includes procedures and practices to prevent discharge of pollutants to the storm drain system or to watercourses as a result of the creation, collection, and disposal of non-hazardous liquid wastes.

Suitable Applications

Liquid waste management is applicable to construction projects that generate any of the following non-hazardous by-products, residuals, or wastes:

- Drilling slurries and drilling fluids;
- Grease-free and oil-free wastewater and rinse water;
- Dredgings; and/or
- Other non-storm water liquid discharges not permitted by separate permits.

Limitations

- Disposal of some liquid wastes may be subject to specific laws and regulations or to requirements of other permits secured for the construction project (e.g. State of Hawaii Department of Health Clean Water Branch, NPDES permits, State of Hawaii Department of Health Safe Drinking Water Branch Underground Injection Control Class V, Subclass D, Army Corps permits, etc.).
- Liquid waste management does not apply to dewatering operations (NS-2 Dewatering Operations), solid waste management (WM-5 Solid Waste Management), hazardous wastes (WM-6 Hazardous Waste Management), or concrete slurry residue (WM-8 Concrete Waste Management).

- Typical permitted non-storm water discharges can include: water line flushing; landscape irrigation; diverted stream flows; rising ground waters; uncontaminated pumped ground water; discharges from potable water sources; foundation drains; irrigation water; springs; water from crawl space pumps; footing drains; lawn watering; flows from riparian habitats and wetlands; and discharges or flows from emergency fire fighting activities.

Implementation

General Practices

- Instruct employees and subcontractors how to safely differentiate between non-hazardous liquid waste and potential or known hazardous liquid waste.
- Instruct employees, subcontractors, and suppliers that it is unacceptable for any liquid waste to enter any storm drainage device, waterway, or receiving water.
- Educate employees and subcontractors on liquid waste generating activities and liquid waste storage and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Verify which non-storm water discharges are permitted by the statewide NPDES permit; different regions might have different requirements not outlined in this permit.
- Apply NS-8 Vehicle and Equipment Cleaning for managing wash water and rinse water from vehicle and equipment cleaning operations.

Containing Liquid Wastes

- Drilling residue and drilling fluids should not be allowed to enter storm drains and watercourses and should be disposed of.
- If an appropriate location is available, drilling residue and drilling fluids that are exempt may be dried by infiltration and evaporation in a containment facility constructed in conformance with the provisions concerning the Temporary Concrete Washout Facilities detailed in WM-8 Concrete Waste Management.
- Liquid wastes generated as part of an operational procedure, such as water-laden dredged material and drilling mud, should be contained and not allowed to flow into drainage channels or receiving waters prior to treatment.
- Liquid wastes should be contained in a controlled area such as a holding pit, sediment basin, roll-off bin, or portable tank.
- Containment devices must be structurally sound and leak free. Washout/liquid waste storage/treatment facilities shall prevent the infiltration of contaminates which may affect subsurface soils and groundwater.
- Containment devices must be of sufficient quantity or volume to completely contain the liquid wastes generated.
- Precautions should be taken to avoid spills or accidental releases of contained liquid wastes. Apply the education measures and spill response procedures outlined in WM-4 Spill Prevention and Control.
- Containment areas or devices should not be located where accidental release of the contained liquid can threaten health or safety or discharge to water bodies, channels, or storm drains.

Capturing Liquid Wastes

- Capture all liquid wastes that have the potential to affect the storm drainage system (such as wash water and rinse water from cleaning walls or pavement), before they run off a surface.
- Do not allow liquid wastes to flow or discharge uncontrolled. Use temporary dikes or berms to intercept flows and direct them to a containment area or device for capture.
- Use a sediment trap (SE-3 Sediment Trap) for capturing and treating sediment laden liquid waste or capture in a containment device and allow sediment to settle.

Disposing of Liquid Wastes

- A typical method to handle liquid waste is to dewater the contained liquid waste, using procedures such as described in NS-2 Dewatering Operations, and SE-2 Sediment Basin, and dispose of resulting solids per WM-5 Solid Waste Management.
- Methods of disposal for some liquid wastes may be prescribed in Water Quality Reports, NPDES permits, Environmental Impact Reports, 401 or 404 permits, and City discharge permits, etc. Review the site-specific BMPs plan to see if disposal methods are identified.
- Liquid wastes, such as from dredged material, may require testing and certification whether it is hazardous or not before a disposal method can be determined.
- For disposal of hazardous waste, see WM-6 Hazardous Waste Management.
- If necessary, further treat liquid wastes prior to disposal. Treatment may include, though is not limited to, sedimentation, filtration, and chemical neutralization.

Costs

Prevention costs for liquid waste management are minimal. Costs increase if cleanup or fines are involved.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-storm water discharge daily while non-storm water discharges occur.
- Remove deposited solids in containment areas and capturing devices as needed and at the completion of the task. Dispose of any solids as described in WM-5 Solid Waste Management.
- Inspect containment areas and capturing devices and repair as needed.

References

California Stormwater Quality Association (CASQA) Best Management Practices Handbook Construction, 2003.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

SECTION 5: GLOSSARY

303(d) Listed: Water bodies listed as impaired as per Section 3 03(d) of the 1972 Clean Water Act.

Best Management Practices (BMPs): Includes schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent, eliminate, or reduce the pollution of waters of the receiving waters. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Catch Basin (Also known as Inlet): Box-like underground concrete structure with openings in curbs and gutters designed to collect runoff from streets and pavement.

City: City and County of Honolulu

Clean Water Act (CWA): (33 U.S.C. 1251 et seq.) requirements of the NPDES program are defined under Sections 307, 402, 318 and 405 of the CWA.

Construction Activity: Includes clearing, grading, excavation, and contractor activities that result in soil disturbance. Construction activities are regulated by the NPDES General Permit Coverage Hawaii Administrative Rules (HAR) Chapter 11-55 Water Pollution Control, Appendix C-Storm Water Associated with Construction Activities, effective October 22, 2007.

Construction General Permit: A National Pollutant Discharge Elimination System (NPDES) Notice of General Permit Coverage (NGPC) permit is issued by the State of Hawaii Department of Health Clean Water Branch for the discharge of storm water associated with construction activity from soil disturbance of one acre or more. Reference HAR Chapter11-55 Water Pollution Control Appendix A Standard General Permit Conditions, Appendix C Discharges of Storm Water Associated with Construction Activities.

Denuded: Land stripped of vegetation or land that has had its vegetation worn down due to the impacts from the elements or humans.

Detention: The capture and subsequent release of storm water runoff from the site at a slower rate than it is collected, the difference being held in temporary storage.

Discharge: A release or flow of storm water or other substance from a conveyance system or storage container. Broader – includes release to storm drains, etc.

Effluent Limits: Limitations on amounts of pollutants that may be contained in a discharge. Can be expressed in a number of ways including as a concentration, as a concentration over a time period (e.g., 30-day average must be less than 20 mg/l), or as a total mass per time unit, or as a narrative limit.

Erosion: The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices related to farming, new development, redevelopment, road building, or timber cutting.

Facility: Is a collection of industrial or construction processes discharging storm water associated with industrial activity within the property boundary or operational unit.

Grading: The cutting or filling of the land surface to a desired slope or elevation.

Hazardous Waste: A waste or combination of wastes that, because of its quantity, concentration, or physical, chemical or infectious characteristics, may either cause or significantly contribute to an increase in mortality or an increase in serious irreversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of or otherwise managed. Possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity) or appears on special EPA or state lists. Regulated under the federal Resource Conservation and Recovery Act and the California Health and Safety Code.

Illicit Discharges: Any discharge to a municipal separate storm sewer that is not in compliance with applicable laws and regulations as discussed in this document.

Industrial General Permit: A National Pollutant Discharge Elimination System (NPDES) Permit issued by the State of Hawaii Department of Health Clean Water Branch Board for discharge of storm water associated with industrial activity.

Inlet: An entrance into a ditch, storm drain, or other waterway.

Integrated Pest Management (IPM): An ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism.

Maximum Extent Practicable (MEP): Economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint source pollution control practices, technologies, processes, siting criteria, operating methods or other alternatives.

Municipal Separate Storm Sewer System (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) designed or used for collecting or conveying storm water; (ii) which is not a combined sewer; and (iii) which is not part of a Publicly Owned Treatment Works (POTW) as defined at Title 40 of the Code of Federal Regulations (CFR) 122.2. A “Small MS4” is defined as an MS4 that is not a permitted MS4 under the Phase I regulations. This definition of a Small MS4 applies to MS4 operated within cities and counties as well as governmental facilities that have a system of storm sewers.

Non-Storm Water Discharge: Any discharge to municipal separate storm sewer that is not composed entirely of storm water.

Nonpoint Source Pollution: Pollution that does not come from a point source. Nonpoint source pollution originates from aerial diffuse sources that are mostly related to land use.

Notice of Intent (NOI): A formal notice to the State of Hawaii Clean Water Branch submitted by the owner of an industrial site or construction site that said owner seeks coverage under a General Permit for discharges associated with industrial and construction activities. The NOI provides information on the owner, location, type of project, and certifies that the owner will comply with the conditions of the construction General Permit.

Notice of Cessation (NOC): Formal notice to the State of Hawaii Clean Water Branch submitted by owner/ developer that a construction project is complete.

NPDES Permit: NPDES is an acronym for National Pollutant Discharge Elimination System. NPDES is the national program for administering and regulating Sections 307, 318, 402, and 405 of the Clean Water Act (CWA). In Hawaii, the Department of Health Clean Water Branch has issued a permit to discharge storm water runoff from the City and County of Honolulu's Municipal Separate Storm Sewer System (MS4) into state waters in and around the Island of Oahu for storm water discharges.

Outfall: The end point where storm drains discharge water into a waterway.

Point Source: Any discernible, confined, and discrete conveyance from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Pollutant: Generally, any substance introduced into the environment that adversely affects the usefulness of a resource.

Pollution Prevention (P2): Practices and actions that reduce or eliminate the generation of pollutants.

Precipitation: Any form of rain or snow.

Pretreatment: Treatment of waste stream before it is discharged to a collection system.

Reclaim (water reclamation): Planned use of treated effluent that would otherwise be discharged without being put to direct use.

Retention: The storage of storm water to prevent it from leaving the development site.

Reuse (water reuse): (see Reclaim)

Runoff: Water originating from rainfall, melted snow, and other sources (e.g., sprinkler irrigation) that flows over the land surface to drainage facilities, rivers, streams, springs, seeps, ponds, lakes, and wetlands.

Run-on: Offsite storm water surface flow or other surface flow which enters your site.

Scour: The erosive and digging action in a watercourse caused by flowing water.

Secondary Containment: Structures, usually dikes or berms, surrounding tanks or other storage containers, designed to catch spilled materials from the storage containers.

Sedimentation: The process of depositing soil particles, clays, sands, or other sediments that were picked up by runoff.

Sediments: Soil, sand, and minerals washed from land into water, usually after rain, that collect in reservoirs, rivers, and harbors, destroying fish nesting areas and clouding the water, thus preventing sunlight from reaching aquatic plants. Farming, mining, and building activities without proper implementation of BMPs will expose sediment materials, allowing them to be washed off the land after rainfalls.

Significant Materials: Includes, but not limited to, raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designed under Section 10 1(14) of CERLCA; any chemical the facility is required to report pursuant to Section 313 of Title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with storm water discharges.

Significant Quantities: The volume, concentrations, or mass of a pollutant in storm water discharge that can cause or threaten to cause pollution, contamination, or nuisance that adversely impact human health or the environment and cause or contribute to a violation of any applicable water quality standards for receiving water.

Source Control BMPs: Operational practices that reduce potential pollutants at the source.

Source Reduction (also source control): The technique of stopping and/ or reducing pollutants at their point of generation so that they do not come into contact with storm water.

Storm Drains: Above- and below-ground structures for transporting storm water to streams or outfalls for flood control purposes.

Storm Water: Defined as urban runoff and snowmelt runoff consisting only of those discharges, which originate from precipitation events. Storm water is that portion of precipitation that flows across a surface to the storm drain system or receiving waters.

Storm Water Discharge Associated with Industrial Activity: Discharge from any conveyance which is used for collecting and conveying storm water from an area that is directly related to manufacturing, processing, or raw materials storage activities at an industrial plant.

Storm Water Pollution Control Plan (SWPCP): A written plan that documents the series of phases and activities that, first, characterizes your site, and then prompts you to select and carry out actions which prevent the pollution of storm water discharges. For construction activities NOI, the Department of Health Clean Water Branch has renamed SWPCP to site-specific construction BMPs plan.

Treatment Control BMPs: Treatment methods to remove pollutants from storm water.

Toxicity: Adverse responses of organisms to chemicals or physical agents ranging from mortality to physiological responses such as impaired reproduction or growth anomalies.

Turbidity: Describes the ability of light to pass through water. The cloudy appearance of water caused by suspended and colloidal matter (particles).

CON APPENDIX B
Hawaii State Department of Transportation Storm Water Best Management Practices Manual

This page intentionally left blank.

Storm Water Permanent Best Management Practices Manual

PROTECT OUR WATER

MĀLAMA I KA WAI

STATE OF HAWAII DEPARTMENT OF TRANSPORTATION

www.stormwaterhawaii.com

Hawaii State Department of Transportation
Highways Division
Storm Water Management Program
NPDES Permit No. HI S000001
April 2015

This page intentionally left blank.

Storm Water Permanent Best Management Practices Manual

State of Hawaii Department of Transportation
Highways Division

PROTECT OUR WATER
MĀLAMA I KA WAI
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION
www.stormwaterhawaii.com

April 2015
Effective: October 27, 2015

This page intentionally left blank.

TABLE OF CONTENTS

LIST OF APPENDICES ..... *v*

LIST OF TABLES ..... *vi*

ACRONYMS AND ABBREVIATIONS ..... *vii*

DEFINITIONS OF KEY TERMS ..... *viii*

RFERENCES ..... *xi*

1. ENVIRONMENTAL BACKGROUND AND INTRODUCTION 1-1

1.1 Environmental Background 1-1

1.2 Introduction to this manual 1-1

2. APPLICABILITY 2-1

2.1 Scope 2-1

2.2 Criteria 2-1

2.2.1 Unified Criteria 2-1

2.2.2 Redevelopment 2-2

2.3 Applicable Projects (Statewide) 2-2

2.3.1 Projects within DOT-HWYS's Rights-of-way 2-2

2.3.2 New Projects Requiring a Connection (to DOT's MS4) Permit 2-2

2.3.3 Specific Projects with Potential to Discharge Pollutants to the MS4 2-2

2.4 Storm Water Control Design Checklist Tool 2-2

3. EXEMPTIONS AND VARIANCES 3-1

3.1 Exemptions 3-1

3.1.1 Projects that are not Eligible for Exemptions 3-1

3.1.2 Exemptions 3-1

3.2 Variances from LID 3-2

4. PERMANENT BMP CONSIDERATION IN PROJECT PLANNING AND DESIGN PHASE 4-1

4.1 Introduction 4-1

4.2 Storm Water Permanent BMP Concepts in Project Planning Phase 4-1

4.2.1 Purpose 4-1
4.2.2 When to Develop Concept 4-1
4.2.3 Concept Development 4-1
4.2.4 Content of Permanent BMP Planning Concept Report 4-2
4.2.5 Review and Approval 4-3
4.3 Storm Water Permanent BMP in Project Design Phase 4-3
4.3.1 Permanent BMP Conceptual Design Process 4-3
4.3.2 Content of Permanent BMP Design Report 4-4
4.3.3 Future Maintenance and Cost Considerations 4-5
4.3.4 Review and Approval 4-5

5. SELECTION OF THE QUANTITATVE CRITERIA 5-1

5.1 DOT-HWYS Hydraulic Design Criteria 5-1
5.2 The Quantitative Criteria 5-1

6. STORM WATER QUALITY BMP DESIGN 6-1

6.1 Water Quality Design Volume Criteria 6-1
6.1.1 Objectives of Water Quality Design Volume 6-1
6.1.2 Management Practices to Meet Criteria 6-1
6.1.3 Additional Requirements and Consideration of Performance 6-1
6.2 Detention Based Water Quality Control 6-2
6.2.1 Design Volume 6-2
6.2.2 Runoff Coefficient 6-2
6.2.3 Detention Time 6-3
6.2.4 Short-circuiting 6-3
6.2.5 Outlet sizing 6-3
6.3 Flow-Through Based Water Quality 6-3
6.3.1 Runoff coefficient 6-4
6.3.2 Design Storm Size (Hourly Rainfall Intensity) 6-4
6.3.3 Flow Calculation 6-4
6.4 Water Quality Design Standards 6-4
6.4.1 Detention Based Storm Water Quality Control Facilities 6-4
6.4.2 LID Treatment Upstream of Detention or Flow-Through Treatment 6-4

7. STORM WATER PERMANENT BMP OPTIONS 7-1

7.1 LID Methods Covered in this Manual 7-3

7.1.1 Pretreatment 7-3

7.1.2 Preserving Existing Vegetation 7-3

7.2 Non-LID Management Methods 7-45

7.3 Trash Management Practices 7-61

8. INSPECTION, MAINTENANCE, AND RECORD KEEPING 8-1

8.1 Site Inspection During Construction 8-1

8.2 As-Built Certification & Acceptance of Permanent BMPs 8-2

8.3 BMP Inspections After Construction 8-2

8.4 BMP Operations and Maintenance 8-2

8.5 Record Keeping 8-3

LIST OF APPENDICES

Appendix	Title
A.	Rain Stations Analyzed for Quantitative Criteria
B.	Storm Water Flow Control and Erosion Techniques

LIST OF TABLES

Table	Title	Page
Table 3-1.	Hydrogeological Constraints	3-3
Table 3-2.	Physical Constraints	3-3
Table 3-3.	Operational Constraints	3-4
Table 3-4.	Other Constraints/Non-Applicability	3-4
Table 5-1.	Summary of Statewide 85th Percentile Storm Averages	5-1
Table 6-1.	Values of Runoff Coefficients, C, for use in the Rational Method	6-2
Table 6-2.	Values of Runoff Coefficients, C, for alternate conditions	6-3
Table 7-1.	LID BMP Selection - Storm Water Treatment Suitability	7-2
Table 8-1.	Inspection Events during Construction of Permanent BMPs	8-1

ACRONYMS AND ABBREVIATIONS

BMPs	Best Management Practices
DOT-HWYS	State of Hawaii Department of Transportation, Highways Division
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
HAR	Hawaii Administrative Rules
HDOH	State of Hawaii Department of Health
HDOT	State of Hawaii Department of Transportation
HWY-DE	DOT-HWYS Division, Design Branch, Environmental Permitting and Compliance Section
HWY-DH	DOT-HWYS Division, Design Branch, Hydraulic Design Section
HWY-P	DOT-HWYS Division, Planning Branch
LID	Low Impact Development
LOS	Lines of Study
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
PS&E	Plan, Specifications, and Estimate Documents for a Plan Submittal
SWMP	DOT-HWYS' Storm Water Management Plan
Tm	Recurrence Interval
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WLAs	Waste Load Allocations
WQDV	Water Quality Design Volume
WQFR	Water Quality Flow Rate
WQLS	Water Quality Limited Segments

DEFINITIONS OF KEY TERMS

303(d) LIST – Under section 303(d) of the Clean Water Act, states are required to compile a list of impaired waters that fail to meet any of their applicable water quality standards or cannot support their designated or existing uses. This list, called a "303(d) list", is submitted to Congress every two years. States are required to develop a Total Maximum Daily Load (TMDL) for each pollutant causing impairment for water bodies on the list.

BEST MANAGEMENT PRACTICE (BMP) – According to CFR § 122.2, schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of 'waters of the Unites States'. A permanent BMP shall be maintained in its perpetuity unless the original purpose of the project no longer exists.

CONTRACT PROJECT – A construction project, which is designed either by DOT-HWYS' personnel or by an engineering consultant firm and is constructed by a private contractor.

DETENTION VOLUME – The volume of runoff that is held and treated in a BMP structure.

DISCHARGE RATE – The rate at which water is discharged out of the BMP after being stored and treated.

DISTURBED AREA / DISTURBANCE OF LAND – The penetration, turning, or moving of soil or resurfacing of pavement with exposure of the base course or the exposure of bare soil or ground surface; including the land surface exposed by construction roads, baseyards, staging areas, demolition, headquarters, and parking areas. It includes "grubbing" in its normal meaning of the use of equipment to knock down and push vegetation out of the way, typically uprooting vegetation and disturbing the ground surface. It does not include grass or weed cutting, bush or tree trimming or felling that leaves soil or ground intact.

DRAINAGE AREA – The specific land area that drains water into a river system or other body of water. Drainage area also refers to the drainage basin or watershed.

ENCROACHMENT PROJECT – A construction project undertaken by a non-DOT-HWYS entity (i.e. third party) within the DOT-HWYS' right-of-way and requires the issuance by DOT-HWYS of a Permit to Perform Work Upon State Highways.

FREEBOARD – The vertical distance between the water surface of the design discharge and a point of interest such as a low chord of a bridge or top of a channel bank.

GEOMORPHIC BALANCE – The balance of changes in hydrology and hydraulics that affect stream shape, planform, slope, and sediment transport.

GROUNDWATER RECHARGE – The process of water soaking into the ground to become groundwater.

GRUBBING – The use of equipment to knock down and push vegetation out of the way, typically uprooting vegetation and disturbing the ground surface.

HYDROLOGIC CYCLE – The cycle of water movement from the atmosphere to the earth and returning to the atmosphere through various stages or processes such as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transportation.

HYDRAULIC GRADE LINE – A line characterized by a plotted ordinate position, which represents the sum of pressure head plus elevation head for the various positions along a given fluid flow path such as a pipeline or groundwater stream line.

HYDRAULIC GRADIENT – The slope of the water surface. The gradient or slope of a water table or piezometric surface in the direction of the greatest slope, generally expressed in feet per mile or feet per feet. Specifically, the change in static head per unit of distance in a given direction, generally the direction of the maximum rate of decrease in head. The difference in hydraulic heads divided by the distance along the flowpath, or expressed in percentage terms.

IMPERVIOUS SURFACE – Surface area which allows little or no infiltration. Impervious surfaces include pavements and roofs.

IN-HOUSE PROJECT – A construction project that is performed by DOT-HWYS personnel. These projects are typically small and maintenance related.

LAND USE – The way land is developed and used in relation to the types of allowable activities (agriculture, residences, industries, etc.) and the sizes of buildings and structures permitted. Certain types of pollution problems are often associated with particular land uses such as sedimentation from construction activities.

LINES OF STUDY (LOS) – Line used for drainage calculations where storm water runoff leaving the DOT-HWYS's right-of-way in a sheet flow fashion.

LOW IMPACT DEVELOPMENT (LID) –A comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds.

PERMANENT BMP – A specific practice intended to reduce storm water volume and/or the pollution typically associated with storm water runoff. Such practices may include LID design features, source control methods, or manufactured devices designed to capture pollutants.

PERVIOUS SURFACE – Surface area which allows infiltration of water.

POLLUTANTS – Refer to the waste material that contaminates air, soil, or water. In the context of storm water quality, pollutants often refer to the following:

- Nutrients- phosphorous and nitrogen;
- Suspended solids- sediment suspended in the water;
- Organic carbon and hydrocarbons;
- Bacteria;
- Trace metals;
- Pesticides; and
- Trash and debris.

PROPRIETARY BMP – A commercially available pre-manufactured or partially manufactured permanent BMP that treats water through filtration or settling methods. Such examples include catch basin inserts, water quality inlets, oil-grit separators, and hydrodynamic devices

REDEVELOPMENT PROJECT – A project that consists of reconstruction of or new construction on an existing impervious area exceeding 5,000 square feet.

ROUGHNESS COEFFICIENT – A value based on the material used to construct a channel such as earth, rock, and gravel; the surface irregularity of the side slopes and bottom of the channel, the variations of successive cross sections in size and shape, obstructions which may remain in the channel and affect the channel flow, vegetation effects should be carefully assessed, channel meandering should also be considered.

RUNOFF VOLUME – The volume of water that flows off of a surface during a storm event.

SHEET FLOW – Flow that occurs overland in places without defined channels. The flood water spreads out over a large area at a uniform depth. Also referred to as overland flow.

SHORT-CIRCUITING – The minimizing of "dead spaces" (areas where little or no exchange occurs during a storm event) to minimize the distance between the inlet and outlet.

SOURCE CONTROL BMP – Appropriate operational or structural measures that prevent or reduce pollutants from entering storm water. Examples of operational source control BMPs include good housekeeping practices, spill prevention, and employee training. Structural source control BMPs consist of enclosures or roofs for working areas where pollutants are present or installing devices that direct contaminated storm water to appropriate treatment BMPs.

STORM WATER RUNOFF – Precipitation which flows over the ground.

SWALE – An elongated depression in the land surface that is at least seasonally wet, usually heavily vegetated, and normally without flowing water. Swales discharge storm water into primary drainage channels and may provide some groundwater recharge.

TAILWATER EFFECT – Water located just downstream of a hydraulic structure, such as a dam, culvert, or bridge.

TOPOGRAPHIC MAP – A type of map depicting a limited set of features but including at the minimum information about elevations or landforms. Topographic maps are commonly used for navigation and reference purposes.

WATERS OF THE UNITED STATES – All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide, all interstate waters and wetlands, tributaries of these waters, and the territorial seas.

WATERS OF THE STATE [ALTERNATIVELY, STATE WATERS] – All waters, fresh, brackish, or salt, around and within the State, including, but not limited to, coastal waters, streams, rivers, drainage ditches, ponds, reservoirs, canals, ground waters, and lakes.

WETLANDS – Lands where water saturation is the dominant factor determining the nature of soil development and the types of plants and animal communities living in the surrounding environment. Wetlands are also referred to as bogs, ponds, estuaries, or marshes.

REFERENCES

California Stormwater Quality Association, January 2003. “California Stormwater BMP Handbook New Development and Redevelopment”.

Department of Planning and Permitting, City and County of Honolulu, June 1, 2013. “Rules Relating to Storm Drainage Standards”.

Low Impact Development Center, September 2014. “Introduction”. Retrieved from www.lowimpactdevelopment.org.

Maryland Department of the Environment, 2000. “2000 Maryland Stormwater Design Manual Volumes I & II.”, Prepared by Center for Watershed Protection. Baltimore, MD.

Maryland Department of the Environment, July 2001. “Maryland Stormwater Management Guidelines for State and Federal Projects”.

Maryland State Highway Administration, Highway Hydraulics Division, April 2003. “Draft Guidelines for preparing Stormwater Management Concept Reports”.

Maryland Department of the Environment, July 2001. “Maryland Stormwater Management Guidelines for State and Federal Projects”.

State of Hawaii, Department of Health, Clean Water Branch, September 2013. “Authorization to Discharge Under the National Pollutant Discharge Elimination System”.

State of Hawaii, Department of Transportation, Highways Division, August 2006. “Oahu Storm Water Management Program Plan”.

State of Hawaii, Department of Transportation, Highways Division, April 2003. “Storm Water Management Program Management Manual”.

State of Hawaii, Department of Transportation, Highways Division, October 2010. “Design Criteria for Highway Drainage”.

U.S. Environmental Protection Agency (EPA), 2005. “National Management Measures to Control Nonpoint Source Pollution from Urban Areas”.

U.S. Department of Transportation, Federal Highway Administration, June 1996. “Evaluation and Management of Highway Runoff Water Quality”.

Washington State Department of Ecology, February 2005. “Stormwater Management Manual for Western Washington”.

Washington State University Extension, December 2012. “Low Impact Development Technical Guidance Manual for Puget Sound”. **.**

1. ENVIRONMENTAL BACKGROUND AND INTRODUCTION

1.1 ENVIRONMENTAL BACKGROUND

Urban development continues to have a profound impact on the quality of Hawaii's state waters. Development, which adds impervious area to watersheds, prevents storm water absorption and creates obstacles in the traditional hydrologic cycle. Storm water runoff generated from impervious areas may carry surface pollutants into Hawaii's state waters and affect natural habitats. With a shift in philosophy, minimizing impervious area and maximizing areas where storm water runoff can infiltrate, evapotranspire, or be reused will provide direct benefits to not only fresh water resources, but also localized and downstream habitats.

Creative use of Permanent Best Management Practices (BMPs) which address storm water runoff volume and quality will be beneficial in keeping Hawaii's state waters clean and help reduce the negative effects of urban development. Permanent BMPs can be activities, prohibitions, procedures, or design projects which provide a positive impact on water quality or reduce storm water runoff from a site.

1.2 INTRODUCTION TO THIS MANUAL

The State of Hawaii Department of Transportation, Highways Division, Oahu District (DOT-HWYS) operates a Municipal Separate Storm Sewer System (hereinafter referred to as the "MS4") on the Island of Oahu. The operation and discharge of the MS4 is authorized and governed by DOT-HWYS' National Pollutant Discharge Elimination System (NPDES) Permit No. HI S000001 (hereinafter referred to as "MS4 Permit"), which became effective on October 28, 2013.

To fulfill the MS4 Permit requirements and to address storm water pollution associated with highway runoff, DOT-HWYS implements Permanent BMP criteria that apply to the applicable new developments and redevelopment projects, highway baseyards, and maintenance facilities statewide. The purpose of this manual is to provide procedures and guidelines to ensure that permanent BMPs are being considered and implemented throughout all phases of DOT-HWYS project development, including planning, design, construction, and maintenance.

This updated DOT-HWYS Permanent BMP Manual was created to comply with Part D.1.e. of the MS4 Permit, which requires the inclusion and prioritization of Low Impact Development (LID) practices. LID is a subset of Permanent BMPs where project planning and design focus on maintaining and enhancing pre-development hydrology during development. This version, revised April 2015 supersedes the March 2007 Permanent BMP Manual and is effective on October 27, 2015. Future revisions to this manual will be released through the Annual Report and on the DOT-HWYS storm water website located at the address www.stormwaterhawaii.com. Always consult with DOT-HWYS to ensure that you are incorporating the latest revisions to this manual.

This manual focuses on Permanent BMPs that are most relevant to DOT-HWYS projects, which are typically space-limited to construction within a narrow right-of-way. However, as industry changes and new BMPs are developed, designers should consider new and creative alternatives

and consult with DOT-HWYS on the applicability of such alternatives. Furthermore, for encroachment projects and projects that require a connection permit to the MS4, as long as safety requirements are met, LID permanent BMPs (when applicable), in addition to those covered in this manual may be appropriate (see Chapter 2.3.1 and 2.3.2 for more information on these projects). Examples of BMPs that are not covered in this manual because they are not typically applicable to DOT-HWYS projects include:

- Permeable Pavement and Interlocking Pavers- permeable pavement has been tested by DOT-HWYS lab personnel, but has not been approved for State road surfaces. However, it may be appropriate for use in encroachment projects adjacent to State Routes or projects connecting to the DOT MS4 in order to fulfill PBMP requirements when applicable (see Chapter 6 regarding Treatment Volumes).

- Vegetated Roofs- there are few situations where a vegetated roof would be appropriate for DOT-HWYS structures. However, this solution provides many benefits to a project with roofed structures including a reduction in storm water runoff.

- Dry Wells- utilizing dry wells for treating rooftop storm water runoff is an effective technique. However, in situations where runoff has the potential for high pollutant concentrations, dry wells are not recommended as these pollutants have the potential to reach ground water aquifers.

- Underground Storage- storing storm water as a resource to be used in non-potable applications (e.g. toilets, landscaping) is a good practice with many benefits, but as with dry wells, it is not recommended for projects that receive runoff from industrial facilities.

- Minimal Excavation Foundations- usually used for residential and commercial structures no higher than three stories, no standards currently exist for incorporating this technique into highway structure design.

The remaining BMPs included in this manual provide many viable options for storm water management on DOT-HWYS projects.

2. APPLICABILITY

2.1 SCOPE

All contract construction and in-house and/or encroachment projects that do not qualify for exemptions are subject to DOT-HWYS review to determine if storm water permanent BMPs are required. If applicable according to the criteria set forth herein, the permanent BMPs and measures shall be designed consistent with this manual and constructed according to the project plans approved by DOT-HWYS.

2.2 CRITERIA

The criteria contained herein becomes effective on October 27, 2015.

2.2.1 Unified Criteria

All non-exempt projects (new development or redevelopment) that disturb an area of one (1) acre or more of land are required to be reviewed for storm water controls.

Smaller projects, less than one (1) acre, that have the potential to discharge pollutants to the MS4 may be required to install specific BMPs (see Section 2.3.3 for qualifiers of such smaller projects) at the direction of discretion of DOT-HWYS

All non-exempt projects (new development or redevelopment) are required to install LID BMP(s) for storm water management if they generate equal to or greater than one (1) acre of new permanent impervious surface. Some projects may qualify for exemptions or variances from this requirement to install LID BMP(s). Projects that qualify for variances from LID may install alternative permanent BMPs approved by DOT-HWYS.

The required permanent BMP(s) shall be designed and installed in accordance with the criteria, guidelines, and design standards described in this manual. The permanent BMP(s) shall be maintained in its perpetuity unless the original purpose of the project no longer exists. The permanent BMPs are intended to reduce storm water volume and/or the pollution created by storm water runoff and shall be selected based on their ability to target pollutants of concern in the project's watershed, particularly those causing water body impairment. Typical pollutants contained in the storm water runoff may include, but are not limited to: phosphorus, nitrogen, sediment, heavy metals, oil, and grease. Unlike temporary construction activity BMPs, permanent BMPs are designed to provide long-term storm water treatment for the completed project and associated site improvements.

The type and size of the permanent BMPs are dependent on the water quality and water quantity a project is required to control and should be designed in accordance to the sizing rules specified in this manual.

2.2.2 Redevelopment

For the purpose of the Post Construction Storm Water Management in New Development and Redevelopment program, any reconstruction of or new construction on existing impervious area

exceeding 5,000 square feet shall be considered redevelopment. New development and redevelopment projects are subject to the same rules and criteria as described in this manual.

2.3 APPLICABLE PROJECTS (STATEWIDE)

2.3.1 Projects within DOT-HWYS's Rights-of-way

- Contract Projects – A construction project, which is designed either by DOT-HWYS' personnel or by an engineering consultant firm and is constructed by a private contractor; and
- Encroachment Projects – A construction project undertaken by a non DOT-HWYS entity (i.e., a third party) within the DOT HWYS' right-of-way and requires issuance by DOT-HWYS of a Permit to Perform Work Upon State Highways.

2.3.2 New Projects Requiring a Connection (to DOT's MS4) Permit

New projects outside of DOT-HWYS' right-of-way that produce storm water runoff that will drain to the MS4 through an authorized connection permit are subject to the unified criteria. Specifically, DOT-HWYS administers a permitting program for any business (industrial or commercial), agency, or project that wishes to establish a permanent connection to the MS4 and release storm water runoff via the MS4. Any new development or redevelopment project that applies for a permit will be subject to this criteria.

2.3.3 Specific Projects with Potential to Discharge Pollutants to the MS4

Retail gasoline outlets, carwashes, automotive repair shops, restaurants, and parking lots with at least 10,000 square feet of total impervious area, will at the minimum apply Source Control BMPs. Such projects that exceed the size of one (1) acre of new impervious area will apply LID BMPs in accordance with the unified criteria.

In addition, any project that DOT-HWYS determines may have the potential to pollute the MS4 through its future industrial or commercial activities may also require BMPs. Furthermore, such projects with special conditions may be subject to the rules and criteria contained in this manual regardless of square footage of the new impervious surface. Special conditions are determined by DOT-HWYS and may include DOT-HWYS projects which drain to sensitive receiving waters (HDOH Water Quality Limited Segments (WQLS)), projects which drain to Class I Inland Waters, Class AA Marine Waters, and selected 303d listed water bodies.

2.4 STORM WATER CONTROL DESIGN CHECKLIST TOOL

Prior to commencement of the detailed engineering design of non-exempt Contract Projects, the design consultant or DOT-HWYS project manager shall complete the Storm Water Control Design Checklist Tool (see Figure 2-1).

The Design Checklist Tool shall also be completed by all non-exempt encroachment or connection permit project applicants to the relevant DOT-HWYS district.

STORM WATER CONTROL DESIGN CHECKLIST TOOL

Project Name: _____

_____

Project Number: _____ Project Route/Milepost: _____

Advertise Date: _____

Exemptions (check all that apply)

	Projects that do not generate 1 acre or more of new permanent impervious and are not a retail gasoline outlet, auto repair shop, restaurant, parking lot with at least 10,000 square feet of total impervious surface area
	Project returns the area to pre-development runoff conditions.
	Project is a utility project (check applicable type) ☐ Pipeline ☐ Conduit ☐ Traffic Sign/Signal
	Projects that are not continuous or involve several locations which may collectively generate 1 acre or more of new permanent impervious surface.
	Projects that do not discharge runoff into any waters of the United States.

If none of the above is checked, the project must provide water quality controls

Water Quality Control:

Water quality volume required: _____ cubic feet

Water quality volume provided by LID: _____ cubic feet

Type of BMP used: _____

*** In the event that water quality volume cannot be treated via LID alone for safety concerns, hydrogeological constraints, physical constraints, or operational constraints alternate approved treatment BMPs will be used**

**** For new gasoline outlets, auto repair shops, restaurants, and parking lots, all with at least 10,000 square feet of total impervious surface area, consider LID and apply Source Control BMPs**

Water Quality Control: (Where applicable)

Existing Site Runoff:

10-year: _____ cubic feet per second

25-year: _____ cubic feet per second

50-year _____ cubic feet per second

100-year: _____ cubic feet per second

Proposed Site Runoff:

10-year: _____ cubic feet per second

25-year: _____ cubic feet per second

50-year _____ cubic feet per second

100-year: _____ cubic feet per second

Type of Treatment used: _____

Description: _____

Signatory:

Figure 2-1. Storm Water Design Checklist Tool

This page intentionally left blank.

3. EXEMPTIONS AND VARIANCES

3.1 EXEMPTIONS

Exemptions may be granted for certain types of projects including operations that conduct routine and emergency maintenance, linear projects, and safety, environmental, and public enhancement projects.

3.1.1 Projects that are not Eligible for Exemptions

The following project types are not eligible for exemptions from the requirements in this manual:

- New Roadway Corridors
- Roadway Realignment
- Roadway Widening
- New Commercial Facility Sites
- Specific project types listed in Section 2.3.3 of this manual

3.1.2 Exemptions

The following types of projects are exempt from the provisions contained in this manual:

- Projects that return an area to pre-development hydrologic conditions
- Projects that do not discharge into State waters
- Projects consisting of multiple unconnected areas that do not generate 1 acre or more of new impervious surfaces
- Operations and Maintenance Activities
  - Pavement Resurfacing, Restoration, Rehabilitation
  - Structural Repairs
  - Baseyard Repairs and Improvements
- Linear Projects
  - Guardrail and Shoulder Improvements
  - Utility Installation and Relocation
- Water Quality Improvement or Preservation
  - Shoreline Protection
  - Landscaping
  - Culvert Rehabilitation or Replacement
  - Permanent BMP projects
  - Erosion and Water Pollution Control
- Emergency
- Temporary Projects

3.2 VARIANCES FROM LID

Circumstances exist where a variance from LID requirements is granted by DOT-HWYS due to the impractical nature of attempting to meet the requirement. Specifically, instituting LID requirements could be physically impossible or unsafe. This variance from LID requirements does not nullify requirements to implement other permanent BMPs in accordance with DOT-HWYS standards. A project may be given a partial variance or full variance from LID requirements. In a partial variance, LID is required to the extent possible and other non-LID permanent BMPs will make up the balance of the Water Quality Design Volume (WQDV) (see Chapter 6 regarding the WQDV) once approved by DOT-HWYS. In a full variance scenario, non-LID permanent BMPs will be used to treat the full Water Quality Design Volume (WQDV) by DOT-HWYS.

The criteria for issuing variances is based on:

- Hydrogeological constraints—e.g., permeability; depth top groundwater; slope stability; structural impacts to buildings/roadbed (shown in Table 3-1)
- Physical constraints—e.g., space constraints; site slope; lack of right of way; contaminated subsoil (shown in Table 3-2)
- Operational constraints—e.g., Strength/loading requirements for pavement; no application for water reuse (shown in Table 3-3)
- Other constraints/Non-Applicability—e.g., no discharge to State Waters; multiple, dispersed project locations, projects that return area to pre-development runoff conditions (shown in Table 3-4)

To obtain a variance, designers must evaluate all LID BMP solutions for their project from the LID BMPs listed in Chapter 7 of this manual. If constraints listed in the following tables or a detail is listed in Chapter 7 eliminates all LID BMP solutions an alternative storm water control may be used. Designers will consult with DOT-HWYS citing the corresponding constraints and stating that all LID BMP solutions are not practical and propose alternative permanent BMPs. Failure to provide proper analysis of permanent BMPs for a site could result in delays to the approval of encroachment permits.

Table 3-1. Hydrogeological Constraints

Constraints	Safety Concern
Permeability	Soil under BMP basin invert does not allow for water to permeate less than 0.5 in/hr
Depth to Ground Water	BMP invert is closer than 3 ft depth to seasonally high groundwater table
Distance to Drinking Water	BMP is closer than 50 ft to nearest groundwater well for drinking
Distance to Septic System	BMP is closer than 35 ft to nearest septic system
Slope Stability	BMP and infiltration would destabilize slope or cause landslide
Structural Impacts to Buildings/Roadbed	BMP is close to the nearest building foundation or roadbed. Proximity is dependent on BMP type, but minimum is 10 feet distance
Sensitive Downstream Areas	Instituting BMPs would significantly affect downstream habitats

Table 3-2. Physical Constraints

Constraints	Safety Concern
Space Constraints	Instituting LID BMPs to MEP doesn’t yield enough treatment for WQDV
Site Slope	Usable flat area doesn’t yield enough treatment for WQDV
Lack of Right of Way	Project is closer than 10 ft to the nearest property line and no memorandum of understanding or joint ownership has been established
Contaminated Subsoil	Project is in the vicinity of industrial contamination
Sensitive Community Site	Excavation for BMP would permanently damage a community resource (e.g. wildlife refuge)
Sensitive Archeological Site	Excavation for BMP would result in disturbance of remains or artifacts

Table 3-3. Operational Constraints

Constraints	Safety Concern
Strength/Loading Requirements for Pavement	BMP is closer than 10 feet to pavement
No Application for Water Reuse	Landscaping or green roof is not an option due to space, energy systems, electrical, or mechanical systems
Hazardous Operations	Nature of site's permanent operations leave potential for mobilizing pollutants via proposed BMPs

Table 3-4. Other Constraints/Non-Applicability

Constraints/Non Applicability	Description
Legality	Implementing a BMP in the project would violate Federal or State Law

4. PERMANENT BMP CONSIDERATION IN PROJECT PLANNING AND DESIGN PHASE

4.1 INTRODUCTION

As DOT-HWYS implements a proactive SWMP and applies unified criteria for all new development and redevelopment projects, it is important for DOT-HWYS' personnel, private consultants, and contractors to consider permanent BMPs throughout every phase of a project, including planning, conceptual engineering, and final design. Early consideration of permanent BMPs will help identify sufficient right-of-way needs and costs, potential community impacts, future maintenance costs, and design conflict. All of these factors may lead to incomplete design and project delays. As detailed in various chapters of this manual, DOT-HWYS emphasizes the consideration of permanent BMPs throughout the "Life Cycle" of a project, from the planning phase to the maintenance phase.

4.2 STORM WATER PERMANENT BMP CONCEPTS IN PROJECT PLANNING PHASE

4.2.1 Purpose

The Environmental Assessment (EA) and Environmental Impact Statement (EIS) processes require documentation of project impacts, avoidance, minimization, and mitigation. As part of these processes, storm water permanent BMPs should be considered in determining impacts to environmental resources such as waters of U.S., wetlands, and groundwater. In certain situations, permanent BMPs can be extremely difficult to accomplish and may affect the feasibility of the highway alternatives being evaluated. The requirements and right-of-way demands of permanent BMPs can greatly affect the selection of project preferred alternatives. Therefore, it is critical to develop permanent BMPs early during the project planning phase and include them in impact assessment and project cost estimating. Early consideration of storm water permanent BMPs will likely lead to more cost-effective projects. Furthermore, as highway settings are typically linear in nature, using some LID techniques may prove difficult. In some cases, using LID and non-LID to satisfy storm water control requirements may be necessary based on constraints.

4.2.2 When to Develop Concept

The storm water permanent BMP concept studies should begin when design alternatives are selected for detailed study.

4.2.3 Concept Development

Once it is determined that a project is subject to permanent BMP requirements, the concept should be developed by a licensed engineer with support from project planners and landscape architects. The study should be completed prior to the initial public hearing discussing the project location and alternatives.

Certain basic information is needed in order to conduct a concept development study. The information should at minimum include topographic mapping for the entire study area, including adequate area on both sides of all the alignments being considered for the entire length of the project in order to locate permanent BMP facilities. The topographic mapping should identify approximate property lines, existing developments, and publicly owned land. The proposed highway alignment or transportation facility should be superimposed on the mapping.

In order to develop permanent BMP concepts, study points need to be identified where storm water runoff leaves DOT-HWYS' right-of-way. In cases where the drainage pathway indicates sheet flow leaving the right-of-way, determination of the study point should be based on engineering judgment.

Approximate locations of permanent BMPs should be identified on the topographic map. Once study points are identified, the volumetric storage requirements should be estimated. This process requires delineation of approximate drainage areas reaching the study point. Water quality volume should be estimated based on the criteria set forth in Chapter 6 of this manual. Since the required volume and footprint of the permanent BMP may affect the right-of-ways required, which in turn influences the selection of the alternative, additional volumes based on a reasonable estimation should be included. This additional volume should be estimated based on site-specific conditions.

Surface areas for the permanent BMPs can be estimated using an assumed depth and the volumes computed. In cases where the designer is proposing flow-through based BMPs, the surface areas of the BMPs should be identified based on the flow rate requirement presented in the Chapter 7 and specific BMP type.

Once the surface area required is determined, the BMP footprints can be placed on the topographic maps. Design engineers should consult with environmental scientists, and landscape architects to ensure that terrain, natural resources, and land use are properly considered in the concept development and to avoid unnecessary impacts.

4.2.4 Content of Permanent BMP Planning Concept Report

The storm water permanent BMP planning concept report should include the following:

Table of Contents

Executive Summary

Introduction

- Description of Project Area
- Location and Vicinity Maps

Design Checklist Tool

- Storm Water Design Checklist Tool

Outfall

- Location and Vicinity Maps
- Description of outfall condition and potential impact

Permanent BMP Description

- Description and intended treatment
- Description of environmental resources
- Regulatory requirements
- 30% Construction Plans with topographic map showing footprints of proposed Permanent BMP(s).
- Location of outfall(s) impacted by the drainage improvements
- Calculations of surface area and volume tabulation
- Right of Way requirements
- Maintenance requirements and cost
- Construction cost estimate

Appendix

- Applicable computations
- Existing and proposed drainage maps
- Photos

References

4.2.5 Review and Approval

The project planner/engineer shall submit the permanent BMP concept report and required information to DOT-HWYS for review and approval.

4.3 STORM WATER PERMANENT BMP IN PROJECT DESIGN PHASE

Development of permanent BMP design concepts starts at the initiation of project design. Detailed surveys and design information are necessary to produce conceptual designs which can be refined as the project progresses. For projects that have a planning concept report, the permanent BMP planning concept should be the basis for developing the design concept.

4.3.1 Permanent BMP Conceptual Design Process

For DOT-HWYS projects, the permanent BMP conceptual design needs to be completed by the 30% plan stage. This requires the engineers to begin the design earlier to identify conflicts, solutions, and cost before a formal 30% cost estimate is generated.

At the design phase, study point identification is similar to the process used for the development of the planning concept. For projects where storm water runoff is discharged from the right-of-way in a sheet flow fashion, lines of study (LOS) should be identified. Care should be taken to

follow the drainage patterns within and outside the right-of-way in order to identify correct study points and or lines of study. Field investigation is required to verify study points or lines.

Hydrologic analysis should be conducted in accordance with DOT-HWYS hydrologic and hydraulic guidelines. Drainage area maps using the best available information should be developed for both existing and proposed conditions.

Outfalls at all study points should be evaluated thoroughly by a licensed engineer. The evaluation should include photographs and channel stability assessment. In some cases, the outfall channel evaluation may be required to extend beyond DOT-HWYS rights-of-way. For connections to a closed storm drain system, the evaluation should include the capacity of the downstream drainage system.

If the proposed project reduces existing water quality treatment in the existing grass channels and buffers by adding new curb or reducing existing sheet flow buffer, the pre-construction pavement draining towards such grass channels and buffers must be identified to compensate for the lost water quality treatment. Computations should be made to determine the amount of existing water quality treatment reduced. Means of compensation or mitigation should also be identified in addition to the new water quality treatment required.

4.3.2 Content of Permanent BMP Design Report

The storm water permanent BMP design concept report should include the following:

Table of Contents

Executive Summary

Introduction

- Description of Project Area
- Location and Vicinity Maps

Design Checklist Tool

- Storm Water Design Checklist Tool

Outfall

- Location and Vicinity Maps
- Description of outfall condition and potential impact

Permanent BMP Description

- Description and intended treatment
- Description of environmental resources
- Regulatory requirements
- 30% Construction Plans with topographic map showing footprints of proposed Permanent BMP(s).
- Location of outfall(s) impacted by the drainage improvements

- Calculations of surface area and volume tabulation
- Right of Way requirements
- Maintenance requirements and cost
- Construction cost estimate

Appendix

- Applicable computations
- Existing and proposed drainage maps
- Photos

References

4.3.3 Future Maintenance and Cost Considerations

Careful and deliberate consideration will be taken with regard to maintenance over the lifespan of the permanent BMP. BMPs that cannot be maintained will not fulfill the original designed treatment volume or designed treatment quality. Accessibility for maintenance personnel, equipment and method of maintenance are among the important considerations during the design process. Furthermore, realistic costs for maintaining the BMP shall also be considered by the designer. Finally, life-cycle and replacement costs shall also be considered for the future of the project.

4.3.4 Review and Approval

Submittals for review and approval include the permanent BMP plans, design report, and other required information. The permanent BMP design shall be made part of the PS&E documents and follow the normal design review process.

This page intentionally left blank.

5. SELECTION OF THE QUANTITATVE CRITERIA

5.1 DOT-HWYS HYDRAULIC DESIGN CRITERIA

While the primary purpose of this permanent BMP manual is to address the management issues associated with water quality of highway runoff and the MS4 system, flood control and preventing channel erosion remain an integral and important part of storm water management. It is essential for planners, engineers, and contractors to be familiar with the DOT-HWYS hydraulic criteria and standards related to storm water quantity. Follow the current DOT-HWYS Design Criteria for Highway Drainage published by the DOT-HWYS Hydraulic Design Section (HWY-DH). Information is constantly updated and can change periodically.

5.2 THE QUANTITATIVE CRITERIA

DOT-HWYS determined that a 1-inch storm correctly models the volume for permanent BMP treatment. This quantitative criteria is essential in designing and sizing BMPs adequate enough to enhance storm water runoff quality through infiltration, evapotranspiration, harvesting/reuse or other activities that treat and release storm water (for calculation details see Chapter 6). The City and County of Honolulu (CCH) conducted research and analysis of the 85th percentile values for 24-hour cumulative depths over 0.10 inches for the island of Oahu. The resulting research, presented in the CCH Standards Revision Plan (dated December 2011), demonstrated the 24-hour 85th percentile value of one (1) inch equaling or exceeding the total for 89% of the stations analyzed. Consequently, in 2013 DOT-HWYS conducted an independent study to confirm Oahu data and the rest of the counties in the State of Hawaii with 24-hour 85th percentile values for the purpose of storm water quantity control.

DOT-HWYS looked at all rainfall stations within a margin seven (7) miles to the left and right of State routes across all counties. Stations were primarily selected for having 35 years of recent continuous monitoring data. In some cases, stations did not have a complete 35 years of data, but were still useful in providing rainfall information. Through the analysis of these stations, no more than half of the stations in the State exceeded the one (1) inch value with most county averages at or close to the one (1) inch value. This information of averages is presented in Table 5-1. Appendix A of this manual graphically shows station locations analyzed.

Table 5-1. Summary of Statewide 85th Percentile Storm Averages

Island Name	No. of Stations Analyzed	Average From All Stations (in.)
Hawaii	107	1.101
Maui	45	1.059
Lanai	3	1.105
Moloka’i	8	0.989
Oahu	62	0.889
Kauai	38	0.939

It is noted that designers may attempt to exceed the one (1) inch value due to their existing site conditions, safety concerns, or other reasons.

This page intentionally left blank.

6. STORM WATER QUALITY BMP DESIGN

6.1 WATER QUALITY DESIGN VOLUME CRITERIA

The water quality design volume for treatment by permanent BMPs (LID and non-LID) is based on the 1" design storm discussed in Chapter 5:

WQDV = C x 1" x A x 3630

WQDV = water quality design volume in cubic feet
C = runoff coefficient (see section 6.2.2)
A = total drainage area in acres
3630 = conversion factor
1" represents the design storm depth

6.1.1 Objectives of Water Quality Design Volume

LID will be the primary treatment for projects that generate one (1) acre or more of impervious area. If a project is subject to a variance and LID cannot be used for some or all of the treatment volume required, the project shall use other permanent BMPs to treat the remaining WQDV such that the total WQDV required is treated by LID and non-LID methods. The purpose of the water quality design volume is to present a unified approach for sizing and selecting storm water permanent BMPs for the applicable projects as listed in Chapter 2 and 3 of this manual. The ultimate goal in this situation is to reduce the pollution associated with storm water runoff discharging into receiving waters to the MEP. The project's remaining volume of water untreated by LID will be treated with water quality as the objective since this water is likely to be discharged directly to State waters.

Since much of the MS4 and the CCH's MS4 are interconnected, it is DOT-HWYS intent to have similar standards for both systems.

6.1.2 Management Practices to Meet Criteria

The quality criteria can be met by either detaining storm water for a length of time that allows storm water pollutants to settle, referred herein as "detention based treatments" such as storm water wetlands, extended detention pond, wet ponds, and structural underground or above ground vaults/tanks, etc., or by use of flow-through based treatments such as infiltration facilities, filtering systems, and commercially available proprietary BMPs. In addition, a flow-through based treatment system may be used in combination with downstream detention to meet the criteria.

6.1.3 Additional Requirements and Consideration of Performance

These are minimum requirements. If DOT-HWYS determines that additional controls and/or lower thresholds for developments are required to meet specific water quality needs in watersheds that drain to sensitive receiving waters (as defined by the Hawaii State Department of Health Water Quality Limited Segments (WQLS), Class I Inland Waters, or Class AA Marine Waters), additional requirements may be imposed. These may include design requirements that

result in larger facilities as well as additional types of structural or non-structural controls. The design solution will be contingent upon the pollutants of concern that are found to be impacting such water bodies and the regulatory status of the water body.

6.2 DETENTION BASED WATER QUALITY CONTROL

6.2.1 Design Volume

The required design volume for detention based control when LID is not feasible is the same as the WQDV discussed in Section 6.1. In the event that LID is partially feasible, treat the untreated WQDV with alternate treatment methods approved by DOT-HWYS.

6.2.2 Runoff Coefficient

The runoff coefficient shall be determined from the following equation as developed by EPA for smaller storms in urban areas:

$$C = 0.05 + (0.009) \times (IMP)$$

C = Runoff coefficient

IMP = Impervious Area (acres) (surface areas which allow little or no infiltration, including pavements, roofs, etc.) for the tributary watershed, expressed as a percentage. It shall be based upon the ultimate use of the drainage area, unless the water quality feature will be re-built/sized during subsequent phases of construction.

The runoff coefficient shall be determined from Table 6-1. Use the lower values presented in Table 6-2 for flat slopes and permeable soil; use higher values for steep slopes and impermeable soil. For drainage areas with multiple land uses (e.g. residential area adjacent to a commercial development), a weighted runoff coefficient based upon the individual land uses shall be used.

Table 6-1. Values of Runoff Coefficients, C, for use in the Rational Method

Type of Surface	Runoff Coefficient (C)
Rural Areas	
Concrete or asphalt pavement	**0.90 - 0.95**
Gravel roadways or shoulders	**0.4 - 0.6**
Bare earth	**0.2 - 0.9**
Steep grassed areas (2:1)	**0.5 - 0.7**
Turf meadows	**0.1 - 0.4**
Forested areas	**0.1 - 0.3**
Cultivated fields	**0.2 - 0.4**

Table 6-2. Values of Runoff Coefficients, C, for alternate conditions

Type of Surface	Runoff Coefficient (C)
Urban Areas	
Flat residential, with about 30 percent of area impervious	**0.4**
Flat residential, with about 60 percent of area impervious	**0.55**
Moderately steep residential, with about 50 percent of area impervious	**0.65**
Moderately steep built up area, with about 70 percent of area impervious	**0.8**
Flat commercial, with about 90 percent of area impervious	**0.8**

6.2.3 Detention Time

For water quality treatment to be effective, longer detention times are required. The draw-down (or draining) time for the detention volume, which is intended to drain down completely (vs. permanent wet volume), shall be greater than or equal to 48 hours.

6.2.4 Short-circuiting

The detention system shall be designed to maximize the distance between the inlet and outlet, and to minimize “dead spaces” (areas where little or no exchange occurs during a storm event), there-by limiting short-circuiting. A minimum flow-path length to width ratio of 3 should be designed.

6.2.5 Outlet sizing

The outlet shall be sized to achieve the above required detention times. In addition, it shall be large enough that clogging is unlikely to occur. It should be 4 inches or larger in diameter. If this is not possible, the use of flow-through based measures should be considered, unless special measures to prevent clogging are provided.

6.3 FLOW-THROUGH BASED WATER QUALITY

Flow-through based water quality control measures achieve water quality treatment by either passing the flow through a filtration media or letting the flow be infiltrated. In addition, there are measures (devices) which utilize hydraulic particle separation techniques (“hydrodynamic” BMPs), however, these alone do not typically address the smaller sized fractions of solids (which typically have a higher portion of other pollutants such as copper and zinc attached to them) that are desired to be removed.

6.3.1 Runoff coefficient

See Section 6.2.2.

6.3.2 Design Storm Size (Hourly Rainfall Intensity)

The required flow rate for treatment is the runoff that would be produced from a rainfall intensity of 0.4 inches per hour. This rate must be maintainable for a minimum of three hours.

6.3.3 Flow Calculation

Flow rate calculation shall be based upon the following:

WQFR = C x 0.4" x A

WQFR = water quality flow rate in cubic feet per second
C = runoff coefficient
A = total drainage area in acres

6.4 WATER QUALITY DESIGN STANDARDS

6.4.1 Detention Based Storm Water Quality Control Facilities

Detention facilities can be designed as the following:

- **Wet Ponds** - The wet pond volume is equal to the WQDV and is entirely a permanent wet pond where storm water exchanges with the pond water to achieve treatment. Detention time requirements do not apply.
- **Wet Extended Detention Ponds** - These are ponds that provide for gradual release of the water quality design volume in order to promote the settling of pollutants. The drawdown time that meets the criteria is required for the extended detention volume.

For wet ponds, the applicant must show a water balance that demonstrates that there will be sufficient dry weather flows to maintain the planned pool volume without creating stagnant conditions.

Detention based water quality systems are recommended to be off-line from flood conveyance. If they are to be on-line or combined with a flood detention facility, then the facility must be designed to pass the appropriate flood without damaging to the facility, as well as to minimize re-entrainment of pollutants.

6.4.2 LID Treatment Upstream of Detention or Flow-Through Based Treatment

LID treatment will be used as the preferred treatment method. In the event that LID practices cannot treat the complete WQDV, excess runoff shall flow to a downstream detention system of flow-through based treatment that is designed to capture and treat the remaining runoff volume. Specifically, the LID treatment will be used where ever possible and any remainder on-site runoff volume will be treated via detention or flow-through systems.

7. STORM WATER PERMANENT BMP OPTIONS

Permanent BMPs that control urban runoff and provide storm water quality treatment can be categorized into the following:

- LID Methods (e.g. Swales, Bioretention, Infiltration Trenches, Engineered Wetlands)
- Non-LID Methods (e.g. Filtration and Proprietary BMPs including "Hydrodynamic" type).

Selection of BMPs must be site specific and treat the WQDV. No single BMP can be applied to all scenarios. The designer should consider the benefits, pollutant removal efficiency, historical data from other installations, aesthetics, community acceptance, and the lifecycle cost, and maintenance factors. A summary of BMP limitations and factors to consider is provided in Table 7-1 to aid the project designer in selecting the most appropriate permanent BMPs. Regarding Non-LID methods, DOT-HWYS does not endorse any particular type of BMP and will review its application and performance on a case by case basis. It is the designer's responsibility to consult with manufacturer and obtain independent performance testing data to support the use of each device and demonstrate it will target the pollutants of concern. For this reason, Table 7-1 does not include any proprietary BMPs.

.

Table 7-1. LID BMP Selection - Storm Water Treatment Suitability

BMP LIST	SAFETY CONCERNS	SPACE REQUIREMENT	ACCEPT HEAVILY POLLUTED RUNOFF	SOILS	WATER TABLE	DRAINAGE AREA (ACRES)	SLOPE RESTRICTIONS	ULTRA URBAN	EASE OF MAINTENANCE	COMMUNITY ACCEPTANCE	COST (RELATIVE TO DRAINAGE AREA)	HABITAT QUALITY	OTHER FACTORS
Dry Swale	No	Varies	Yes	Made soil	2 feet	5 max	4% max cross-slope	Not practical	Easy	High	Medium	Low	
Wet Swale	No	Varies	No	OK	Below WT	5 max	4% max cross-slope	Not practical	Easy	High	Low	Low	Mosquitoes possible
Infiltration Trench	No	Low	No	f ≥ 0.52 inch/hour	4 feet	5 max	Installed in no more than 15% slopes	Depends	Difficult	High	Medium	Low	Avoid large stone
Infiltration Basin	No	Varies	No	f ≥ 0.52 inch/hour	5 feet	10 max	None	Not practical	Medium	Low	Medium	Low	Frequent pooling
Bioretention	No	Varies	Yes	Made soil	7 feet	5 max	None	Not practical	Medium	Medium	Medium	Low	Landscaping
Shallow Wetland	No	High	Yes	"A" soils may require liner	4 feet If hotspot or aquifer	25 min	None	Not practical	Medium	High	Medium	High	
ED Wetland	Varies	Varies	Yes	"A" soils may require liner	5 feet If hotspot or aquifer	25 min	None	Not practical	Medium	Medium	Medium	High	Limited ED depth
Pond Wetland	Yes	High	Yes	"A" soils may require liner	6 feet If hotspot or aquifer	25 min	None	Not practical	Difficult	High	Medium	High	
Pocket Wetland	No	Varies	Yes	OK	Below WT	5 max	None	Depends	Medium	Low	Low	Medium	Drawdowns
Wet ED Pond	Yes	Low	Yes	"A" soils may require pond liner "B" soils may require testing	6 feet If hotspot or aquifer	26 min	None	Not practical	Easy	High	Low	High	
Micropool ED	No	Low	Yes	"A" soils may require pond liner "B" soils may require testing	4 feet If hotspot or aquifer	10 min	None	Not practical	Medium	Medium	Low	Medium	Trash/Debris
Wet Pond	Yes	Varies	Yes	"A" soils may require pond liner "B" soils may require testing	5 feet If hotspot or aquifer	25 min	None	Not practical	Easy	High	Low	High	
Pocket Pond	Varies	Low	Yes	OK	Below WT	5 max	None	OK	Difficult	Medium	Low	Low	Drawdowns
Multiple Pond	Yes	High	Yes	"A" soils may require pond liner "B" soils may require testing	7 feet If hotspot or aquifer	27 min	None	Not practical	Easy	High	Medium	High	

7.1 LID METHODS COVERED IN THIS MANUAL

VEGETATED SWALES
- Dry Swales
- Wet Swales

INFILTRATION FACILITIES
- Infiltration Trenches
- Infiltration Basins
- Bioretention

STORM WATER WETLANDS
- Shallow Wetland
- Pond Wetland
- Pocket Wetland

STORM WATER PONDS
- Extended-Detention Ponds
- Wet Ponds
- Pocket Ponds

Note that not all of the most current BMPs will be covered in this Manual. The most appropriate LID BMP may not be listed. Industry standards change and new unlisted BMPs may be proposed to DOT-HWYS for any given project.

7.1.1 Pretreatment

Pretreatment should be considered for all LID BMPs. Pretreatment extends the life and therefore the replacement frequency of LID BMPs. Sediment, whether it is clogging the media of a BMP or other components (e.g. in a reuse project), is one of the biggest reasons for premature failure of LID BMPs. Designers should plan for necessary space to accommodate pretreatment in the form of filters or sediment forebays along with the space that will be required for the main LID BMP. Designers can also consider utilizing proprietary BMPs to filter sediment or reduce flow velocities upstream of LID BMPs even if the LID BMPs alone are sufficient to treat the WQDV. Finally, utilizing pretreatment will add complexity to the long-term maintenance of the project site and should be planned for and documented in operations accordingly. See Appendix B regarding various techniques which may extend the life of LID BMPs or encourage maximum treatment of design volumes.

7.1.2 Preserving Existing Vegetation

Preserving existing vegetation is one of the strongest assets in project site development. Non-invasive or acceptable vegetation that is appropriate to the subclimate will, on the average, have a higher success in bio-remediating storm water. Emphasizing the preservation of existing vegetation will also reduce the amount of disturbed area and could be leveraged to prevent the need for instituting additional LID BMPs. More information on preserving existing vegetation is found in chapter 7.2.

This page intentionally left blank.

DRY SWALE

DESCRIPTION & PURPOSE

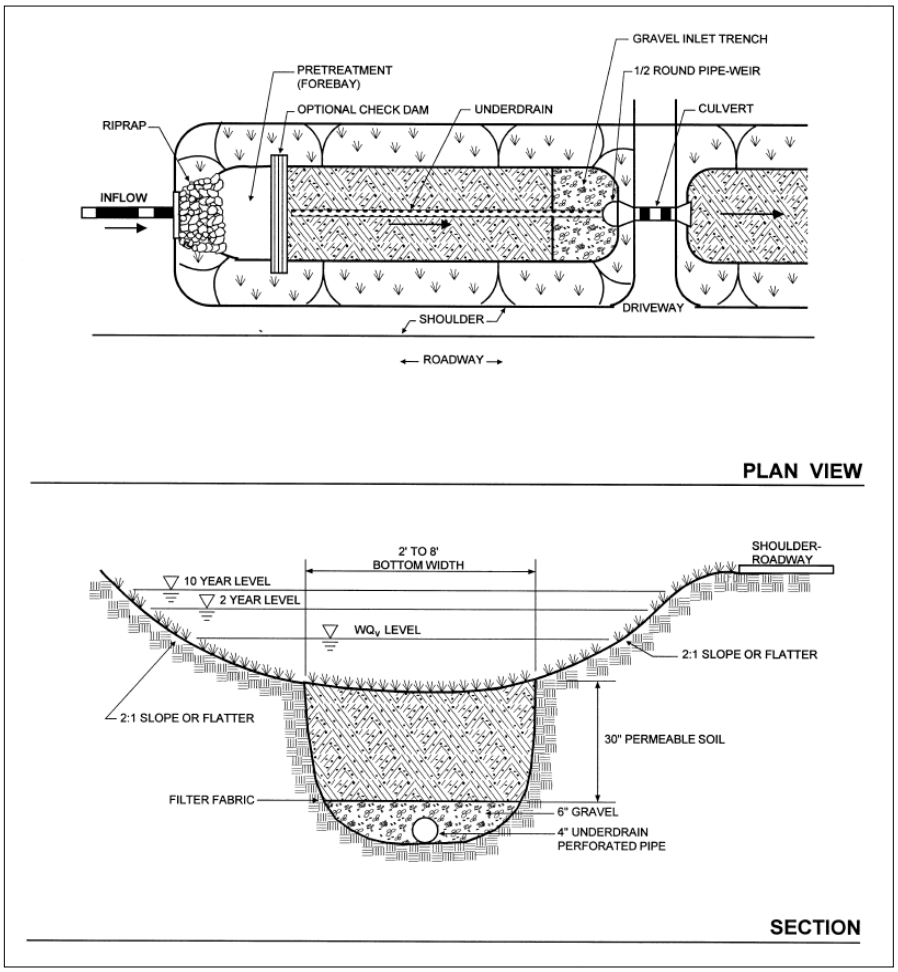
Swales are vegetated open channels that are designed to capture and treat the full water quality volume within dry or wet cells that are formed by check dams or other means.

APPLICATIONS

Dry swales are used at low density residential projects or for very small impervious areas. Dry swales are applicable for land uses such as roads, highways, residential development, and pervious areas.

DESIGN CRITERIA

- Required volume is based on a rainfall intensity of 0.4 inches per hour.
- WQFR: C*0.4”*A is the Water Quality Flow Rate (cfs).
- C is the runoff coefficient, calculated using tables.
- 0.4 inches is the hourly rainfall intensity.
- A is the site area in acres.
- Longitudinal slopes shall be less than 4.0% to qualify for water quality volume treatment.
- Channels shall have moderate side slopes (flatter than 3:1) for most conditions and may NOT be steeper than 2:1.
- Peak velocity shall be non-erosive for the soil and vegetative cover provided.
- The maximum allowable ponding time shall be less than 48 hours, and the minimum ponding time shall be 30 minutes is recommended.
- A bottom width of no wider than 8 feet or a meandering drainage pattern shall be established.
- There should be a maximum ponding depth of one foot at the mid-point of the channel profile and a maximum depth of 18 inches at the downstream end of the channel.
- At the water quality flow rate, the swale width should be that which will have a flow depth of no greater than 4 inches and the hydraulic grade line is no greater than 2% between structures.
- The flow length in the swale should be a minimum of 100 feet.



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Pretreatment storage of 0.1 inches of runoff per impervious acre storage shall be provided, which is usually obtained by check dams at pipe inlets and/or driveway crossings.
- A diaphragm of pea gravel and gentle side slopes should be provided along the top of channels to accommodate pretreatment for lateral sheet flows.
- Direct discharge of concentrated flow shall be pretreated.

CONSTRUCTION CONSIDERATIONS

- The inflow should be directed towards the upstream end of the swale but should occur evenly over the swale.
- Swales that directly receive runoff from impervious surfaces may have a six inch drop onto a protected shelf of pea gravel to minimizing the clogging of the inlet.
- An underdrain shall be provided to ensure maximum ponding time of 48 hours.

LANDSCAPING REQUIREMENTS

- Landscape design should specify proper grass species and wetland plants based on the specific site, soils and hydric conditions present along the channel.
- A permeable soil mixture 30”-30” deep should meet the bioretention “planting” soil specifications listed in the Bioretention section.
- Seed should be flood and drought resistant grasses.

MAINTENANCE AND INSPECTIONS

- Swales should be mowed as required during the growing season to maintain heights in the 4-6 inch range.
- Sediment buildup in the bottom of the swale shall be removed when 25% of the original water quality volume has been exceeded.

LIMITATIONS

- The bottom of the facility shall be above the seasonally high water table.
- No gravel or perforated pipe shall be placed under driveways.

This page intentionally left blank.

WET SWALE

DESCRIPTION & PURPOSE

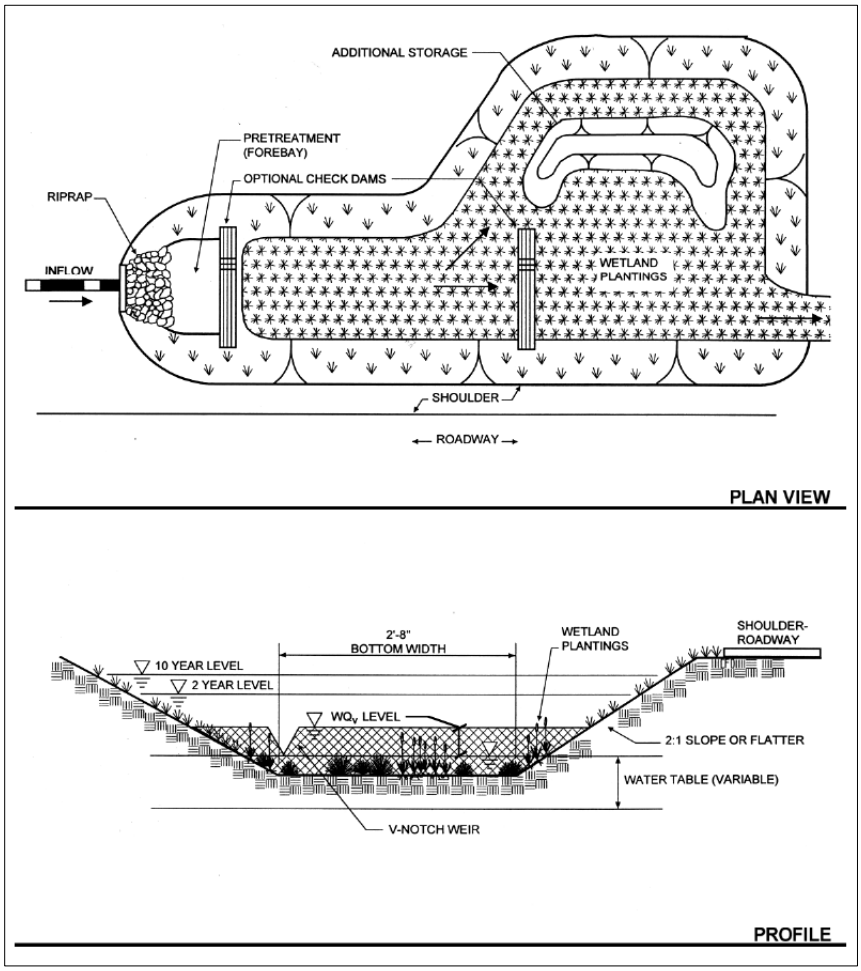
Swales are vegetated open channels that are designed to capture and treat the full water quality volume within dry or wet cells that are formed by check dams or other means.

APPLICATIONS

Wet swales are ideal for treating highway runoff in low lying or flat areas. Wet swales are applicable for land uses such as roads, highways, and pervious areas.

DESIGN CRITERIA

- Required volume is based on a rainfall intensity of 0.4 inches per hour.
- WQFR: C*0.4”*A is the Water Quality Flow Rate (cfs).
- C is the runoff coefficient, calculated using tables.
- 0.4 inches is the hourly rainfall intensity.
- A is the site area in acres.
- Longitudinal slopes shall be less than 4.0% to qualify for water quality volume treatment.
- Channels shall have moderate side slopes (flatter than 3:1) for most conditions and may NOT be steeper than 2:1.
- Peak velocity shall be non-erosive for the soil and vegetative cover provided.
- The maximum allowable ponding time shall be less than 48 hours, and the minimum ponding time shall be 30 minutes is recommended.
- A bottom width of no wider than 8 feet or a meandering drainage pattern shall be established.
- There should be a maximum ponding depth of one foot at the mid-point of the channel profile and a maximum depth of 18 inches at the downstream end of the channel.
- At the water quality flow rate, the swale width should be that which will have a flow depth of no greater than 4 inches and the hydraulic grade line is no greater than 2% between structures.
- The flow length in the swale should be a minimum of 100 feet.



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Pretreatment storage of 0.1 inches of runoff per impervious acre storage shall be provided, which is usually obtained by check dams at pipe inlets and/or driveway crossings.
- A diaphragm of pea gravel and gentle side slopes should be provided along the top of channels to accommodate pretreatment for lateral sheet flows.
- Direct discharge of concentrated flow shall be pretreated.

CONSTRUCTION CONSIDERATIONS

- The inflow should be directed towards the upstream end of the swale but should occur evenly over the swale.
- Swales that directly receive runoff from impervious surfaces may have a six inch drop onto a protected shelf of pea gravel to minimizing the clogging of the inlet.
- Excavation should be performed in undisturbed areas.
- No underdrain system should be used.

LANDSCAPING REQUIREMENTS

- Landscape design should specify proper grass species and wetland plants based on the specific site, soils and hydric conditions present along the channel.
- A permeable soil mixture 30”-30” deep should meet the bioretention “planting” soil specifications listed in the Bioretention section.
- Seed should be flood and drought resistant grasses.

MAINTENANCE AND INSPECTIONS

- Swales should be mowed as required during the growing season to maintain heights in the 4-6 inch range.
- Sediment buildup in the bottom of the swale shall be removed when 25% of the original water quality volume has been exceeded.
- Swales with wetland vegetation or other low maintenance ground cover do not require frequent mowing of the channel.

LIMITATIONS

- The seasonally high water table may inundate the swale, but not above the bottom of the channel.
- No gravel or perforated pipe shall be placed under driveways.
- Not recommended for residential developments since they can create potential nuisance or mosquito breeding conditions.

This page intentionally left blank.

INFILTRATION TRENCH

DESCRIPTION & PURPOSE

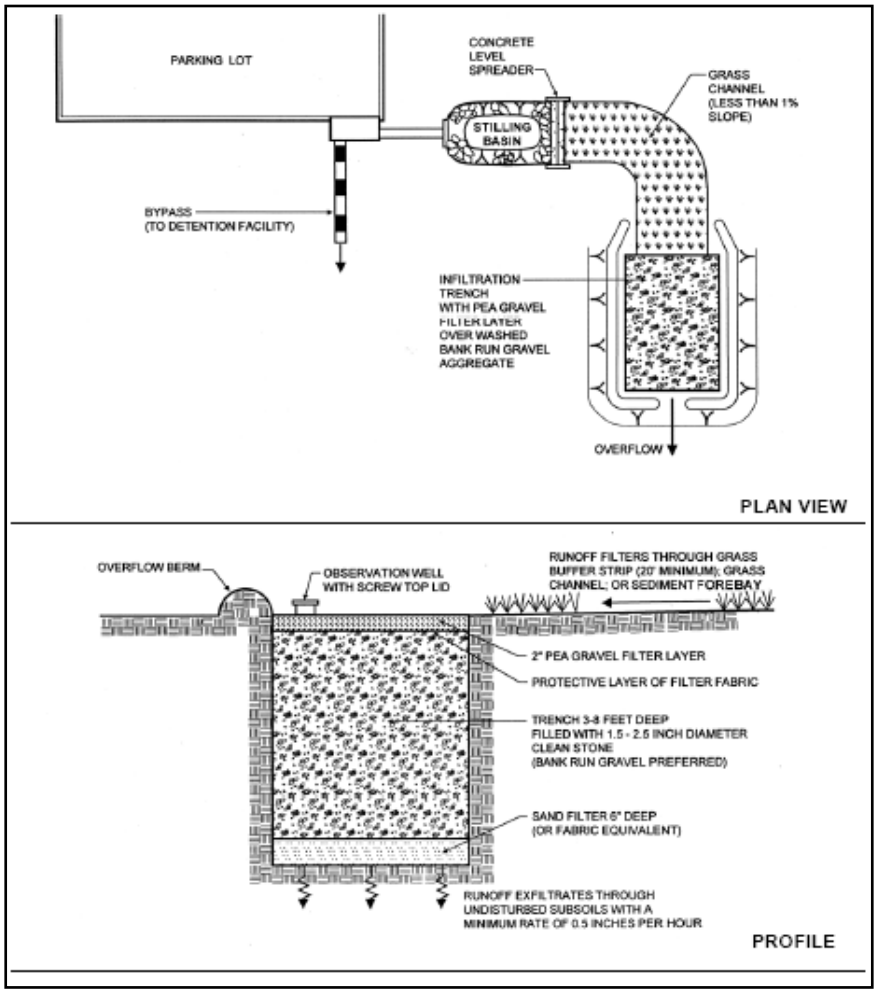
The infiltration trench provides recharge and water quality volume in one location.

APPLICATIONS

Infiltrated storm water shall be infiltrated through soils capable of filtering prior to entering groundwater.
Other suitable media filters pollutants that are accompanied by a certification from a licensed civil engineer that the filter/device will remove 80 percent of total suspended solids from the design flow rate are also acceptable. Infiltration shall only be used where soil conditions and slope stability are suitable.

DESIGN CRITERIA

- A porosity value “n” (n=Vv/Vt) of 0.40 should be used in the design of stone reservoirs for infiltration methods.
- Required volume is based on a rainfall intensity of 0.4 inches per hour.
- WQFR: C*0.4”*A is the Water Quality Flow Rate (cfs).
- C is the runoff coefficient, calculated using tables.
- 0.4 inches is the hourly rainfall intensity.
- A is the site area in acres.
- Groundwater shall be protected from possible contamination by avoiding potential storm water areas.
- The bottom of the facility shall be separated by at least 4’ (vertically) from the seasonally high water table or bedrock layer.
- Facilities shall be located at least 100 feet from any water supply well.
- Facilities shall have a maximum contributing area of five acres.
- The facility should not be placed in locations that cause water problems to downgrade properties and should be setback (25’) downgrade from structures
- All trenches shall be designed to fully de-water the entire water quality volume within 48 hours after the storm event.
- Adequate storm water outfalls shall be provided for the overflow associated with the ten-year design storm event.
- Since the trench will be located “off-line” from the main conveyance system, a flow splitter will be required to divert the water quality volume into the filter



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- A minimum of 25% of the water quality volume is to be pretreated in the stilling basin prior to entering the facility.
- Exit velocities shall be non-erosive during the two year design storm.
- Long-term techniques for infiltration protection (2 per trench):
    - Grass channel;
    - Grass filter strip (minimum 20 feet and only if sheet flow is established and maintained);
    - Bottom sand layer;
    - Upper sand layer (6 inches minimum) with filter fabric at sand/gravel interface; and
    - Washed bank run gravel used as aggregate.

CONSTRUCTION CONSIDERATIONS

- Phases of trench construction shall be coordinated with the overall project construction schedule.
- Rough excavation and rough grading phases of construction should be scheduled together to permit the exchange of cut and fill. The partially excavated trench **CANNOT** serve as a sedimentation basin.
- Trench construction specifications should state:
    - The earliest point in progress when storm drainage may be directed to the trench; and
    - The means by which the delay will be accomplished.
- Initial trench excavation should be carried to within 2 feet of the final elevation of the trench floor.
- Final excavation to the final grade should be done after all disturbed areas in the watershed area stabilized or protected.
- Final phase excavation should remove all accumulated sediment.
- Light tracked equipment is recommended to avoid compaction in the trench.
- After the completion of final grading, the trench should be well-aerated and have a highly porous surface texture.
- Trenches may be lined with a 6 to 12 inch layer of filter material, such as coarse sand to help prevent the buildup of impervious deposits. The filter layer can be replaced or cleaned when clogged.
- Establish dense vegetation on trench side slopes and floor, preventing erosion, sloughing, and a natural means of maintaining high infiltration rates.
- Use NRCS requirements for vegetative materials for side slopes and other areas to be vegetated.
- Fescue family grasses are recommended for seeding.

LANDSCAPING REQUIREMENTS

- Dense and vigorous vegetative cover is to be established over the contributing pervious drainage areas before runoff can be accepted into the facility. Infiltration trenches are not to be constructed until all of the contributing drainage areas have been completely stabilized.

MAINTENANCE AND INSPECTIONS

- Are not to serve as a sediment control device during site construction.
- Erosion and sediment plans for the site must clearly indicate methods that will prevent sediment from entering the infiltration device.
- Recommended that infiltration designs include dewatering methods such as underdrain pipe systems to accommodate drawdown in the event of a failure.
- Direct access provided to all infiltration practices for maintenance and rehabilitation.
- Should not be covered by an impermeable surface.

LIMITATIONS

- Often best used with other BMPs downstream.
- Underlying soils shall have specific infiltration rates to be tested with geotechnical borings.
- Soils shall have a clay content of less than 20% and a silt/clay content of less than 40%.
- Infiltration cannot be located on slopes greater than 15% or within fill soils.

INFILTRATION BASIN

DESCRIPTION & PURPOSE

Water quality volume is retained in an infiltration basin, where it percolates through the basin in a 2 day period. The facility must be able to completely treat the flow rate as determined from storm water quality control flow rate charts. Flows above this rate can either be by-passed, or routed through the facility if it can be demonstrated that velocities will not re-entrain captured pollutants.

APPLICATIONS

Infiltrated storm water shall be infiltrated through soils capable of filtering prior to entering groundwater.

Other suitable media filters pollutants that are accompanied by a certification from a licensed civil engineer that the filter/device will remove 80 percent of total suspended solids from the design flow rate are also acceptable. Infiltration shall only be used where soil conditions and slope stability are suitable.

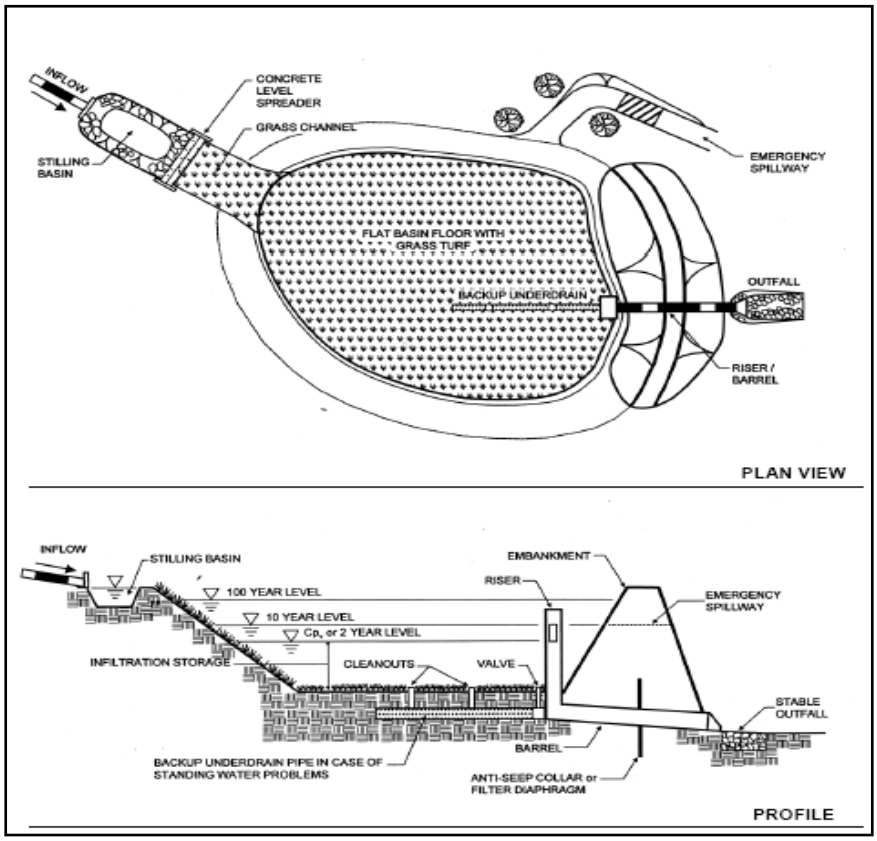
LIMITATIONS

- Often best used with other BMPs downstream.
- Underlying soils shall have specific infiltration rates to be tested with geotechnical borings.
- Soils shall have a clay content of less than 20% and a silt/clay content of less than 40%.
- Infiltration cannot be located on slopes greater than 15% or within fill soils.

DESIGN CRITERIA

- A porosity value “n” (n=Vv/Vt) of 0.40 should be used in the design of stone reservoirs for infiltration methods.
- Required volume is based on a rainfall intensity of 0.4 inches per hour.
- WQFR: C*0.4”*A is the Water Quality Flow Rate (cfs).
- C is the runoff coefficient, calculated using tables.
- 0.4 inches is the hourly rainfall intensity.
- A is the site area in acres.

- Groundwater shall be protected from possible contamination by avoiding potential storm water areas.
- The bottom of the facility shall be separated by at least 4’ (vertically) from the seasonally high water table or bedrock layer.
- Facilities shall be located at least 100 feet from any water supply well.
- Facilities shall have a maximum contributing area of five acres.
- The facility should not be placed in locations that cause water problems to downgrade properties and should be setback 25’ downgrade from structures.
- All basins shall be designed to fully de-water the entire water quality volume within 48 hours after the storm event.
- Adequate storm water outfalls shall be provided for the overflow associated with the ten-year design storm event.



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- A minimum of 25% of the water quality volume is to be pretreated in the stilling basin prior to entering the facility.
- Exit velocities shall be non-erosive during the two year design storm.
- Long-term techniques for infiltration protection (2 per basin)
    - Grass channel;
    - Grass filter strip (minimum 20 feet and only if sheet flow is established and maintained);
    - Bottom sand layer;
    - Upper sand layer (6 inches minimum) with filter fabric at sand/gravel interface; and
    - Washed bank run gravel used as aggregate.

CONSTRUCTION CONSIDERATIONS

- Phases of basin construction shall be coordinated with the overall project construction schedule.
- Rough excavation and rough grading phases of construction should be scheduled together to permit the exchange of cut and fill. The partially excavated basin **CANNOT** serve as a sedimentation basin.
- Basin construction specifications should state:
    - The earliest point in progress when storm drainage may be directed to the basin; and
    - The means by which the delay will be accomplished.
- Initial basin excavation should be carried to within 2 feet of the final elevation of the basin floor.
- Final excavation to the final grade should be done after all disturbed areas in the watershed area stabilized or protected.
- Final phase excavation should remove all accumulated sediment.
- Light tracked equipment is recommended to avoid compaction in the basin.
- After the completion of final grading, the basin should be well-aerated and have a highly porous surface texture.
- Basins may be lined with a 6 to 12 inch layer of filter material, such as coarse sand to help prevent the buildup of impervious deposits. The filter layer can be replaced or cleaned when clogged.
- Establish dense vegetation on basin side slopes and floor, preventing erosion, sloughing, and a natural means of maintaining high infiltration rates.
- Use NRCS requirements for vegetative materials for side slopes and other areas to be vegetated.
- Fescue family grasses are recommended for seeding.

LANDSCAPING REQUIREMENTS

- Dense and vigorous vegetative cover is to be established over the contributing pervious drainage areas before runoff can be accepted into the facility. Infiltration trenches are not to be constructed until all of the contributing drainage areas have been completely stabilized.

MAINTENANCE AND INSPECTIONS

- Are not to serve as a sediment control device during site construction.
- Erosion and sediment plans for the site must clearly indicate methods that will prevent sediment from entering the infiltration device.
- Recommended that infiltration designs include dewatering methods such as underdrain pipe systems to accommodate drawdown in the event of a failure.
- Direct access provided to all infiltration practices for maintenance and rehabilitation.
- Should not be covered by an impermeable surface.

BIORETENTION

DESCRIPTION & PURPOSE

Bioretention combines open space with storm water treatment in vegetated areas where runoff is directed through vegetation and soils for filtration. It captures and temporarily stores the water quality volume and passes it through a filter bed of sand, organic matter, soil, or other media.

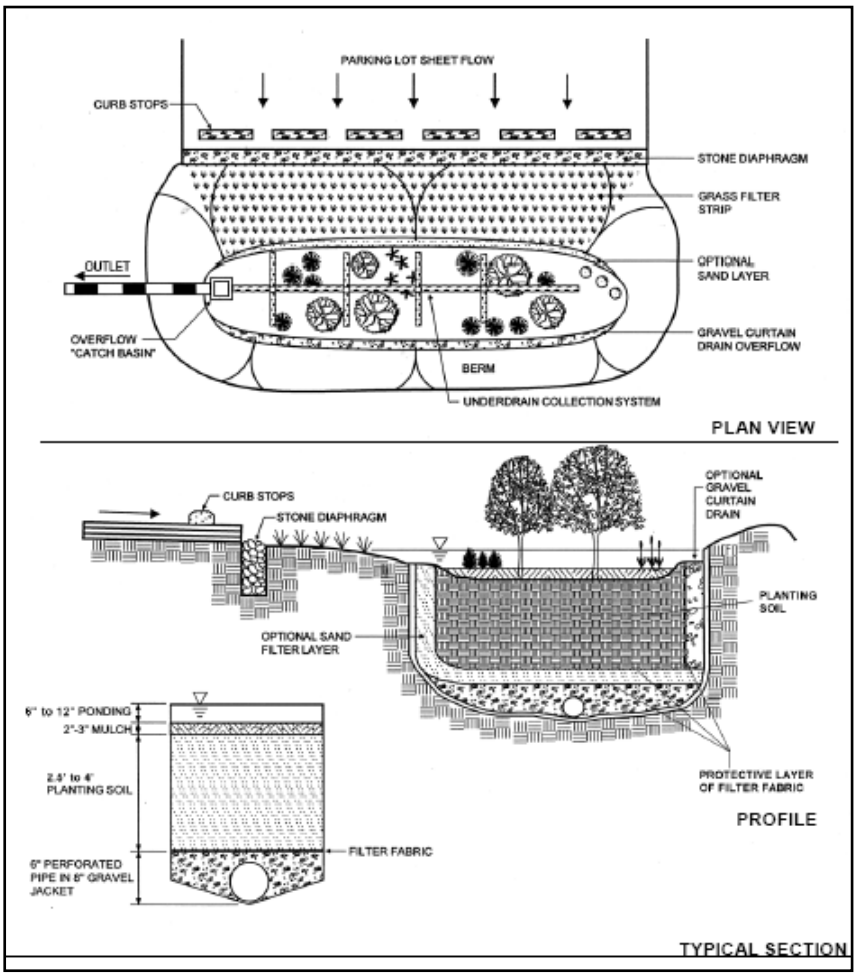
APPLICATIONS

Filtered runoff may be collected and returned to the conveyance system or allowed to partially exfiltrate into the soil.

DESIGN CRITERIA

- A porosity value "n" (n=Vv/Vt) of 0.40 should be used in the design of stone reservoirs for infiltration methods.
- Required volume is based on a rainfall intensity of 0.4 inches per hour.
- WQFR: C*0.4"*A is the Water Quality Flow Rate (cfs).
- C is the runoff coefficient, calculated using tables.
- 0.4 inches is the hourly rainfall intensity.
- A is the site area in acres.
- The required filter bed area (Af) is computed using the following equation:

  Af= (WQv) (df) / [(k) (hf+df) (tf)]
  - WQv is the water quality volume (cu. ft);
  - df is the filter bed depth (ft);
  - k is the coefficient pf permeability of the filter bed (ft/day);
  - hf is the height of water above the filter bed (ft); and
  - tf is the design filter bed drain time (days)- 2 days recommended.



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Pretreatment is provided when all of the following are provided:
  - 20’ grass filter strip below a level spreader or sand filter layer;
  - Gravel diaphragm; and
  - Mulch layer.
- Treatment components shall include:
  - 2 ½ to 4 foot deep planting soil bed;
  - Surface mulch layer; and
  - 12 inches deep surface ponding area.

CONSTRUCTION CONSIDERATIONS

- Overflow for the ten-year storm event shall be provided to a non-erosive outlet point and non-erosive velocities shall result.

- A flow regulator shall be provided to divert the water quality volume to the filtering practice.
- The filters shall have a 6 inch perforated underdrain pipe in a gravel layer.
- A permeable filter fabric shall be places between the gravel layer and the filter media.

LANDSCAPING REQUIREMENTS

- Landscaping is critical to the function and performance of the bioretention areas. A landscaping plan shall be provided for these areas.
- Planting recommendations:
    - Native plant species;
    - Select vegetation based on the zone of hydric tolerance;
    - Trees with an understory of shrubs and herbaceous materials should be selected; and
    - Woody vegetation should not be used at inflow locations.
- The ponding depth should be 6 inches or less with a mulch layer of 2 to 3 inches.
- A sandy planting soil of 2 to 3 inches should be used.
- Dense and vigorous vegetation should be established over the contributing drainage area before accepting runoff into the facility.

MAINTENANCE AND INSPECTIONS

- Direct maintenance access is to be provided to the pretreatment area and the filter bed.
- At least a six inch drop shall be provided at the inlet of the facility (stone diaphragm).
- Dead or diseased plants shall be replaced.
- Areas with mulch that has been washed out should be re-mulched annually.

LIMITATIONS

- Unless there is adequate infiltration capacity, underdrains and overflow drains should be included to collect and discharge filtered runoff to the storm drainage system.

This page intentionally left blank.

SHALLOW WETLAND

DESCRIPTION & PURPOSE

Shallow wetlands provide water quality volume in a shallow pool that has a large surface area.

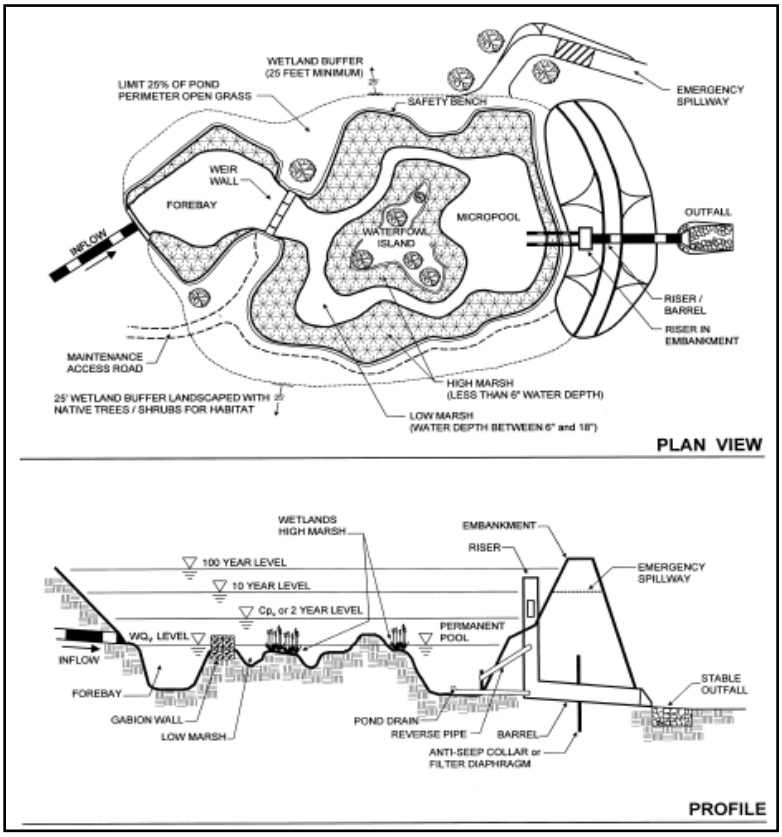
APPLICATIONS

Practices that create shallow wetland areas to treat urban storm water and often incorporate small permanent pools and/or extended detention storage to achieve the full water quality volume.

DESIGN CRITERIA

- Required volume based on the 1-inch storm.
- C=0.05+0.009*IMP is the runoff coefficient.
- IMP is the percentage of impervious area.
- WQDV=C*1”*A*3630 (Water Quality Design Volume (cf)).
- C is the runoff coefficient.
- 1 inches is the 1-inch storm.
- A is the area of the site in acres.
- 3630 is a conversion factor.
- The volume must meet minimum detention times.
- Flowpaths from inflow points to outflow points within storm water wetlands shall be maximized.
- Flowpaths of 1.5:1 (L:W) and irregular shapes are recommended and achieved by constructing internal berms.
- Microtopography is encouraged to enhance diversity in the wetland.
- Surface area shall be at least 1.5 percent of the total drainage area to the facility.
- At least 25% of the total water quality volume shall be in deepwater zones with a minimum depth of four feet. This may be reduced if the wetland is located where thermal impacts area a primary concern.
- A minimum of 35% of the total surface area shall have a depth of 6 inches or less.
- At least 65% of the total surface area shall be shallower than 18 inches.
- If using extended detention, the extended detention volume shall not comprise more than 50% of the total wetland design. Maximum surface elevation shall not extend more than 3 feet above the normal pool.

- In order to promote greater nitrogen removal, rock beds may be used as a medium for growth of wetland plants. Rock should be 1-3 inches in diameter and placed up to the normal pool elevation. Rock beds should be open to flow-through from either direction.



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Sediment regulation is critical for sustaining storm water wetlands.
- Sediment forebay:
  - Located at the inlet and the micropool shall be located at the inlet;
  - Micropool located at the outlet; and
  - Forebay shall be sized to contain 0.1 inches per impervious acre of contributing drainage. The storage in the forebay counts toward the total amount of water quality volume required to be treated.
- Micropool is a 3-6 foot deep pool used to protect the low flow pipe from clogging and prevent sediment resuspension.
- Exit velocities shall be non-erosive.

CONSTRUCTION CONSIDERATIONS

- The wetland bed should be graded to create maximum internal flowpaths and microtopography.

LANDSCAPING REQUIREMENTS

- Landscaping plans shall be provided that indicate methods used to establish and maintain wetland coverage.
- Minimum plan elements include:
    - Delineation of pondscaping zones;
    - Selection of corresponding plant species;
    - Planting configuration; and
    - Sequence for preparing wetland bed.
- Landscaping plans for Use III and IV watersheds should incorporate plant species and plants found in wooded wetlands.
- Fascines, coconut rolls, or straw bales can be used in high energy areas of the storm water wetland to create shallow marsh cells.
- Landscaping plans should promote greater wildlife and waterfowl use within the watershed.
- A wetland buffer should extend 25 feet outward from the maximum water surface elevation with an additional 15 foot setback to structures.

MAINTENANCE AND INSPECTIONS

- If a minimum coverage of 50% is not achieved in the planted wetland zones after the second growing season, a reinforcement planting will be required.
- Storm water wetlands are created in upland areas and away from jurisdictional wetlands and are not regulated by state and federal laws as long as regular maintenance is performed.

LIMITATIONS

- A water balance must be performed to demonstrate that a wetland can withstand a thirty day drought at summer evaporation rates without completely drawing down.
- Storm water wetlands may not be located within jurisdictional waters, including wetlands without obtaining a wetlands and waterways permit from the state.
- Use III watersheds may require a small pond review and approval from dam safety in wetlands that include permanent ponds as design components.

This page intentionally left blank.

POCKET WETLAND

DESCRIPTION & PURPOSE

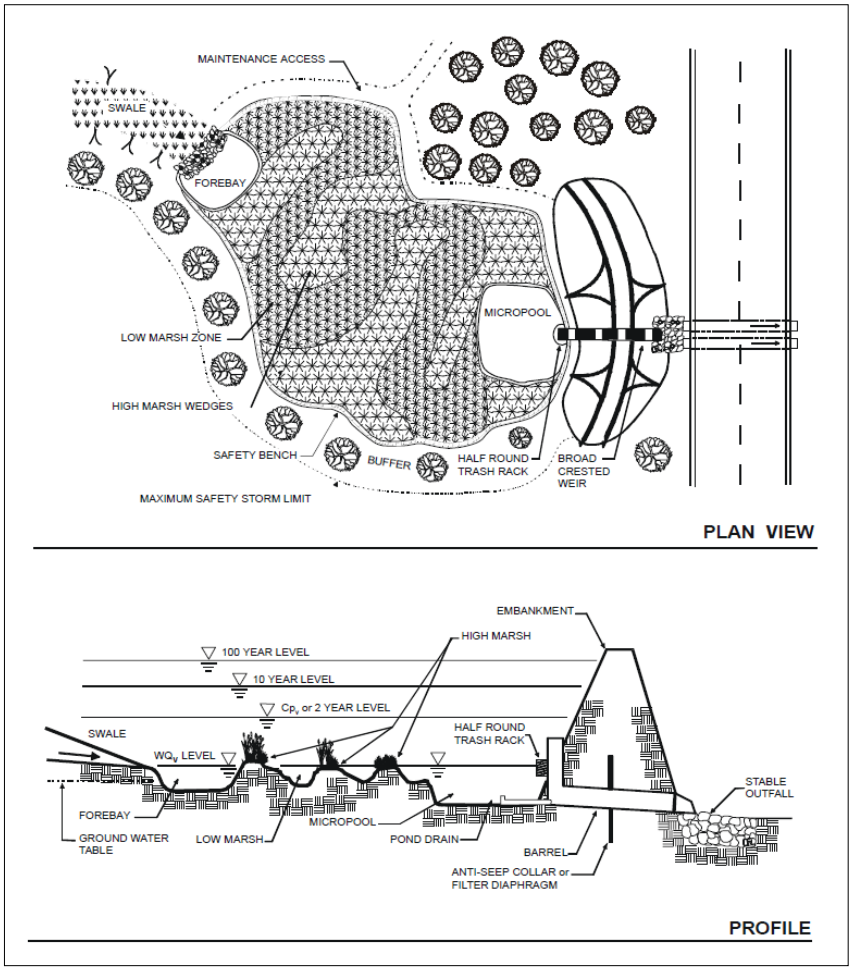
A high water table or groundwater interception helps maintain the shallow wetland pool in the pocket wetland.

APPLICATIONS

Practices that create wetland areas to treat urban storm water and often incorporate small permanent pools and/or extended detention storage to achieve the full water quality volume.

DESIGN CRITERIA

- Required volume based on the 1-inch storm.
- C=0.05+0.009*IMP is the runoff coefficient.
- IMP is the percentage of impervious area.
- WQDV=C*1”*A*3630 (Water Quality Design Volume (cf)).
- C is the runoff coefficient.
- 1 inches is the 1-inch storm.
- A is the area of the site in acres.
- 3630 is a conversion factor.
- The volume must meet minimum detention times.
- Flowpaths from inflow points to outflow points within storm water wetlands shall be maximized.
- Flowpaths of 1.5:1 (L:W) and irregular shapes are recommended and achieved by constructing internal berms.
- Microtopography is encouraged to enhance diversity in the wetland.
- Surface area shall be at least one percent of the total drainage area to the facility.
- At least 25% of the total water quality volume shall be in deepwater zones with a minimum depth of four feet. This may be reduced if the wetland is located where thermal impacts area a primary concern.
- A minimum of 35% of the total surface area shall have a depth of 6 inches or less.
- At least 65% of the total surface area shall be shallower than 18 inches.
- If using extended detention, the extended detention volume shall not comprise more than 50% of the total wetland design. Maximum surface elevation shall not extend more than 3 feet above the normal pool.
- In order to promote greater nitrogen removal, rock beds may be used as a medium for growth of wetland plants. Rock should be 1-3 inches in diameter and placed up to the normal pool elevation. Rock beds should be open to flow-through from either direction.



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Sediment regulation is critical for sustaining storm water wetlands.
- Sediment forebay:
  - Located at the inlet and the micropool shall be located at the inlet;
  - Micropool located at the outlet; and
  - Forebay shall be sized to contain 0.1 inches per impervious acre of contributing drainage. The storage in the forebay counts toward the total amount of water quality volume required to be treated.
- Micropool is a 3-6 foot deep pool used to protect the low flow pipe from clogging and prevent sediment resuspension.
- Exit velocities shall be non-erosive.

CONSTRUCTION CONSIDERATIONS

- The wetland bed should be graded to create maximum internal flowpaths and microtopography.

LANDSCAPING REQUIREMENTS

- Landscaping plans shall be provided that indicate methods used to establish and maintain wetland coverage.
- Minimum plan elements include:
    - Delineation of pondscaping zones;
    - Selection of corresponding plant species;
    - Planting configuration; and
    - Sequence for preparing wetland bed.
- Landscaping plans for Use III and IV watersheds should incorporate plant species and plants found in wooded wetlands.
- Fascines, coconut rolls, or straw bales can be used in high energy areas of the storm water wetland to create shallow marsh cells.
- Landscaping plans should promote greater wildlife and waterfowl use within the watershed.
- A wetland buffer should extend 25 feet outward from the maximum water surface elevation with an additional 15 foot setback to structures.

MAINTENANCE AND INSPECTIONS

- If a minimum coverage of 50% is not achieved in the planted wetland zones after the second growing season, a reinforcement planting will be required.
- Storm water wetlands are created in upland areas and away from jurisdictional wetlands and are not regulated by state and federal laws as long as regular maintenance is performed

LIMITATIONS

- A water balance must be performed to demonstrate that a wetland can withstand a thirty day drought at summer evaporation rates without completely drawing down.
- Storm water wetlands may not be located within jurisdictional waters, including wetlands without obtaining a wetlands and waterways permit from the state.
- Use III watersheds may require a small pond review and approval from dam safety in wetlands that include permanent ponds as design components.

This page intentionally left blank.

WET EXTENDED DETENTION POND

DESCRIPTION & PURPOSE

Water quality storage is provided through a combination of permanent pool and extended detention storage.

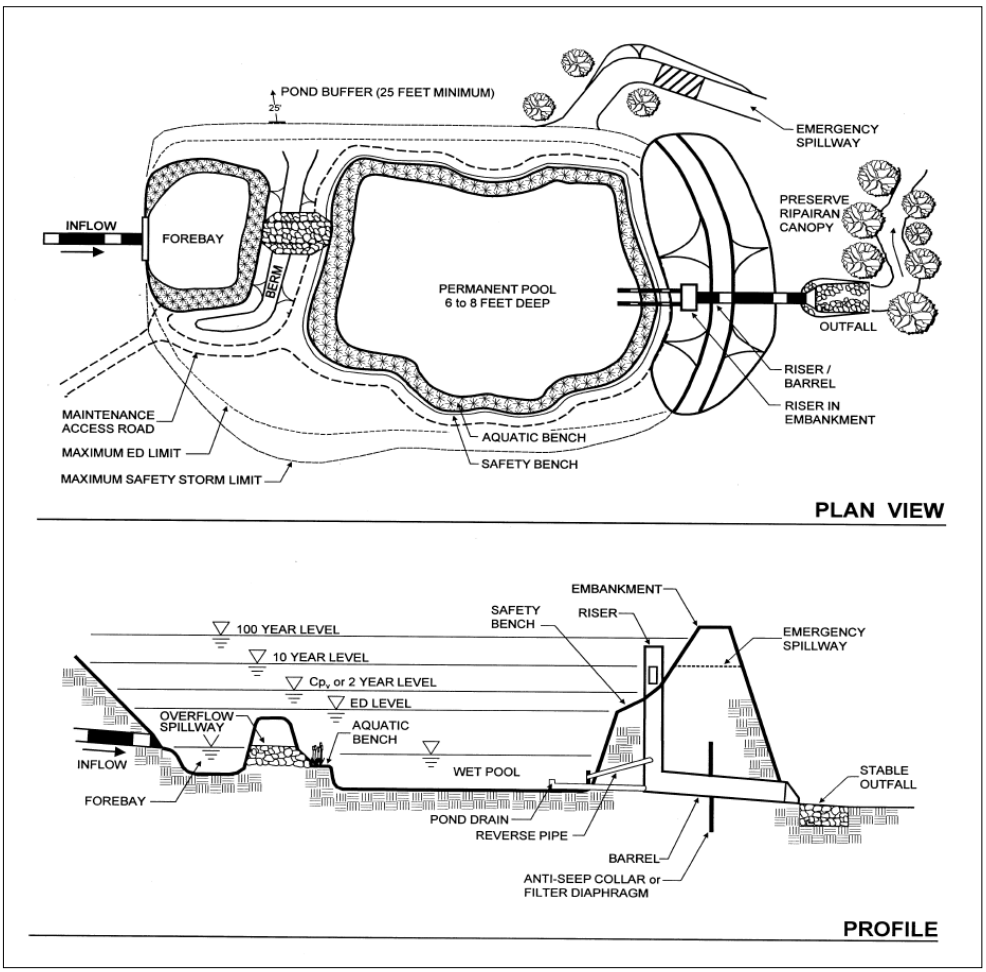
APPLICATIONS

Detention of storm water runoff allows for the settling of fine particles and pollutants that are associated with these particles.

DESIGN CRITERIA

- Required volume based on the 1-inch storm.
- C=0.05+0.009*IMP is the runoff coefficient.
- IMP is the percentage of impervious area.
- WQDV=C*1”*A*3630 (Water Quality Design Volume (cf))
    - C is the runoff coefficient;
    - 1 inches is the 1-inch storm;
    - A is the area of the site in acres; and
    - 3630 is a conversion factor
- The volume must meet minimum detention times.
- The draw-down time for the detention volume shall be greater than or equal to 48 hours. For the bottom half of the detention volume, the draw-down time shall be greater than or equal to 36 hours.
- The detention system shall be designed to maximize the distance between the inlet and outlet, and to minimize “dead spaces” (areas with little or no exchange occurs during a storm event), limiting short-circuiting. A minimum flow path length to width ratio of 3 should be utilized.
- The outlet shall be sized to achieve the above required detention times. It shall also be large enough that clogging is unlikely to occur. It should be 4 inches or larger in diameter. If this is not possible, the use of flow-through based measures should be considered, unless it can be demonstrated that clogging can be avoided.
- There shall be a minimum contributing drainage area of ten acres or more unless groundwater ground water is the primary water source.
- The ten year design storm is to be used to design for a stable outfall.
- Dams shall meet class A dam safety hazard classification.
- The principal spillway/riser shall provide anti-floatation, anti-vortex, and trash-rack designs.

- One foot of freeboard shall be provided above the design high water for the 10 year storm.
- Woody vegetation is prohibited on the embankment.
- Pond benches:
    - The safety bench extends outward from the normal water edge to the toe of the pond side slope. Maximum slope=6%; and
    - Aquatic bench extends inward from the normal shoreline and has a maximum depth of 18 inches below normal pool water surface elevation. Not required in forebays.
- Pond buffers and setbacks:
    - Buffer should be provided that extends 25 feet outward from the maximum water surface elevation of the pond and should be contiguous with other required buffer areas; and
    - Existing trees should be preserved during construction and forest conservation areas should be located.
- Non-clogging low flow orifice:
    - Shall have a minimum diameter of 3 inches and shall be adequately protected from clogging by an external trash rack;
    - Orifice diameter can be reduced to 1 inch if using an internal orifice;
    - Submerged reverse-slope pipe that extends downward from the riser to an inflow point one foot below normal pool elevation is preferred;
    - Alternatives include broad crested rectangular, v-notch, or proportional weird, protected by half-round CMP that extends 12 inches below permanent pool;
    - Horizontal perforated pipe protected by geotextile and gravel not recommended; and
    - Vertical pipes can be used if a permanent pool is present.
- Riser:
    - Shall be located within the embankment for maintenance access, safety and aesthetics;
    - Access to riser to be provided by lockable manhole covers and steps within reach of valves and controls; and
    - Openings should be fenced with pipe or rebar to prevent trash accumulation.
- Pond Drain:
    - Ponds shall have a drain pipe that can drain the pond within 24 hours;
    - Prevent downstream discharge of sediment and slope instability caused by drawdown by exercising care during these processes; and
    - Appropriate jurisdictions shall be notified before draining a pond.
- Valves:
    - Drain shall be equipped with adjustable valve;
    - Drain should be sized one pipe size larger than the calculated design diameter;
    - Controls should be located inside of the riser they will not be inundated and can be operated safely; and
    - Handwheel shall be chained to a ringbolt or manhole step to prevent vandalism.



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Sediment forebay:
  - Each pond shall have a sediment forebay or equivalent upstream treatment and shall consist of a separate cell, formed by an adequate barrier; and
  - Forebay shall be sized to contain 0.1 inches per impervious acre of contributing drainage. The storage in the forebay counts toward the total amount of water quality volume required to be treated.
- Exit velocities shall be non-erosive.
- The bottom may be hardened to make sediment removal easier.
- The fixed vertical sediment depth marker should be installed to measure sediment deposition over time.

CONSTRUCTION CONSIDERATIONS

- Inlet protection shall not be fully submerged at normal pool elevations.
- A forebay shall be provided at each inlet, unless the inlet provides less than 10% of the total design storm inflow to the pond.
- Flared pipe sections that discharge at or near the stream invert or into a step-pool arrangement should be used at the spillway outlet.
- The channel immediately below the pond outfall shall be modified to prevent erosion and conform to natural dimensions in the shortest possible distance, usually by the use of large riprap over filter cloth.
- A stilling basin or other outlet protection should be used to reduce flow velocities form the principal spillway to non-erosive.
- In ponds that daylight to channels with dry weather flow, tree clearing should be minimized along the downstream channel. Avoiding the excessive use of riprap is important to prevent stream warming.
- Pond liners should be used in areas of karst topography, gravelly sands or fractured bedrock.

LANDSCAPING REQUIREMENTS

- The landscaping plan for storm water ponds and its buffer shall indicate how aquatic and terrestrial areas will be vegetatively stabilized and established.
- Wetland plants are encouraged either along the aquatic bench, safety bench and side slopes, or within shallow areas of the pool. The best elevations for establishing these plants are within six inches of the normal pool.
- It is advised to excavate large and deep holes around the proposed planting sites and backfill with uncompacted topsoil.
- Planting holes should be at least six inches larger than the diameter of the rootball (balled and burlap stock) and three inches wider for container grown stock.
- Avoid species requiring full shade which are prone to wind damage.
- Extra mulching around the base is strongly recommended to conserve moisture and prevent weeds.

MAINTENANCE AND INSPECTIONS

- Maintenance responsibility for the pond and its buffer shall be given to a responsible party by means of a legally binding and enforceable maintenance agreement.
- The principal spillway shall be equipped with a trash rack that has maintenance access.
- Sediment removal in the forebay shall take place when 50% of the forebay capacity is lost.
- Sediment removed from ponds shall be disposed of according to current erosion and sediment control regulations.
- A maintenance right-of-way or easement at least 12 feet wide and a maximum slope of 15% and stabilized shall extend to a pond from a public or private road.

- Maintenance access should extend to the forebay, safety bench, riser, and outlet and should allow vehicles to turn around.
- Annual mowing of the buffer is only required on maintenance rights-of-way.

LIMITATIONS

- Although a detention system for water quality could be combined with a flood control system, the volume assigned for water quality control must meet minimum detention times. This volume will typically not be available for peak rate volume control.
- Ponds cannot be located within jurisdictional waters such as wetlands without obtaining proper permits.

This page intentionally left blank.

WET POND

DESCRIPTION & PURPOSE

A wet pond provides all of the water quality volume storage in a permanent pool.

APPLICATIONS

Detention of storm water runoff allows for the settling of fine particles and pollutants that are associated with these particles.

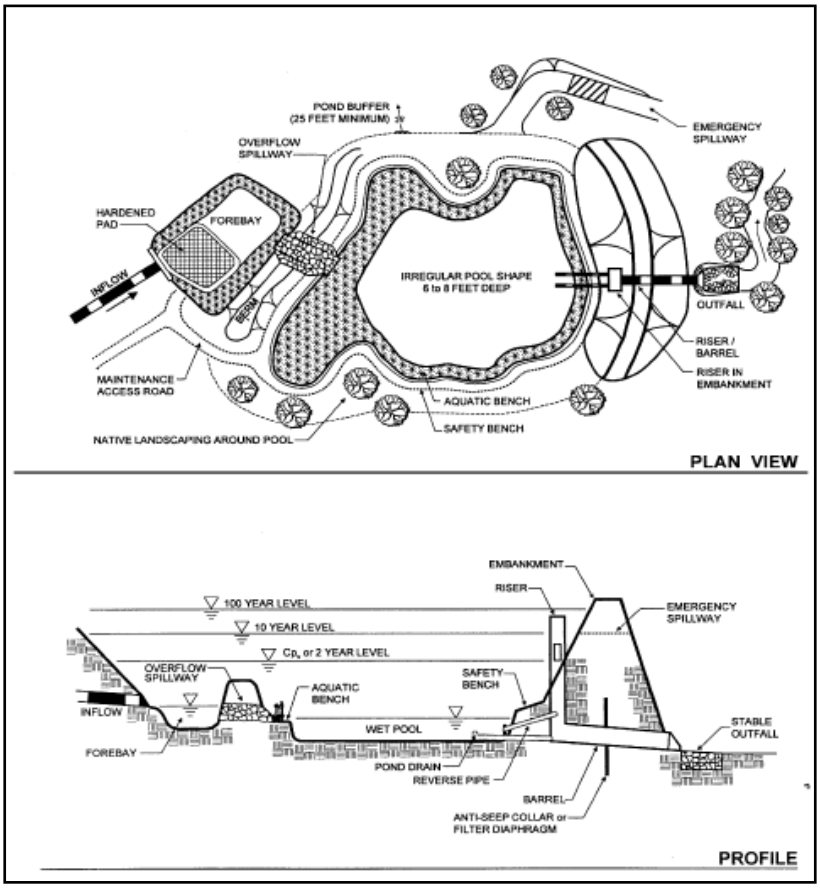
The wet pond volume is equal to the water quality design volume and is entirely a permanent wet pond, where storm water exchanges with the pond water to achieve treatment.

DESIGN CRITERIA

- Required volume based on the 1-inch storm.
- C=0.05+0.009*IMP is the runoff coefficient.
- IMP is the percentage of impervious area.
- WQDV=C*1”*A*3630 (Water Quality Design Volume (cf))
    - C is the runoff coefficient;
    - 1 inch is the 1-inch storm;
    - A is the area of the site in acres; and
    - 3630 is a conversion factor.
- Detention time requirements do not apply.
- The draw-down time for the detention volume shall be greater than or equal to 48 hours. For the bottom half of the detention volume, the draw-down time shall be greater than or equal to 36 hours.
- The detention system shall be designed to maximize the distance between the inlet and outlet, and to minimize “dead spaces” (areas with little or no exchange occurs during a storm event), limiting short-circuiting. A minimum flow path length to width ratio of 3 should be utilized.
- The outlet shall be sized to achieve the above required detention times. It shall also be large enough that clogging is unlikely to occur. It should be 4 inches or larger in diameter. If this is not possible, the use of flow-through based measures should be considered, unless it can be demonstrated that clogging can be avoided.
- There shall be a minimum contributing drainage area of ten acres or more unless groundwater ground water is the primary water source.
- The ten year design storm is to be used to design for a stable outfall.
- Dams shall meet class A dam safety hazard classification.

- The principal spillway/riser shall provide anti-floatation, anti-vortex, and trash-rack designs.
- One foot of freeboard shall be provided above the design high water for the 10 year storm.
- Woody vegetation is prohibited on the embankment.
- Pond benches:
    - The safety bench extends outward from the normal water edge to the toe of the pond side slope. Maximum slope=6%; and
    - Aquatic bench extends inward from the normal shoreline and has a maximum depth of 18 inches below normal pool water surface elevation. Not required in forebays.
- Pond buffers and setbacks:
    - Buffer should be provided that extends 25 feet outward from the maximum water surface elevation of the pond and should be contiguous with other required buffer areas; and
    - Existing trees should be preserved during construction and forest conservation areas should be located.
- Non-clogging low flow orifice:
    - Shall have a minimum diameter of 3 inches and shall be adequately protected from clogging by an external trash rack;
    - Orifice diameter can be reduced to 1 inch if using an internal orifice;
    - Submerged reverse-slope pipe that extends downward from the riser to an inflow point one foot below normal pool elevation is preferred;
    - Alternatives include broad crested rectangular, v-notch, or proportional weir, protected by half-round CMP that extends 12 inches below permanent pool;
    - Horizontal perforated pipe protected by geotextile and gravel not recommended; and
    - Vertical pipes can be used if a permanent pool is present.
- Riser:
    - Shall be located within the embankment for maintenance access, safety and aesthetics;
    - Access to riser to be provided by lockable manhole covers and steps within reach of valves and controls; and
    - Openings should be fenced with pipe or rebar to prevent trash accumulation.
- Pond Drain:
    - Ponds shall have a drain pipe that can drain the pond within 24 hours;
    - Prevent downstream discharge of sediment and slope instability caused by drawdown by exercising care during these processes; and
    - Appropriate jurisdictions shall be notified before draining a pond.
- Valves:
    - Drain shall be equipped with adjustable valve;
    - Drain should be sized one pipe size larger than the calculated design diameter;
    - Controls should be located inside of the riser they will not be inundated and can be operated safely;

- Handwheel shall be chained to a ringbolt or manhole step to prevent vandalism; and
- Applicant must show a water balance that demonstrates that there will be sufficient dry weather flows to maintain the planned pool volume, without creating stagnant conditions.



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Sediment forebay:
  - Each pond shall have a sediment forebay or equivalent upstream treatment and shall consist of a separate cell, formed by an adequate barrier; and
  - Forebay shall be sized to contain 0.1 inches per impervious acre of contributing drainage. The storage in the forebay counts toward the total amount of water quality volume required to be treated.
- Exit velocities shall be non-erosive.
- The bottom may be hardened to make sediment removal easier.
- The fixed vertical sediment depth marker should be installed to measure sediment deposition over time.

CONSTRUCTION CONSIDERATIONS

- Inlet protection shall not be fully submerged at normal pool elevations.
- A forebay shall be provided at each inlet, unless the inlet provides less than 10% of the total design storm inflow to the pond.
- Flared pipe sections that discharge at or near the stream invert or into a step-pool arrangement should be used at the spillway outlet.
- The channel immediately below the pond outfall shall be modified to prevent erosion and conform to natural dimensions in the shortest possible distance, usually by the use of large riprap over filter cloth.
- A stilling basin or other outlet protection should be used to reduce flow velocities form the principal spillway to non-erosive.
- In ponds that daylight to channels with dry weather flow, tree clearing should be minimized along the downstream channel. Avoiding the excessive use of riprap is important to prevent stream warming.
- Pond liners should be used in areas of karst topography, gravelly sands or fractured bedrock.

LANDSCAPING REQUIREMENTS

- The landscaping plan for storm water ponds and its buffer shall indicate how aquatic and terrestrial areas will be vegetatively stabilized and established.
- Wetland plants are encouraged either along the aquatic bench, safety bench and side slopes, or within shallow areas of the pool. The best elevations for establishing these plants are within six inches of the normal pool.
- It is advised to excavate large and deep holes around the proposed planting sites and backfill with uncompacted topsoil.
- Planting holes should be at least six inches larger than the diameter of the rootball (balled and burlap stock) and three inches wider for container grown stock.
- Avoid species requiring full shade which are prone to wind damage.
- Extra mulching around the base is strongly recommended to conserve moisture and prevent weeds.

MAINTENANCE AND INSPECTIONS

- Maintenance responsibility for the pond and its buffer shall be given to a responsible party by means of a legally binding and enforceable maintenance agreement.
- The principal spillway shall be equipped with a trash rack that has maintenance access.
- Sediment removal in the forebay shall take place when 50% of the forebay capacity is lost.
- Sediment removed from ponds shall be disposed of according to current erosion and sediment control regulations.
- A maintenance right-of-way or easement at least 12 feet wide and a maximum slope of 15% and stabilized shall extend to a pond from a public or private road.

- Maintenance access should extend to the forebay, safety bench, riser, and outlet and should allow vehicles to turn around.
- Annual mowing of the buffer is only required on maintenance rights-of-way.

LIMITATIONS

- Although a detention system for water quality could be combined with a flood control system, the volume assigned for water quality control must meet minimum detention times. This volume will typically not be available for peak rate volume control.
- Ponds cannot be located within jurisdictional waters such as wetlands without obtaining proper permits.

This page intentionally left blank.

7.2 NON-LID MANAGEMENT METHODS

Non-LID management methods for storm water control include many current proprietary and non-proprietary BMPs These BMPs include:

- Sand filters; and
- Proprietary BMPs:
  - Catch basin inserts;
  - Water quality inlets;
  - Oil/grit separators; and
  - Hydrodynamic devices.

Structural, hydrodynamic, and proprietary BMPs have not been studied as extensively as other BMPs described in this chapter but have been used with varying degrees of success. The intended functions of these products may vary widely. Some BMPs are designed to primarily remove solid waste and floatable trash while others use hydrodynamic separation techniques to separate sediment and oil/grease. Many of these BMP devices are not able to decrease Total Suspended Solids (TSS) and/or Total Phosphorus (TP) to meet water quality standards and some lack adequate independent testing data or long-term records. In some cases, these devices are used for pre-treatment or part of an overall storm water quality treatment system ("treatment train"). For example, they may be helpful in removing a portion of the pollutants present in storm water runoff before it enters storm water ponds or other LID practices.

DOT-HWYS does not endorse any specific Proprietary BMP described in this section. Designers working on DOT-HWYS projects are encouraged to consult with manufacturers, obtain independent performance testing data, and demonstrate how these devices will be utilized to meet both quantity and quality criteria.

This page intentionally left blank.

SURFACE SAND FILTER

DESCRIPTION & PURPOSE

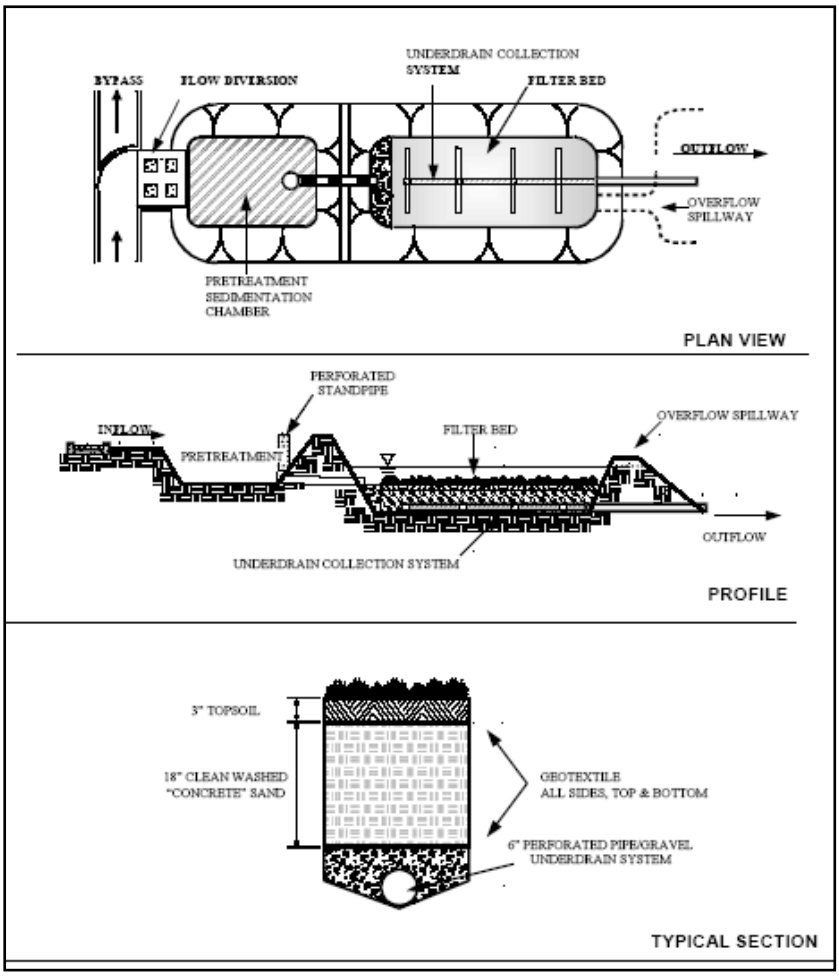
Surface sand filters can treat the largest drainage area of all the filtering systems. It captures and temporarily stores the water quality volume and passes it through a filter bed of sand, organic matter, soil, or other media.

APPLICATIONS

Filtered runoff may be collected and returned to the conveyance system or allowed to partially exfiltrate into the soil. Applied to land uses with a high percentage of impervious surfaces. Drainage areas with imperviousness less than 75% discharging to a filtering practice shall require full sedimentation pretreatment techniques.

DESIGN CRITERIA

- A porosity value "n" (n=Vv/Vt) of 0.40 should be used in the design of stone reservoirs for infiltration methods.
- Required volume is based on a rainfall intensity of 0.4 inches per hour.
- WQFR: C*0.4"*A is the Water Quality Flow Rate (cfs).
- C is the runoff coefficient, calculated using tables.
- 0.4 inches is the hourly rainfall intensity.
- A is the site area in acres.
- The required filter bed area (Af) is computed using the following equation:
  Af= (WQv) (df) / [(k) (hf+df) (tf)]
  - WQv is the water quality volume (cu. ft);
  - df is the filter bed depth (ft);
  - k is the coefficient pf permeability of the filter bed (ft/day);
  - hf is the height of water above the filter bed (ft); and
  - tf is the design filter bed drain time (days)- 2 days recommended.
- If runoff is delivered by a storm drain pipe or is along the main conveyance system, the filtering practice shall be designed off-line.
- Filter bed has a minimum depth of 12".



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Dry or wet pretreatment equivalent to at least 25% of the computed water quality volume shall be provided prior to the filter media.
- Typically, sedimentation basins with a length to width ratio of 2:1 are used.
- Pretreatment is provided when all of the following are provided:
    - 20’ grass filter strip below a level spreader or sand filter layer;
    - Gravel diaphragm; and
    - Mulch layer.
- Treatment components shall include:
    - 2 ½ to 4 foot deep planting soil bed;
    - Surface mulch layer; and
    - 12 inches deep surface ponding area.

CONSTRUCTION CONSIDERATIONS

- Overflow for the ten-year storm event shall be provided to a non-erosive outlet point and non-erosive velocities shall result.
- A flow regulator shall be provided to divert the water quality volume to the filtering practice.
- The filters shall have a 6 inch perforated underdrain pipe in a gravel layer.
- A permeable filter fabric shall be places between the gravel layer and the filter media.

LANDSCAPING REQUIREMENTS

- The ponding depth should be 6 inches or less with a mulch layer of 2 to 3 inches.
- A sandy planting soil of 2 to 3 inches should be used.
- Dense and vigorous should be established over the contributing drainage area before accepting runoff into the facility.
- A grass cover is permitted to aid in pollutant adsorption and should be cable of withstanding frequent periods of inundation and drought.

MAINTENANCE AND INSPECTIONS

- Direct maintenance access is to be provided to the pretreatment area and the filter bed.
- Dead or diseased plants shall be replaced.
- Areas with mulch that has been washed out should be re-mulched annually.
- The sediment chamber outlet devices shall be cleaned/repaired when drawdown times within the chamber exceed 36 hours. Trash and debris shall be removed as necessary.
- Sediment shall be cleaned out of the sedimentation chamber when it accumulates to a depth of more than 6 inches.
- Vegetation in the sediment chamber should be no greater than 18 inches in height.
- When water ponds on the surface of the filter for more than 72 hours, the top few inches of the discolored material shall be replaced with fresh material, and the removed sediment should be disposed of (landfill).
- When silt and sediment accumulation exceeds one inch, it should be removed from the filter bed.
- Filters with a grass cover should be mowed at least 3 times per growing season to maintain grass heights of less than 12 inches.

LIMITATIONS

Unless there is adequate infiltration capacity, underdrains and overflow drains should be included to collect and discharge filtered runoff to the storm drainage system.

This page intentionally left blank.

UNDERGROUND SAND FILTER

DESCRIPTION & PURPOSE

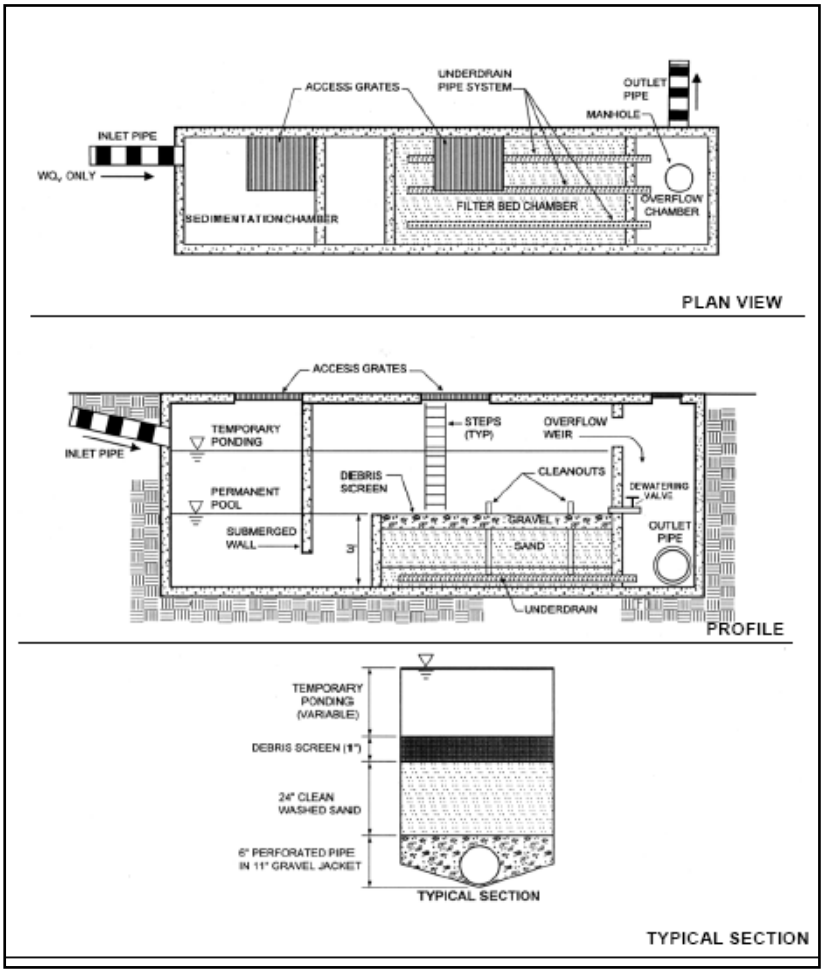
The underground sand filter is an option for providing water quality volume where space is limited.

APPLICATIONS

Filtered runoff may be collected and returned to the conveyance system or allowed to partially exfiltrate into the soil. Applied to land uses with a high percentage of impervious surfaces. Drainage areas with imperviousness less than 75% discharging to a filtering practice shall require full sedimentation pretreatment techniques.

DESIGN CRITERIA

- A porosity value “n” (n=Vv/Vt) of 0.40 should be used in the design of stone reservoirs for infiltration methods.
- Required volume is based on a rainfall intensity of 0.4 inches per hour.
- WQFR: C*0.4”*A is the Water Quality Flow Rate (cfs).
- C is the runoff coefficient, calculated using tables.
- 0.4 inches is the hourly rainfall intensity.
- A is the site area in acres.
- The required filter bed area (Af) is computed using the following equation:
  Af= (WQv) (df) / [(k) (hf+df) (tf)]
  - WQv is the water quality volume (cu. ft);
  - df is the filter bed depth (ft);
  - k is the coefficient pf permeability of the filter bed (ft/day);
  - hf is the height of water above the filter bed (ft); and
  - tf is the design filter bed drain time (days)- 2 days recommended
- If runoff is delivered by a storm drain pipe or is along the main conveyance system, the filtering practice shall be designed off-line.
- Filter bed has a minimum depth of 12”.



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Dry or wet pretreatment equivalent to at least 25% of the computed water quality volume shall be provided prior to the filter media.
- Typically, sedimentation basins with a length to width ratio of 2:1 are used.
- Pretreatment is provided when all of the following are provided:
    - 20’ grass filter strip below a level spreader or sand filter layer;
    - Gravel diaphragm; and
    - Mulch layer.
- Treatment components shall include:
    - 2 ½ to 4 foot deep planting soil bed;
    - Surface mulch layer; and
    - 12 inches deep surface ponding area.

CONSTRUCTION CONSIDERATIONS

- Overflow for the ten-year storm event shall be provided to a non-erosive outlet point and non-erosive velocities shall result.
- A flow regulator shall be provided to divert the water quality volume to the filtering practice.
- The filters shall have a 6 inch perforated underdrain pipe in a gravel layer.
- A permeable filter fabric shall be places between the gravel layer and the filter media.

LANDSCAPING REQUIREMENTS

- The ponding depth should be 6 inches or less with a mulch layer of 2 to 3 inches.
- A sandy planting soil of 2 to 3 inches should be used.
- Dense and vigorous should be established over the contributing drainage area before accepting runoff into the facility.

MAINTENANCE AND INSPECTIONS

- Direct maintenance access is to be provided to the pretreatment area and the filter bed.
- Dead or diseased plants shall be replaced.
- Areas with mulch that has been washed out should be re-mulched annually.
- The sediment chamber outlet devices shall be cleaned/repaired when drawdown times within the chamber exceed 36 hours. Trash and debris shall be removed as necessary.
- Sediment shall be cleaned out of the sedimentation chamber when it accumulates to a depth of more than 6 inches.
- Vegetation in the sediment chamber should be no greater than 18 inches in height.
- When water ponds on the surface of the filter for more than 72 hours, the top few inches of the discolored material shall be replaced with fresh material, and the removed sediment should be disposed of (landfill).
- When silt and sediment accumulation exceeds one inch, it should be removed from the filter bed.

LIMITATIONS

- Unless there is adequate infiltration capacity, underdrains and overflow drains should be included to collect and discharge filtered runoff to the storm drainage system.

This page intentionally left blank.

ORGANIC SAND FILTER

DESCRIPTION & PURPOSE

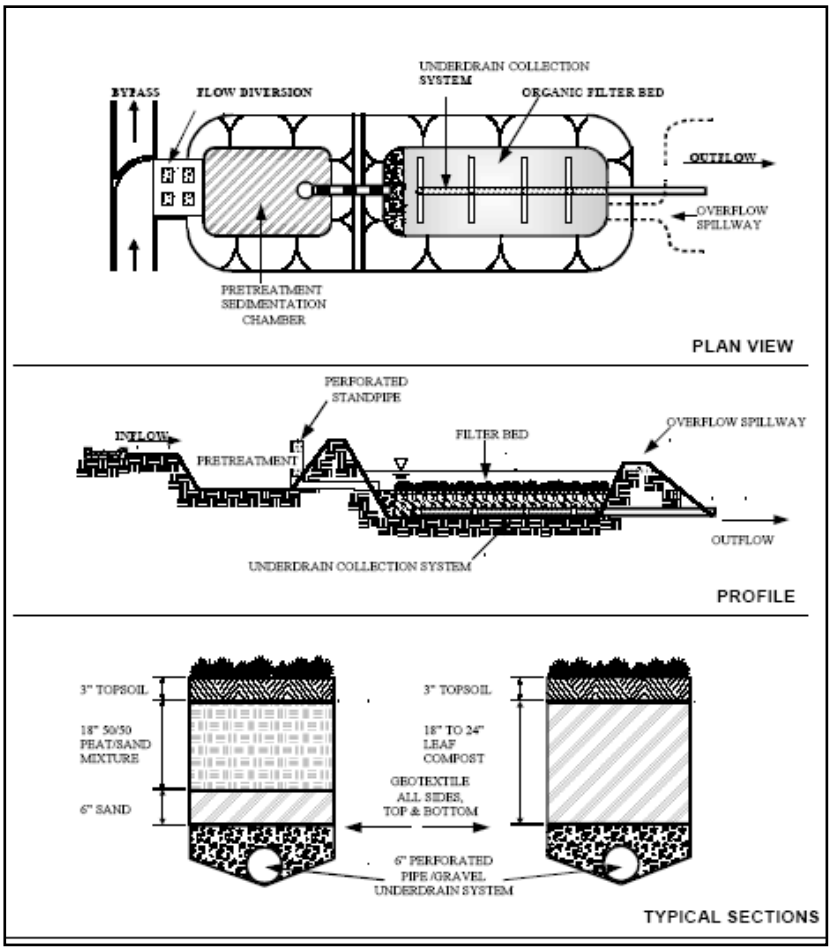
The organic filter is used when maximum nutrient or trace metal removals are desired.

APPLICATIONS

Filtered runoff may be collected and returned to the conveyance system or allowed to partially exfiltrate into the soil. Applied to land uses with a high percentage of impervious surfaces. Drainage areas with imperviousness less than 75% discharging to a filtering practice shall require full sedimentation pretreatment techniques.

DESIGN CRITERIA

- A porosity value "n" (n=Vv/Vt) of 0.40 should be used in the design of stone reservoirs for infiltration methods.
- Required volume is based on a rainfall intensity of 0.4 inches per hour.
- WQFR: C*0.4"*A is the Water Quality Flow Rate (cfs).
- C is the runoff coefficient, calculated using tables.
- 0.4 inches is the hourly rainfall intensity.
- A is the site area in acres.
- The required filter bed area (Af) is computed using the following equation:
  Af= (WQv) (df) / [(k) (hf+df) (tf)]
  - WQv is the water quality volume (cu. ft);
  - df is the filter bed depth (ft);
  - k is the coefficient pf permeability of the filter bed (ft/day);
  - hf is the height of water above the filter bed (ft); and
  - tf is the design filter bed drain time (days)- 2 days recommended.
- If runoff is delivered by a storm drain pipe or is along the main conveyance system, the filtering practice shall be designed off-line.
- Filter bed has a minimum depth of 12".



SOURCE: Maryland Department of the Environment 2000.

PRETREATMENT REQUIREMENTS

- Dry or wet pretreatment equivalent to at least 25% of the computed water quality volume shall be provided prior to the filter media.
- Typically, sedimentation basins with a length to width ratio of 2:1 are used.
- Pretreatment is provided when all of the following are provided:
    - 20’ grass filter strip below a level spreader or sand filter layer;
    - Gravel diaphragm; and
    - Mulch layer.
- Treatment components shall include:
    - 2 ½ to 4 foot deep planting soil bed;
    - Surface mulch layer; and
    - 12 inches deep surface ponding area.

CONSTRUCTION CONSIDERATIONS

- Overflow for the ten-year storm event shall be provided to a non-erosive outlet point and non-erosive velocities shall result.
- A flow regulator shall be provided to divert the water quality volume to the filtering practice.
- The filters shall have a 6 inch perforated underdrain pipe in a gravel layer.
- A permeable filter fabric shall be places between the gravel layer and the filter media.

LANDSCAPING REQUIREMENTS

- The ponding depth should be 6 inches or less with a mulch layer of 2 to 3 inches.
- A sandy planting soil of 2 to 3 inches should be used.
- Dense and vigorous should be established over the contributing drainage area before accepting runoff into the facility.
- A grass cover is permitted to aid in pollutant adsorption and should be cable of withstanding frequent periods of inundation and drought.

MAINTENANCE AND INSPECTIONS

- Direct maintenance access is to be provided to the pretreatment area and the filter bed.
- Dead or diseased plants shall be replaced.
- Areas with mulch that has been washed out should be re-mulched annually.
- The sediment chamber outlet devices shall be cleaned/repaired when drawdown times within the chamber exceed 36 hours. Trash and debris shall be removed as necessary.
- Sediment shall be cleaned out of the sedimentation chamber when it accumulates to a depth of more than 6 inches.
- Vegetation in the sediment chamber should be no greater than 18 inches in height.
- When water ponds on the surface of the filter for more than 72 hours, the top few inches of the discolored material shall be replaced with fresh material, and the removed sediment should be disposed of (landfill).
- When silt and sediment accumulation exceeds one inch, it should be removed from the filter bed.
- Filters with a grass cover should be mowed at least 3 times per growing season to maintain grass heights of less than 12 inches.

LIMITATIONS

- Unless there is adequate infiltration capacity, underdrains and overflow drains should be included to collect and discharge filtered runoff to the storm drainage system.

This page intentionally left blank.

PROPRIETARY NON-LID BMPS

CATCH BASIN INSERTS

Catch basin inserts consist of a frame that fits below the inlet grate of a catch basin and can be fitted with various trays that target specific pollutants. The trays may also contain a variety of media. The device is typically designed to accept the design flow rate of the inlet grate with bypasses as the trays become clogged with debris. The media require routine maintenance for replacement and cleaning. Catch basin inserts are typically used for smaller drainage areas.

WATER QUALITY INLETS

Water quality inlets are underground retention systems designed to remove settleable solids. There are several water quality inlet designs. Some water quality inlets include a second chamber with a sand filter to remove finer suspended solids by filtration.

OIL/GRIT SEPARATORS

Typical oil/grit separators consist of three chambers. The first chamber removes coarse material and debris; the second chamber separates oil, grease, and gasoline; and the third chamber provides safety relief if blockage occurs. Similar to water quality inlets, frequent maintenance and disposal of trapped residuals and hydrocarbons are necessary for oil/grit separators.

HYDRODYNAMIC DEVICES

A variety of manufactured hydrodynamic devices are available for removing pollutants from storm water runoff. The hydrodynamic separation concept these devices are based on involves the settlement of sediment as runoff moves in a swirling path. Typically these devices are prefabricated in a range of sizes targeted at specific flow rates.

One type of hydrodynamic device is designed to remove suspended particles, oil, and grease during low flow conditions. Higher flows are diverted around the treatment chamber to prevent scour and high velocity from carrying the collected pollutants out of the treatment chamber. Maintenance requirements include the periodic removal of oil/grease and sediments by using a vacuum truck.

A second type of hydrodynamic device utilizes centrifugal motion to remove litter, floatable debris, and larger sediment particles from runoff. Since this technology is designed to capture trash rather than pollutants, these devices are most applicable in coastal areas or areas that receive heavy trash loads. These devices are constructed so that a vacuum truck can regularly remove the floatable and settled debris collected in the treatment chamber.

RECOMMENDED PERFORMANCE STANDARDS

Ultimately, choosing a proprietary BMP will be based on document performance standards. There are numerous performance standards and testing done by third parties for various

proprietary BMPs. Any proposed BMPs for projects submitted to DOT-HWYS or new projects that will connect to the DOT-HWYS MS4 must have evidence of documented third party testing for the pollutants of concern.

7.3 TRASH MANAGEMENT PRACTICES

Trash reduction will be done in accordance with a focused trash reduction plan completed by DOT-HWYS. All BMPs, whether LID or non-LID will address trash as a pollutant of concern and have the adequate maintenance procedures to remove trash from the BMP. Most of the BMPs prescribed in this manual will prevent trash from entering the MS4.

This page intentionally left blank.

8. INSPECTION, MAINTENANCE, AND RECORD KEEPING

This section outlines the inspections and maintenance procedures for DOT-HWYS permanent BMPs. To ensure that the performance of BMP meets the design criteria and they serve the intended purpose, the following activities are essential during construction and after construction:

- Regular site inspections;
- Acceptance of final BMP construction & As-built certification;
- Proper BMP maintenance; and
- Good record keeping.

8.1 SITE INSPECTION DURING CONSTRUCTION

Regular inspections shall be conducted and documented at the stages listed in Table 8-1. The table is to be used as a tool for helping inspectors understand the appropriate times inspection of BMPs during the construction process is necessary:

Table 8-1 Inspection Events during Construction of Permanent BMPs

Recommended Inspection Events During Construction of Permanent BMPs **If applicable, inspections will occur:**
- During excavation to subgrade or sub-foundation
- During placement of underdrain systems and observation wells
- During backfill for foundations, trenches, underdrain systems and observation wells
- During placement of geotextile and filter media
- During construction of appurtenant conveyance systems such as diversion structures, pre-filters and filters, inlets, outlets, catch basins, piping, anti-seep collars, diaphragms, watertight connectors on pipes, and flow distribution structures
- During wetland reservoir area planting
- During the placement of structural fill and concrete
- Upon completion structural supports or reinforcement for structures, to include core trenches for structural embankments
- Upon completion of embankments
- Upon completion of enclosed trenches for storm water facilities
- Upon completion of wetland reservoir area planting
- Upon completion of final grading
- Upon establishment of permanent stabilization
- At any construction stage highlighted on the fact sheet for the relevant LID BMP or filtration BMP listed in Chapter 7
- At any critical construction stage highlighted by the manufacturer for proprietary BMPs

8.2 AS-BUILT CERTIFICATION & ACCEPTANCE OF PERMANENT BMPs

Once construction is complete, as-built plan certification shall be submitted to DOT-HWYS by either a registered professional engineer or professional land surveyor licensed in the State of Hawaii to ensure that constructed BMPs and associated conveyance systems comply with the specifications contained in the approved plans. At a minimum, as-built plan certification shall include a set of drawings comparing the approved permanent BMPs plan with what was constructed. DOT-HWYS may require additional information.

8.3 BMP INSPECTIONS AFTER CONSTRUCTION

Contract construction projects requiring Permanent BMPs based on the Unified Criteria are to be inspected at least once a year after construction and within fourteen (14) days after the first storm event that produces one inch or more precipitation after construction of the BMP. Inspections after a storm event provide an evaluation of the effectiveness of the BMPs and early detection of potential damages as a result of the storm. The after-storm inspection also aids in identifying maintenance activities needed. Annual inspections are important to determine if vegetation has survived past the growing season. The result of the inspection and evaluation for DOT-HWYS BMPs must be written in the latest inspection form as provided by DOT-HWYS. If deficiencies are observed during the inspections, follow-up procedures must be performed to ensure that the required repair, maintenance, or modification activity is completed in a timely manner.

8.4 BMP OPERATIONS AND MAINTENANCE

General maintenance tasks that are to be performed periodically, as specified in the BMP description or determined by site inspection include the following:

- Removal of the sediment and debris;
- Removal of grease and oil;
- Replacement or repair of worn or damaged geotextile fabrics;
- Reseeding or replanting of damaged vegetated areas;
- Re-mulching of damaged stabilized areas; and
- Replacement or repair of damaged flow control structure or devices.

Specific maintenance tasks are identified in the Chapter 7 of this manual for each BMP description.

A maintenance schedule shall be developed for the life of the permanent BMP and shall state the maintenance to be completed, the time period for completion, and who shall perform the maintenance. This maintenance schedule shall be printed on the approved permanent BMP plan. This information will be used to update or augment the current DOT-HWYS Permanent BMP Operations and Maintenance manual (if applicable)

8.5 RECORD KEEPING

Records of all inspections and follow-up activities for deficiencies in the conditions of DOT-HWYS BMPs are to be retained for a minimum of five years. This record information can be used to improve the BMP performance for future applications. In addition to the inspection form, records of maintenance activities for DOT-HWYS BMPs shall also be kept. These records are to indicate specific maintenance activities that have been completed, record observations of maintenance personnel, and provide useful information regarding future maintenance requirements for a particular BMP. Furthermore, should the BMPs be owned on a private parcel but connect to the MS4, not maintaining proper records is evidence of improperly maintained BMPs and a potential violation of polluted discharge to the MS4. Finally, this information is important to ensure DOT-HWYS can maintain its database of permanent BMPs. The database shall include the BMP type and location, as well as all inspection and maintenance records of DOT-HWYS BMPs. The database is part of the DOT-HWYS' storm water asset management system.

This page intentionally left blank.

Storm Water Permanent BMP Manual

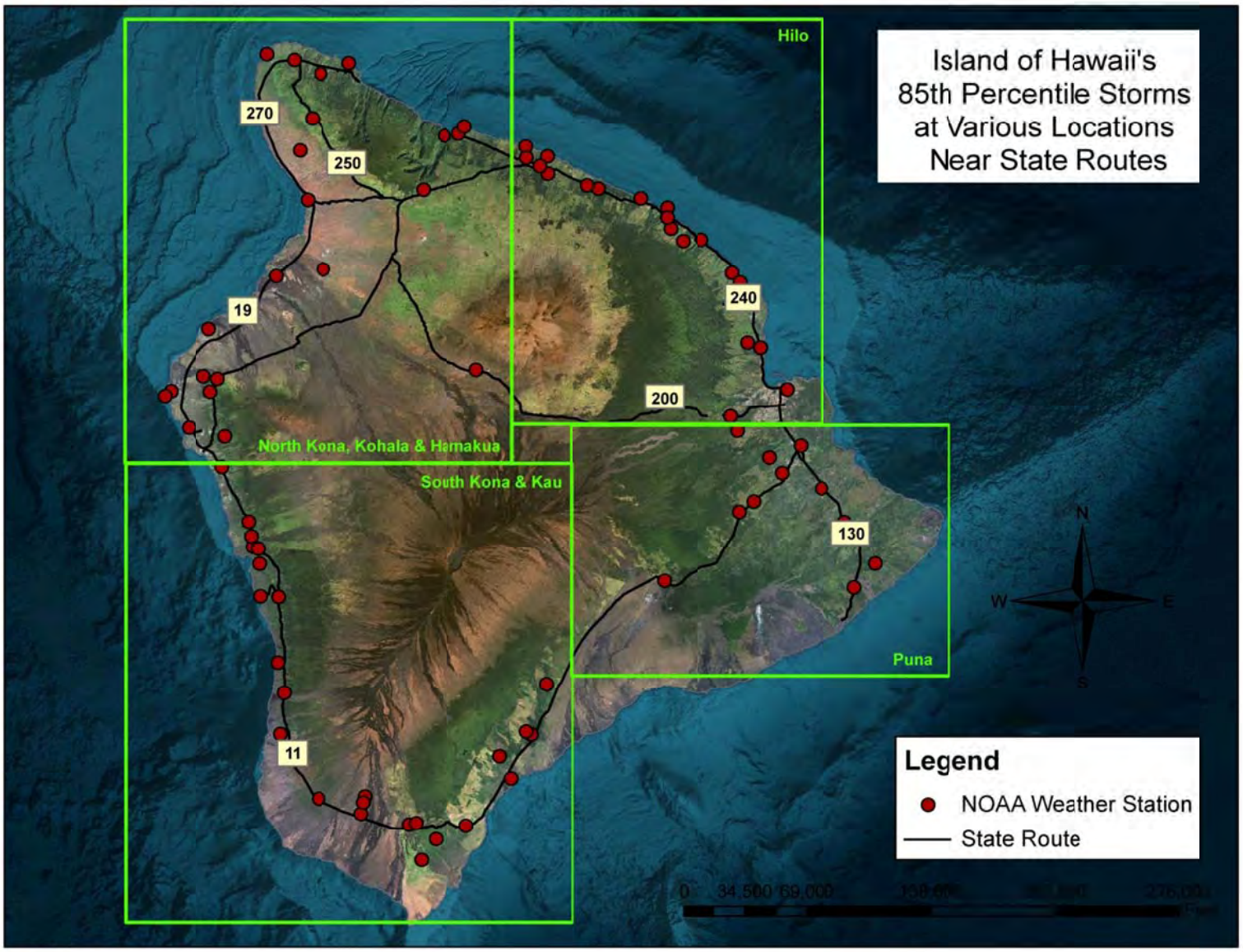
APPENDIX A: RAIN STATIONS ANALYZED FOR QUANTITATIVE CRITERIA

This page intentionally left blank

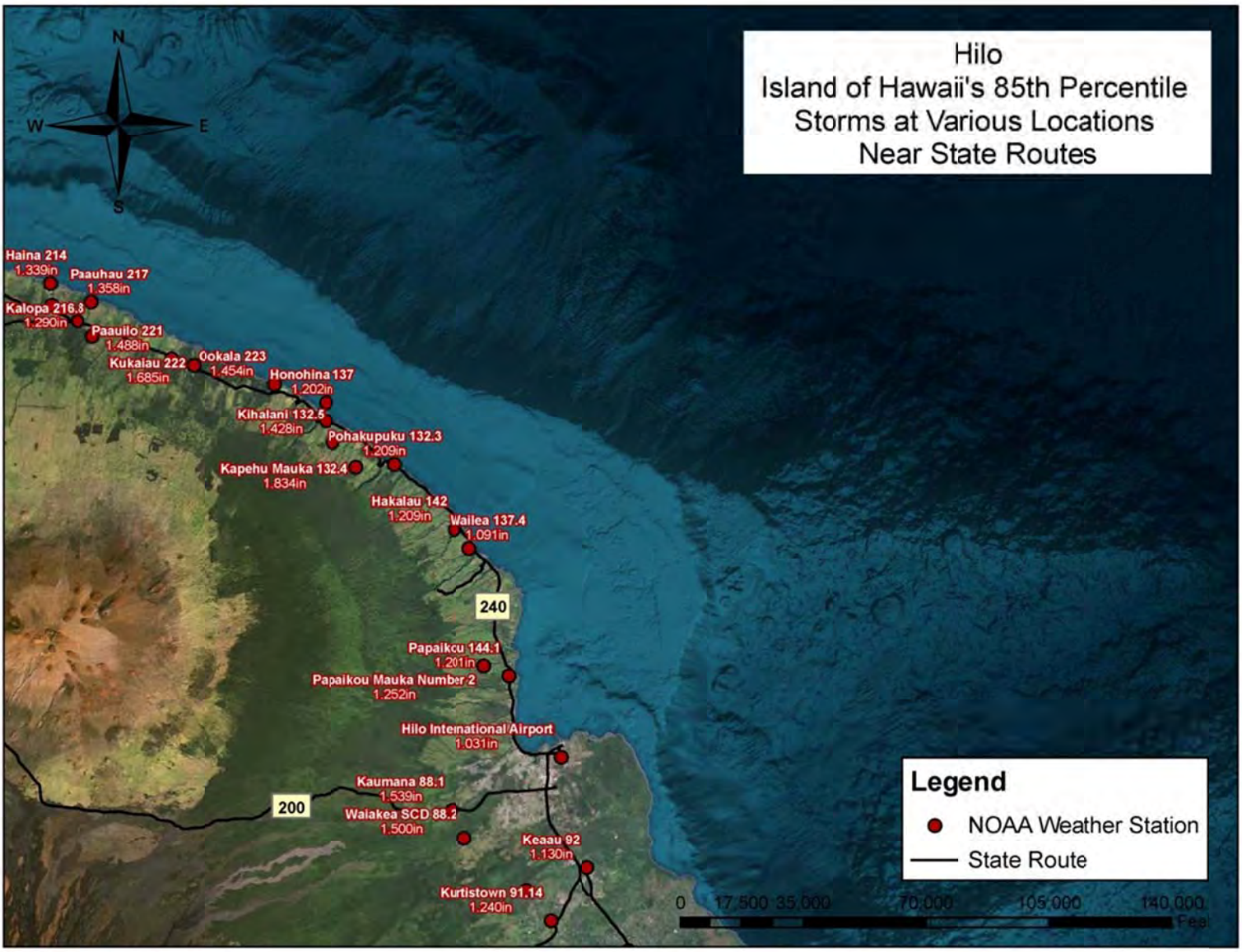
Introduction

This appendix provides graphical references regarding the rain gauge stations used in determining the quantitative criteria. These references are not to be used in local estimation of reducing the water quality design volume.

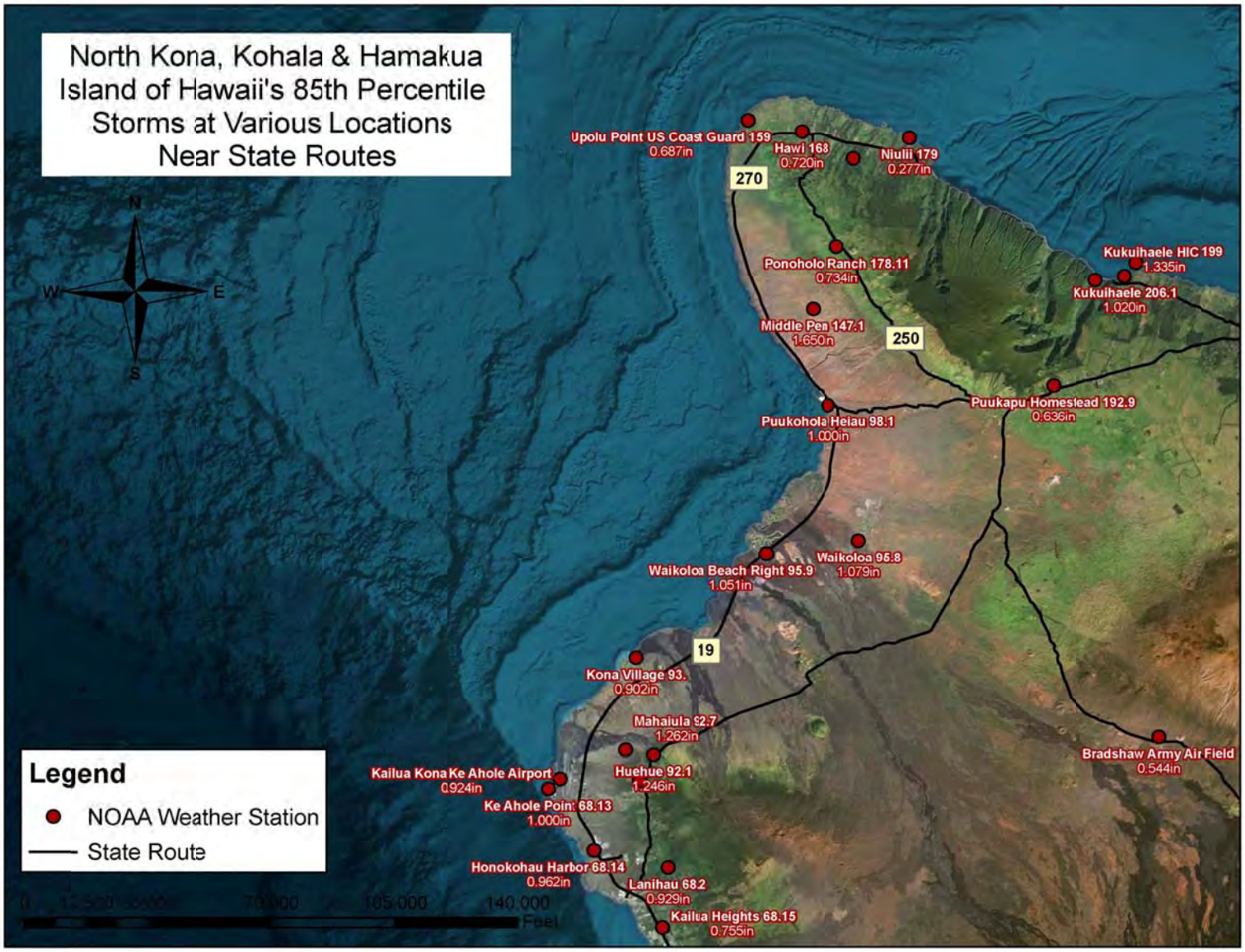
Hawaii County



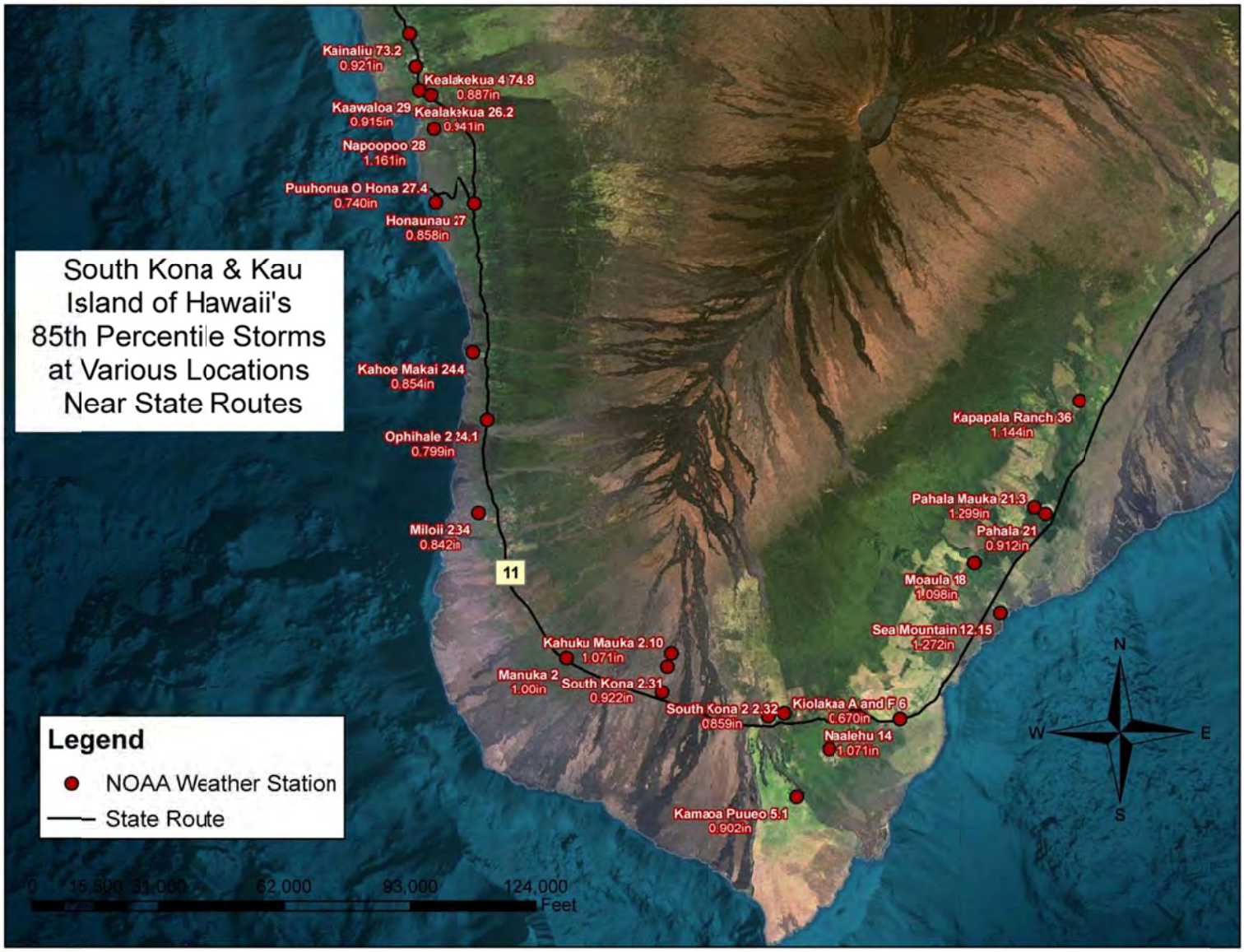
Hawaii County (Hilo Area)



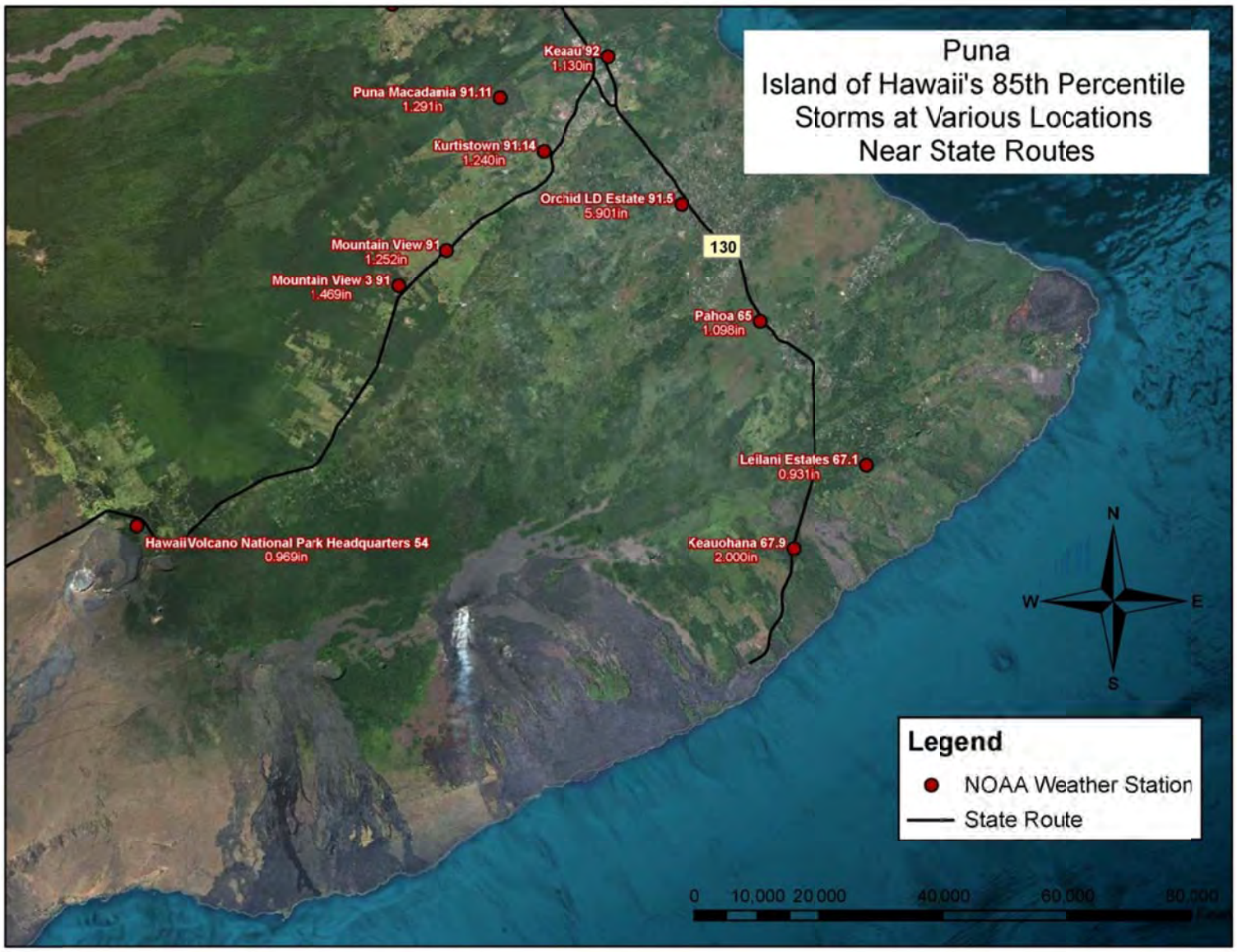
Hawaii County (North Kona, Kohala, & Hamakua Area)



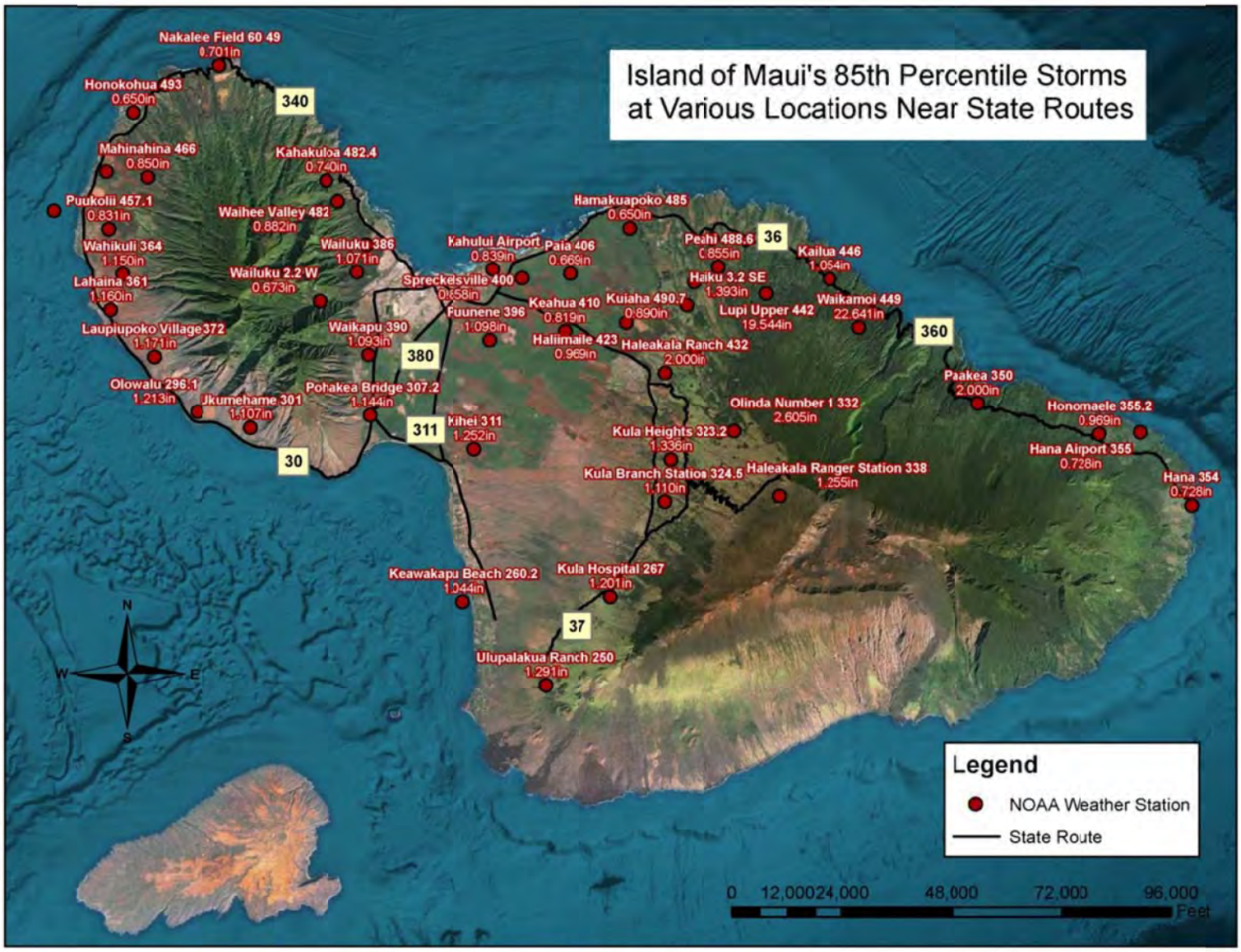
Hawaii County (South Kona & Ka'u Area)



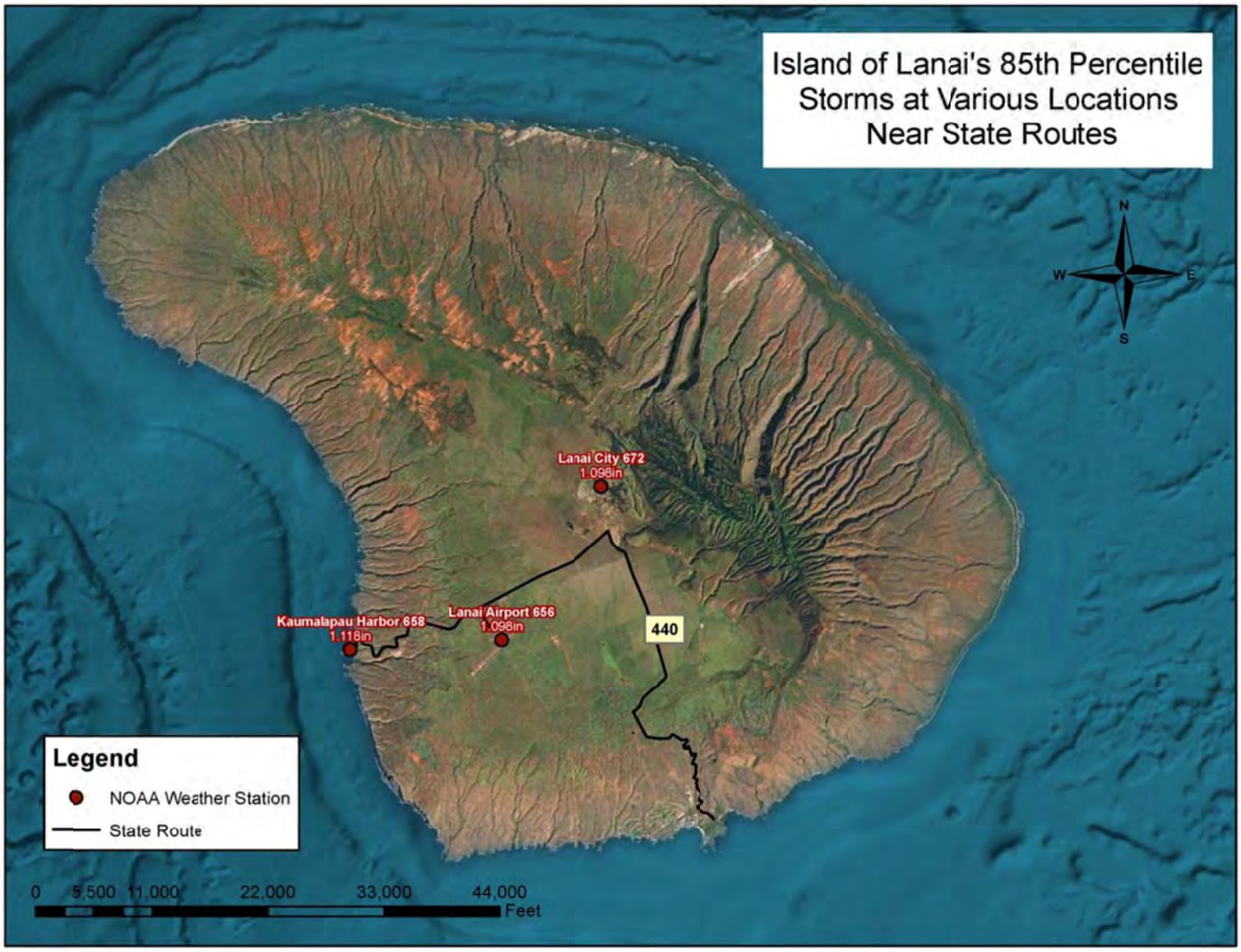
Hawaii County (Puna Area)



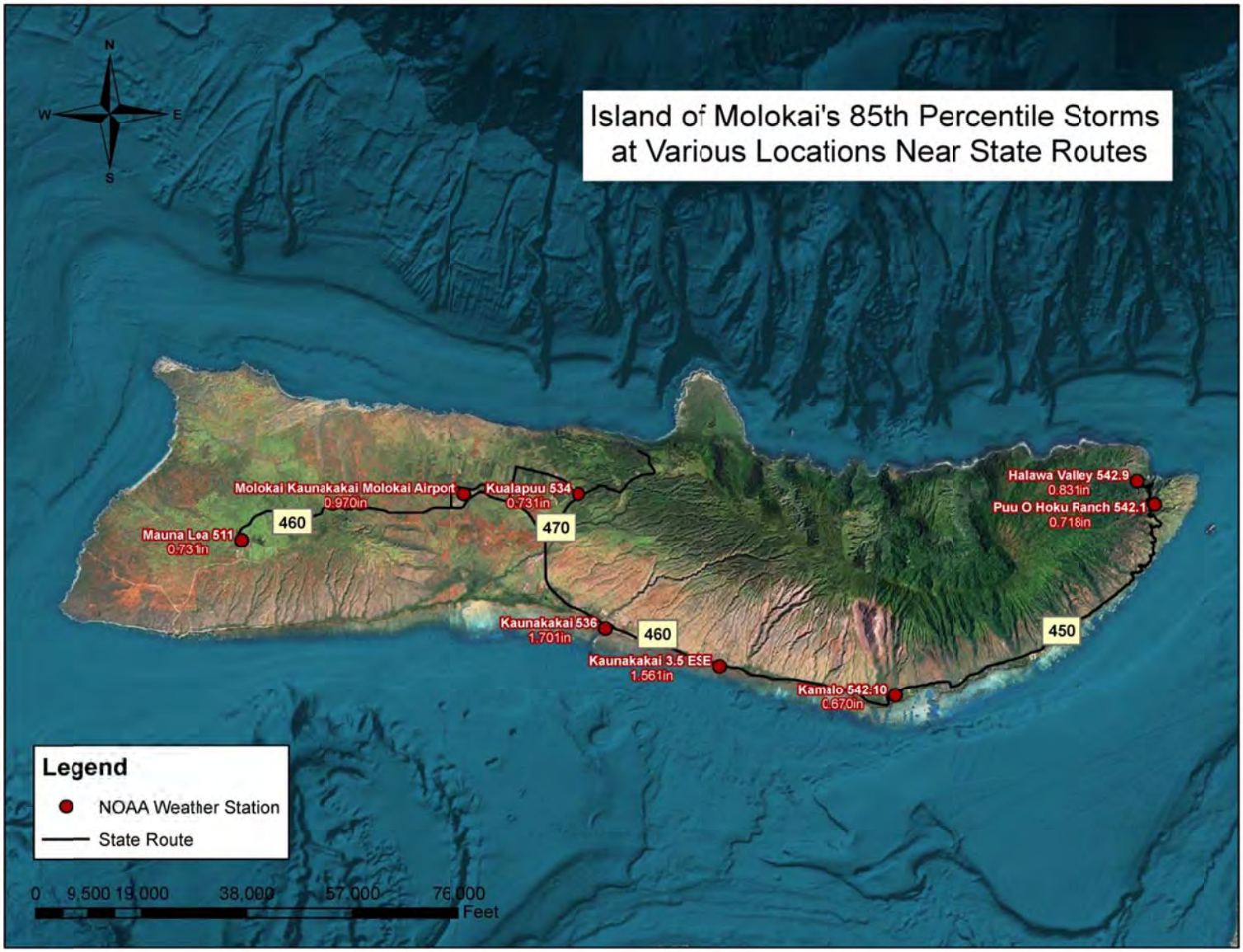
Maui County (Maui)



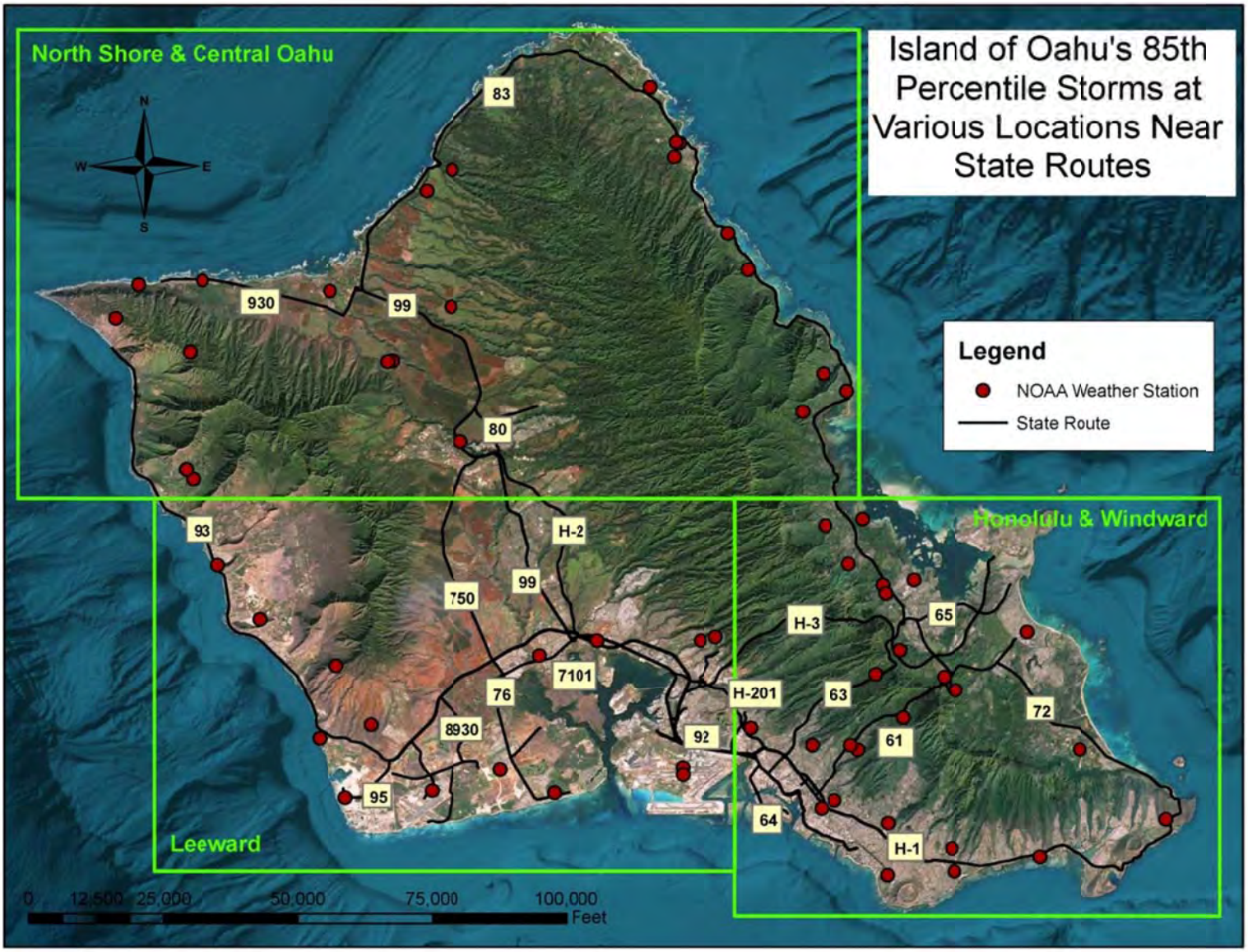
Maui County (Lana'i)



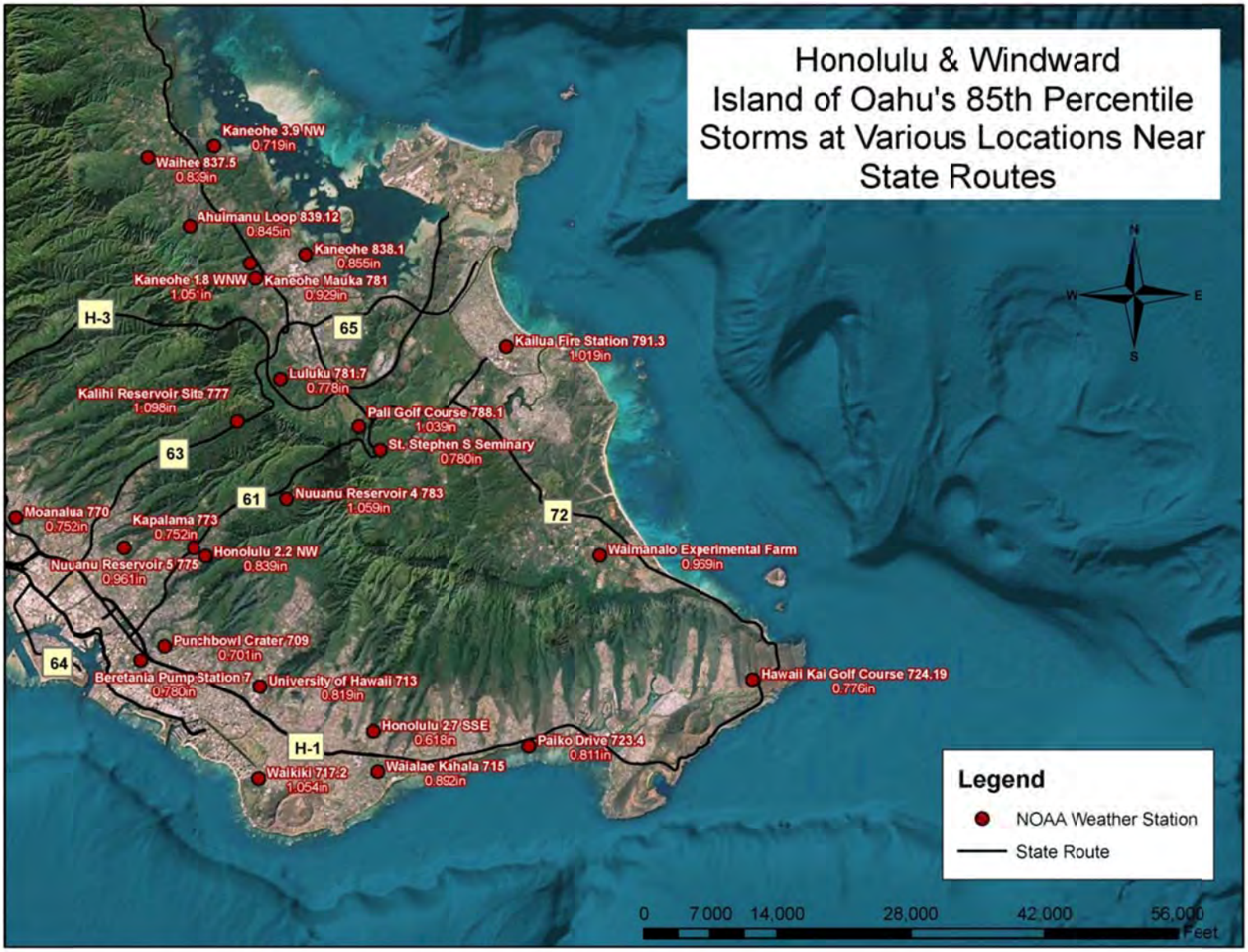
Maui County (Moloka'i)



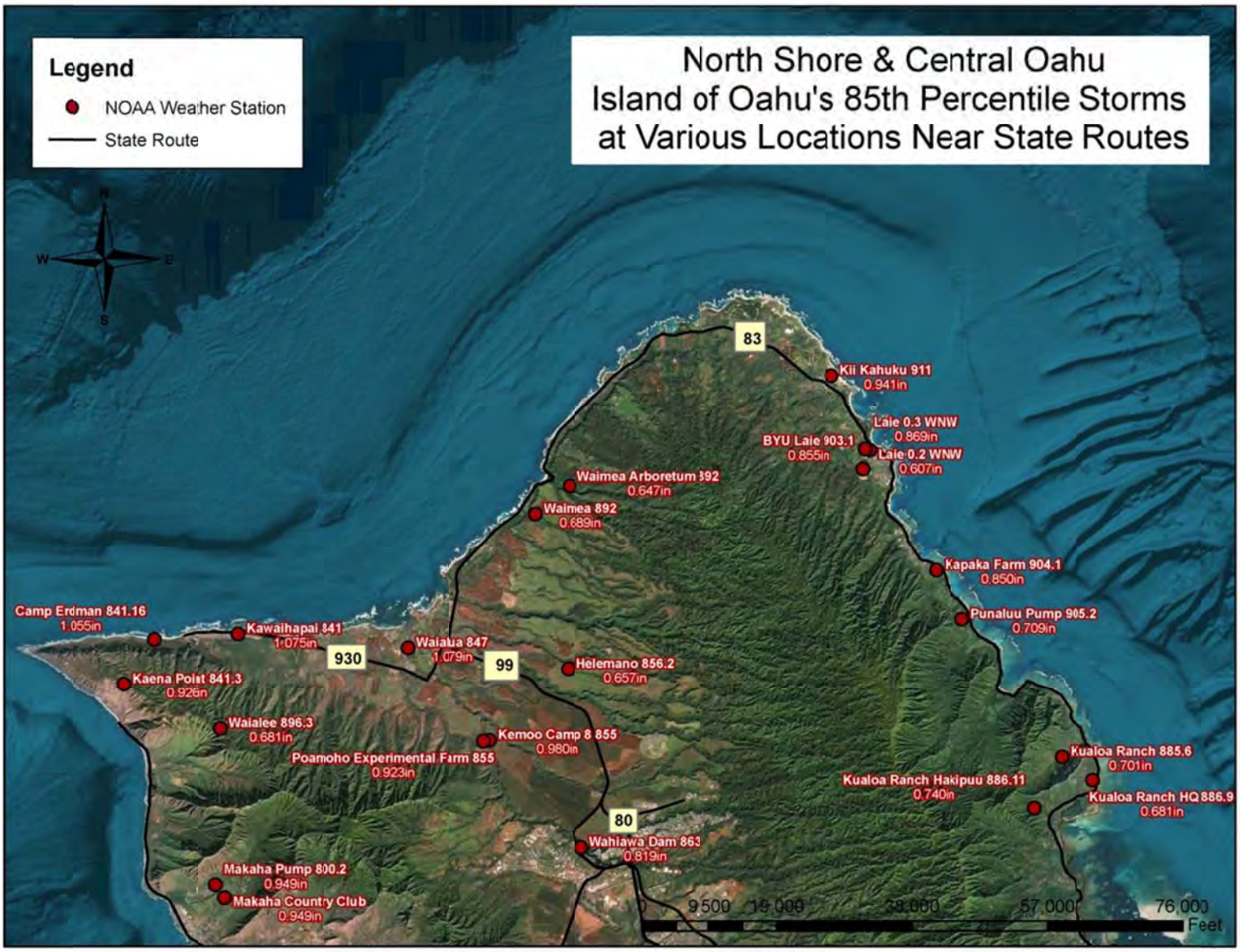
Honolulu County



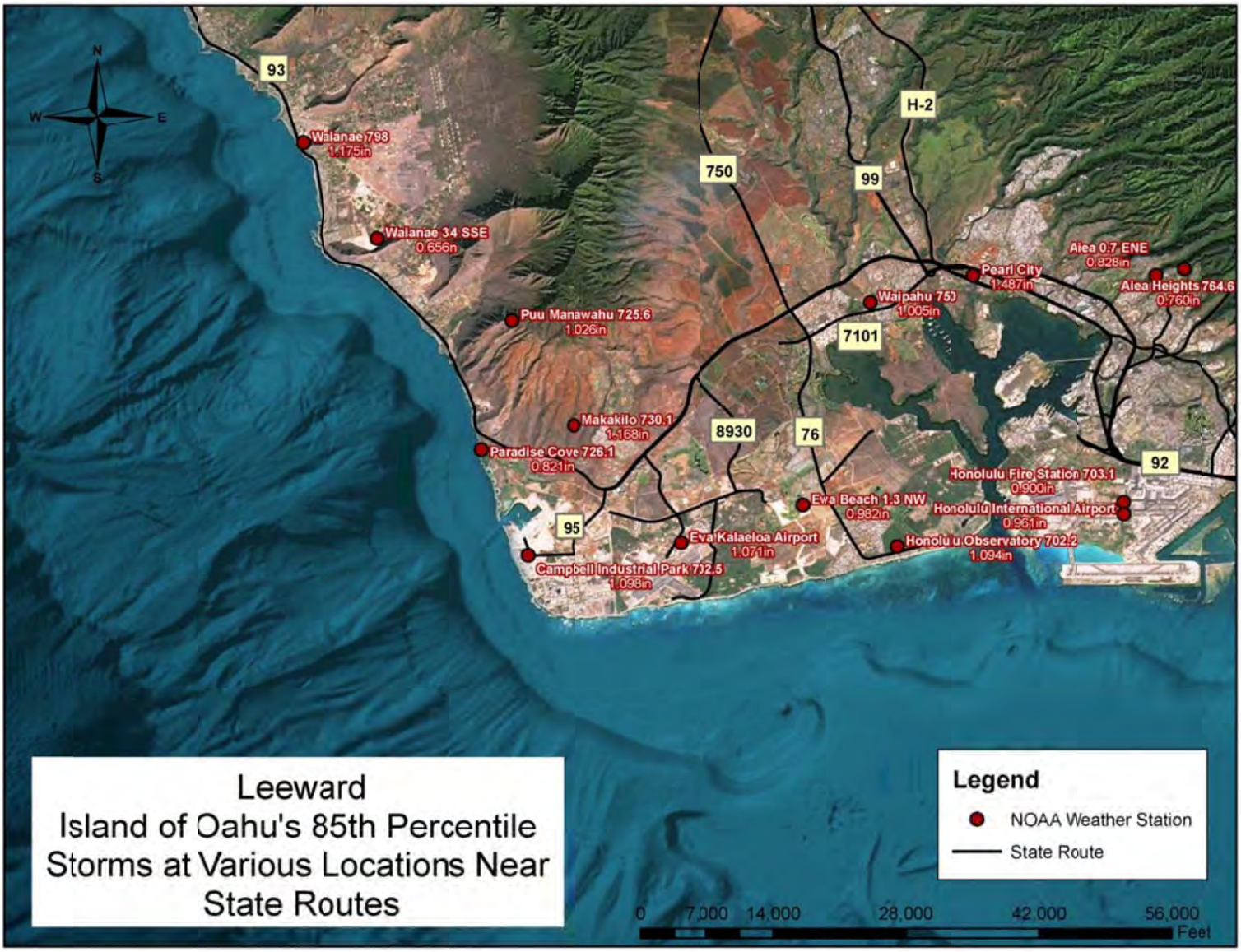
Honolulu County (Honolulu & Windward Area)



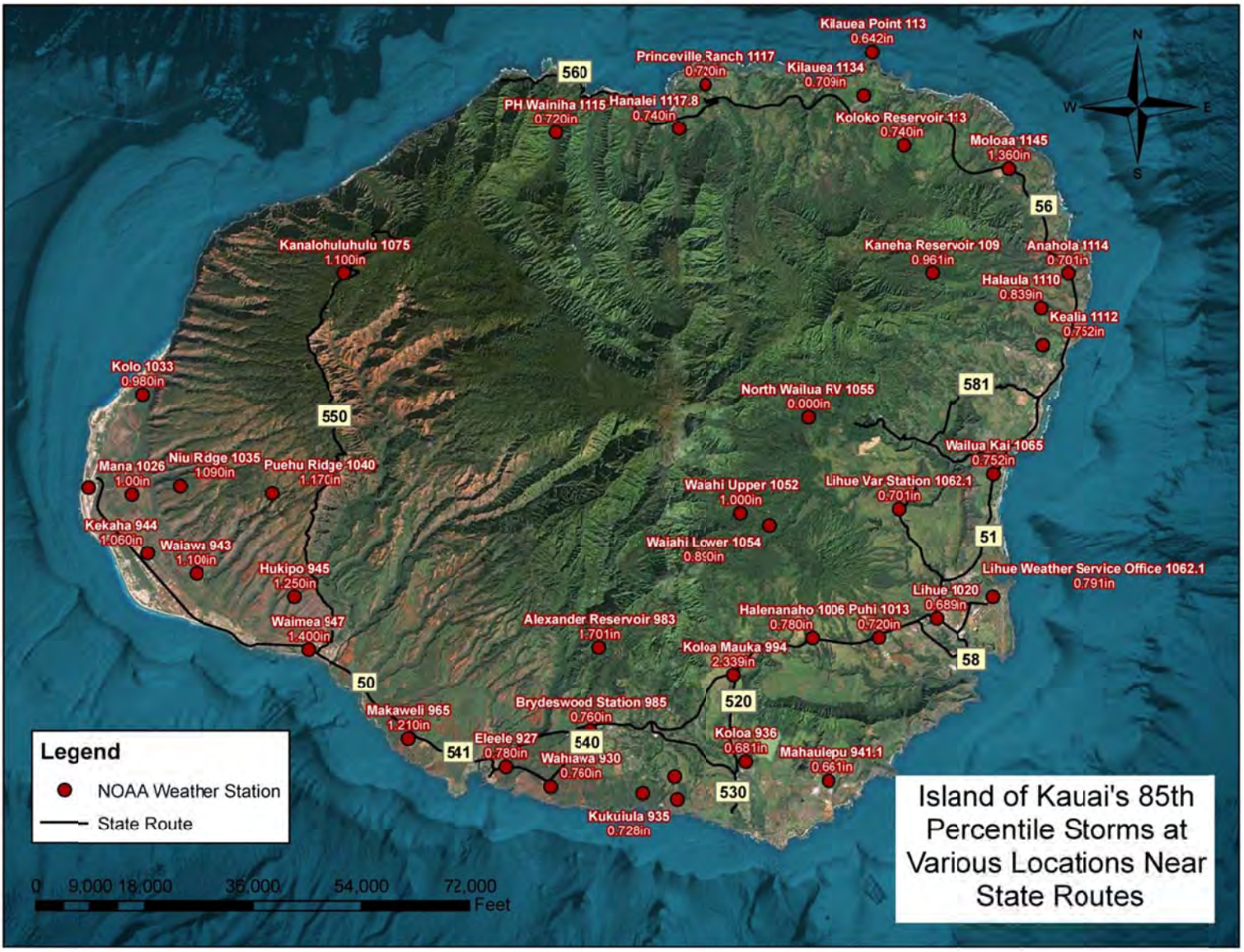
Honolulu County (North Shore & Central Oahu)



Honolulu County (Leeward Oahu)



Kauai County



Storm Water Permanent BMP Manual

APPENDIX B: SOIL STABILIZATION AND STORM WATER CONTROL TECHNIQUES

This page intentionally left blank.

Introduction

The purpose of this appendix is to provide the designer with ideas for site management and tools that will be helpful in storm water control. These tools will not fulfill the requirement of providing required BMPs under the unified criteria, but should be used at a site in order to reduce the maintenance and increase the longevity of permanent BMPs used for LID Design Volume or for Storm Water Quality Control.

B.1 Soil Stabilization

PRESERVATION OF EXISTING VEGETATION

PERMANENT SEEDING AND PLANTING

MULCHING

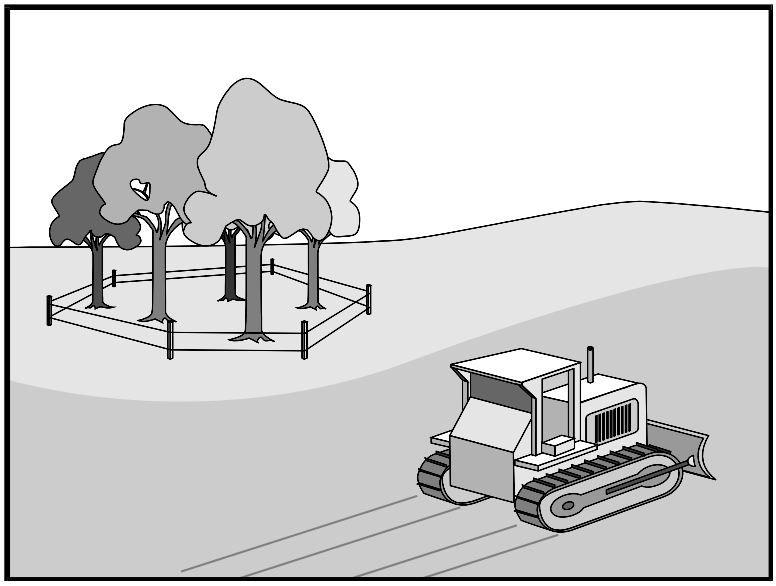
GEOTEXTILES, MATS AND EROSION CONTROL BLANKETS

VEGETATED BUFFER STRIPS AND CHANNELS

This page intentionally left blank.

PRESERVATION OF EXISTING VEGETATION

DESCRIPTION AND PURPOSE



Identification of existing vegetation to remain provides erosion and sediment control on a site with future land disturbing activities.

APPLICATIONS

Preservation of existing vegetation practices apply to the following:

- Areas on-site where no construction activity occurs or will occur at a later date.
- Areas where the existing vegetation should be preserved such as steep slopes, watercourses, and building sites in wooded areas.
- Natural resources or environmental protection areas such as wetlands and marshes requiring preservation by local, state, and federal governments.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

- Incorporate existing vegetation into landscaping plans when possible. Proper care of this vegetation before and after construction is required.
- Consider aesthetic and environmental values, tree/plant health, life span, sun exposure limitations, and space requirements when determining which vegetation to preserve.
- When preparing the landscaping plans, avoid using vegetation which competes with the existing vegetation.
- Establish setback distances defined by devices such as berms, fencing, or signs. Setback distances are based on vegetation species, location, size, and age. The type of construction activity in the vicinity of the vegetation shall also be considered. Construction activities are not permitted within the setback.
- Protect existing vegetation using one of the following methods:
    - Mark, flag, or fence areas of vegetation to be preserved;
    - Designate limits of root system (tree drip line);
    - Tree wells and retaining walls which are large enough to protect the root system;
    - Limit grading to within one foot of the tree drip lines, if grading under the tree is necessary; and
    - Locate construction traffic routes, spoil piles, etc. away from existing vegetation.

MAINTENANCE AND INSPECTIONS

- Inspect protective measures and immediately repair or replace damaged protection measures.

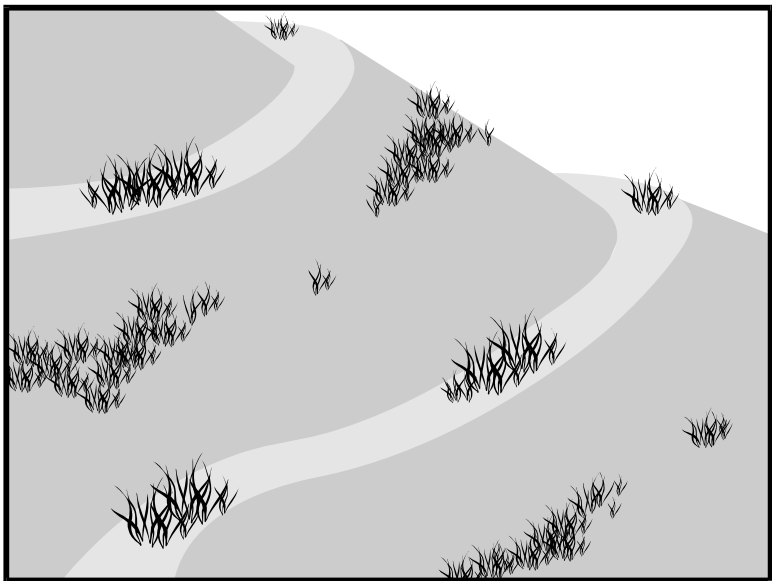
LIMITATIONS

- Requires advanced planning and coordination between the owner/developer, contractor, and designer.
- Limited use if final site design does not incorporate existing vegetation.
- Diverse site topography may result in additional expenses to satisfy vegetation preservation and the grading required for the site improvements.

SEEDING AND PLANTING

DESCRIPTION AND PURPOSE

Seeding and planting of trees, vines, shrubs, and ground cover for soil stabilization.



APPLICATIONS

Soil stabilization during or after the construction phase applies to the following site conditions:

- Graded/cleared areas;
- Open space and fill areas;
- Steep slopes;
- Vegetated swales;
- Landscape corridors; and
- Stream banks.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

Requirements for each seeding/planting application shall be considered and include:

- Type of vegetation;
- Site and seedbed preparation;
- Seasonal planting times;
- Fertilization; and
- Water.

GRASSES

- Ground preparation requires fertilization and mechanical stabilization of the soil.
- Short-term temperature extremes and waterlogged soil conditions tolerable.
- Appropriate soil conditions include a shallow soil base, good drainage, and 2:1 or flatter slope.
- Quickly develops from seeds.
- Vigorous grass growth dependent on mowing, irrigating, and fertilizing.

TREES AND SHRUBS

- Selection dependent on vigor, species, size, shape, and potential wildlife food source.
- Consider wind/exposure and irrigation requirements.
- Use indigenous species where possible.

VINES AND GROUND COVER

- Lime and fertilizer required for ground preparation.
- Use appropriate seeding rates.
- Consider requirements for drainage, acidity, and ground slope.
- Use indigenous species where possible.
- Avoid species which require irrigation.

MAINTENANCE AND INSPECTIONS

- Monitor vegetation growth
- Water, fertilize, mow, and/or prune the grasses/plants as needed.

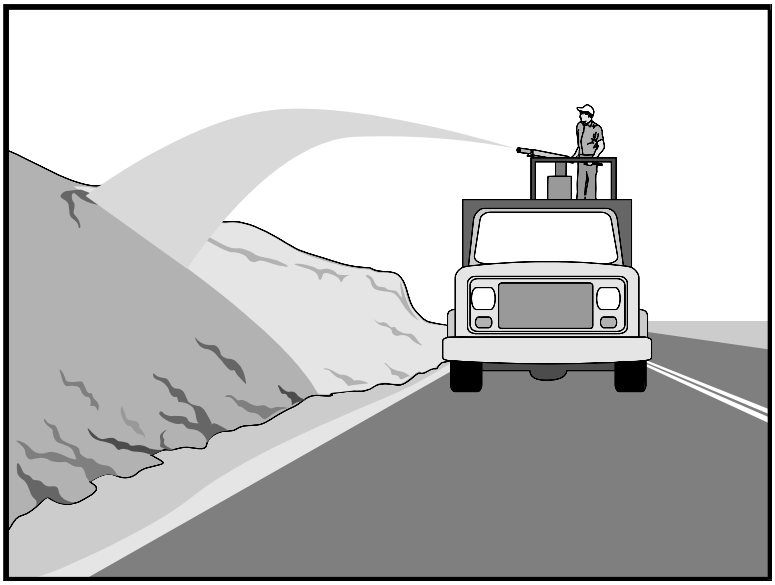
LIMITATIONS

- Vegetation may not be appropriate during dry periods without irrigation.
- Improper application of fertilizer may contribute to storm water pollution.

MULCHING

DESCRIPTION AND PURPOSE

Mulching is the application of loose bulk material to stabilize disturbed soil by protecting bare soil, increasing infiltration, and reducing runoff. Materials used for mulching include green material, hydraulic matrices, hydraulic mulches of recycled paper or wood fiber, stone and aggregate, vegetable fibers (hay or straw), and wood/bark chips.



APPLICATIONS

Mulching BMPs apply to the following:

- Temporary ground cover until permanent vegetation has been established.
- Method used in combination with temporary or permanent seeding to enhance plant growth.
- Areas requiring soil moisture retention to prevent cracking of the soil.
- Ground cover for exposed soil between trees or shrubs.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

The following materials may be used for mulching:

VEGETABLE FIBERS (HAY OR STRAW)

- Loose hay or straw which may be used in combination with seeding. Mulching usually follows seeding and the process is described in the following:
    - Apply seed and fertilizer to bare soil;
    - Apply loose hay or straw over top of seed and fertilizer prior to seed germination. Apply at a rate of 2 tons/acre by machine or hand distribution;
    - Evenly distribute mulch on the soil surface to cover 80% to 90% of the ground;
- Maintain maximum fiber length. Average fiber length shall be greater than 6 inches.
    - Use a tackifier, netting, or mechanical "punching" method to anchor mulch. Method depends on slope steepness, accessibility, soil conditions, and longevity;
    - Punching" straw or hay into soil is the preferred method of anchoring mulch for the following conditions:
        - Use a spade or shovel on small areas,

- Use a knife-blade roller or straight bladed coulter ("crimper") on slopes with soil, which can support construction equipment without undesirable compaction or instability,
- Use plastic netting or jute on small areas and/or steep slopes. Geotextile pins, wooden stakes, or 11 gauge wire staples shall secure netting in place. This condition warrants consideration of the use of matting rather than mulch, and
- Use tackifiers on steep slopes unable to support construction equipment or large application areas where use of nettings, straw, or hay is not cost-effective. Tackifiers glue vegetable fibers together and to the soil surface until the establishment of permanent vegetation.

GREEN MATERIAL

- Consists of recycled vegetation trimmings such as grass and shredded shrubs and trees.
- Generally applied by hand.
- Temporary ground cover with or without seeding.
- Evenly distribute green material on soil surface. Depth shall not exceed 4 inches.
- Anchor with a tackifier or netting on steep slopes or for areas with anticipated overland sheet flow. This condition warrants consideration of the use of matting rather than mulch.

WOOD/BARK CHIPS

- Suitable for areas which will not be mowed such as around trees, shrubs, and landscape plantings.
- Test soils prior to application. Add a minimum of 12 pounds of nitrogen per ton of mulch to counteract the effect of decomposing wood-based materials, which extract nitrogen from soil. Use a balanced, slow-release fertilizer or an organic source such as compost.
- Apply mulch by hand.
- Evenly distribute wood/bark chips on soil surface and maintain a mulch depth of 2 to 3 inches.

HYDRAULIC MULCHES OF RECYCLED PAPER

- Consists of recycled newsprint, magazines, and other waste paper sources.
- May be applied with or without tackifiers.
- Hydraulic mulch materials shall conform to *Hawaii Standard Specifications for Road and Bridge Construction (2005).*
- Mix mulch in a hydraulic application machine (hydroseeder) and apply as a liquid slurry.
- May be sprayed from a cannon up to 200 feet or from a hose up to 1,500 feet away from the application area.
- Mix mulch with seed and fertilizer as specified by the manufacturer. Apply mulch at the manufacturer's recommended rate to ensure uniform, effective coverage.

HYDRAULIC MULCHES OF WOOD FIBER

- Consists of wood waste from lumber mills or urban sources.
- May be manufactured with or without a tackifier.
- Hydraulic mulch shall conform to *Hawaii Standard Specifications for Road and Bridge Construction (2005)* or comply with the following requirements:

  - 100% wood fiber;
  - Maximum moisture content (total weight basis) shall not exceed 12% ±3%;
  - Minimum organic matter content (oven dry weight basis) of 99.3%;
  - Maximum inorganic matter (ash) content (oven dried basis) of 0.7%
  - pH of 4.9±10% for a 3% water slurry; and
  - Minimum water holding capacity (oven dried basis) of 1.2 gallons per pound of fiber.
- Mix mulch in a hydraulic application machine (hydroseeder) and apply as a liquid slurry.
- Mix mulch with seed and fertilizer as specified by the manufacturer. Apply mulch at the manufacturer's recommended rate to ensure uniform, effective coverage.

HYDRAULIC MATRICES

- Hydraulic slurries consisting of wood fiber, paper fiber, or a combination of wood and paper fiber mixed with a binder system.
- Exceeds erosion control performance of blankets due to close contact with soil.
- Apply as an aqueous slurry (with seed) using standard hydroseeding equipment.
- Application rates vary for different combinations of conditions and products.
- A typical mixture based on one acre of treated area includes the following:
  - 500 pounds wood fiber mulch;
  - 1,000 pounds recycled paper mulch; and
  - 55 gallons acrylic copolymer with a minimum solids content of 55%.
- Bonded Fiber Matrix (BFM) consists of premixed fiber and binders.
  - After application and upon drying, BFM shall adhere to soil and form a 100% cover. The cover shall be biodegradable, promote vegetation, and prevent soil erosion.
  - Composed of long strand, thermally produced wood fibers (>88% of total volume by weight), held together by organic tackifiers (10%) and mineral bonding agents (<2%), which become insoluble and non-dispersible upon drying. Composition of BFM varies based on supplier.
  - Perform a free liquid quality control test on the liquid slurry.
  - Binder shall not dissolve or disperse upon watering.
  - Upon application to the soil, holes in the matrix shall not exceed 0.04 inches in size.
  - There shall not be any gaps between the matrix and the soil.
  - Minimum water holding capacity of the matrix shall be 1.2 gallons per pound matrix.
  - The matrix shall be free of germination or growth inhibiting factors and shall not form a water resistant crust.
  - Materials used for the matrix shall be 100% biodegradable and 100% beneficial to plant growth.
  - Testing and evaluation of the matrix by an independent research laboratory shall have been conducted to verify reported erosion control performance.
  - A trained and manufacturer certified applicator with knowledge of proper mixing and product application shall install the BFM.
  - Typical BFM application rates range from 3,000 to 8,000 pounds per acre per recommendations from various manufacturers.

  - BFM shall not be applied immediately before, during, or after a rainfall event to ensure a drying time of 24 hours after installation.

- Mulch used as temporary ground cover shall be reapplied to bare areas until permanent vegetation has been established.
- Avoid spraying mulch onto sidewalk, lined drainage channels, travelway, and existing vegetation.

MAINTENANCE AND INSPECTIONS

- Mulches applied to seeded areas may be disturbed due to wind or runoff. Recover exposed areas until permanent vegetation has been established.
- Mulches applied to areas, which will be regraded and revegetated, shall be inspected once every 2 weeks. Corrective measures shall be initiated within 14 days of inspection.
- Inspect ornamental and landscape mulches of bark or wood chips once every 8 to 10 months. Replace mulch if soil is visible in more than 75% of the area.

LIMITATIONS

VEGETABLE FIBERS (HAY OR STRAW)

- Require three-step machinery.
- Labor intensive installation.
- Weed seeds and undesirable plant material may be introduced to sensitive areas.
- For applications using straw blowers, the applicable area must be located within 150 feet of a road or surface capable of supporting loads from large vehicles. If both hay and straw are available, it is preferable to use straw.

GREEN MATERIAL

- Limited commercial availability.
- Variable quality.
- Weeds or undesirable plant material may be introduced to the mulched area.
- Application primarily uses manual labor.
- Unpredictable effectiveness as an erosion control measure. Requires overspray with a tackifying agent to increase effectiveness.
- Application of fertilizer may be required.
- Limit use to non-critical steep slopes and areas where alternative erosion control measures may be readily applied.

WOOD/BARK CHIPS

- Poor erosion control effectiveness.
- Anchoring of chips onto steep slopes is difficult due to potential movement from high winds.
- Subject to displacement from concentrated flows.

- Use of a fertilizer with high nitrogen content is required to prevent nutrient deficiency in plants due to decomposing wood-based materials, which extract nitrogen from soil. Improper fertilizer use may contribute to water quality pollution.
- Limit use to non-critical steep slopes and areas where alternative erosion control measures may be readily applied.

HYDRAULIC MULCHES OF RECYCLED PAPER

- Limited erosion control effectiveness due to short fiber length and absence of a tackifier.
- Limited moisture and soil temperature moderation.
- Residual inks within mulches may be an undesirable in environmentally sensitive areas.
- Significant decrease in longevity compared with wood fiber mulch.
- Difficulty budgeting for this product due to volatile prices for recycled paper products.

HYDRAULIC MULCHES OF WOOD FIBER

- Limited erosion control effectiveness.
- Short-term use of one growing season.

HYDRAULIC MATRICES

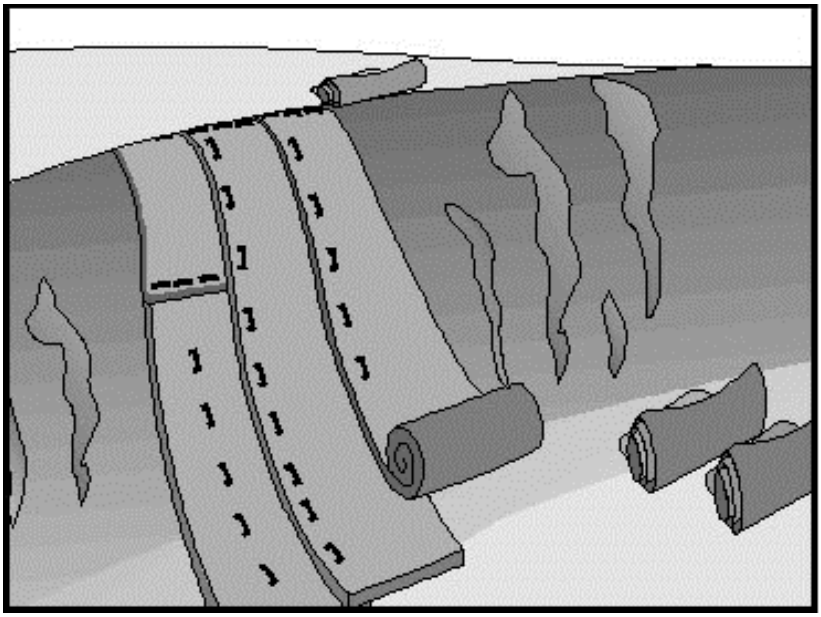
- Avoid application of mulch immediately before, during, or after a rainfall event.
- Requires drying time of 24 hours.

This page intentionally left blank.

GEOTEXTILES AND MATS

DESCRIPTION AND PURPOSE

Natural or synthetic mats may be used for temporary or permanent soil stabilization.



APPLICATIONS

Geotextiles and mats apply to the following:

- Drainage ditches, channels, and streams.
- Steep slopes.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

- Apply matting to disturbed soils and areas where vegetation has been removed.
- Organic matting provides temporary protection until permanent vegetation has been established, optimal weather conditions occur, or construction delays are resolved. Organic matting materials include the following:
    - Jute matting; and
    - Straw matting.
- Synthetic matting provides temporary or post-construction soil stabilization in both vegetated and non-vegetated areas. Synthetic matting materials include the following:
    - Excelsior™ matting;
    - Glass fiber matting;
    - Staples; and
    - Mulch netting.
- Other proprietary devices may be used and shall be installed per manufacturer's recommendations.

MAINTENANCE AND INSPECTIONS

- Periodically inspect matting after installation.

LIMITATIONS

- Minimize use of matting to areas where other erosion control measures are not applicable such as channels or steep slopes since matting is more costly compared to other erosion control measures.
- Seed germination may be delayed due to decreased soil temperature.
- An experienced maintenance engineer is required during installation.

VEGETATED BUFFER STRIPS AND CHANNELS

DESCRIPTION AND PURPOSE

Vegetated buffer strips and channels protect soil from erosion, increase infiltration, and remove sediment from surface runoff. Located adjacent to pollutant sources such as construction sites, vegetated buffer strips also provide protection to downstream receiving inlets or water bodies.

APPLICATIONS

Vegetated buffer strips and channels apply to the following conditions:

- Any site which is suitable for establishment of vegetation.
- Vegetated buffer strips are appropriate for uncurbed, paved areas; steep and potentially unstable slopes; and areas adjacent to sensitive water bodies.
- Vegetated channels are appropriate for surface runoff conveyed by channels to downstream inlets or receiving waters.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

- Refer to the Preservation of Existing Vegetation section in this manual if existing vegetation will be used as a buffer strip.
- Installation of a buffer strip with new vegetation shall comply with the following:
    - Prior to cultivation of the designated buffer strip area, remove and dispose of all weeds and debris in accordance with *Hawaii Standard Specifications for Road and Bridge Construction (2005)*;
    - During construction, strip and stockpile good topsoil for surface preparation purposes prior to planting activities;
    - Plant the area upon completion of grading in the area;
    - Fine grade and roll areas to be planted after cultivating soil and, if applicable, installing the irrigation system;
    - Provide additional watering or irrigation of vegetation to supplement rainfall until vegetation has been established;
    - Fertilize vegetation in accordance with manufacturers' instructions and grass/soil requirements determined by testing of the soil;
    - Vehicular traffic passing through vegetated buffer strips or channels shall be avoided to protect vegetation from damage and maximize its effectiveness;

- Comply with applicable regulations and manufacturers' instructions when applying fertilizers, pesticides, soil amendments, or chemicals;
- Comply with the following during seeding activities:
  - Add soil amendments such as fertilizer when preparing seedbed. Apply mulch after seeding to protect vegetation during establishment. Select an appropriate seed mixture based on site conditions. Dense grasses are more effective in reducing flow velocities and removing sediment. Thick root structures are necessary for erosion control,
  - Use proper equipment and methods to ensure uniform distribution and appropriate seed placement, and
  - Overseed, repair bare spots, and apply additional mulch as necessary; and
- Comply with the following during sodding activities:
  - Protect sod with tarps or other types of protective covering during delivery and do not allow sow to dry between harvesting and placement,
  - Any irregular or uneven areas observed prior to or during the plant establishment period shall be restored to a smooth and even appearance,
  - Prior to placing sod, ground surface shall be smooth and uniform,
  - Areas, which will be planted with sod and are adjacent to paved surfaces such as sidewalks and concrete headers, shall be 1.5±0.25 inches below the top grade of the paved surface after fine grading, rolling, and settlement of the soil,
  - Ends of adjacent strips of sod shall be staggered a minimum of 24 inches,
  - Edges and ends of sod shall be placed firmly against paved borders,
  - After placement of the sod, lightly roll sodded area to eliminate air pockets and ensure close contact with the soil,
  - After rolling, water the sodded area to moisten the soil to a depth of 4 inches,
  - Do not allow sod to dry,
  - Avoid planting sod during extremely hot or wet weather, and
  - Sod shall not be placed on slopes steeper than 3:1 (H:V) if the area will be mowed.

MAINTENANCE AND INSPECTIONS

- Inspect weekly and after significant rain events until vegetation is established. Repair eroded or damaged areas as necessary.
- Maintenance activities include mowing, weeding, and verification of a properly operating irrigation system, if applicable.
- Properly remove and dispose of clippings from mowing and trimming in accordance with *Hawaii Standard Specifications for Road and Bridge Construction (2005).*

LIMITATIONS

- Site conditions such as availability of land.

- Flow depth and vegetative condition determine BMP effectiveness.
- May require irrigation to maintain vegetation.
- High maintenance requirements may exist depending on the design condition of the vegetation.
- Unless existing vegetation is used as a buffer strip, an area will need to be provided specifically for a buffer strip and vegetation will need to be established.
- Maintaining sheet flow in buffer strips may be difficult.
- Vegetated channels require a larger area than lined channels.
- Vegetated channels require gradual slopes since runoff with high flow velocity may flow over grass rather than through it.

This page intentionally left blank.

B.2 Storm Water Flow Control

EARTH DIKES, DRAINAGE SWALES, AND LINED DITCHES

SLOPE DRAINS AND SUBSURFACE DRAINS

TOP AND TOE OF SLOPE DIVERSION DITCHES/BERMS

OUTLET PROTECTION/VELOCITY DISSIPATION DEVICES

FLARED CULVERT END SECTIONS

SLOPE ROUGHENING/TERRACING/ROUNDING

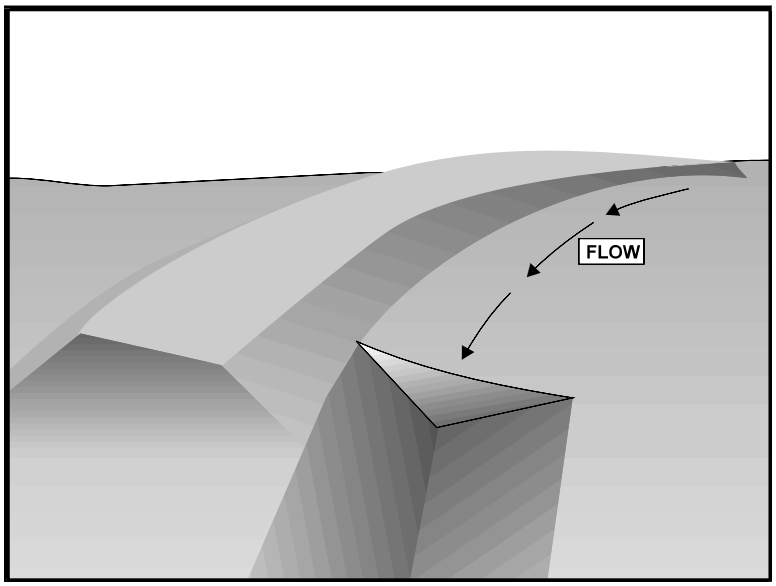
LEVEL SPREADER

This page intentionally left blank.

EARTH DIKES, DRAINAGE SWALES, AND LINED DITCHES

DESCRIPTION AND PURPOSE

Earth dikes, drainage swales, and lined ditches are structures that prevent erosion by intercepting, diverting, and conveying surface run-on to a stabilized area or other sediment trapping device.



APPLICATIONS

Earth dikes, drainage swales, and lined ditches may be applied for the following purposes:

- Direct runoff around unstable or disturbed areas to a stabilized water course, drainage pipe, or channel.
- Divert runoff to sediment basins or sediment traps.
- Intercept runoff at the point of concentration.
- Supplement other sediment control measures.
- Intercept and divert runoff to prevent sheet flow over sloped surfaces.
- Convey surface runoff down sloping land.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

- Firmly compact to minimize erosion and prevent unequal settling.
- Drain to a stabilized outlet.
- Drain sediment laden runoff to a sediment trapping device.
- Ensure continuous, positive grade along dike, swale, or ditch to prevent ponding of runoff.
- Stabilize with vegetation, chemicals, or other physical devices.
- Conform to predevelopment drainage patterns and capacities.
- The design of dikes, swales, and ditches shall be submitted to the HWY-OM Engineer or Hydraulic Section staff for review. The review will evaluate structural stability and drainage capacity.
- Design flow and safety factor shall be determined by an evaluation of risks associated with overtopping, flow backups, or washout of structures.
- Evaluate potential run-on from off-site properties.
- Flow velocity limit shall be determined by on-site soil type and drainage flow patterns.

- Establish minimum flow velocity requiring lining (rip-rap, geotextile filter fabric, vegetation, concrete) for earthen diversion devices. Refer to Highways Division's *Hawaii Statewide Uniform Design Manual for Streets and Highways*.
- Incorporate an emergency overflow section or bypass area into the design for storms exceeding the design storm.

MAINTENANCE AND INSPECTIONS

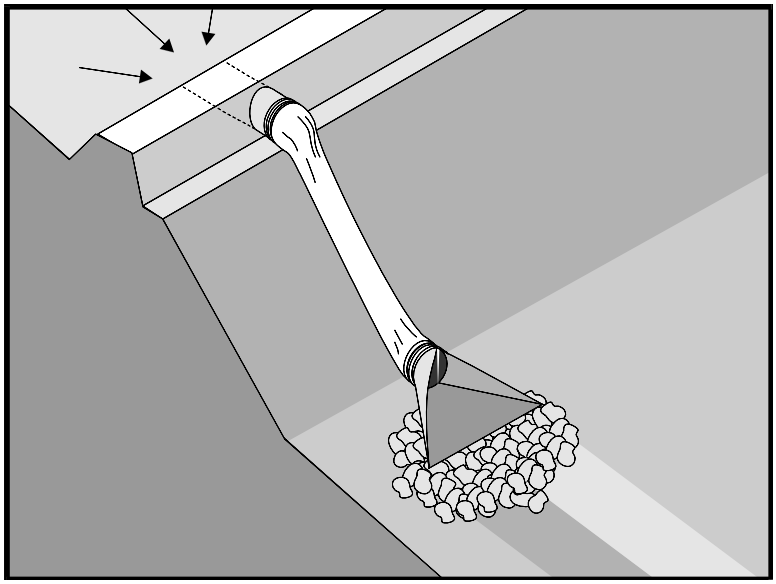
- Inspect dikes, swales, and ditches periodically. Inspections shall include the following:
    - Check for erosion along berms, channel linings, embankments, or beds of ditches. Restore all bare areas with the appropriate lining material;
    - Remove accumulated sediment and debris; and
    - Inspect dike walls, embankments, compacted fills, and earthen channel sidewalls for cracks, washouts, animal habitation, exposed materials, and other signs of potential failure. Restore areas with the appropriate materials. Coordinate restoration with the HWY-OM Engineer or Material Testing and Research Section as necessary. The Hydraulic Section shall also be consulted for problems associated with structural design or runoff flow patterns.

LIMITATIONS

- Unsuitable for use as a sediment trapping device.
- Use of additional sediment and erosion control devices may be required to prevent scour and erosion in recently graded dikes, swales, and ditches.
- Select size and location to prevent unintended consequences such as erosion along steep and unlined ditches and ponding within the travelway or material storage areas. Alteration of existing waterways and clearing of existing vegetation are subject to permit requirements of the U.S. Army Corps of Engineers and state or local agencies.
- Ditches and swales may require check dams or lining to prevent erosion.

SLOPE DRAINS AND SUBSURFACE DRAINS

DESCRIPTION AND PURPOSE



Slope drains and subsurface drains are pipes which prevent erosion along slopes by intercepting and conveying runoff or groundwater from the top of the slope to a stabilized discharge point located at the bottom of the slope. Slope drains are primarily used to convey runoff down cut or fill slopes. Subsurface drains are primarily used to remove water from the soil in sloped areas.

APPLICATIONS

Slope drains and subsurface drains may be used for the following purposes:

- Emergency spillways for sediment basins;
- Use of slope drains apply to the following conditions:
    - Drainage of concentrated runoff from within swales or behind dikes located at the top of slopes, and
    - Drainage of surface runoff to prevent erosion along the slope; and
- Use of subsurface drains applicable to areas where water must be removed from the soil to lower the groundwater table or to prevent excessive soil saturation.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

Design of slope drains shall consider the following:

- Consult with a hydro-geologist or qualified engineer regarding design flows;
- Limit drainage area discharging to slope drain to 5 acres;
- Direct surface runoff into slope drain using interceptor dikes at the top of slope. Refer to Earth Dikes, Drainage Swales, and Lined Ditches in this manual for more information;
- Pipe slope drains exceeding 12 inches in diameter require a standard flared end section or headwall constructed at the inlet and outlet;
- Install lining such as vegetation or geotextile filter fabric to protect area around inlet;
- Install rip-rap or other energy dissipation device at outlets;
- Compact soil under and around inlet, outlet, and along the pipe;
- Slope drains may be installed above ground or buried beneath the slope surface;
- Above ground installation shall utilize pipe anchors to secure pipe to ground;
- Align slope drain perpendicular to contours of slope;

- Generally limit maximum slope to 2:1 (H:V). For slopes exceeding 2:1 (H:V), velocity dissipation is required at the pipe outlet; and
- Direct sediment-laden storm water to a sediment trap or sediment basin.

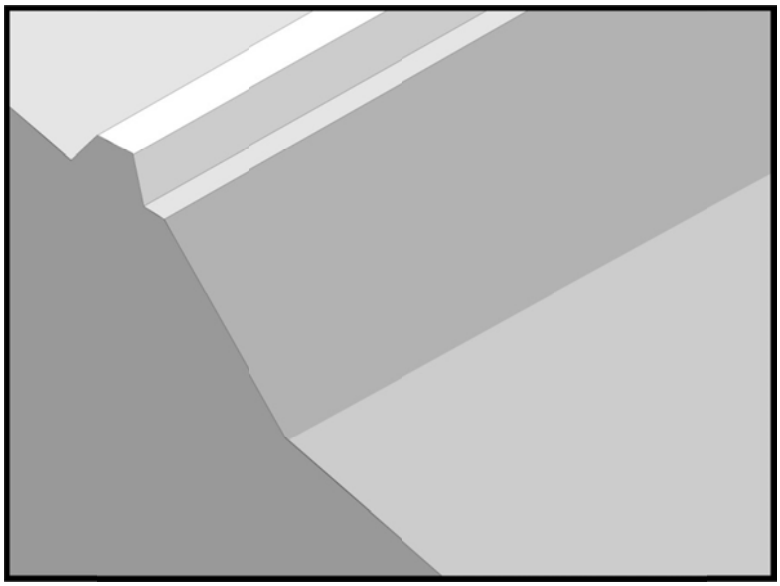
MAINTENANCE AND INSPECTIONS

- Inspect regularly and after significant rainfall events for erosion at outlet and downstream scour. Repair damage and install energy dissipation devices as necessary.
- Inspect slope drains for debris and sediment accumulation. Remove sediment and debris from entrances, outlets, and within drains.
- Inspect pipe anchors to ensure pipe remains anchored to slope.
- Verify ponding does not occur in areas such as active traffic lanes and material storage areas.

LIMITATIONS

- Drainage area discharging to slope drains shall not exceed 5 acres. For larger areas, use multiple pipes, paved chute, or rock lined channel.
- Clogged slope drains direct runoff around pipe which may result in erosion along the slope.
- High flow velocities at the pipe outlet require implementation of velocity dissipation devices to prevent downstream erosion.
- Severe flooding and erosion may result from failure of slope drains.

TOP AND TOE OF SLOPE DIVERSION DITCHES/BERMS



DESCRIPTION AND PURPOSE

Slope diversion ditches and berms are placed along the top and/or toe of slopes to minimize sheet flow over slopes. These devices reduce erosion by intercepting and conveying runoff to sediment removing structures or a protected drainage system.

APPLICATIONS

Top and toe of slope diversion ditches and berms apply to the following:

- Areas which must be protected from runoff flowing down slopes; and
- Areas where runoff must be intercepted at bottom of slope.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

- Design flows and safety factors shall be determined by an evaluation of risks associated with erosion and overtopping, flow backups, or structure washouts. Consult with the HWY-OM Engineer or Hydraulic Section to determine these values.
- Line or stabilize ditches with high flow velocities.
- Direct flows at top of slopes to slope drains. Refer to Slope Drains and Subsurface Drains in this manual for more information.
- Protect outlets from erosion.

MAINTENANCE AND INSPECTIONS

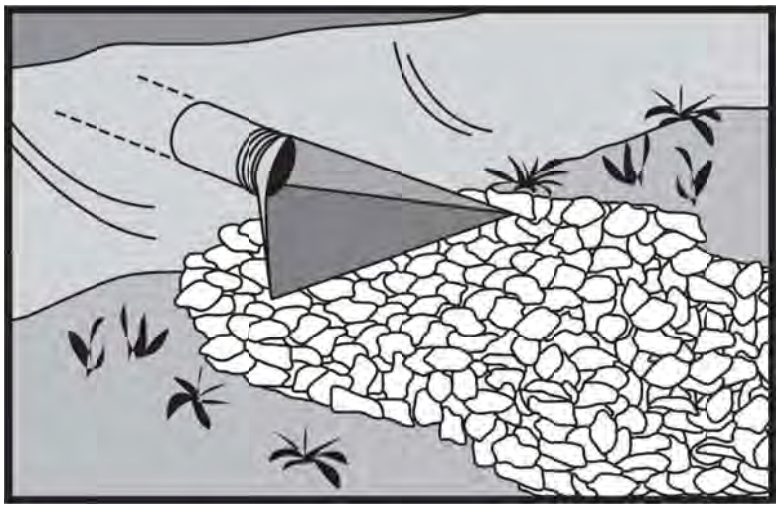
- Inspect prior to the rainy season and after rainfall events exceeding the design storm intensity (25-year recurrence interval, 1-hour duration), unless otherwise directed.
- Inspect ditches/berms for washouts. Repair requirements shall be reported and include replacement of rip-rap, damaged lining, or soil stabilizers and compaction and revegetation of fill berms and ditches.
- Establish a repair schedule with priority assigned to areas with compromised highway safety and Class AA and Class 1 waters (refer to HAR Chapter 11-54 for State water classification). Repair work for remaining areas shall be based on potential erosion, potential habitat damage, and land use of areas located downslope.
- All repairs shall be completed within 1 year of inspection.

- Inspect structures for accumulated sediment and debris and remove as necessary. The schedule for removal of sediment and debris shall be as described in the repair section.

LIMITATIONS

- Additional sediment trapping BMP devices may be necessary for sediment-laden runoff.

OUTLET PROTECTION AND VELOCITY DISSIPATION DEVICES



DESCRIPTION AND PURPOSE

Devices placed at outlets of pipes and channels prevent or minimize scouring and erosion resulting from the high velocity of storm water flows.

APPLICATIONS

Applicable conditions include the following:

- Outlets with continuous flows.
- Outlets located at the bottom of slopes.
- Outlets subject to short, intense flows.
- Discharge points from lined conveyances to unlined conveyances.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

- Apron length shall be determined by outlet flow rate and tailwater level.
- Align apron with direction of flow and avoid curves in apron. If a curve is necessary, place it in the upper section of the apron.
- Protect the underlying geotextile filter fabric with a 4 inch minimum rock blanket if the rip-rap is 12 inches or larger.

MAINTENANCE AND INSPECTIONS

- Establish an inspection schedule and inspect all structures a minimum of once every three years.
- Inspect beneath the rip-rap and around the outlet for scour. Immediately repair damaged slopes or underlying geotextile filter fabric with priorities based on highway safety and protection of Class AA and Class 1 waters, followed by erosion potential and possible damage to down-slope areas.
- Inspect apron for damage to underlying geotextile filter fabric or dislodged rip-rap. Report any damage exceeding 10% of the apron surface area for evaluation by the HWY-OM Engineer or Highway Design Section, as appropriate.

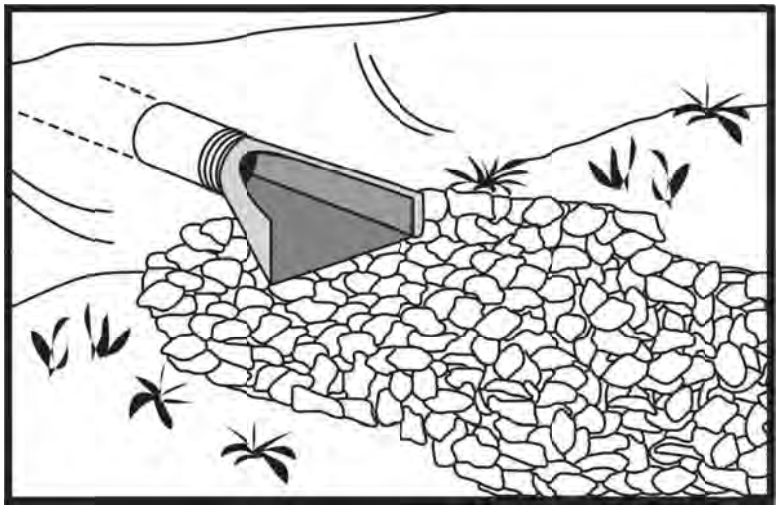
LIMITATIONS

- Potential for stones to wash away.
- Break up of grouted riprap resulting from hydrostatic pressure caused by water accumulation.

FLARED CULVERT END SECTIONS

DESCRIPTION AND PURPOSE

Flared culvert end sections are devices placed at the inlet or outlet of pipes and channels to enhance hydraulic operation while minimizing scour and erosion.



APPLICATIONS

Flared culvert end sections may be placed at inlets and outlets of slope drains and culverts.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

- Construct on level ground where possible.
- Supplement with other outlet protection.
- Protect the transition to the flared end section at inlets to prevent scouring.
- Obtain guidance from the District Maintenance Engineer or Highways Division's Hydraulic Section and refer to Highways Division's Standard Plans.

MAINTENANCE AND INSPECTIONS

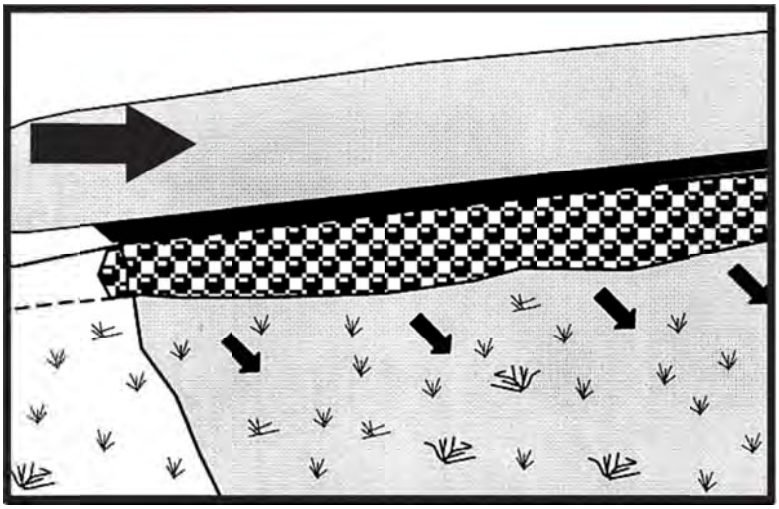
- Establish an inspection schedule and conduct inspections a minimum of once every three years.
- Monitor accumulation of debris and sediment and remove within 60 days of notification. Immediately clean culverts located where Class AA or Class 1 waters or highway safety may be adversely affected. Refer to HAR Chapter 11-54 for State waters classification.
- Inspect around and beneath flared end sections for scour. Report any scour exceeding 10% of the flared end section area for evaluation by the HWY-OM Engineer or Highway Design Section, as appropriate.
- Establish a repair schedule with priorities based on highway safety and protection of Class AA and Class 1 waters, followed by erosion potential and possible damage to down-slope areas.

LIMITATIONS

- Limited use as an erosion control measure since primarily used to increase hydraulic efficiency.

This page intentionally left blank.

LEVEL SPREADER



DESCRIPTION AND PURPOSE

Level spreaders are devices used at outlets that convert concentrated flow to sheet flow preventing erosion of the receiving area. Tops of channels, earthen berms, or rigid weir-like structures may function as level spreaders.

APPLICATIONS

Level spreaders may be used for the following:

- Flat or gentle sloping areas.
- Oulets for dikes and diversions.

INSTALLATION AND IMPLEMENTATION REQUIREMENTS

- Construct on undisturbed soil.
- Do not construct on fill material.
- Locate where re-concentration of water will not occur.
- A stabilized and well vegetated slope of less than 10% shall be located below the level spreader.
- Filter runoff containing high sediment loads through a sediment-trapping device prior to release to the level spreader.
- Incorporate a rigid outlet lip design for high discharge flows.
- Zero percent grade on the spreader lip is necessary for uniform sheetflow.
- Avoid operating vehicles and heavy equipment on the level spreader to maintain a smooth level surface for the overflow weir.

MAINTENANCE AND INSPECTIONS

- Conduct inspections of the level spreaders prior to the rainy season and after rain events exceeding the design storm intensity (25 year recurrence interval, 1 hour duration, unless otherwise directed).
- Inspect level spreader channel for accumulation of debris and sediment regularly and remove debris and sediment.
- Verify a slope of zero percent along the spreader lip.
- Inspect the discharge area for signs of erosion or concentrated flow.

LIMITATIONS

- Not applicable to sediment laden runoff.

CON APPENDIX C
USAG-HI Storm Water Pollution Prevention Plan Content Review Checklist

This page intentionally left blank.

U.S. Army Garrison-Hawaii
Storm Water Pollution Prevention Plan Content Review Checklist

Project Name: _____ Location:_____ Date: _____

NPDES Tracking No: _____ Reviewed By:_____ Contractor Name_____

Permit Citation	Are the required SWPPP elements included?	Yes	No	N/A	Comments/ Notes
	Project Activity and Description				
7.2.1	SWPPP identifies a "storm water team" including personnel name and individual responsibilities				
7.2.2	Defines the nature of construction activities, total site area (in acres) that is expected to be disturbed by construction activities (including any off-site areas)				
	Indicates the maximum area expected to be disturbed at one time				
7.2.3	If applicable, an explanation is given if the project is in response to a public emergency or natural disaster				
7.2.4	Provides the name of all contractors and indicates the areas of the project each contractor controls				
	Project Scheduling				
7.2.5	Contains a sequence of scheduled construction activities and approximate start and end dates				
7.2.5.1	Includes a schedule of the approximate dates storm water control measures will be installed and made operational				
7.2.5.2	Maintains a schedule of the initiation and duration of earth-disturbing activities including when grading, excavating and filling activities will occur				
7.2.5.3	If applicable, the work schedule indicates when construction activity will be temporarily or permanently ceased				
7.2.5.4 & 5.2.1	The dates of temporary and final site stabilization are included, including when ground disturbance will occur, which is consistent to stabilizing soil immediately after earth-disturbing activities have ceased on all portions of the site				

7.2.5.5	The schedule includes approximate dates of when temporary storm water control measures, construction equipment, and vehicles will be removed from the project site				
	The schedule outlines the estimated start and end dates of pollutant-generating activities				
	Site Maps and Work Boundaries				
7.2.6	Contains a legible site map showing property boundaries and locations where construction activities will occur				
7.2.6.1.	Map includes approximate slopes before and after grading and drainage patterns with flow patterns				
7.2.6.1.c & 7.2.6.1.d	Map includes locations where sediment, soil and other materials will be stockpiled, including contaminated spoils				
7.2.6.1.e & 7.2.6.1.f	Crossings of any state waters and vehicle exit points (to paved roads) are included				
7.2.6.1.g	All impervious surfaces are identified including built structures (upon completion of construction)				
7.2.6.1.h	Construction support area locations are included				
7.2.6.2	Site maps include locations of all state waters and listed impaired water bodies within or in the immediate vicinity of the project site				
7.2.6.3	If state waters are identified within 50 feet of earth disturbances, the map provides boundary lines of natural buffers (50-foot undisturbed) or buffers with double sediment control				
7.2.6.4	Map includes topography of the site, existing vegetation cover and drainage patterns of storm water onto, over and from the site property before and after major grading activities				
	Storm Water Discharge Locations				
7.2.6.5	Storm drain inlets have been located on and near the immediate vicinity of the sites that receive project storm water discharge				
7.2.6.7& 7.2.6.8	Includes the locations of storm water control measures and the locations where chemicals will be used and stored				
	Construction Site Pollutants				
7.2.7.a	A list and description of all pollutant-generating activities are included				

7.2.7.b	Inventory of pollutants or pollutant constituents for each pollutant-generating activity that could be discharged from the construction site are listed				
7.2.8	All sources of non-storm water are identified, including control measures to prevent discharges				
7.2.9	If state waters are located within 50 feet of project earth disturbances, natural buffers and additional sediment control measures are described				
	Erosion and Sediment Control				
7.2.10.1	All storm water control measures that will be installed and maintained on the project site are described				
7.2.10.1.a	Information is included on the type and design of all storm water control measures to be implemented and maintained				
7.2.10.1.b	Site specific sediment controls will be made operational prior to the initiation of earth disturbing activities				
7.2.10.1.c	If applicable, control measures are enacted to prevent the contact of any contaminated soil to storm water				
7.2.10.1.d	Stabilization techniques are used for vehicle exit points				
7.2.10.1.e	If applicable, linear project's BMPs are documented to the extent practicable				
7.2.10.2	Specific vegetative and/or non-vegetative stabilization measures are outlined				
	Post Construction and Spill Prevention Management				
7.2.10.3	Post construction BMP measures are described				
7.2.11.1	A spill prevention plan is included with spill response procedures for stopping, containing and cleaning up spills				
7.2.11.1.b	Procedures are defined for notifying appropriate facility personnel in the case of a hazardous substance spill				
7.2.11.2	Measures for handling and disposing of waste (including hazardous, sanitary) generated onsite are outlined				
	Staff Training Documentation and Inspections				
7.2.12	Procedures for maintaining storm water control measures, conducting inspections and taking corrective actions are outlined				

7.2.12.a, 7.2.12.b & 7.2.12.c	Personnel responsible for conducting inspections, an inspection schedule and any implemented inspection forms are included				
7.2.13	Documentation included shows personnel have been trained on their specific responsibilities				
7.2.14	If applicable, documentation of compliance with the Safe Drinking Water Act Underground Injection Control (UIC) is included				
7.2.15	The contactors information is listed (name, position title, address, phone, email)				
7.2.15.2.a	If applicable, the following are included: a copy of the drainage system owner's approval, county-approved grading permit, section 401 water quality certification and a copy of the department of the army permit				
	SWPPP Certifications and Amendments				
7.2.17	The SWPPP has been certified, signed and dated				
7.2.18.a & 7.2.18.b	After the issuance of the NGPC the SWPPP includes a copy of the NOI (with any correspondence with the department) and a copy of the NGPC including attachments				
7.4.1.4.	If applicable, where the department requires additional discharge requirements, a copy of any correspondence is included with a description of additional storm water control measures				
7.4.4	If applicable, modifications made to the SWPPP are certified, signed and dated by the Certifying Person				
	Is a hydrotesting or other non-storm water permit required?				

Additional Comments:
Date Corrections Received by DPW ENV:

DPW Environmental, Clean Water Program will not allow construction to commence on any contract or in-house project until a Clean Water Program employee has reviewed the SWPPP to verify that it meets the requirements of HAR, Chapter 11-55, Appendix C and any other requirements under the NPDES permit program.

The SWPPP document has been reviewed according to the above criteria.

_____ _____

Reviewed By (DPW-ENV Clean Water Program Signature) Date

This page intentionally left blank.

CON APPENDIX D
USAG-HI Letter Of Authorization SAMPLE

This page intentionally left blank.

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
DIRECTORATE OF PUBLIC WORKS
947 WRIGHT AVENUE, WHEELER ARMY AIRFIELD
SCHOFIELD BARRACKS, HAWAII 96857-5013

REPLY TO
ATTENTION OF:

MAR 19 2015

Directorate of Public Works

Mr. Anthony Peresa
USACE Schofield Barracks Residence Office
USAED Honolulu Bldg 230
Fort Shafter, HI 96858

Dear Mr. Paresa:

The "Notice of Intent, Discharge of Storm Water Associated with Construction Activities" requires written approval from the Directorate of Public Works (DPW) in order to allow your contractor to discharge into the Army's storm drain system.

I approve the USACE and its subcontractors to discharge storm water runoff to the Army's storm drain system during the construction of the Drain System Repair Project at Trimble and Maile Road, Schofield Barracks provided all conditions of the Hawaii Department of Health Clean Water Branch issued permit, all applicable regulations and the site specific Storm Water Pollution Prevention Plan (SWPPP) are met.

The contractor must notify DPW Environmental after Best Management Pratices are installed but before construction activities begin so that an initial inspection can be conducted. Construction site visits will be conducted by DPW, Environmental Division staff to ensure compliance with the construction site SWPPP.

If you require assistance, please contact Mr.Clinton Pandaraoan, Clean Water Program Manager, DPW at 656-3105 or clinton.u.pandaraoan.civ@mail.mil.

Sincerely,

Steven M. Raymond
Director of Public Works

This page intentionally left blank.

CON APPENDIX E
USAG-HI Initial BMP Site Inspection Checklist

This page intentionally left blank.

INITIAL BMP SITE INSPECTION CHECKLIST

Site Name: _____ Installation: _____ Location: _____

Date: _____ Permit Number:_____ Inspector: _____

Inspection Criteria	Yes	No	N/A	Comments
Is the inspection occurring before the initiation of ground-disturbing activities?				
Is the SWPPP/ BMP plan complete including all site maps?				
Are BMPs installed in the locations specified in the plan?				
Are all site BMPs and erosion/sediment controls installed correctly?				
Are good housekeeping practices used?				
Is the site in compliance with all Permittee-accepted permits, plans?				
Will other pollutant discharges occur as a result of the project's construction activity?				
Will any part of the site have the potential for erosion and sediment runoff?				

Additional Comments:

CON APPENDIX F
USAG-HI Corrective Procedures for Construction Storm Water Inspections

This page intentionally left blank.

REQUIREMENT

In accordance with the US Army Garrison, Hawaii (USAG-HI) Municipal Separate Storm Sewer System (MS4) Permit Number HI S000090 effective April 7, 2014, Part D.1.d.(5)(iv), USAG-HI is required to submit reporting and corrective procedures for construction site inspections. This document establishes construction site inspection, corrective actions, tracking and reporting procedures to ensure compliance with the MS4 permit requirements.

DEFINITIONS

The terms minor, major and critical when relating to deficiencies in this document are defined as the following:

Critical Deficiency: A deficiency that poses an immediate risk of discharge of pollutants to a storm drain MS4 system, surface waters or State waters. Critical deficiencies include, but are not limited to, the following examples:

- Any evidence or observed discharge of non-storm water to the storm drain system, surface waters, or State waters generated by construction activity
- No SWPPP document or NPDES permit
- Absence of perimeter controls and/or linear barriers required by the SWPPP document
- There are identified storm drain inlets, surface waters, or State waters within or adjacent to the project site in close proximity to disturbed soil areas without control measures in place that pose an immediate threat of untreated storm water discharges;
- Work in an active stream channel or other surface water body without proper implementation of required BMPs; and
- Any presence of any spilled oil or hazardous materials near to unprotected storm drain inlets, surface waters, or State waters

Major Deficiency: A deficiency that is a significant issue that could result in the discharge of pollutants to the storm drain system, surface waters or State waters. Major deficiencies include, but are not limited to, the following examples:

- Linear barriers and/or perimeter controls in areas tributary to a water body or drain inlet that are installed as required by the SWPPP document, but are not functional, such as silt fences that are not anchored properly, have collapsed, or are overwhelmed by accumulated sediment;
- Hazardous materials or waste stored within a project without containment or implementation of BMPs;
- Any fluid spills covering more than one square yard and/or are adjacent to protected storm drain inlets, surface waters, or State waters;
- Sediment tracking more than 50 feet from project entrance/exit location(s);
- Expansion of the active disturbed soil area limit without written approval

- Soil stabilization and sediment controls are not installed in accordance with the current SWPPP document/ BMP site map;
- Sediment controls are installed in accordance with the SWPPP document, but there is a large unstabilized disturbed soil area with insufficient controls down gradient to prevent the discharge of untreated storm water to the storm drain system, surface waters, or State waters if a rain event generates runoff; and
- Dust from project site visibly blowing off the site and into storm drain conveyances or adjacent surface water bodies.

Minor Deficiency: A deficiency that does not pose a threat of discharge of untreated storm water or pollutants to the storm drain system, surface waters, or State waters, but are not in direct conformance with the SWPPP document. Minor deficiencies include, but are not limited to, the following examples:

- BMPs are not deficient, but are not consistent with the SWPPP plan;
- SWPPP does not reflect current operations and an amendment is recommended;
- Linear barriers and/ or perimeter controls are properly installed according to the SWPPP document, but require minor maintenance
- Sediment controls are installed per the SWPPP plan, but not properly maintained;
- Site inspections by project staff are not being conducted at the required frequencies;
- Non-storm water or waste management BMPs that are improperly maintained;
- Any fluid spills covering less than one square yard and not adjacent to storm drain inlets, surface waters, or State waters;
- Evidence of active wind erosion on unstabilized slopes/stock piles;
- Minor tracking less than 50 feet from project entry/exit locations and
- Major deficiencies which are corrected prior to the inspector leaving the site

PROCEDURES

Permit Citation	Permit Requirement	DPW Environmental Procedure
Part D.1.d(4)	Plan review and approval	DPW Environmental will review all project SWPPP's and supporting documents. DPW Environmental will verify that all documents meet HAR, Chapter 11-55, Appendix C, section 7 and approved BMP manual requirements by using an approved SWPPP document checklist. Comments and notes will be made to the document preparer if any SWPPP elements are omitted or any portion is believed insufficient. Deficiencies will be noted with the date comments were addressed by the document preparer to the satisfaction of DPW Environmental.
Part D.1.d(5)i	Inspections	Prior to the start of any ground-disturbing activities, except for activities associated with the installation of BMPs at a site, the qualified DPW Environmental inspector will inspect the site to verify BMPs have been properly installed to the SWPPP specifications. The inspector will document any site conditions having the potential for erosion and sediment runoff as a result of the project's construction activities. A spreadsheet will be used to verify all comments made by DPW Environmental during the review process have been properly resolved.
Part D.1.d.(5)ii,	Inspection frequency	All contract, in-house and maintenance construction projects greater than one acre will be inspected at least monthly by an independent qualified DPW Environmental construction inspector(s), who is familiar with the project SWPPP. Initial inspections will verify BMPs have been properly installed prior to the start of earth disturbing activities. The inspector(s) will use the attached "Construction Oversight Field Inspection Checklist" that will document any BMP deficiencies and inconsistencies between the approved SWPPP and project site conditions. The inspection form will include the date, inspection observations with photographs, potential noncompliance issue(s) and any necessary corrective actions needed to be addressed. Inspection forms will be sent (via email) to the construction contractor and the United States Army Corps of Engineers (USACE) project manager(s) within 48 hours of the inspection (working business days). A photographic log will be kept to document all minor, major and critical issues observed on site. A response (via email) from the contracting project manager to DPW Environmental verifying (with photographs, maps.ect) appropriate corrective action was taken to address the identified deficiencies is expected within 5 calendar days

		of receiving the inspection form. DPW Environmental will track all inspections using an internal public share drive. Upon three successive monthly site inspections that indicate, in total, no critical or major project BMP and storm water control deficiencies or less than six minor deficiencies with no more than three minor deficiencies in one month, DPW Environmental may decrease inspection frequency to quarterly per the permit. This will be at the discretion of the DPW Environmental qualified inspector(s). However, If under quarterly inspection frequency, a critical deficiency is observed or three (3) or more minor deficiencies are detected, inspection frequency shall return to no less than monthly. All reporting and tracking procedures will be kept consistent using the DPW Environmental internal share drive.
Part D.1.d(5).ii	Corrective actions and reporting	If any critical deficiencies are observed DPW Environmental will immediately notify DOH verbally and in writing. DPW Environmental will verbally notify the responsible construction contractor and ensure all critical deficiencies are addressed and adequately corrected before the close of business day on the day the deficiency is identified. In the event a major deficiency is detected, DPW Environmental will immediately send a written notification with an attached inspection checklist containing photographs to the responsible construction contractor and USACE project manager(s) explaining the site nonconformities. DPW Environmental will ensure all major deficiencies are addressed or corrected as soon as possible, but in no event later than five calendar days after the deficiency is identified or before the next forecasted rain event, whichever is sooner. In the event a minor deficiency is detected, DPW Environmental will document the issue using the approved inspection checklist, photograph log and internal project tracking system. The responsible construction contractor and USACE project manager(s) will be notified verbally of any non conformities at the end of the inspection and provided an emailed copy of the inspection form (with attached photographs) within 48 hours of the inspection (normal business days). A response from the contractor documenting the corrective action taken to address the identified issues is expected within 5 calendar days from receiving the completed inspection form. Per the permit, the DPW Environmental qualified construction inspector(s) will conduct follow-up inspections as needed, at least monthly to ensure site deficiencies have been properly addressed and all storm water controls are in proper working order. Inspections will also be conducted upon complaints from citizens or concerned

		groups. Unannounced and follow-up inspections will be conducted as necessary. For all projects, if the corrective measures are not completed, then the deficiency will be elevated to the DPW Director. A written correspondence will be sent to the USACE Chief of Construction and Regional Project Managers, or to the principal executive officer within Lend Lease/Island Palm Community requesting a timeline and resolution
	Record keeping	Electronic inspection reports, spreadsheets and supporting photographic logs will be kept on file with the DPW Environmental Division. Records shall be kept for five (5) years in accordance with the NPDES permit.

This page intentionally left blank.

CON APPENDIX G
USAG-HI Construction Oversight Field Inspection Checklist

This page intentionally left blank.

Construction Oversight Field Inspection Checklist

Inspection Date:		Name and phone # of those present during inspection:	
Time:			

Site Information

Construction site name:	
Permit number:	Location/ watershed:
Inspection: ☐ Announced ☐ Unannounced	Surface waters located within 50 feet of disturbance? ☐ Yes ☐ No
Approximate % of exposed site: _____	Phase (if construction site is multi-phased):
Construction stage: ☐ Preliminary Stage ☐ Mass Grading Stage ☐ Streets and Utilities Stage ☐ Vertical Construction Stage	
Completed Activities:	

Weather and Discharge Observations

Weather during inspection: (*complete weather observations below if inspection performed during rain event*)

Date rain predicted to occur:		Predicted % chance of rain:	
Estimate storm beginning: _____ (date and time)	Estimate storm duration: _____ (hours)	Estimate time since last storm: _____ (days or hours)	Rain gauge reading: _____ (inches)

Discharge Observations (if inspection performed during a rain event) Location(s):

Odors	Yes ☐	No ☐	N/A ☐	Floating material	Yes ☐	No ☐	N/A ☐
Suspended Material	Yes ☐	No ☐	N/A ☐	Sheen	Yes ☐	No ☐	N/A ☐
Discolorations	Yes ☐	No ☐	N/A ☐	Turbidity	Yes ☐	No ☐	N/A ☐

BMP Effectiveness

(*add additional sheets or attached detailed BMP Inspection Checklists*)

Outfalls or BMPs Evaluated	Deficiencies/ Comments
EROSION CONTROL (vegetation preservation, etc. see SWPPP)	
SEDIMENT CONTROL – Storm drain inlet protection	
HOUSE KEEPING- General housekeeping , washout facilities, litter, solid waste	
SEDIMENT CONTROL – Tracking control	
SEDIMENT CONTROL – Perimeter control/silt fence	
NON-STORMWATER – Vehicle & equipment fueling, storage, and maintenance	
NON-STORMWATER – Other (paving, concrete, water conservation)	

WASTE MANAGEMENT – Material and stockpile management	
Photos Taken: Yes ☐ No ☐	Photo Reference IDs:

Site Inspections, Monitoring, and Sampling

Requirement			Comments
SWPPP Retained Onsite:	Yes ☐	No ☐	
SWPPP Site maps Current:	Yes ☐	No ☐	
Weekly Inspections Performed:	Yes ☐	No ☐	
Amendment log up to date:	Yes ☐	No ☐	
Inspections conducted within 24 hours of storm event of< 0.25 inches:	Yes ☐	No ☐	
Documented staff training:	Yes ☐	No ☐	

Corrective Actions Identified

Corrective Action:	
Location:	
Follow-up:	Date correction received: _____ Photo reference: _____ Initials: _____
Corrective Action:	
Location:	
Follow-up:	Date correction received: _____ Photo reference: _____ Initials: _____
Corrective Action:	
Location:	
Follow-up:	Date correction received: _____ Photo reference: _____ Initials: _____

Inspector Information

Inspector Name:	Inspector Title:
Signature:	Date:

CON APPENDIX H
USAG-HI Construction Site Runoff Control Enforcement Program Policy Memo - DRAFT

This page intentionally left blank.

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND, PACIFIC REGION
HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
745 WRIGHT AVENUE, BUILDING 107, WHEELER ARMY AIRFIELD
SCHOFIELD BARRACKS, HAWAII 96857-5000

REPLY TO
ATTENTION OF:

IMHW-ZA

MEMORANDUM FOR ALL Military Personnel and Department of Defense Civilian Employees within United States Army Garrison, Hawaii (USAG-HI) Installations

SUBJECT: Policy Memorandum USAG-HI-__, Construction Site Runoff Control Enforcement Program

1. References.

a. Army Regulation (AR) 200-1, Environmental Protection and Enhancement, 13 Dec 07.

b. USAG-HI National Pollutant Discharge Elimination System Permit Number HI S000090, 7 Apr 14.

c. USAG-HI Storm Water Management Plan, Construction Site Runoff Control Enforcement Response Plan.

d. Hawaii Administrative Rules, Title 11 Department of Health, Chapter 54 Water Quality Standards (HAR 11-54) and Chapter 55 Water Pollution Control (HAR 11-55), 15 Nov 14.

2. Purpose. To provide a formal, written Construction Site Runoff Control Program enforcement policy statement to ensure that garrison facilities and activities are in compliance with the requirements of the USAG-HI National Pollutant Discharge Elimination System (NPDES) permit and the State's General Permit for construction activities.

3. Background. The Hawaii State Department of Health (SDOH), Clean Water Branch (CWB) issued USAG-HI an NPDES Municipal Separate Storm Sewer System (MS4) permit effective 7 Apr 14. This policy is prepared in compliance with Part D.1.d.(6) of the permit which requires USAG-HI to perform the following:

Establish policies for enforcement and penalties for entities found to be in non-compliance with requirements developed in accordance with Construction Site Runoff Control Best Management Practices (BMPs) and NPDES General Permit coverage if applicable.

4. Applicability. This policy applies to all Soldiers, Civilians, Family members, contractors, subcontractors and other personnel who work on, reside on, or visit any US Army installation, facility, or work site in the State of Hawaii.

DRAFT

5. General. The USAG-HI holds an NPDES permit issued by the SDOH CWB. The permit requires the USAG-HI to develop and implement a Storm Water Management Plan (SWMP) and Construction Site Runoff Control procedures for all construction projects to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP) from its MS4 to waters of the State. The Directorate of Public Works (DPW) is required by the permit to develop and implement enforcement procedures and policies. All construction projects must use BMPs to reduce the discharge of pollutants to the MEP. In addition, if the construction site disturbs one acre or more then NPDES General Permit coverage must be obtained prior to the start of construction activities in accordance with HAR 11-55, Appendix C. To obtain NPDES General Permit coverage, an application must be submitted to the SDOH. The SDOH requires the construction contractor to prepare a Storm Water Pollution Prevention Plan (SWPPP) prior to submitting the permit application. In accordance with the NPDES General Permit, erosion and sediment control BMPs must be in place and functional before earth moving operations begin and must be maintained through the duration of the project.

a. Inspections. DPW ENV must inspect construction sites to maintain compliance with the USAG-HI NPDES permit. Inspections may be scheduled or un-announced and will be conducted in accordance with part D.1.d.(5) of the permit and the USAG-HI Construction Site Runoff Control Enforcement Response Plan (ERP).

(1) A certified EnviroCert International, Inc. inspector or other qualified DPW-ENV inspector(s) familiar with the project SWPPP shall conduct construction site inspections on a regular basis (frequency depends on size and permit requirements) and upon complaints from citizens or concerned groups for all construction activities.

(2) DPW ENV will send the relevant Contracting Officer, Project Manager, and/or DPW Division and Branch Chiefs written notification using the Construction Oversight Field Inspection Checklist with attached photographs within 48 hours of the inspection (normal business days).

b. Violations/Findings. Violations can occur when the Contractor is not in full compliance with the applicable State permits and regulations or the site specific SWPPP, fails to address non-compliances as directed by DPW ENV, or discharges pollutants into the Army's MS4. Categories of non-compliances may include but are not limited to deficiencies in storm water and erosion control measures and failure to meet administrative requirements. Non-compliances may be identified through DPW ENV personnel conducting random wet weather construction inspections or unannounced construction storm water inspections, scheduled routine inspections of NPDES General Permit covered projects, public complaints, and inspections or audits by regulatory agencies such as the SDOH or Environmental Protection Agency (EPA).

DRAFT

(1) The construction site superintendant or representative will be notified on the spot of any inconsistencies between the approved SWPPP and the actual site conditions and any other finding or violation. The construction site superintendant or representative shall immediately correct the deficiency when possible.

(2) If the deficiency cannot be corrected immediately, DPW ENV will send the relevant Project Manager and/or DPW Division and Branch Chiefs notification of the deficiency via email. A written response from the contractor documenting the corrective action taken to address the identified issues is expected within five (5) calendar days from receipt of the completed inspection form. The response should include what actions were taken to correct the deficiency, photo documentation, and the date(s) when actions were completed.

(3) DPW ENV qualified construction inspector(s) will conduct follow-up inspections as needed to ensure site deficiencies have been properly addressed and all storm water controls are in proper working order.

c. Enforcement. If the contractor does not correct deficiencies identified during the inspection then the following enforcement procedures will be initiated:

(1) For all projects, if the corrective measures are not completed, then the deficiency will be elevated to the DPW Director who is USAG-HI's authorized representative. A written correspondence will be sent to the relevant Contracting Officer, DPW Division Chief, or Owner/Representative of the project requesting a timeline and resolution in accordance with the USAG-HI Construction Site Runoff Control ERP.

(2) If a resolution is not provided then the project Contracting Officer has several options which may include withholding payment, stopping work, or termination for convenience or default.

(3) In the event that the non-compliance has not been resolved and DPW has exhausted its use of sanctions and cannot bring a construction site or construction operator into compliance with its policies, standards, or the USAG-HI NPDES permit, or if DPW believes the site poses an immediate and significant threat to water quality, DPW ENV shall, in accordance with permit Part D.1.d.(7): provide an email notification to the SDOH CWB Enforcement Section within one week of such determination. Email notification will be followed by written notification and include supporting inspection documentation (e.g. checklists, notes) and correspondence within two (2) weeks of determining a site is non-compliant. In instances where an inspector identifies a site

DRAFT

that has not applied for permit coverage under the NPDES permit program, DPW ENV will provide written notification to SDOH CWB Enforcement Section within two (2) weeks of the discovery.

d. Penalties. For all projects, the contractor shall be solely responsible for remedying all Federal, State and local environmental and safety violations or non-compliance and any payment of fines, penalties and fees levied as a result of the violations or non-compliance. The government reserves the right to withhold payment in the amount of the fines, penalties, and fees levied if not paid by the contractor. Violation of the Clean Water Act can result in fines of up to $25,000 per violation per day and/or criminal enforcement actions including imprisonment.

e. Record Keeping. Findings and inspection reports shall be kept on file with the DPW Environmental Division. Records shall be kept for five (5) years in accordance with the permit.

6. The Construction Site Runoff Control Enforcement Program policy shall be given widest dissemination. This policy memorandum will be available for download at: www.garrison.hawaii.army.mil/sites/policies/policies.asp and available to the public upon request.

7. This policy supersedes Policy Memorandum Subject: United States Army Garrison, Hawaii Enforcement Procedures and Actions for Construction Storm Water Management, dated 27 Aug 13 and remains in effect until superseded or cancelled in writing.

8. Proponent. The proponent for administration of the USAG-HI Construction Site Runoff Control Enforcement Program policy is the DPW Environmental Division, at 656-5790.

DRAFT

RICHARD A. FROMM
COL, AD
Commanding

DISTRIBUTION
Electronic Media

CON APPENDIX I
USAG-HI Construction Site Runoff Control Enforcement Response Plan

This page intentionally left blank.

REQUIREMENT

The State Department of Health (SDOH), Clean Water Branch (CWB) issued U.S. Army Garrison, Hawaii (USAG-HI) a National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit effective April 7, 2014. This Enforcement Response Plan (ERP) is being prepared in compliance with Part D.1.d.(6) of the USAG-HI NPDES permit number HI S000090. It describes the USAG-HI program for construction site runoff control implementation and enforcement. Part D.1.d.(6) of the NPDES permit requires USAG-HI to perform the following:

"The Permittee shall establish policies for enforcement and penalties for those in non-compliance with Part D.1.d.(2) requiring the implementation of standards, and Develop and implement an Enforcement Response Plan to include written procedures for appropriate corrective and enforcement actions, and follow-up inspections when an inspected project is not in full compliance with its requirements, other permits, and any other applicable requirements under the NPDES permit program."

The USAG-HI is required to develop and implement the ERP under Part D.1.d, Construction Site Runoff Control Program of the MS4 permit for all construction projects of 1 acre in efforts to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP) from its MS4 to water of the State.

PURPOSE

The purpose of the ERP is to ensure that the design and construction agents (DCA) comply with the requirements of the USAG-HI NPDES permit and the State's General Permit for construction activities disturbing larger than one acre. The intent of this plan is to enforce procedures that will improve water quality at all USAG-HI installations and ensure that construction storm water, sediment, erosion control measures and Best Management Practices (BMPs) are properly designed, installed, and maintained. The ERP provides structure for Directorate of Public Works-Environmental (DPW-ENV) to impose enforcement and penalties on construction projects if necessary.

ENFORCEMENT AUTHORITY

Construction projects of 1 acre or more must obtain NPDES General Permit Coverage (HAR 11-55, Appendix C) prior to construction, and must comply with NPDES General Permit conditions, including implementation, inspection, and maintenance of erosion and sediment controls. All construction projects regardless of size must install erosion and sediment control BMPs before earth moving operations begin to help prevent discharge of pollutants to the Maximum Extent Practicable (MEP). BMPs must be maintained throughout the project and until the site is stabilized. DPW-ENV conducts inspections to ensure the requirements are met. This section provides the legal framework to enforce the construction activities to correct any deficiencies identified during a DPW-ENV inspection.

The construction that occurs on USAG-HI consists primarily of 5 categories. They are Military Construction (MILCON) Army administered by the Army Corps of Engineers (COE), Residential

Communities Initiative currently awarded to ACTUS Lend Lease/Island Palm Communities LLC (IPC), DPW Job Order Contract (JOC), DPW In-House projects and Miscellaneous projects. Occasionally miscellaneous projects occur with other organizations that include: Army Commands, Army Service Component Commands, Direct Reporting Units; Army and Air Force Exchange Service (AAFES); Defense Commissary Agency (DECA); and non-appropriated activities, Army privatization initiatives programs; and all tenant activities. Each has specific contract language mechanisms, lease agreements or procedures that allow DPW to enforce violations identified during construction site inspections. The contracts hold the contractor liable for all environmental fines and clean up costs associated with violations of Federal, State, and local environmental protection laws and regulations. The government reserves the right to withhold payment in the amount of the fines, penalties and fees levied if not paid by the contractor.

Construction Projects and Enforcement Mechanisms

MILCON *Projects*-MILCON projects are executed by the USACE. Almost 100% of projects exceed one acre or more and require NPDES general permit coverage. Typical projects include Barracks, Motor Pools and Maintenance Facilities, Command and Control Facilities, etc. Contract language provides the mechanisms to enforce construction site and runoff control policies and regulations.

USACE General Environmental Standards, Section 52.223.5000

Part 1.11 of Contract# W912CN-13-D-005, Section 01 57 20.00 10- Environmental Protection states, "The Contracting Officer will notify the contractor in writing of any observed non-compliance with Federal, State or local environmental laws or regulations, permits and other elements of the contractors Environmental Protection Plan. After receipt of the notice, the contractor will inform the Contracting Officer of the proposed corrective action and take such action when approved by the contracting Officer. The contracting officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or equitable adjustments allowed for such suspensions. This is in addition to any other actions the contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation or Federal law.

ACTUS/Lend Lease/IPC Projects- All family housing projects are executed by ACTUS. Almost 100% of projects exceed one acre or more and require NPDES general permit coverage. ACTUS has 3 agreements that govern accountability regarding environmental regulations and impacts: Ground Lease Agreement, Municipal Service Agreement and the Design Build Agreement. These documents guarantee that IPC will be responsible for and correct any violation of Federal, State, and local environmental protection laws, permits and regulations. Failure to comply with these documents can result in termination of lease.

JOC, O&E and Miscellaneous *Projects*- JOC and OE projects are executed by the DPW Engineering (ENG) project managers. About 50% of projects exceed one acre or more and require NPDES general permit coverage. Typical projects include road and parking area resurfacing, roofing, small linear utilities replacement, tank removal, AC and Boiler installation, etc. Contract language provides the mechanisms to enforce construction site and runoff control policies and regulations.

Environmental Protection, Section 01430

Part 1.2.2 of Contract# W912CN-10-D-005, Section 01430 Environmental Protection states, "The Contracting Officer will notify the contractor in writing of any observed non-compliance with Federal, State or local laws or regulations, permits and other elements of the contractors Environmental Protection Plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved. If the contractor fails to comply within receipt of such notice, the contracting officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or costs or damages allowed to the contractor for any such suspension.

DPW-In House *Projects*- DPW-In House projects are executed by the shops in DPW Operations and Maintenance (O&M) personnel. These small projects never exceed one acre or more and do not require NPDES general permit coverage. Typical projects include side-walk repair, painting, carpentry, welding, plumbing, transformer replacement, etc. Environmental regulations on DPW O&M projects are enforced with this ERP. If a deficiency is noticed on one of these small projects by anyone on the installation, they can immediately stop work on site and the O&M section supervisor is notified verbally immediately. If the activity continues then the deficiency is reported to the O&M division Chief. If the Division Chief deems it necessary then it can be elevated to the Director of DPW for disciplinary action.

Other Enforcement Policies

Construction BMP Field Manuals-Construction sites must the following City and County of Honolulu design documents serve as guidelines for design, construction and inspections of erosion and sediment control plans and specifications on the USAG-HI Installation. All contracts require the contractor to use:

"Storm Water Best Management Practice Manual: Construction", prepared by the Department of Environmental Services City and County of Honolulu, November 2011.

"Rules Relating to Erosion Control Standards and Guidelines", prepared by the Department of Planning and Permitting City and County of Honolulu, April 1999.

Military Law Enforcement

Military Law Enforcement has the ability to enforce Hawaii State laws through the Assimilative Crimes Act (ACA). The ACA is a Federal statute (18U.S.C.A. § 13) which provides adoption by Congress of State criminal laws for areas of exclusive or concurrent federal jurisdiction if the crime is not punishable under Federal law. In short, when a criminal offense has been committed on land or buildings that have been reserved or acquired by the Federal government, and the offense is not a federal offense, state law will apply to the offense under the ACA. The military police can enforce Hawaii Revised Statue (HRS) Chapter 342D, Water Pollution.

Hawaii Department of Health

USAG-HI National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permits Number HI S000090, dated 07 April 2014.

Hawaii Administrative Rules (HAR), Title 11 Department of Health (DOH), Chapter 54-Water Quality Health (HAR 11-54) and Chapter 55-Water Pollution Control (HAR 11-55)

VIOLATIONS AND METHODS OF DISCOVERY

A certified EnviroCert International, Inc. inspector or other qualified DPW-ENV inspector(s) familiar with the project SWPPP shall conduct monthly inspections, and upon complaints from citizens or concerned groups, for all Military Construction-Army, Lend Lease/IPC, Job Order Contract (JOC), and In-House DPW construction activities disturbing one acre or more. For each inspection, a checklist will be completed and if necessary follow-up actions will be taken per standards identified in DPW-ENVs "*Construction Procedures for Construction Storm Water Inspections*" document (July 2014). Violations can occur when the Contractor is not in full compliance with the applicable State permits and regulations, the site specific SWPPP, fails to address non-compliances as directed by DPW ENV or when the Contractor discharges pollutants into the Army's MS4. Categories of non-compliances may include but not limited to, deficiencies in storm water and erosion control measures and failure to meet administrative requirements. Non-compliances may be identified through DPW ENV personnel conducting random wet weather construction inspections, NPDES covered projects that require scheduled routine inspections, Public complaints, Regulatory Agency inspections of audits (SDOH, EPA) and DPW-ENV unannounced construction storm water inspections.

ENFORCEMENT ACTIONS

USAG-HI DPW uses contract language and lease agreements as mechanisms to enforce violations identified during construction inspections. These documents provide the framework for DPW to initiate the following enforcement actions.

Verbal Notification

The construction site superintendant or representative will be notified of any inconsistencies between the approved SWPPP and the actual site conditions and any other finding or violation on the spot. The construction site superintendant or representative shall immediately correct the deficiency when possible or bay end of working day in accordance with the "Reporting and corrective procedures for Stormwater Construction Inspections".

Electronic Notification

If the deficiency cannot be corrected immediately, DPW ENV will send the relevant project Contracting Officer, Project Manager and/or Division and Branch Chiefs notification of the deficiency via email within 48 hours which will include the "Construction Oversight Field Inspection Checklist" and photo documentation. An electronic response from the contractor documenting the corrective action taken to address the deficiencies is expected within 5 calendar days or before next forecasted precipitation from receiving the completed inspection form. The response should include what actions were taken to correct the deficiency, photo documentation and the date the actions were completed. Per the MS4 permit, the DPW Environmental qualified construction inspector(s) will conduct follow-up inspections as needed to ensure site deficiencies have been properly addressed and all storm water controls are in proper working order.

Written Notification

For all projects, if the corrective measures are not completed, then DPW ENV will notify the project Contracting Officer. The Contracting Officer will notify the contractor in writing of any violations of deficiencies. The contractor shall, after receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved. If the contractor fails to comply within receipt of such notice, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or costs or damages allowed to the contractor for any such suspension.

In the case of the COE, if a resolution is not provided, then the Contracting Officer will issue a cure notice in accordance with the Defense Federal Acquisition Regulations/Federal Acquisition Regulations. If the contractor has not remedied the situation, then the contracting officer has several options, which may include stopping work, termination for convenience or default.

Stop Work

If the contractor fails to comply within receipt of such notice, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or costs or damages allowed to the contractor for any such suspension.

Withholding Payment

The government reserves the right to withhold payment in the amount of the fines, penalties and fees levied if not paid by the contractor per USACE contract language section 52.223.5000(3)(f). No time extensions shall be granted or costs or damages allowed to the contractor for any such suspension

Hawaii Department of Health Notification

In the event that the noncompliance has not been resolved, DPW has exhausted its use of sanctions and cannot bring a construction site or construction operator into compliance with its policies, standards, or the NPDES permit, or otherwise believes the site poses an immediate and significant threat to water quality, DPW-ENV shall, in accordance with MS4 permit Part D.1.d.(7):

- Provide an e-mail notification to SDOH CWB Enforcement Section within one week of determination.
- E-mail notifications will be followed by written notification and include supporting inspection documentation (checklists, notes) and correspondence within two weeks of determining a site noncompliant.
- In instances where an inspector identifies a site that has not applied for permit coverage under the NPDES program, DPW-ENV will provide written notification to SDOH CWB Enforcement Section within two weeks of the discovery.

Termination of Contract

In extreme cases the Army can terminate contracts for cause.

PENALITIES

For all projects, the contractor shall be solely responsible for remedying all Federal, State and local environmental and safety violations or non-compliance and any payment of fines, penalties and fees levied as a result of the violations or noncompliance. The government reserves the right to withhold payment in the amount of the fines, penalties and fees levied if not paid by the contractor. Violation of the Clean Water Act can result in fines of up to $25,000 per violation per day and/or criminal enforcement actions including imprisonment.

RECORD KEEPING

Inspection reports shall be kept on file with the DPW, Environmental Division. Records shall be kept for three (3) years in accordance with the NPDES permit.

CON APPENDIX J
USAG-HI Construction Best Management Practice (BMP) Storm Water Training

This page intentionally left blank.

Construction Best Management Practice (BMP) Storm Water Training

List of Acronyms

BMP	Best Management Practice
CFR	Code of Federal Regulation
CWA	Clean Water Act
CWB	Clean Water Branch
DPW-ENV	Directorate of Public Works, Environmental Division
EPA	U.S. Environmental Protection Agency
HAR	Hawaii Administrative Rules
LOA	Letter of Authorization
MS4	Municipal Separate Storm Sewer System
NGPC	Notice of General Permit Coverage
NOC	Notice of Cessation
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
SDOH	State Department of Health
SWPPP	Storm Water Pollution Prevention Plan

Outline

- Background
  - Environmental
  - Regulatory
- NPDES Permit Requirements
- Erosion and Sediment Control
  - BMP Overview
  - Common BMP Issues
- Inspection Procedures

Background

Goal of the SDOH-CWB:

"Keeping Hawaii's water clean for 'Beneficial uses' which include recreation and the protection and propagation of fish and aquatic life."

http://www.celebratebig.com/hawaii-big-island/i6-hawaii-south-point-honaunau-bay-puuhonua-o-honaunau-mango-sunset-bb-lyman-farms-wawaloli-beach.htm /

What is a MS4 Permit?

Municipal Separate Storm Sewer System (MS4) programs are intended to improve the Nation's waterways by reducing the quantity of pollutants

6 permit requirements incorporated into Army storm water management programs:

1. Public Education and Outreach
2. Public Involvement and Participation
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post-Construction Storm Water Management
6. Pollution Prevention

Clean Water Compliance

No **"illicit discharges"** allowed to any storm water systems

Definition of **"illicit discharge"**- 40 CFR §122.26:

"There should be no non-storm water discharges into State waters except for NPDES permitted discharges"

Background

According to the EPA:

- Storm water runoff is the top cause of water pollution
- Sediment is the number one pollutant
- Storm water runoff from construction sites is a primary contributor to the impairment of water quality

Background

- The table represents the erosion rates categorized by land use.

- Notice that *construction* (along with mining) is the number one contributor to sediment pollution!

SOIL EROSION RATE

LAND USE	EROSION RATE Tons/SqMi/Yr	RATIO RELATIVE TO FOREST
Forest	24	1
Grassland	240	10
Abandoned Surface Mine	2,400	100
Cropland	4,800	200
Harvested Forest	12,000	500
Active Surface Mine	48,000	2,000
Construction	48,000	2,000

Background

- 1972 CWA gave the EPA and COE the power to regulate the discharge of pollutants to US Waters

- Under the CWA, storm water discharges are regulated through the NPDES permit program, administered by the SDOH-CWB

- NPDES permit requires development of construction enforcement procedures and actions to reduce pollutants in storm water runoff from construction activities disturbing one acre or more

    - USAG-HI Updated Enforcement Policy to be available early 2015 (available on the Clean Water Program website)
    - Quarterly Site Inspections and Follow-ups (monthly inspections after SWMP submitted)
    - Storm Water Pollution Prevention Plan (SWPPP) Review and Letter to Authorize Discharge

Background

Hawaii Revised Statutes (HRS) § 342D-50(a):

"No person, including any public body, shall discharge any water pollutant into state waters, or cause or allow any water pollutant to enter state waters, except as in compliance with the provisions of this chapter, rules adopted pursuant to this chapter, or a permit or variance issued by the Director."

HRS § 342D-1 defines "Water Pollutant" as:

"Dredged spoil, solid refuse, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical waste, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, soil, sediment, cellar dirt and industrial, municipal, and agricultural waste."

Source: State Department of Health Clean Water Branch (2005). "NPDES Storm Water Associated with Construction Activities."

Background

HAR: Basic water quality criteria, Section 11-54-04:

a. The Permittee shall not cause or contribute to a violation of the narrative basic water quality criteria specified in Section 11-54-04(a) which states:

(a) All waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants, including:

(1) Materials that will settle to form objectionable sludge or bottom deposits;

(2) Floating debris, oil, grease, scum, or other floating materials;

(3) Substances in amounts sufficient to produce taste in the water or detectable off-flavor in the flesh of fish, or in amounts sufficient to produce objectionable color, turbidity, or other conditions in the receiving waters;

Background

HAR: Basic water quality criteria, Section 11-54-04 (continued):

(4) Substances or conditions or combinations thereof in concentrations which produce undesirable aquatic life;

(5) Soil particles resulting from erosion on land involved in earthwork, such as the construction of public works; highways; subdivisions; recreational, commercial, or industrial developments; or the cultivation and management of agricultural lands."

Non-Compliance

Consequences of CWA Non-Compliance:

- Warning Letter - Notice of Apparent Violation or Notice of Potential Violation letter

- Administrative / Civil Penalties - Notice and Finding of Violation and Order
    - Monetary penalties up to $25,000 per day per violation

- Criminal Enforcement
    - Monetary penalties up to $50,000 per day per violation and jail time possible (2005)

Background

Consequences of Non-Compliance: who gets the bill?

- The Permit holder for NPDES permitted projects

- The general contractor for not maintaining BMPs or for having prior violations of a similar nature

- The individual responsible for discharge

- “It is the prerogative of the SDOH-CWB to assign responsibility for the enforcement action. However, the Attorney General may also assign responsibility for enforcement actions.”

General Permit Requirements

SWPPP Document (Chapter 11-55, Appendix C, Section 7):

- As of December 2013, a SWPPP document is required prior to submitting a NOI Form C to SDOH.

- DPW-ENV will only issue LOAs to discharge storm water runoff to the Army's drain system during construction when SWPPPs are determined complete (containing all elements of NPDES permit section 7.2)

- A current SWPPP must be retained onsite and include: a project description, site contractor information, construction schedule, detailed site maps, site pollutants, sources of non-storm water, storm water control measures, pollution prevention procedures, spill plan, inspection logs/documentation records, staff BMP training, certified signature

- Changes to plan and site conditions must be documented in modification log
- SWPPP and site map must reflect current site conditions

Keys to Maintaining Compliance

1. Prepare and submit a SWPPP to DPW-ENV
2. When determined acceptable, DPW-ENV will issue a LOA
3. File a NPDES Permit NOI Form C via the SDOH E-Permitting Portal 60 days before the start of construction (SWPPP submittal not needed to SDOH)
4. Carefully read the issued NGPC and HAR 11-55, Appendix C
5. Install all erosion and sediment controls according to SWPPP specifications
6. Notify DPW-ENV before the initiation of ground-disturbing activities (after BMPs have been installed) to conduct an inspection
7. Maintain BMPs as needed, a “qualified person” conducts site inspections according to SWPPP schedule, maintain all documents on site
8. File a NOC upon completion

Erosion and Sediment Control

- SWPPPs are living documents subject to change!

- Maintain records showing the dates of all SWPPP modifications in the appendix amendment log

AMENDMENT LOG

Project Name: _____

SSCBMP Contact: _____

Amendment No.	*Description of the Amendment*	*Date of Amendment*	*Amendment Prepared by [Name(s) and Title]*

Add rows as needed.

Erosion and Sediment Control

Erosion Control (keeping the dirt in place) and Minimizing the Impact of Construction

1. Minimize disturbed area and protect natural features and soil
2. Phase construction activity
3. Control storm water flowing onto and through the project
4. Stabilize soils promptly
5. Protect slopes

Sediment Controls (the second line of defense)

6. Protect storm drain inlets
7. Establish perimeter controls
8. Retain sediment on-site and control dewatering practices
9. Establish stabilized construction exits
10. Inspect and maintain BMPs

General Permit Requirements

SWPPP Plan Inspections/ Documentations (Chapter 11-55, sct 9.1.2):

• At a minimum, a "*qualified person*" shall conduct a site inspection in accordance with one of the two schedules:

•At least once every 7 calendar days or;

•Once every 14 calendar days and within 24 hours of the occurrence of a storm event of 0.25 inches or greater. Must obtain rain fall data via a properly maintained rain gauge on the site or weather station data (NOAA, Weather Underground), attach rain data and photos to inspection reports

•A "*qualified person*" is a person knowledgeable in the principles of erosion and sediment controls, pollution prevention, the site specific SWPPP and NPDES General Permit requirements, (e.g. engineer, QA/QC, superintendent)

•Inspections only required during normal working days

•Keep current copies of all inspection reports and photos onsite

General Permit Requirements

Corrective Action Requirements (Chapter 11-55, sct 10)

•The permittee is required to stop, reduce, or modify construction, or implement new or revised BMPs as needed to stop or prevent a water quality violation

•Minor BMP failures (silt fence, inlet protection, sediment track-out, etc.) must be repaired in 24 hrs. or by the end of the following work day, major repairs (slope rill erosion, repairs that require heavy equipment, etc.) must be complete in 7 days)

•Repair, modify, or replace any deficient storm water controls. Immediately take all responsible steps to minimize or prevent the discharge of pollutants until a permanent solution is made operational .

•The permittee shall immediately notify DPW ENV of any incidents and identify the pollutant(s) source(s) and the proposed and implemented control or mitigation measures as required

General Permit Requirements

HAR Chapter 11-55, Appendix C Section:
Record Retention

•The permittee shall retain all records and information resulting from the activities required by this general permit for a minimum of 5 years from the date the permit coverage is expired or terminated.

• The SDOH, or EPA can conduct unannounced audits, inspections and sampling at any time to ensure compliance with permit requirements.

Erosion and Sediment Control

Nature filters storm water through vegetation, healthy soils, organic matter and beneficial soil organisms

Vegetation mitigates erosion:

- It shields the soil surface from the impact of falling rain
- It holds soil particles in place
- It maintains the soil's capacity to absorb water
- It slows the velocity of runoff
- It removes subsurface water through evapotranspiration

Erosion and Sediment Control

Phase construction activity:

- Construction schedule should reflect phasing activities
- Only clear and grub the portions of the site where it is necessary for construction
- When less area is disturbed for construction, there is less erosion of soil
- Phased construction helps to lessen the risk of erosion by minimizing the amount of exposed disturbed soil

Erosion and Sediment Control

Control storm water flowing onto and through the project

5.3 Pictures and Diagrams

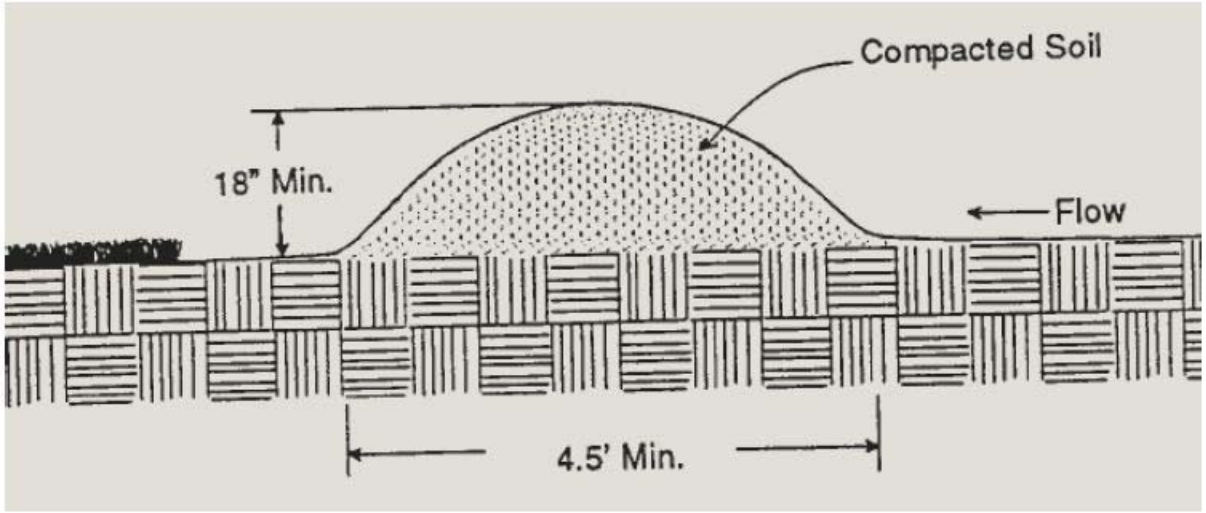


Figure 1. Temporary diversion dike lateral view.

Source: Land Rehabilitation and Maintenance

Erosion and Sediment Control

- Slope protection issue: slope not fully covered with geotextile, silt fence not properly installed

Silt fencing should be installed per manufacturers recommendations!

Sediment Control

Inlet protection:

- Install inlet protection measures that remove sediment from the discharge prior to entry into the storm drain inlet

- Many methods and Products available

- Clean or replace devices as sediment accumulates

- Remove inlet protection measures in the event of a flood or to prevent erosion

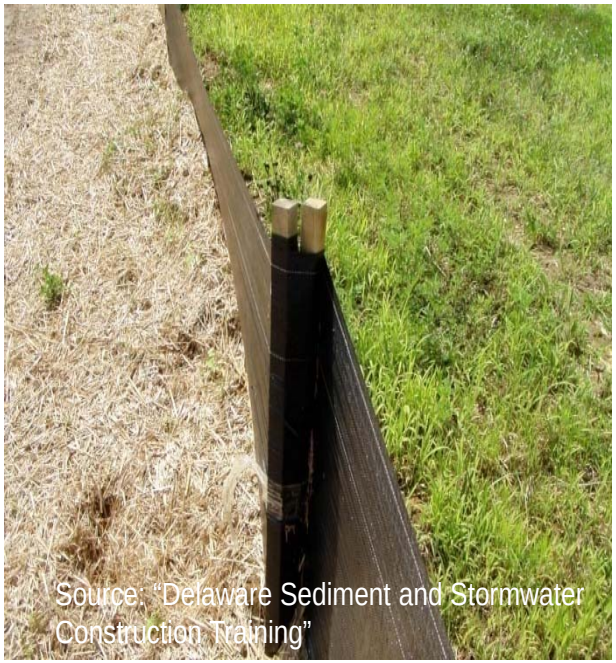
Erosion and Sediment Control

Perimeter controls:

- All runoff must pass through a sediment removal BMP

- Practices must be fully functional before land disturbance- DPW ENV inspects BMP installation prior to the initiation of construction

- Proper maintenance is critical; the permittee shall remove sediment before it accumulates to ***½ the height*** of any perimeter control



Source: "Delaware Sediment and Stormwater Construction Training"

Sediment Control

Stabilized construction exit:

- Restrict vehicle use to properly designated exit points

- Use appropriate stabilization techniques at all points that exit onto paved roads so that sediment removal occurs prior to vehicle exit;

- Sweep, shovel or vacuum sediment by the end of the work day in which track-out occurred

- Do not hose down or sweep sediment on pavement into a storm drain

Sediment Control

- Stabilized construction exit issue; sediment tracked outside project limits

- Remove sediment build up in rock entrance/exit

- Tire washing: is sediment being tracked away from the wash area? Channel runoff to a sediment-trapping device

Erosion and Sediment Control

Maintain all storm water control measures:

- All BMPs require maintenance

- Proper installation is only the first step

- The permittee shall ensure all erosion and sediment controls required remain in effective operating condition during permit coverage (until the NOC is filed)

- Modify BMPs as needed! Don’t want to use silt fence? Want to use something more effective? Go right ahead, but UPDATE YOUR SWPPP accordingly!

Erosion and Sediment Control

Other BMPs:

- Vehicle and Equipment Maintenance/Fueling
- Concrete Waste Management
- Material Storage and Use
- Stockpile Management
- Solid and Hazardous Waste Management
- Training (everyone should be familiar with the SWPPP plan)

DPW-ENV Inspection Procedures

- DPW-ENV will contact COE project POC to schedule an inspection, (inspections can also be unannounced)

- DPW-ENV will meet with contractor at site trailer to review SWPPP, maps, inspection documentation, training logs ect.

- Will walk the site to inspect BMPs, photograph noncompliance issues, debrief with group, findings will be discussed

- Inspection report with findings and photos will be emailed to contractor, COE representatives and DPW-ENV Program Manager within 3 calendar days

- All deficiencies shall be corrected ASAP or by no later than 5 calendar days after the inspection. ***Enforcement procedures will be applied if not received!***

New Permit Requirements

Significant Program/ Plan Changes:

- OCT2015-Clean Water Program will publish an improved MS4 Storm Water Management Plan which will include more stringent program requirements, monitoring and enforcement action

- NPDES permitted construction projects will be inspected at least monthly by DPW-ENV, notifications of noncompliance's will be forwarded to project managers

- The permittee shall install, repair, or modify storm water controls within 7 calendar days of discovering a deficiency.

- DPW-ENV is required to report all critical deficiencies to SDOH

Storm Water Materials

Helpful SDOH storm water resources:

- State NPDES General Permit- effective 6 DEC 2014
http://health.hawaii.gov/cwb/files/2013/04/Clean_Water_Branch_20131210_Appendices_C_and_A.pdf

- EPA SWPPP Construction Templates and Examples
http://water.epa.gov/polwaste/npdes/stormwater/Stormwater-Pollution-Prevention-Plans-for-Construction-Activities.cfm#template

- EPA NPDES Permit Website
http://cfpub.epa.gov/npdes/index.cfm

Questions?

Contact Us:

DPW Environmental

Clean Water Program Manager: Clinton Pandaraoan

656-3501; clinton.u.pandaraoan.civ@mail.mil

Clean Water Program Support:

Shane Bourke; 656-3086

Trisha Di Paola; 656-3316

24/7 DPW Emergency Spill Line: 656-1111

Mahalo!

References:

NPDES General Permit, Chapter 11-55 Appendix C. Effective: December 2013

Department of Environmental Services, City and County of Honolulu.
"Storm Water Best Management Practice Manual: Construction." November 2011.
Available online at:
http://www.cleanwaterhonolulu.com/storm/learning_center/BMP_manual_2011-11.pdf

CERTIFICATE

This is to certify that

ENTER NAME HERE

has completed the DPW Environmental Construction BMP Storm Water Training

XX XXX 20XX

Date

This page intentionally left blank.

SECTION 5: Post-Construction Storm Water Management Program
PR APPENDIX

This page intentionally left blank.

PR APPENDIX A
Army Stormwater Management Using Low Impact Development Memorandum

This page intentionally left blank.

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT
600 ARMY PENTAGON
WASHINGTON, DC 20310-0600

DAIM-OD

21 SEP 2015

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Army Stormwater Management Using Low Impact Development

1. References.

a. Memorandum, ASA(IE&E), 16 Dec 2013, subject: Sustainable Design and Development Policy Update.

b. Memorandum, Deputy Under Secretary of Defense (Installations and Environment), 19 Jan 10, subject: DoD Implementation of Storm Water Requirements under Section 438 of the Energy Independence and Security Act (EISA).

2. The Land Holding Commands concurred with the Army's implementing guidance titled *Army Stormwater Management Using Low Impact Development*. The incorporation of low impact development (LID) best management practices (BMPs) as a means to manage stormwater is effective starting in FY15 for Military Construction, Army, and all projects funded with other appropriations.

3. This guidance provides users with the information needed to ensure compliance with stormwater management requirements. HQDA developed LID planning, design and cost tools and provided training for master planners, design engineers and stormwater managers. Army LID references are available at the following USACE website: https://mrsi.erdc.dren.mil/sustain/cx/lid.

4. My point of contact for this action is Mr. Bill Sproul, 571-256-3961 william.e.sproul2.civ@mail.mil.

FOR THE ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT:

Encl

AL AYCOCK
MG, USA
Director, Operations

DISTRIBUTION:
Chief, Army Reserve (Attn: DAAR-IM)
Director, Army National Guard (Attn: ARNG-ILI-R)
Commander, U.S. Army Materiel Command (Attn: AMCLG-IFC)
Commander, U.S. Army Installation Management Command (Attn: IMPW-FM)
Commander, U.S. Army Corps of Engineers (Attn: CEMP-IA)

CF:
Commander
U.S. Army Forces Command (Attn: AFOP-EN)
U.S. Army Training and Doctrine Command (Attn: ATBO-GP)
U.S. Army Pacific (Attn: APEN)
U.S. Army Europe (Attn: AEOP-SPP)
U.S. Army Central (Attn: ACOP-EN)
U.S. Army North (Attn: ARNO-LG)
U.S. Army South (Attn: ARSO-ENG)
U.S. Army Africa/Southern European Task Force (Attn: ARAF-EN)
U.S. Army Special Operations Command (Attn: AOEN)
Military Surface Deployment and Distribution Command (Attn: AMSSD-PLF)
U.S. Army Space and Missile Defense Command/Army Strategic Command (Attn: SMDC-ENC)
U.S. Army Medical Command (Attn: MCFA-PPD)
U.S. Army Intelligence and Security Command (Attn: IALO-E)
U.S. Army Criminal Investigation Command (Attn: CISP-EN)
U.S. Army Military District of Washington (Attn: ANLG)
U.S. Army Test and Evaluation Command (Attn: CSTE-EL)
Superintendent, United States Military Academy (Attn: MARM)
Director, U.S. Army Acquisition Support Center (Attn: SAAL-ZAS)
Executive Director, Arlington National Cemetery (Attn: SAAC)
Commander, U.S. Army Accessions Support Brigade (Attn: ATAL-SBD)
Commandant, U.S. Army War College
Commander, Second Army (Attn: ARCC-CS)
Director of Business Transformation (Attn: SAUS-OBT)
Commander, Eighth Army (Attn: USARPAC)
Commander, U.S. Army Cyber Command (Attn: ARCC-EN)
Commander, U.S. Army Intelligence Center of Excellence and Fort Huachuca
U.S. Army Corrections Command (Attn: DAPM-ACC)
Director, U.S. Army Center of Military History
Judge Advocate General's Legal Center and School (Attn: TJAGLCS, G-3/5/7)
Army Air Force Exchange Service
Defense Commissary Agency
Deputy Assistant Secretary of the Army (I,H&P)
Deputy Assistant Secretary of the Army (ESOH)
Deputy Assistant Secretary of the Army (E&P)
Deputy Assistant Secretary of the Army (SI)
Office of the Provost Marshall General (Attn: DAPM)

PR APPENDIX B
Army Stormwater Management Using Low Impact Development

This page intentionally left blank.

Army Stormwater Management Using Low Impact Development

1. References.

a. Title 42, USC, Chapter 52, Section 17094, Section 438 Energy Independence and Security Act, December 2007.

b. Memorandum, Deputy Under Secretary of Defense (Installations and Environment), 19 Jan 10, subject: DoD Implementation of Storm Water Requirements under Section 438 of the Energy Independence and Security Act (EISA).

c. Memorandum, Assistant Secretary of the Army (Installations, Energy and Environment), ASA(IE&E), 16 Dec 13, subject: Sustainable Design and Development Policy Update.

d. Memorandum, ASA(IE&E), 20 Dec 12, subject: Water Goal Attainment Responsibility for Installations

e. Army Regulation (AR) 420-1, Army Facilities Management, Feb 2008

f. AR 210-20, Real Property Master Planning for Army Installations, May 2005

g. Unified Facilities Criteria (UFC) 2-100-01, Installation Master Planning, May 2012

h. UFC 3-210-10, Low Impact Development, Apr 2010

i. Army Low Impact Development Technical User Guide, Jan 2013

2. Introduction. Investing in and properly implementing low impact development (LID) features called best management practices (BMPs) will provide the Army with increased sustainable solutions and help the Army achieve Leadership in Energy and Environmental Design (LEED) excellence.

a. Incorporation of LID BMPs into the Army's construction program is the method used to meet requirements of Section 438 of the Energy Independence and Security Act (EISA), Department of Defense and Army policy regarding stormwater management. The design objective of LID is to maintain or restore the predevelopment (pre-project) hydrology of the property with regard to the temperature, rate, volume, and duration of flow. The pre-development hydrology is the hydrology of the site prior to the planned project being carried out.

b. Installation/activity commanders and installation managers, master planners, design engineers, stormwater program managers, maintenance personnel, land users, tenants, U.S. Army Corps of Engineers (Military Construction Army executive agent) and all construction contractors are integral to the successful implementation of LID within the Army's construction program. Effective master planning and site planning are

critical aspects of implementing sustainable practices across Army installations. If Army installations are truly to be sustainable, we must systematically change the way we manage stormwater which requires commitment to LID principles in the installation-wide visioning and planning processes as well as implementing these principles through area development plans and site specific planning actions.

3. Philosophy. A primary goal of this guidance is to refocus typical planning and storm water management practices through a paradigm shift to LID BMPs as solutions. The BMPs actively manage stormwater runoff by mimicking a project site's pre-development hydrology using design techniques that infiltrate, store, and evaporate runoff close to its source of origin. In planning and development of installations, we must plan more holistically, around designated area development districts. We must look at more multi-use and compact, multi-story solutions that reduce the development footprint, incorporating designs that limit impermeable surfaces including vast parking lots. Implementation of this guidance will reduce the number and size of typical stormwater construction practices i.e. curb and gutter, drop inlets, storm drain pipe and eliminate nearly all retention/detention ponds. This suite of approaches when properly implemented will maintain and/or restore pre-development hydrology and remove pollutants such as nutrients (nitrogen and phosphorus), oil and grease, and sediments from stormwater as well as free up usable land space by significantly reducing the use of retention and detention basins.

4. Applicability. At a minimum, construction and renovation projects regardless of funding source on Army installations, sites, enclaves and activities that disturb 5,000 SF or more in area (except projects limited to utility trenching activities, unless they are for the purpose of managing storm water in an open channel) are to meet the intent of this guidance and includes Government Owned Contractor Operated (GOCO) installations and all Army National Guard projects that receive federal funds; while it is encouraged for all other projects when not in conflict with State and local laws and procedures. Exceptions to policy and this guidance include privatization initiatives and medical facilities constructed using DoD Medical (DoDM) funding. At Joint Installations, the owning Service guides all construction policy and guidance. If the Navy or Air Force builds on Army installations, they will comply with Army policy and guidance. Overseas Commands, installations/activities will strive to achieve LID approaches consistent with applicable host nation requirements and operate in accordance with applicable international agreements, e.g., Status of Force Agreements.

5. LID Guidance and Support. The USACE Hydrology and Low Impact Development site: https://mrsi.erdc.dren.mil/sustain/cx/lid is used to house official documents, planning and design tools for use in development of Army projects. Army LID implementation will be accomplished using Army LID guidance "Army Stormwater Management Using Low Impact Development" (this document), the Army Low Impact Development Technical User Guide (see Best Practices section of the mrsi site), and the Army's LID Planning Tool and LID Cost Planning Tool (see Design Tools section of

the mrsi site). The Technical User Guide provides practical planning and design examples on how to construct successful LID BMPs. Additional support can be found in the Low Impact Development UFC 3-210-10 and Environmental Protection Agency (EPA) Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act. Other professionally recognized industry standards including guidance developed by the Service components should be considered if it is not available from the Army, Department of Defense (DoD) or EPA. Many Army, Service Component, DoD and Federal Agency LID references are available at the USACE Hydrology and Low Impact Development site referenced above.

6. Planning. A focus on area development planning provides an opportunity to optimize how we incorporate building, road and other infrastructure requirements with the need to manage stormwater.

a. Master Planning. The use of LID BMPs in the management of stormwater warrants a broad holistic approach that addresses the development of watershed areas across our installations, sites, enclaves and activities. The installation master planner shall include LID considerations throughout the planning and programming process. This includes the entire planning process from initial visioning through definition of Installation Design Guide principles, area development planning, and ultimately to the site planning level for specific facilities. The Installation Development Plan of the Real Property Master Plan (RPMP) identifies the citing of all development on an installation/ activity. Master planning will be conducted by the installation master planner and will consider all of the following:

(1) Use Area Development Planning Practices for Holistic District Planning. This allows planners to determine the broad planning requirements for a designated district on the installation, to include storm drainage management and use of LID features in conjunction with the long-term development plan.

(2) Embrace Compact Development Planning Patterns. Installations must conserve the land resources they have. Compact development patterns include multi-story buildings, greater residential densities, mixed-uses, and minimal spacing between buildings while maintaining consideration of AT/FP requirements. These features allow less land to be disturbed.

(3) Promote Infill Development Planning. Planners should, to the maximum extent possible, plan development within the installation core (existing cantonment area) using brownfields or previously developed land to conserve limited land resources. Access to existing built infrastructure including utilities and roadways must be considered.

(4) Use Appropriate Landscaping. Sustainable development requires the integration of regionally appropriate, local indigenous vegetation and landscaping across the installation/activity. Landscaping supports mission effectiveness, security, and future installation viability. Sustainable development strategies use landscaping and vegetation to improve the environment through controlling soil erosion, reducing heat island effect, and improving air quality.

(5) Use of Parking Lots and on-Street Parking. One planning approach to LID is to minimize the amount of new paved parking areas. To encompass this, planners are encouraged to retrofit existing paved areas including existing streets (where appropriate) to provide on-street parking instead of building vast new sprawling parking area. Where appropriate and funding is available, vertical parking structures will be given first consideration over larger horizontal parking lots.

(6) LID Integration. The integration of LID BMPs in the management of stormwater will enhance and support: The preservation of native vegetation, the disconnection and minimization of impervious areas, reduction of longitudinal slopes of swales and ditches, use of alternative roadway layouts that minimize imperviousness and heat island effect, the limitation of sidewalks to one side of roadways, on-street parking, the use of permeable paving materials, rainwater harvesting and direct drainage to vegetated areas including site development that encourages sheet flow.

b. Site Planning. Comprehensive planning criteria that support the principles of sustainable design and development, environmental, economic and community factors are to form the basis for achieving LEED silver construction. Site planning will include avoidance of natural resources, protected species, sensitive areas/habitats, and protected cultural resource sites. Stormwater is to be managed incorporating LID principles. Building orientation will provide for maximum energy efficiency taking into account heating ventilation and air conditioning requirements as well as water conservation including mechanical equipment condensate and stormwater harvesting in order to restore the pre-project hydrology. During the planning charrette event, the installation project planning team (Master Planner and Engineer) led by the Master Planner will present the approved site from which the project will be developed. Further, the Master Planner will provide a LID BMP strategy that meets stormwater policy, this guidance and the planning principles of the RPMP.

(1) Non-Structural LID BMPs (see the Army Low Impact Development Technical User Guide) should be incorporated into each project during the planning process in order to minimize site disturbance and overall project cost.

(2) Structural LID BMPs (see the Army Low Impact Development Technical User Guide) are planned, identified and updated from inception through the Parametric Definition Report (PDR) (Code 3) and the ENG 3086 using the LID Planning and Cost

Planning Tools. Use of LID BMPs that are both appealing and efficient can easily be implemented to meet water quality and quantity requirements for most projects.

7. Implementation. In all instances LID BMPs are to be designed and constructed by professionals trained and experienced in LID implementation.

a. Execution Timeline. All current SRM (OMA and other non-MILCON) and FY15 MILCON funded projects, and beyond, are to be planned, designed and budgeted to fully incorporate LID BMPs. Low impact development BMPs will be identified as the means to manage all increases in stormwater runoff where project request for proposals (RFP) and invitation for bid (IFB) packages reference stormwater solutions. No solicitation packages will reference stormwater management criteria/standards from installation design guide (IDG) material unless it meets the intent of Army LID policy and this guidance. In instances where IDGs have not been updated to meet Army LID policy and guidance, this guidance may be referenced.

b. Requirements. When new construction or renovation activities on sites 5,000 SF or greater in size increase the amount of runoff (based on an increase in runoff curve number), the increased amount of runoff is required to be managed on-site using LID BMPs. Water quality and quantity criteria must be met in order to comply with the requirements established in Section 438 of EISA. Special consideration must be given to the planning and design of LID BMPs on installations/activities where State and/or local regulations already exceed EISA 438 requirements. Planners and designers must be aware of LID BMP design capacities to ensure BMPs handle the appropriate quantity of water flowing from a site as well as provide the appropriate removal efficiency for pollutants. Installation/activity personnel are to give strong consideration to placing LID BMPs in series with one another in order to meet existing and planned/proposed water quality requirements to include Total Maximum Daily Loads (TMDLs).

(1) Site Boundary. It is highly recommended that the Master Planner/Engineer establish the "site boundary" (term used in LEED) as the limit of disturbance (LOD) on construction sites 5,000 SF or greater in size. The purpose for using this nomenclature is to ensure all LID BMPs are included within the "site boundary" for LEED scoring. The initial LOD is identified during the concept design and finalized during the design process. For this reason the estimated LOD (site boundary) should be identified and provide adequate space for LID BMP positioning.

(2) LID BMPs. Installation/activity Master Planners/Engineers are to complete both Army LID Planning and LID Cost Planning worksheets respectively at https://mrsi.erdc.dren.mil/sustain/cx/lid (note the Army LID Planning Tool is also available at the project Tab J, Storm Drainage/Low Impact Development worksheet of the DD1391).

(i) Each LID BMP "type" (bio-retention, swale, permeable paving, etc.) and "quantity" planned for use on the project is to be identified on a LID Planning worksheet. The process includes saving an Army LID Planning worksheet to your desktop computer, completing the worksheet, and attaching it to the Storm Drainage/Low Impact Development worksheet at Tab J of the DD1391. See Appendix A for an example on how an Army LID Planning Tool worksheet is developed.

(ii) The estimated cost for each planned LID BMP is calculated using the LID Cost Planning worksheet. The process includes saving a copy of the worksheet to your desktop computer and completing the worksheet. LID BMP costs are to be entered into Tab A of the DD1391. See Appendix B for an example on how an Army LID Cost Planning Tool worksheet is developed.

(iii) Installation/activity and USACE personnel must recognize that the incorporation of LID BMPs need only meet minimum requirements to satisfy EISA, OSD and Army policy. Conversely, Federal, state and/or local regulation may require LID BMPs meet stringent water quality standards and warrant construction of more complex LID BMPs including placing them in series with one another. In all instances the Army must balance constructing above and beyond what is required from a regulatory stand point with existing/planned regulatory requirements and constrained budgets.

(3) Runoff Calculations. The quantity of storm water required to be managed on-site using LID BMPs is calculated as the difference between pre-project and post project runoff from the site boundary delineated by the LOD, based on the "95th percentile storm event" and the project location "soil type". The amount of runoff required to be managed is calculated using Page 1 of the Army LID Planning Tool. The 1st step is to save a copy of the worksheet to your desktop computer; 2nd step is to enter project specific data including estimated acreage for pre and post construction land cover; 3rd step is to identify any increase in runoff volume (calculated by the spreadsheet at the bottom of page 1); 4th step is to develop a LID BMP strategy (using page 2) that includes a combination of different "types and quantities" of LID BMPs that is able to manage the increase in runoff (calculated by the spreadsheet at the bottom of page 1); 5th step is to save the worksheet on your desktop computer; and the 6th step is to attach it to the Storm Drainage/Low Impact Development worksheet at Tab J, DD1391. See Appendix A, Army LID Planning Tool (Note: the data developed in the example at Appendix A support the example project on "How to Incorporate LID in a DD1391" at Appendix C.

(4) LID BMP Strategy. Installation/activity Master Planners are responsible to develop the installation wide strategy for stormwater management including selection of LID BMPs for use in developing the LID strategy. The LID strategy is a concept specific to the project being planned and includes an estimate of both the type and number of each respective LID BMP planned for use including their configuration (some may be used in series with another). Both the increased quantity and quality of runoff need to

be taken into account when choosing the type, size, number and sequencing of LID BMPs planned for use. The second page of the Army LID Planning Tool is used to assist in determining the type and number of LID BMPs required. The installation DPW Master Planner and Engineer develop a LID BMP strategy to incorporate LID into the project during the site approval process, prior to planning charrette (PC). The strategy is developed using knowledge of the planned project and a site plan including drainage micro sheds across the planned project site.

(i) The LID Strategy is developed to ensure consideration is given to LID BMPs that may have special significance or effect on the overall project performance and in advance of the planning charrette (PC, Code 0) when other staff office personnel initiate input.

(ii) The Master Planner and Engineer use page two of the “Army LID Planning Tool” to identify each "type” and “quantity” of LID BMP being planned for use in the project. Note: There are six primary categories of LID BMPs typically used and include: bio-retention, grassy swale, permeable paving, rainwater harvesting, green roof and infiltration practice. Within these broad categories there are a multitude of BMP variations that can be developed. The completed worksheet is saved and attached at Tab J.

(iii) The Master Planner and Engineer develop a narrative that supports the LID BMP Strategy in the text box at Tab J, Storm Drainage/Low Impact Development worksheet of the respective DD1391 prior to the PC. The text box provides 400 lines to describe the strategy and should contain a comprehensive write-up for each type of LID BMP planned so the reader is able to develop an understanding of the significance for each BMP type including quantity, shape, size and function of LID BMP. See Appendix C, How to Incorporate LID in a DD1391, including the narrative to describe the strategy for the text box in Tab J.

(iv) Installation DPW in conjunction with PC Members increase fidelity in the LID BMP strategy (using the “Army LID Planning Tool” and resave data to Tab J) to ensure stormwater is managed in accordance with Army policy while working to meet the intent of the installation LID BMP strategy (PC, Code 0).

(v) Installation/activity DPW or the DD1391 preparer develops final proposed LID BMP narrative in Tab J, text box and inputs separate sub-line item(s) under Storm Drainage (Supporting Costs) with an estimated cost for each BMP in the detailed cost estimate in Tab A.

(5) LID BMP Design Stage. The following subparagraphs outline the general process involved in developing LID design. The USACE Geographic District/Executive Agent develops the LID requirement during the Code 3 process. Detailed instruction is

provided in accordance with the PDR and ENG 3086 requirements as defined in the USACE Code 3 Guidance (updated annually).

(i) USACE Geographic District develops/validates an estimate of the "increased runoff" during the design charrette (DC) (Code 3) (Use the Army LID Planning Tool).

(ii) Incorporate planned LID BMPs into the project definition report (PDR). LID BMPs must be designed to manage the increased amount of runoff. Both the increased quantity and runoff quality are to be taken into account when choosing the type, size, number and sequencing of LID BMPs planned for use.

(iii) USACE Geographic District develops cost effective plan/design to accomplish the installation LID BMP strategy (Reviewed and approved by the installation/activity Master Planner/Engineer). All USACE planned changes to the LID strategy are coordinated through the installation/activity DPW to develop consensus and approval. Low impact development is not to be cost engineered out of the project. (Code 3).

(iv) Refined estimates are developed for LID BMPs in the ENG3086 Cost Estimate. Low impact development BMPs reflected on the 3086 will be identified numerically with the word "LID (1), (2) etc." in front of the description (see example in Appendix C). Approved ENG3086 is used to update Tab A cost estimates.

(v) Provide LID BMP designs and supporting documentation to support LID through the RFP process as necessary.

(6) Tracking LID BMP Strategy. For planning, design and cost estimating purposes, the project DD1391 for MILCON and DA4283 for Sustainment Restoration and Modernization (SRM) (OMA and other non-MILCON) funded projects should identify the type, number (quantity) and size of each type of structural LID BMP planned for use. The LID BMP data will be described in the PDR and ENG3086. Specific LID BMPs used in project planning and identified in the DD1391 should be included in the solicitation package and contract as appropriate, but may be changed based on the site conditions, design criteria and/or cost. Changes to the LID BMP strategy must meet the requirements of Army LID policy, EISA section 438 and state and local regulations. In all instances where modifications/wholesale changes to the LID BMP strategy (identified in Tab J of the 1391) are planned, the USACE Geographic District representative will coordinate with the installation/activity DPW, Master Planner/Engineer on proposed new LID courses of action and develop consensus on how to best meet LID requirements.

(7) Real Property Inventory. All structural LID BMPs meet the definition of real property and require a real property unique identifier (RPUID) number. LID BMPs are to be included in the accountable property systems of record (APSR), coded with a category code and included in the sustainment model. Appendix D contains a list of

temporarily assigned CATCODES that will be used until LID BMP CATCODES are developed.

(8) Operation and Maintenance. The LID BMP design engineers are responsible for providing installation/activity DPW staff with a BMP Owners Manual that identifies the BMP designed and constructed. The manual is required to contain the processes used to maintain the BMP to ensure proper operation. Long term operation and maintenance costs are to be incorporated in the decision process when determining which BMPs to install on a site.

8. General.

a. LID BMP Selection. Low impact development BMPs in the LID strategy and agreed upon by the installation/activity Master Planner and the USACE Geographical District are to be incorporated into the project design. Any changes to BMPs will be reviewed and agreed upon by the installation/activity Master Planner.

b. Site Management. Tree clearing and soil grubbing activities are to be reduced to the maximum extent possible, but are not to impede contractor requirements for storage, parking, delivery, and other specific project requirements, e.g. developing clear zones for airfield construction. Low impact development BMPs should be constructed within the LOD. Native vegetative cover will be maintained and replaced as necessary. Projects must take into account the location of protected species, sensitive areas/ habitats, and protected cultural resources sites, avoiding these areas whenever possible.

c. Ties to Traditional Stormwater Systems. Proper LID BMP designs may require drain disconnects, underdrain (overflow) connections or reconfigurations to existing and traditional storm sewer systems.

d. Stormwater Harvesting. Installation/activity Master Planners with projects located in jurisdictions that forbid stormwater harvesting (e.g. riparian water rights) are not required to consider stormwater harvesting BMPs. Stormwater harvesting is to be considered during all planning and design activities in order to meet both water quantity and quality requirements. Stormwater harvesting may be used to achieve numerous objectives all while managing runoff rate and volume. Stormwater use includes but is not limited to: process makeup water, irrigation, grey water (purple pipe), personal and tactical vehicle wash, and emergency fire fighting requirements. When a cost benefit analysis seems appropriate prior to BMP consideration it should take into account a minimum 50-year project period and use the 95th percentile storm event. Calculations and supporting analysis must remain part of the design documentation.

e. Retention/Detention Ponds. Land is a dwindling Army resource. Stormwater retention and detention ponds take up valuable space, are not considered LID BMPs

and are highly discouraged. Planners and designers are to integrate traditional LID BMPs as solutions to manage stormwater including storage as necessary. The use of cisterns and/or the installation of interconnected pipe networks below parking areas to catch and hold runoff are just a couple of appropriate techniques. Site conditions of these storage areas including elevation/grade and soil conditions may necessitate pumping and other maintenance burdens to be included in garrison O&M requirements. It is imperative for garrison DPW staff including Operations and Maintenance personnel to understand the LID BMP strategy and support the O&M requirements to ensure proper BMP function once complete. Water storage under parking and drive areas accessible to tactical vehicles, e.g. Striker, MRAP and tanks must be given special consideration during scoping and budgeting to ensure proper project design. Retention ponds should be considered as a last resort and may be appropriate where they are designed for and made accessible to soldiers and their families, retirees and civilians for recreational use. Coordination must be made with the installation/activity Directorate of Public Works and the Directorate of Family, Morale, Welfare and Recreation (DFMWR) office that provides oversight/management for recreational purposes prior to design and construction. Documentation demonstrating coordination and approval by the DFMWR must be maintained in the project design documentation.

f. Training Areas. Building construction in training areas projects greater than 5,000 sq-ft in size will incorporate LID BMPs as the methodology to manage storm water. Construction of roadways, trails, ranges, pads etc. will incorporate LID BMPs to the greatest extent possible.

g. Demolition. Project activity including demolition must be evaluated to ensure any increased runoff from the site is managed using LID BMPs.

h. Stormwater Modeling. Installation/activity DPW Engineer and USACE Geographic District PMs are responsible for maintaining all pertinent site modeling data and calculations to include: Installation/activity name, name of Master Planner, LID Design Engineer(s), Project Name, Location (using GIS coordinates), Watershed Name (per state/EPA), 95th percentile rainfall, pre and post project runoff, and list of LID BMPs to be constructed.

(1) Practical Application. In all instances LID BMPs are to meet local, state and federal requirements for management of stormwater and will be incorporated into projects in an attempt to restore pre-project hydrology. As a general rule, EISA compliance is accomplished through management of the difference in pre and post project runoff from the 95th percentile rain event. This calculation is based on the difference in runoff coefficient for the pre and post project land cover. Each planned LID BMP is modeled to determine its ability to manage an amount of runoff. The quantity (cubic feet) of water that each LID BMP is capable of managing is cumulative across the site boundary and must be greater than the amount of increased runoff from the site.

(2) Watershed Approach. Installation DPW personnel have a responsibility to ensure they understand the overall watershed they are located in as well as the micro sheds they have oversight and responsibility for on their respective installations. Micro sheds can have a variety of unique challenges including: threatened and endangered species, historical properties, invasive species, soil instability and erosion, aggressive/ steep slope, current and planned development and associated runoff and others. It should be pointed out that modeling of LID BMPs using the LID Planning Tool (during the Planning Charrette and/or Design Charrette) may not be sufficient to address planned/future state requirements for water quality and/or quantity issues related to construction permits (see the Modeling Section in the Army LID Tech User Guide). Installation DPW personnel must remain knowledgeable of construction permit requirements and may be required to institute an enhanced modeling approach to meet future requirements. Modeling will be used to determine the effect of the planned project construction and results will be incorporated into the designated development area as cited in the installation master plan. To restore a site to pre-project hydrological conditions an installation/activity may need to consider a broad area/community or development approach. Project success may involve the cumulative effect of LID BMP initiatives, as single features by themselves may not be capable of restoring the site to pre-project hydrologic conditions.

i. Special Considerations. Planners and designers must be careful when planning to incorporate LID BMPs into parts of projects that have a potential to contribute to environmental contamination. As an example, LID BMPs designed for infiltration are not appropriate for use where end user activities include petroleum, oil and lubricants (POL) offloading, fueling, hazmat/waste loading/unloading, etc. Instead stormwater will be managed or diverted in such a way that any spills will minimize impact on the environment. In order to ensure integrity of the environment project planners and engineers may consider unique and innovative methodologies on the project under consideration and if necessary may apply LID mitigation initiatives to other areas within the watershed.

j. Exception to Policy. Garrison Commanders may request an exception to policy if LID BMP implementation would adversely affect mission performance, security, or Antiterrorism/Force Protection requirements, health, safety or welfare. In instances where the exception is directly related to the technical infeasibility of LID BMP performance the exception request will be provided as follows:

(1) The Garrison Commander submits a request through the chain of command; thru the Director, Operations Directorate, Office of the Assistant Chief of Staff for Installation Management (DAIM-OD); to the Deputy Assistant Secretary of the Army for Installations, Housing and Partnerships (DASA(IH&P)).

(2) The memorandum request is to include: Subject: Technical Infeasibility Report to incorporate LID in (Project Name), a summary statement that demonstrates

why LID BMP implementation is not practical for the specific project, the DPW master planner name, installation/activity address, email and phone number, the name of LID design engineer(s), project type considered, site location (using GPS coordinates), watershed name (per state/EPA), engineering calculations, geologic reports, hydrologic analyses and site maps.

k. Reporting. Army achievement in meeting the intent of EISA is recorded through annual reports to OSD on accomplishments in meeting DoD, Strategic Sustainability Performance Plan (SSPP) sub-goal 2.3; the percentage of projects completed that, Maintain Pre-Development Hydrology to the Maximum Extent Technically Feasible, (Development and Redevelopment Projects of 5,000 Square Feet or Greater).

(1) Each installation/activity that has a project completed on their grounds regardless of funding source and with a LOD greater than 5,000 sq-ft in size is to provide a report including all data elements identified in Appendix E, Maintaining Hydrology on Army Construction Projects. The report must be filed electronically using a file format that will be provided to land holding commands. Project reporting is to be completed by 31 October for all projects completed in the previous fiscal year (FY). Reporting is to include all new construction and redevelopment projects for DECA, AAFES and tenant organizations completed on installation/activity grounds during the fiscal year of report. All reporting is the responsibility of the installation/activity DPW.

(2) The following example contract language is provided for use in the event a garrison/activity commander should choose to have the project Designer of Record, develop the required reporting data elements. Example contract language: The Designer of Record shall determine the Low Impact Development Volume required to be retained on site (difference between pre-project and post-project runoff, ft^3) and complete section A-E of the Maintaining Hydrology on Army Construction Projects reporting form, see attached (attach the form). The Army is required to report as-built conditions of low impact development features for completed projects to demonstrate pre-project hydrology is maintained. Therefore, the Designer of Record shall provide the completed reporting form to the Installation Directorate of Public Works or equivalent as part of the DD Form 1354 Transfer and Acceptance of DoD real property contract close-out process.

l. Mitigation. The construction of LID BMPs may provide mitigation credits or offsets for use in meeting local, state or Federal requirements related to installation/activity discharges. Installation/activity personnel should check with their local and state agencies to determine if a LID mitigation program exists. These LID projects may be located in previously developed or disturbed areas. As a general rule, projects located within the same watershed receive increased support.

APPENDIX A. Army LID Planning Tool

ARMY LID PLANNING TOOL

SIMPLIFIED RUNOFF CURVE NUMBER METHOD FOR PRELIMINARY SELECTION AND SIZING OF LID PRACTICES

FOR COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, MODIFIED EPA OPTION 2

V 9.2 — PLANNING ESTIMATES for PRE & POST RUNOFF VOLUMES — Page 1 of 2

DATE:	5-Aug-2015	ARMY INSTALLATION:	Fort Pick a Post
PLANNER:	WES		
PROJECT NAME:	Admin Facility		
PROJECT LOCATION:	2100 First Street		
PROJECT AREA (acres):	5	95% RAINFALL	1.6

SELECT THE SITE'S OVERALL SOIL TYPE: Sandy-Loam — HSG = B

PRE-PROJECT

LAND COVER	AREA (AC)	% of SITE	CN
WOODED (fair)	1	20.0%	60
MEADOW	2	40.0%	58
BRUSH & WEEDS (fair)			
LAWN			
ROADS & DRIVES (W*/C&G)			
ROADS & DRIVES (W/C&G)			
PARKING, DRIVEWAYS & SIDEWALKS	2	40.0%	98
BUILDING ROOF			
TOTALS	5	100%	

WEIGHTED AVERAGE CN_n = 74

PRE-PROJECT RUNOFF VOLUME (95% RAIN) = 0.08 ACRE-FEET; 24782 GALLONS; 3313 CUBIC FEET

Assumes a one day runoff 0.04 CFS

SELECTION OF OTHER LAND COVER TYPES (USE DROP DOWN MENU)

POST-PROJECT

LAND COVER	AREA (AC)	% of SITE	CN
WOODED (fair)			
MEADOW			
BRUSH & WEEDS (fair)			
LAWN	2	40.0%	69
ROADS & DRIVES (W*/C&G)			
ROADS & DRIVES (W/C&G)			
PARKING, DRIVEWAYS & SIDEWALKS	2	40.0%	98
BUILDING ROOF	1	20.0%	98
TOTALS	5	100%	

WEIGHTED AVERAGE CN_d = 86

POST-PROJECT RUNOFF VOLUME (95% RAIN) = 0.23 ACRE-FEET; 75972 GALLONS; 10157 CUBIC FEET

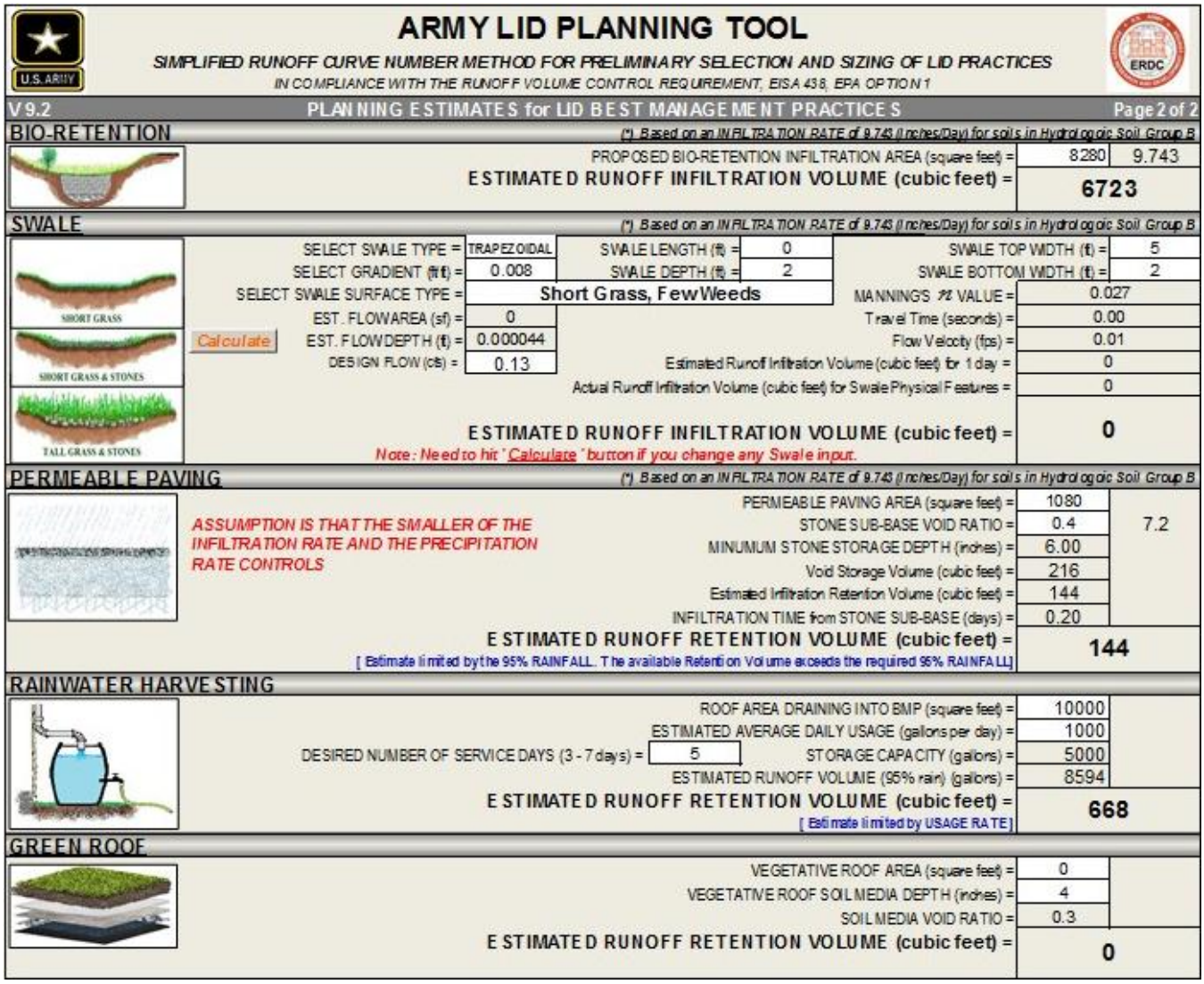
Assumes a one day runoff 0.12 CFS

MINIMUM RUNOFF RETENTION VOLUME TO COMPLY WITH EISA 438 VOLUME CONTROL REQUIREMENT:

0.16 ACRE-FEET — 6844 CUBIC FEET — 51190 GALLONS

Page 1. This work sheet assists the user in determining the volume of runoff that needs to be managed to comply with EISA Section 438, using the difference in runoff between pre- and post-project conditions for the 95th percentile storm. The inputs include the acreage of the project site, the 95th percentile rainfall, the soil type, the pre-project land cover acreages and the proposed post-project land cover acreages. The output is the minimum runoff volume required to be managed on-site.

APPENDIX A. Army LID Planning Tool



ARMY LID PLANNING TOOL

SIMPLIFIED RUNOFF CURVE NUMBER METHOD FOR PRELIMINARY SELECTION AND SIZING OF LID PRACTICES

IN COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, EPA OPTION 1

V 9.2 — PLANNING ESTIMATES for LID BEST MANAGEMENT PRACTICES — Page 2 of 2

BIO-RETENTION — *(*) Based on an INFILTRATION RATE of 9.743 (inches/Day) for soils in Hydrologoic Soil Group B*

PROPOSED BIO-RETENTION INFILTRATION AREA (square feet) =	8280	9.743
ESTIMATED RUNOFF INFILTRATION VOLUME (cubic feet) =	**6723**	

SWALE — *(*) Based on an INFILTRATION RATE of 9.743 (inches/Day) for soils in Hydrologoic Soil Group B*

SELECT SWALE TYPE =	TRAPEZOIDAL	SWALE LENGTH (ft) =	0	SWALE TOP WIDTH (ft) =	5
SELECT GRADIENT (ft/ft) =	0.008	SWALE DEPTH (ft) =	2	SWALE BOTTOM WIDTH (ft) =	2
SELECT SWALE SURFACE TYPE =	Short Grass, Few Weeds			MANNING'S n VALUE =	0.027
EST. FLOW AREA (sf) =	0			Travel Time (seconds) =	0.00
Calculate — EST. FLOW DEPTH (ft) =	0.000044			Flow Velocity (fps) =	0.01
DESIGN FLOW (cfs) =	0.13			Estimated Runoff Infiltration Volume (cubic feet) for 1 day =	0
				Actual Runoff Infiltration Volume (cubic feet) for Swale Physical Features =	0
				ESTIMATED RUNOFF INFILTRATION VOLUME (cubic feet) =	**0**

Note: Need to hit "Calculate" button if you change any Swale input.

PERMEABLE PAVING — *(*) Based on an INFILTRATION RATE of 9.743 (inches/Day) for soils in Hydrologoic Soil Group B*

ASSUMPTION IS THAT THE SMALLER OF THE INFILTRATION RATE AND THE PRECIPITATION RATE CONTROLS

PERMEABLE PAVING AREA (square feet) =	1080	7.2
STONE SUB-BASE VOID RATIO =	0.4	
MINUMUM STONE STORAGE DEPTH (inches) =	6.00	
Void Storage Volume (cubic feet) =	216	
Estimated Infiltration Retention Volume (cubic feet) =	144	
INFILTRATION TIME from STONE SUB-BASE (days) =	0.20	
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	**144**	

[Estimate limited by the 95% RAINFALL. The available Retention Volume exceeds the required 95% RAINFALL]

RAINWATER HARVESTING

ROOF AREA DRAINING INTO BMP (square feet) =	10000	
ESTIMATED AVERAGE DAILY USAGE (gallons per day) =	1000	
DESIRED NUMBER OF SERVICE DAYS (3 - 7 days) = 5 — STORAGE CAPACITY (gallons) =	5000	
ESTIMATED RUNOFF VOLUME (95% rain) (gallons) =	8594	
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	**668**	

[Estimate limited by USAGE RATE]

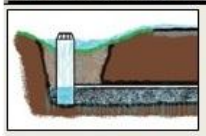
GREEN ROOF

VEGETATIVE ROOF AREA (square feet) =	0
VEGETATIVE ROOF SOIL MEDIA DEPTH (inches) =	4
SOIL MEDIA VOID RATIO =	0.3
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	**0**

Page 2. This worksheet assists the user in selecting LID BMPs and determining the estimated sizes of the LID BMPs to manage the required minimum runoff volume determined in Sheet 1 above. The interactive tool allows the user to select one or more BMPs and alter their dimensions to determine the size each BMP is required to manage the required runoff volume.

APPENDIX A. Army LID Planning Tool

INFILTRATION PRACTICE *(*) Based on an INFILTRATION RATE of 9.743 (Inches/Day) for soils in Hydrologoic Soil Group B*



INFILTRATION BED AREA (sqft) =	0	INFLITRATION BED DEPTH (ft) =	5	STONE VOLUME (cf) =	0
STONE SUB-BASE VOID RATIO =	0.4			INFILTRATION RATE FOR HSG (inches/day) =	9.743
		RUNOFF VOLUME STORAGE (cf) =	0	POTENTIAL INFILTRATION VOLUME (cf) =	0

ESTIMATED INFILTRATION VOLUME (cubic feet) = 0

VEGETATIVE FILTER STRIP

THE REDUCTION IN POST PROJECT RUNOFF FOR THIS LID PRACTICE IS ACCOUNTED FOR BY SELECTING IN AS ONE OF THE VARIOUS POST PROJECT "LAND COVERS" AND ENTERING SITE AREA PROPOSED FOR THIS USE.

REFORESTATION AND AFFORESTATION

THE REDUCTION IN POST PROJECT RUNOFF FOR THIS LID PRACTICE IS ACCOUNTED FOR BY SELECTING IN AS ONE OF THE VARIOUS POST PROJECT "LAND COVERS" AND ENTERING THE SITE AREA PROPOSED FOR THIS USE.

RIPARIAN BUFFER RESTORATION

THE REDUCTION IN POST PROJECT RUNOFF FOR THIS LID PRACTICE IS ACCOUNTED FOR BY SELECTING IN AS ONE OF THE VARIOUS POST PROJECT "LAND COVERS" AND ENTERING THE SITE AREA PROPOSED FOR THIS USE.

LEVEL SPREADER

LEVEL SPREADERS MAY INCLUDE A RUNOFF RETENTION COMPONENT, BUT ITS PRIMARY FUNCTION IS TO INCREASE FLOW TIME AND DECREASE FLOW RATES. SPREADERS WITH STONE BEDS THAT ALSO INFILTRATE WATER INTO THE GROUND CAN BE ASSESSED AS A LID INFILTRATION PRACTICE (1.1.7.)

CONSTRUCTED FILTER

FILTERS MAY INCLUDE A RUNOFF RETENTION COMPONENT, BUT ITS PRIMARY FUNCTION IS TO REMOVE POLLUTANTS. FILTERS WITH STONE BEDS THAT INFILTRATE WATER INTO THE GROUND CAN BE ASSESSED AS A LID INFILTRATION PRACTICE (1.1.7.) OR BIORETENTION PRACTICE (1.1.1)

SOIL RESTORATION

ALTHOUGH THIS LID PRACTICE REDUCES RUNOFF VOLUMES, THE VARIABLES ARE TOO COMPLEX FOR A GENERALIZED PLANNING ESTIMATE OF THE POTENTIAL RUNOFF REDUCTION

TOTAL VOLUME RETAINED ON SITE

ESTIMATED VOLUME RETAINED BY LID BMPs (cubic feet) = 7535

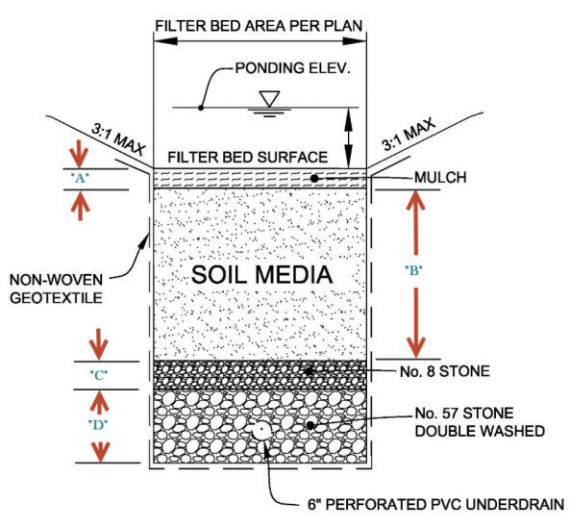
CHECK for EISA 438 VOLUME CONTROL COMPLIANCE

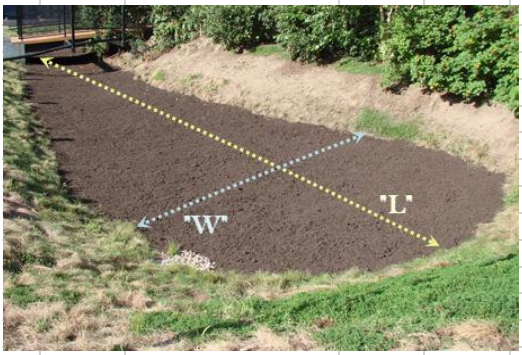
Since the Estimated Volume Retained of (7535 cf) is greater than or equal to the Minimum Retention Volume Requirement of (6844 cf), the selected LID Practices and sizes should be sufficient for compliance with EISA Section 438

Page 2 (Continued). This worksheet assists the user in selecting LID BMPs and determining the estimated sizes of the LID BMPs to manage the required minimum runoff volume determined in Sheet 1 above. The interactive tool allows the user to select one or more BMPs and alter their dimensions to determine the size each BMP is required to manage the required runoff volume. The bottom of the Figure shows the "Estimated Volume Retained by LID BMPs as 7535 cf and is ***more*** that the requirement of 6844 cf" (see bottom of page 1, A-1 above

APPENDIX B. Army LID Cost Planning Tool

LID (2) – This estimate is for a 6ft X 300ft bio-retention in the Example in Appendix B.
LID (2) BMP Cost = $108,239





A (in)	B (in)	C (in)	D (in)	W (FT)	L (FT)
3	24	4	12	6	300

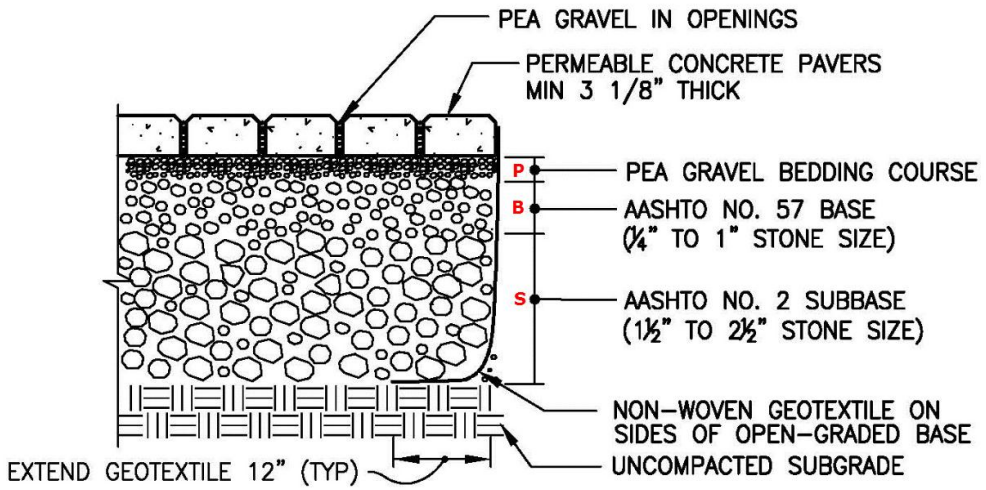
INPUT THE DIMENSIONS

BASED ON THE DIMENSIONS INSERTED ABOVE, THE ESTIMATED CONSTRUCTION COST ESTIMATE IS:

$	108,239

APPENDIX B. Army LID Cost Planning Tool

LID (2b) – This estimate is for a 6ft X 180ft permeable paver walkway in the Example Parking Lot in Appendix B.
LID (2b) BMP Cost = $53,496



P	B	S	W	L
(in)	(in)	(in)	(FT)	(FT)
2	4	12	6	180

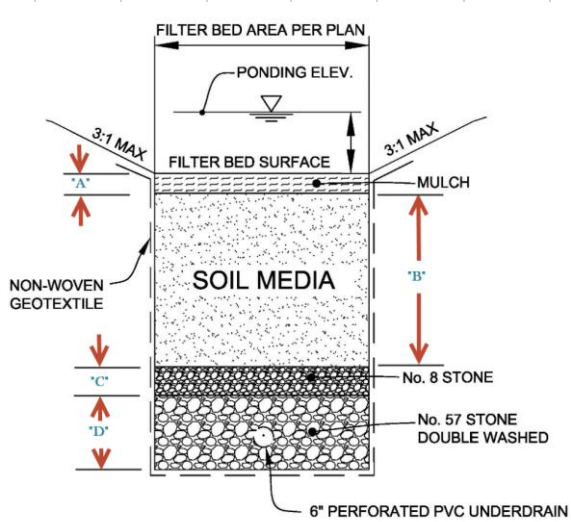
INPUT THE DIMENSIONS

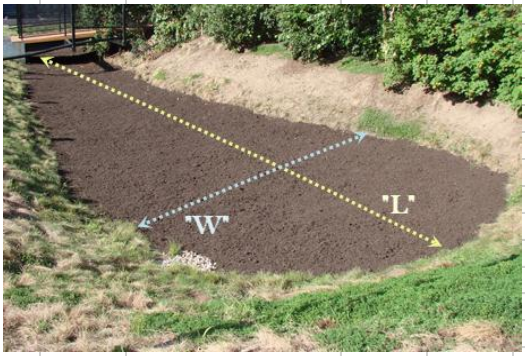
BASED ON THE DIMENSIONS INSERTED ABOVE, THE ESTIMATED CONSTRUCTION COST ESTIMATE IS:

$	53,496

APPENDIX B. Army LID Cost Planning Tool

LID (3a) – This estimate is for a 20ft X 50ft bio-retention (Rain Garden) along the west side of the building in the Example in Appendix B. This estimate is for 1,000SF of Rain Garden and the project calls for 3,000SF.
LID (3a) BMP Cost is 3 X $62,371 = $187,113.





A (in)	B (in)	C (in)	D (in)	W (FT)	L (FT)
3	24	4	12	20	50

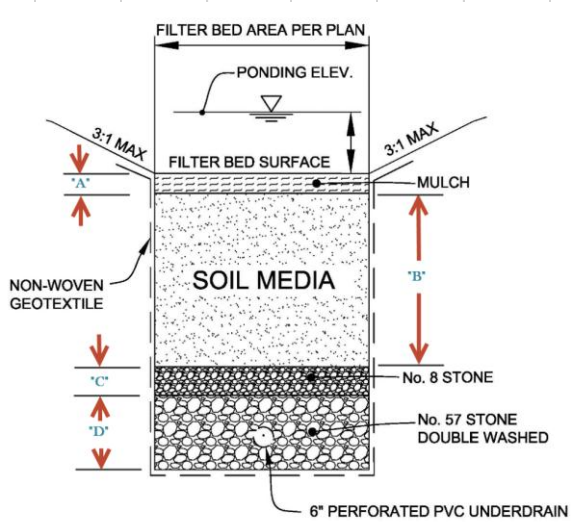
INPUT THE DIMENSIONS

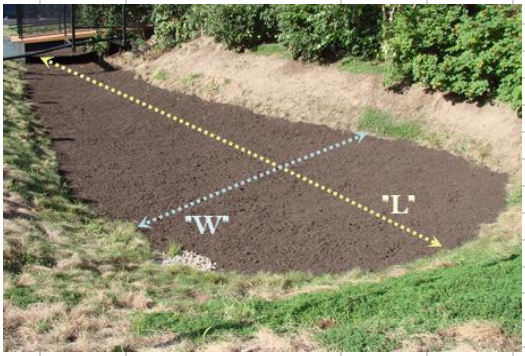
BASED ON THE DIMENSIONS INSERTED ABOVE, THE ESTIMATED CONSTRUCTION COST ESTIMATE IS:

$	62,371

APPENDIX B. Army LID Cost Planning Tool

LID (3b) – This estimate is for a 30ft X 50ft bio-retention (Rain Garden) to be located at the northwest corner of the building in the Example in Appendix B. This estimate is for 1,500SF of Rain Garden and the project calls for 3,000SF**.**
LID BMP Cost is 2 X $92,008 = $184,016.





A (in)	B (in)	C (in)	D (in)	W (FT)	L (FT)
3	24	4	12	30	50

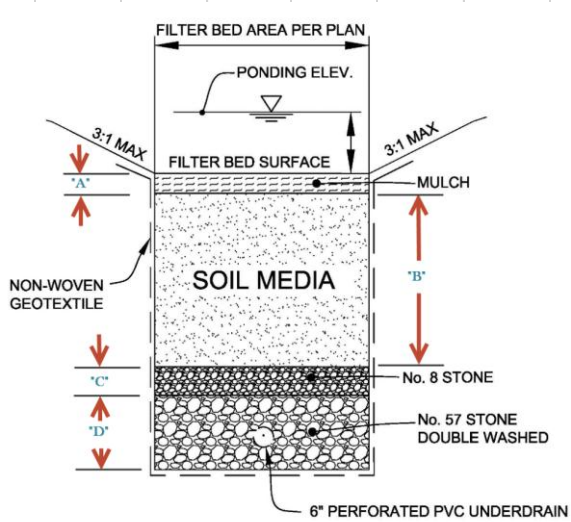
INPUT THE DIMENSIONS

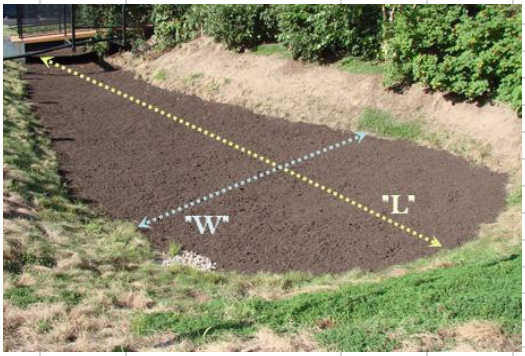
BASED ON THE DIMENSIONS INSERTED ABOVE, THE ESTIMATED CONSTRUCTION COST ESTIMATE IS:

$	92,008

APPENDIX B. Army LID Cost Planning Tool

LID (4) – This estimate is for a 6ft X 80ft bio-retention BMP along the northwest side of the building in the Example in Appendix B. This BMP is to discharge to a manmade Wetland LID BMP identified as LID (4a).
LID (4) BMP Cost = $32,567.





A (in)	B (in)	C (in)	D (in)	W (FT)	L (FT)
3	30	4	12	6	80

INPUT THE DIMENSIONS

BASED ON THE DIMENSIONS INSERTED ABOVE, THE ESTIMATED CONSTRUCTION COST ESTIMATE IS:

$ 32,567

Remaining LID BMP Cost Estimates: The current LID Cost Planning Tool is not able to develop cost estimates for the Wetland BMP or the Overflow Tie to Storm Sewer. The Cost Estimates provided for these BMPs at Step 6, Appendix B are notional and would require an engineer/cost estimator and actual site conditions in order to develop an actual estimate.
LID (4a) – Wetland accepts discharge from bio-retention and discharges through overflow to nearby Storm Sewer.
LID (4b) – Provide an overflow tie from Wetland to the Storm Sewer system.

APPENDIX C. How to Incorporate LID in a DD1391

1. Step One - The DD1391. The Master Planner identifies the need for a construction project and develops the shell for a DD1391. Tab J, Storm Drainage/Low Impact Development contains a link to the LID Planning Worksheet and is attached and updated through project development.

2. Step Two - The Limit of Disturbance and Runoff. In this example the project Limit of Disturbance (LOD) will be greater than 5,000 sf and includes construction on a proposed site that will result in an increase in runoff across the site boundary. The project will require implementation of LID best management practices (BMPs) to manage the increase in storm water runoff. The Master Planner develops an estimate for the site boundary defined as the LOD.

Determine Project LOD: The project is planned for construction at 2100 First Street, Fort Pick a Post. The standard design for the facility type will include approximately 1 acre of building roofline and 2 acres of parking, driveways and sidewalk hardstand. Approximately 2 additional acres of area surrounding the built infrastructure will be disturbed during construction and finished as open grassed area. The estimated LOD for this project is 5.0 acres.

3. Step Three - Runoff Calculation. Based on the estimated LOD, installation/ activity Master Planner/Engineer uses the Army LID Planning Tool found at Tab J, Storm Drainage/Low Impact Development Worksheet of a DD1391 or https://mrsi.erdc.dren.mil/sustain/cx/lid to calculate the estimated increase in runoff required to be stored/managed onsite. Calculations are based on estimated quantities for pre and post construction land cover.

Determine Runoff Quantity to be Managed/Stored on-Site. Save the LID Planning worksheet to your desktop computer and enter project information including the acreage for each type of Land Cover (for both pre and post project conditions), the 95th percentile rainfall for the project location (1.6 inches in this example) and the project site soil type (Sandy-Loam, HSG = 8) **the increase in runoff required to be stored/managed onsite using LID BMPs is calculated as 6,844 cubic feet (cf).**

4. Step Four - The LID Strategy. The Master Planner develops a “LID Strategy” prior to the Planning Charrette (PC). The Strategy is nothing more than identifying a list of preferred LID BMPs (Non-Structural and Structural) that meet stormwater runoff policy and guidance, support the Master Planning Installation Design Guide (IDG) and enhance the overall architectural appearance of the project. The LID Strategy results from developing a list of LID BMPs planned for inclusion in the project and defined in narrative form in the Text Box at Tab J.

APPENDIX C. How to Incorporate LID in a DD1391

BMP Types and Quantities. Page 2 of the Army LID Planning Tool is used to form the basis (LID BMP types and quantities) for the LID Strategy. The LID BMP worksheet allows the user to input planned "types" and "sizes" of LID BMPs and the worksheet calculates the amount of runoff each BMP will manage/store. The following is an example of how LID may be portrayed on the worksheet.

a. Bio-Retention	Retain 6,723 cf
b. Permeable Paving	Retain 144 cf
c. Rainwater Harvesting	Retention 668 cf
TOTAL Runoff Stored/Managed	***7,535 cf****

* Note: For this example, the **LID BMPs planned store/manage *7,535 cf*** which is more than that **required from step 3, which was 6,844 cf.**

Develop the LID Strategy. The LID strategy is a listing of LID BMPs planned for use and input into the Text Box at Tab J, Storm Drainage/Low Impact Development. The following is an example of how an "early" version of the LID Strategy might look for this notional project.

LID (1) - Maintain yellow pine grove along south boundary and do not disturb sandy soils at northwest boundary.

LID (2) - Install a significant amount of bioretention BMPs across parking lot areas to include tree planting to reduce heat island effect. Plan for runoff sheet flow to bioretention and narrow strips of concrete pavers over water collection system (w/under drain) and tied to bioretention as accent to parking lot finish.

LID (3) - Construct rain gardens along west edge of LOD and at two opposing corners of the building (actual locations to be determined later, however strong consideration to be given to southeast and northwest corners as they have good slope from LOD and northwest corner also has existing storm water pipe to tie BMP overflow to as necessary).

LID (4) - Give strong consideration to enhanced bioretention (placing two or more BMPs in series) as water temperature and sediment are water quality concerns (see State TMDLs for installation).

LID (5) - Project has significant roofline area and high volume of personnel including troop activity. At a minimum consider rainwater harvesting to flush latrines planned for building foyer area.

5. Step Five - Refined LID BMP Planning at the Planning Charrette (PC). The Installation/activity Master Planner and Engineer lead a discussion on the "LID Strategy" at the PC. This is a time to bring up LID desires/must haves and concerns. The PC Team uses the latest version of the Army LID Planning Tool attached to the DD1391 and the base line LID Strategy (in the Text Box) as a starting point for developing a "Refined LID Strategy." The LID PC Team validates the estimated amount of runoff required to be managed onsite and 2) refines the LID Strategy including the type, number and size of proposed LID BMPs for use on the project (while accommodating as many of the Master Planner/Engineer desires as feasible). The LID Strategy saved to the Text Box narrative might be updated to look like the following:

LID (1) Conserve the stand of yellow pine along the southern boundary

LID (1a) Leave sandy soils along northwest boundary in place.

LID (2) Construct two 150ft long parallel bio-retention BMPs in the parking lot. Bio-retention is to have a 6ft X 4ft cross-sectional area and utilize parking lot slope to flow stormwater into the bio-retention BMPs. Do not install hard curb that would impede water flow to BMPs. BMP area is 2 X 6ft X 150ft = 1,800 SF. **BMP Storage is 1,461cf.**

LID (2a) Plant eight (8) Willow Oak trees at 50 foot intervals along the bio-retention.

LID (2b) Construct 180 linear feet of parking lot walkways at 6 foot width using permeable pavers. BMP area is 6ft X 180ft = 1,080 SF. **BMP Storage is 144cf.**

LID (3) Construct 5 Rain Gardens with Total Area = 6,000 SF (rain gardens can vary in size from one another and must total at least 6,000 SF).

LID (3a) Construct three (3) rain gardens along west side of the building. Install overflow/underdrain as necessary to surrounding slope. BMP area is 3 X 1,000 SF = 3,000 SF. **BMP Storage is 2,436cf.**

LID (3b) Construct two (2) rain gardens at the northwest corner of the building BMP area is 2 X 1,500 SF = 3,000 SF. **BMP Storage is 2,436cf.**

LID (4) Construct an 80 foot long bio-retention BMP along the Northwest portion of project site with an underdrain to a wetland feature that ties to the existing storm sewer. BMP area is 6ft X 80ft = 480 SF. **BMP Storage is 390cf.**

APPENDIX C. How to Incorporate LID in a DD1391

LID (4a) Construct a wetland at the discharge from the bio-retention along northwest portion of building in LID (4) above. Assume no BMP Storage. (BMP is designed for runoff to flow through a vegetated treatment train. No infiltration as BMP bottom is to be constructed using clay).

LID (4b) Construct an overflow connection from the existing storm sewer to the wetland in LID (4a) above.

LID (5) Install a 5,000 gallon elevated storage tank for latrine flushing. **BMP Usage is 668cf.**

6. Step Six – Develop LID Cost Estimate at Planning Charrette. Use the LID Cost Planning Tool at the following link https://mrsi.erdc.dren.mil/sustain/cx/lid to develop a cost estimate for each planned LID BMP (from Text Box) and enter into Tab A. Review each line of planned BMPs in the Text Box as some line items may have multiple BMPs identified. Input to Tab A may vary but should be developed using nomenclature similar to the following:

Storm Drainage Description	UM	No.	UC($)	Total ($)
LID (1) Keep Stand of Yellow Pine	NA	-	0	0
LID (1a) Leave Sandy Soils	NA	-	0	0
LID (2) Parking Lot Bio-Retention	SF	1,800	60.13	108,239
LID (2a) Plant Willow Oak Trees	EA	8	200	1600*
LID (2b) Permeable Paver Walkway	SF	1,080	49.53	53,496
LID (3a) Westside Rain Gardens	SF	3,000	62.37	187,113
LID (3b) Northwest Corner Rain Gardens	SF	3,000	61.33	184,016
LID (4) Northwest Bio-Retention	SF	480	67.86	32,567
LID (4a) Wetland BMP	EA	1	38,000	38,000*
LID (4b) Overflow to Storm Drain	EA	1	17,000	17,000*
LID (5) 5,000 (Gal) Storage Tank	EA	1	21,000	21,000*

Notes:
- The first two BMPs are to keep an existing stand of trees and sandy soil and does not cost anything.
* Costs associated with these BMPs are notional. Actual costs are project specific and need to be developed by a project designer and/or cost estimator.

7. Changes to the LID BMP Strategy. Changes to the BMP strategy may take place along the way through project development. In all instances installation/activity Master Planner/Engineer staff are to be coordinated with planned changes. These changes may take place during the Parametric Design Report (PDR) (Code 3) and Project Design (Code 6/7).

APPENDIX C. How to Incorporate LID in a DD1391

a. Parametric Design Report (PDR) (Code 3). The PDR results in a 15% design. The LID BMP data is updated in Tab J of the DD1391.

(1) PDR. A PDR consists of a 1391 review resulting in a refined scope of work and a completed ENG Form 3086 cost estimate. LID BMPs identified in Tab - J are refined during the PDR process and updated in Tab J of the 1391.

(2) ENG Form 3086. The ENG 3086 is a detailed cost estimate based on the scope of work in the PDR. Cost estimates for LID BMPs and developed during the PC are refined during the ENG Form 3086 and updated in Tab A.

b. Project Design (Code 6/7). The Designer of Record uses the information in the DD1391 as the starting point to identify installation Master Planner supported LID BMPs that meet Army Policy and Guidance.

Appendix D. LID BMP CATCODES

1. The following Category Codes (CATCODES) are for use when placing a LID BMP in the Accountable Property Systems of Record (APSR). These CATCODES are to be used until notified otherwise.

2. Table of LID BMP Assets and corresponding CATCODE.

LID BMP Asset	CATCODE	Long Name	(UM)
a. Bio-Retention	83180	(Gravity Oil and Grease Separator)	(KG)
b. Swale	87120	(Drainage Ditch)	(LF)
c. Permeable Pavement	85110	(Cantonment Area Roads, Paved)	(SY)
d. Rainwater Harvesting	84710	(Water Storage Tank, Nonpotable)	(GA)
e. Green Roof	11380	(Aircraft Loading Apron)	(SY)

3. Army Commands are to use the above CATCODES when entering data into the APSR. Some of the "long names" are closely associated with the LID BMP while others have no association. The intent of selecting CATCODES with "no association" was to pick a facility type that could have a maintenance cycle and cost that could resemble that of the LID BMP.

4. The HQDA is working to develop new CATCODES specific to each BMP Asset.

Appendix E. Maintaining Hydrology on Army Construction Projects

1. Installation/Activity Name	Name: City: State:
2. Project Name	
3. Project Street Address	
4. GPS Coordinates of Approximate Center of Site (from Google Earth)	Latitude: Longitude:
5. Project Description	
6. DD1391 Project Number	
7. Project Funding Source (*e.g. MILCON, OMA, etc.*)	
8. Installation Master Planner	Name: Email: Phone #:
9. USACE Geographic District	
10. USACE Project Manager	Name: Email: Phone #:
11. USACE or AE LID Designer of Record	Name: Email: Phone #:

Appendix E. Maintaining Hydrology on Army Construction Projects

SECTION B: EISA SECTION 438 LID CALCULATIONS To be filled in by LID Designer of Record (Reference UFC 3-210-10, Army LID Technical User Guide, and Army LID Planning Tool)	
12. Project Limit of Disturbance (LOD) (acres)	
13. 95th Percentile Rainfall Depth (*e.g. Baltimore, 1.6 inches)*	
14. Pre-Project Site Runoff Curve Number	
15. Pre-Project Runoff Volume (ft^3) (From LID Planning Tool)	
16. Post-Project Site Runoff Curve Number	
17. Post-Project Runoff Volume (ft^3) (From LID Planning Tool)	
18. LID Volume Required to be Retained on Site (Difference between pre-project and post-project runoff, #17 - #15, ft^3)	
19. Total Volume Retained on Site by LID BMPs (Infiltrated or Reused, ft^3)	
20. Does project comply with EISA? **YES** if Runoff Volume Retained on site (#19) is greater than or equal to Volume Required (#18). If **NO**, provide justification in #25.	

Note: The word “Retained” implies storm water is managed through infiltration to underlying soils or rainwater harvesting/reuse.

Appendix E. Maintaining Hydrology on Army Construction Projects

SECTION C: LID BMPS IMPLEMENTED						
21. BMP Type	BMP Location on Site	State Plane Coordinates (Northings and Eastings)	BMP Surface Area (ft^2)	Impervious Area Treated (ft^2)	Volume of Runoff Retained (ft^3)	BMP* Cost (000)
EXAMPLE: Bioretention	*SE corner of parking lot*	*N:518732.23 E:1388767.57*	*1500 ft^2*	*5000 ft^2*	*1000 ft^3*	*$47.3*

* LID BMP cost estimates are developed using the Army LID Planning Cost Tool.

SECTION D: OTHER STORMWATER MANAGEMENT REQUIREMENTS	
22. Name of Watershed project is located in (per State and/or EPA)	
23. If the installation/activity is required to comply with Total Maximum Daily Load regulations?	(Identify pollutants i.e. nitrogen, phosphorus)
24. Name of State and/or Local Stormwater Management Regulatory Authority (*e.g. Maryland Department of the Environment*)	

SECTION E: TECHNICAL INFEASABILITY	
25. If project does not fully comply with EISA, attach a technical infeasibility report to this reporting form.	Include all site constraints that prevent the project from full compliance (*e.g. engineering calculations, soil data, hydrologic analyses, geotechnical considerations, local water restrictions, etc.*)

This page intentionally left blank.

PR APPENDIX C
DoD Unified Facilities Criteria: UFC 3-120-10 Low Impact Design

This page intentionally left blank.

UFC 3-210-10
15 NOVEMBER 2010

UNIFIED FACILITIES CRITERIA (UFC)

LOW IMPACT DEVELOPMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

Any copyrighted material included in this UFC is identified at its point of use.
Use of the copyrighted material apart from this UFC must have the permission of the copyright holder.

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by **1**\ ... /**1**/)

Change No.	**Date**	**Location**

This UFC supersedes UFC 3-210-10, dated 25 October 2004, UFC 3-210-10N (DRAFT) and ITG FY10-2, both dated 6 April 2010.

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD(AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Center for Engineering and the Environment (AFCEE) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: Criteria Change Request (CCR). The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site http://dod.wbdg.org/.

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

JAMES C. DALTON, P.E.	JOSEPH E. GOTT, P.E.
Chief, Engineering and Construction	Chief Engineer
U.S. Army Corps of Engineers	Naval Facilities Engineering Command
TERRY G. EDWARDS, P.E.	MICHAEL McANDREW
Director, Air Force Center for Engineering and the Environment	Director, Facility Investment and Management
Department of the Air Force	Office of the Deputy Under Secretary of Defense (Installations and Environment)

UNIFIED FACILITIES CRITERIA (UFC)
REVISION SUMMARY SHEET

Document: **UFC 3-210-10, Low Impact Development**

Superseding: **This UFC supersedes UFC 3-210-10, dated 25 October 2004, UFC 3-210-10N and ITG FY1-0-2, both dated 6 April 2010.**

Description of Changes: This update to UFC 3-210-10 presents criteria necessary to comply with new policy and legislation regarding implementation of Section 438 of the Energy Independence and Security Act 2007. These changes are required to handle stormwater runoff from development or redevelopment projects involving a Federal facility with a footprint that exceeds 5,000 square feet.

Reasons for Changes:

- In December 2007, Congress enacted the Energy Independence and Security Act (EISA). Section 438 of that legislation establishes stormwater runoff requirements for Federal development and redevelopment projects.

- A January 2010 Deputy Under Secretary of Defense, Installation and Environment (DUSD(IE)) memorandum directs DoD components to implement EISA Section 438 using LID techniques. The memorandum directs the policy be incorporated into applicable DoD Unified Facilities Criteria.

Impacts: Sites with available land and good vegetative cover and soil conditions may see a net reduction in site civil construction costs. Highly developed sites with fair to poor soils may see increased costs for LID implementation. However, the following benefits should be realized.

- Standardized criteria will provide a simple, uniform approach to assist the Services in complying with the Energy Independence and Security Act (EISA) Section 438 requirements.
- While care must be taken to ensure a shift in design paradigms, LID techniques can be used to manage site civil costs.
- Newer site design philosophies will provide additional treatment and control at a localized level. Low Impact Development techniques work alongside the current stormwater management approach to provide a micro-view of handling runoff at its source or point of origination, to mitigate adverse impacts from stormwater runoff and hold the net increase in stormwater runoff in the LID facilities provided on-site.
- Low Impact Development (LID) will help to protect natural resources from continuing degradation.

TABLE OF CONTENTS

CHAPTER 1- INTRODUCTION 1
1-1 PURPOSE AND SCOPE 1
1-2 DEFINITION OF LOW IMPACT DEVELOPMENT 1
1-3 APPLICABILITY 1
1-4 REFERENCES 1
CHAPTER 2 - POLICY AND GENERAL REQUIREMENTS 2
2-1 STATUTORY REQUIREMENT 2
2-2 DoD POLICY 2
2-2.1 Establishing Design Objective and Pre-Development Condition 2
2-2.2 Maximum Extent Technically Feasible 2
2-2.3 Restoration of Natural Hydrological Conditions 3
2-2.4 Documentation of Project Costs 3
2-3 General building requirements 3
CHAPTER 3 – PLANNING AND DESIGN 5
3-1 HYDROLOGIC ANALYSIS & RECOMMENDED TR-55 METHODOLOGY 5
3-2 DESIGN OPTIONS FOR LID INTEGRATED MANAGEMENT PRACTICES 6
3-2.1 Bioretention 7
3-2.2 Permeable Pavements 7
3-2.3 Cisterns/Recycling 7
3-2.4 Green Roofs 7
3-3 TIME OF CONCENTRATION FOR PRE- AND POST-DEVELOPMENT CONDITIONS 7
3-3.1 Stormwater Flow Segments 7
3-4 DESIGN STORM EVENT 8
3-5 OFF-SITE OPTIONS 8
3-6 CLEAN WATER ACT PERMITS 8
3-7 OTHER DESIGN REQUIREMENTS 8
3-7.1 Regional Requirements 8
3-7.2 Sustainable Design 9
3-7.3 Architectural Compatibility 9
3-7.4 Base Design and Development Documents 9
3-7.5 Anti-Terrorism (AT) 9
3-7.6 Airfield Criteria 9
APPENDIX A – REFERENCES 10
APPENDIX B – LOW IMPACT DEVELOPMENT BEST PRACTICES 11
APPENDIX C – DUSD (IE) Policy Memo 19 JAN 2010 39

LIST OF FIGURES

Figure 1: Implementation of EISA Section 438 4

APPENDIX B
LIST OF TABLES

Table 1: U.S. EPA Websites related to LID 15
Table 2: Summary of Concepts of SWM and LID Techniques. 21
Table 3: Comparison of Conventional SWM and LID Technologies 22
Table 4: Summary of LID Techniques, Constraints, Requirements and Applicability 24
Table 5: Summary of Hydrologic Functions of LID Practices 25
Table 6: Initial Abstraction for Indicated Soil Types 27
Table 7: Analysis Method Comparison 36
Table 8: Summary of Rainfall Analysis (1978-1997) 37

CHAPTER 1- INTRODUCTION

1-1 PURPOSE AND SCOPE

This UFC provides technical criteria, technical requirements, and references for the planning and design of applicable projects to comply with stormwater requirements under Section 438 of the Energy Independence and Security Act (EISA) enacted in December 2007 (hereafter referred to as EISA Section 438).

1-2 DEFINITION OF LOW IMPACT DEVELOPMENT

Low Impact Development (LID) is a stormwater management strategy designed to maintain site hydrology and mitigate the adverse impacts of stormwater runoff and nonpoint source pollution.

LID actively manages stormwater runoff by mimicking a project site's pre-development hydrology using design techniques that infiltrate, store, and evaporate runoff close to its source of origin. LID strategies provide decentralized hydrologic source control for stormwater runoff. In short, LID seeks to manage the rain, beginning at the point where it falls. This is done through a series of techniques that are referred to as LID Integrated Management Practices (LID-IMPs). The LID-IMPs are distributed small scale controls that closely mimic hydrological behavior of the pre-project sites for a design storm event.

1-3 APPLICABILITY

The criteria and design standards in this UFC are required for all Department of Defense construction in the United States and United States Territories.

EISA Section 438 requirements apply to projects that construct facilities with a "footprint" greater than 5,000 gross square feet, or expand the footprint of existing facilities by more than 5,000 gross square feet. The project "footprint" consists of all horizontal hard surfaces and disturbed areas associated with the project development, including both building area and pavements (such as roads, parking, and sidewalks). These requirements do not apply to internal renovations, maintenance, or resurfacing of existing pavements.

Where EISA Section 438 is not applicable (e.g., projects under 5,000 square feet), LID techniques apply to the extent practical.

1-4 REFERENCES

Appendix A contains the list of references used in this document.

CHAPTER 2 - POLICY AND GENERAL REQUIREMENTS

2-1 STATUTORY REQUIREMENT

EISA Section 438 established into law new stormwater design requirements for Federal development and redevelopment projects. Under these requirements, Federal projects with a footprint over 5,000 square feet must "maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow".

2-2 DOD POLICY

The Deputy Under Secretary of Defense (Installations and Environment) memorandum of 19 January 2010 (Appendix C) directs DoD components to implement EISA Section 438 using LID techniques in accordance with the methodology illustrated in Figure 1 and further described below. In addition, this policy memo references U.S. Environmental Protection Agency (EPA) *Technical Guidance on Implementing the Stormwater Runoff requirements for Federal Projects under Section 438 of the Energy Independence and Security Act*. Individual Services may have more stringent implementation and applicability requirements relating to Low Impact Development.

2-2.1 Establishing Design Objective and Pre-Development Condition

The overall design objective for each applicable project is to maintain predevelopment hydrology and prevent any net increase in stormwater runoff. DoD defines "predevelopment hydrology" as the pre-project hydrologic conditions of temperature, rate, volume, and duration of stormwater flow from the project site. The analysis of the predevelopment hydrology must include site-specific factors (such as soil type, ground cover, and ground slope) and use modeling or other recognized tools to establish the design objective for the water volume to be managed from the project site.

The increase in runoff between pre- and post-development conditions is to be managed on the project site, to the maximum extent technically feasible, through interception, infiltration, storage, and/or evapotranspiration processes. Other design requirements may need to be considered.

2-2.2 Maximum Extent Technically Feasible

The designer shall evaluate project site options to achieve the design objective to the maximum extent technically feasible. The "maximum extent technically feasible" criterion requires full employment of accepted and reasonable stormwater retention and reuse technologies (further described in Chapter 3) subject to site and applicable regulatory constraints (e.g., site size, soil types, vegetation, demand for recycled water, existing structural limitations, state or local prohibitions on water collection). All site-specific technical constraints that limit the full attainment of the design objective shall be documented. If the design objective cannot be met within the project footprint, LID measures may be applied at nearby locations on DoD property (e.g., downstream from the project) within available resources. Examples of technical constraints are as follows:

- Retaining stormwater on-site would adversely impact receiving water flows
- Site has shallow bedrock, contaminated soils, high groundwater table, underground

facilities or utilities
- Soil infiltration capacity is limited
- Site is too small to infiltrate significant volume
- Non-potable water demand (irrigation, toilets, wash-water, etc.) is too small to warrant water harvesting and reuse system
- Structural, plumbing, and other modifications to existing building to manage stormwater are infeasible
- State or local regulations restrict water harvesting
- State or local regulations restrict use of green infrastructure/LID.

2-2.3 Restoration of Natural Hydrological Conditions

The designer shall consult with the government representative to determine whether natural hydrological conditions of the property can be restored, to the extent practical.

2-2.4 Documentation of Project Costs

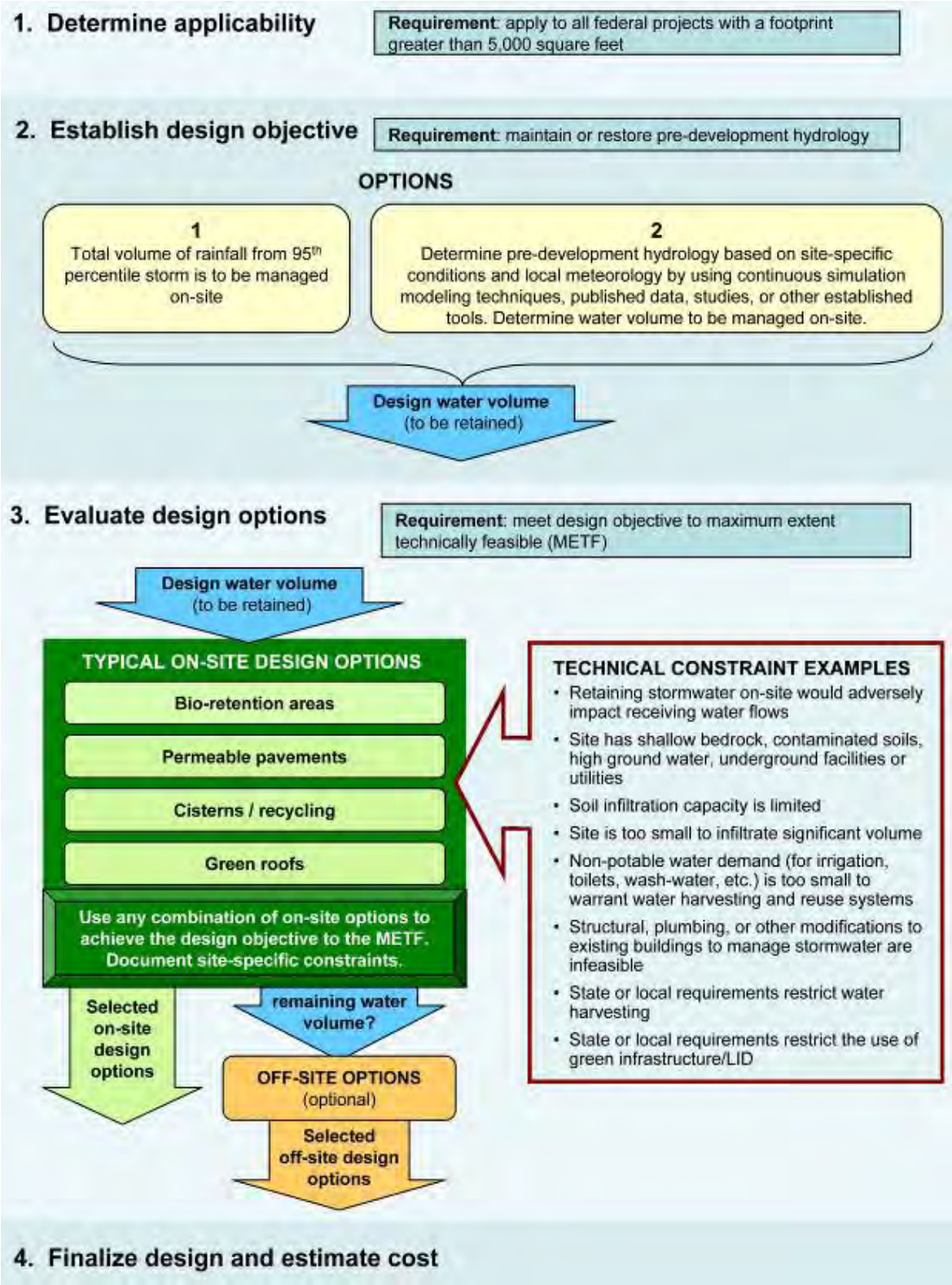
Estimated design and construction costs for implementing EISA Section 438 shall be documented in the project cost estimate as a separate line item. Final implementation costs will be documented as part of the project historical file.

Post-construction analysis shall also be conducted to validate the effectiveness of as-built stormwater features. For compliance the Designer of Record (DOR) shall provide documentation to validate the as-built LID-integrated management practices (IMP) meet the design requirements and analyses.

2-3 GENERAL BUILDING REQUIREMENTS

UFC 1-200-01, General Building Requirements, provides applicability of model building codes and government-unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, sustainability, and safety. Use this UFC in addition to UFC 1-200-01 and the UFCs and government criteria referenced therein.

FIGURE 1: IMPLEMENTATION OF EISA SECTION 438



CHAPTER 3 – PLANNING AND DESIGN

3-1 HYDROLOGIC ANALYSIS & RECOMMENDED TR-55 METHODOLOGY

DoD policy specifies that the designer is to determine pre-development hydrology based on site-specific conditions and local meteorology by using continuous simulation modeling techniques, published data, studies, or other established tools. The designer would then identify the pre-development condition of the site and quantify the post-development runoff volume and peak flow discharges that are equivalent to pre-development conditions. The post-construction rate, volume, duration and temperature of runoff should not exceed the pre-development rates and the redevelopment hydrology should be replicated through site design and other appropriate practices to the maximum extent technically feasible. These goals should be accomplished through the use of infiltration, evapotranspiration, rainwater harvesting and/or other proven LID techniques. Defensible and consistent hydrological assessment tools should be used and documented.

Service components may use a methodology or standard practice for estimating surface hydrology. These methods include, but or not limited to, Soil Conservation Service (SCS) weighted flow, the rational formula, or a dynamic rainfall-runoff simulation model like the EPA's Storm Water Management Model (SWMM). Models developed for watershed nonpoint source analysis like EPA's Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) should not be used for this type of hydrologic analysis.

To control the stormwater volume in accordance with DoD policy, the use of methodology from TR-55 Curve Number Methodology (SCS 1986), Chapter 2: "Estimating Runoff" is recommended. Calculate the runoff depth for both the pre- and post-development conditions, and the difference will be the depth from which the volume to be retained on-site can be determined (see equation 2 below).

This methodology is likely the most efficient and practical for designers to comply with EISA Section 438 requirements. Therefore, details of this methodology have been summarized in the following paragraphs.

During a storm event a portion of the precipitation is caught in the form of interception, depression storage, evaporation, transpiration, and infiltration. These losses are collectively referred to as *abstractions*. Only that part of the rainfall in excess of abstractions is defined as stormwater runoff.

The Soil Conservation Service (SCS 1986), now the Natural Resources Conservation Service (NRCS), presented an empirical method of determining initial abstraction based on the runoff curve number (CN) of the site and is given by:

EQUATION 1: Initial abstraction (inches), $I_a = 0.2*S$

Where S = potential maximum retention after <u>runoff</u> begins (inches) = $\frac{1000}{CN} - 10$

The initial abstraction defined in Eq. 1 also represents the rainfall at which the direct runoff begins. Any rainfall over and above the initial abstraction results in direct surface runoff.

EQUATION 2: Total depth of increase in runoff (inches), $D = \frac{(P-0.2*S')^2}{(P+0.8*S')} - \frac{(P-0.2*S)^2}{(P+0.8*S)}$

Where, P = design storm rainfall depth (inches)

S & S' = potential maximum retention after runoff begins (inches) during the pre- and post-development conditions, respectively

Note: Eq. 2 is valid if P > 0.2*S. Otherwise, the term calculating the runoff depth

$$\frac{(P-0.2*S)^2}{(P+0.8*S)} = 0$$

D= the depth of rainfall that becomes runoff

EQUATION 3: The design storage, V_{LID} = D * A

D = total depth of increase in stormwater runoff (inches)

A = drainage area or the area of the parcel being developed (square units)

The design storage of LID-IMP features, calculated using Equation 3, ensures no net increase in stormwater runoff volume for the design rainfall event replicating pre-development hydrology.

Additional details on hydrologic analysis are located in Appendix B – Low Impact Development Best Practices, Chapter 4.

3-2 DESIGN OPTIONS FOR LID INTEGRATED MANAGEMENT PRACTICES

The site designer shall give priority to those LID-IMPs that are proven in their regional area to have the greatest cost benefit ratio and lowest lifecycle costs. Highly developed sites, sites with a high ratio of impervious to pervious area, industrial sites, and airfield projects may require more costly, higher maintenance LID-IMPs in order to meet LID goals within the constraint of maximum extent technically feasible (see section 2-2.2).

The designer shall verify with the Installation the capability to maintain LID-IMPs prior to selecting for use on-site. LID-IMPs that cannot be maintained by the Installation with current capability and contract capacity shall require approval prior to construction.

LID-IMPs can be categorized in four main categories:

3-2.1 Bioretention

Natural type depression storage, infiltration, and evapotranspiration. This design option is typically the least costly and easiest to accomplish if site availability, soils, water table, etc. are conducive. Other site treatments such as swales, rain gardens, open space, etc. fall under this general category and are advisable due to lower initial costs.

3-2.2 Permeable Pavements

Provide infiltration and prevent concentrated flow. Permeable pavements (including pavers) are the next most cost effective method of meeting the design goals. Limitations on the use of these design options are wheel loading, traffic, ability to maintain, FOD danger, etc.

3-2.3 Cisterns/Recycling

Re-use systems that store and re-use stormwater. This design option is preferable if adequate demands for reuse water exist. Many facilities do not have the potential for reuse to make this option cost effective.

3-2.4 Green Roofs

Limit peak discharges and seasonal evapotranspiration. Green roofs are a design option where the site is constrained by space limitations and other design options do not meet the design goals. Green roofs should be assessed with consideration of other benefits such as lower energy costs.

3-3 TIME OF CONCENTRATION FOR PRE- AND POST-DEVELOPMENT CONDITIONS

In order to mimic pre-project hydrologic patterns the site designer needs to provide features that limit the rate at which runoff leaves the site. To the maximum extent technically feasible, the post-development time of concentration (T_c) must be equal to or greater than the pre-development T_c.

Maintaining T_c close to pre-development conditions is critical because the peak runoff rate, and thereby the volume of runoff from individual lots, is inversely proportional to the time of concentration. The T_c shall be maintained to the maximum extent technically feasible, by strategies such as reduction of impervious areas, maintaining natural vegetation, siting of impervious areas in poor draining soils, and disconnecting impervious areas.

3-3.1 Stormwater Flow Segments

The Soil Conservation Services TR-55 Curve Number Methodology (SCS, 1986) is well documented and is used widely in engineering practice and may be used to determine the T_c (other computerized methods based on site-specific conditions and acceptable to the local regulating authority may also be used). The method presumes that rainfall-runoff moves through a watershed as sheet flow, shallow concentrated flow, pipe/channel flow, or some combination of these. The time of concentration T_c is the sum of travel flow times calculated separately for the consecutive flow segments along the longest flow path. These three flow segments along with their implications on time of concentration are discussed separately. Typical site design shall use SCS TR-55 Manual: *Urban Hydrology for Small Watersheds* for calculating time of concentration. Other methods may be used for larger more complex sites.

3-4 DESIGN STORM EVENT

The design storm event shall be the 95th percentile rainfall depth or the required water quality depth as defined by State or local requirements, whichever is more stringent. Most Local and State stormwater regulations include a first-flush or water quality depth for 2-, 5-, 10-, 25-, 50-, or 100-year regulated storm events. The LID-IMPs shall be designed to control all regulated storm events, as stipulated by Local and State regulations, to handle the peak rate and/or volume of discharge for flood control purposes.

3-5 OFF-SITE OPTIONS

If the design goals objectives cannot be met within the project footprint, LID measures may be applied at nearby locations on DoD property (e.g.downstream from the project) to manage the remaining design water volume within available resources. Off-site options are generally less desirable than on-site options, as many of the benefits of managing the stormwater close to the source may be lost.

3-6 CLEAN WATER ACT PERMITS

Any applicable State and local requirement for stormwater management shall be met in addition to UFC requirements. State stormwater construction permits required under the Clean Water Act shall be obtained using their approved methodology. Coordination of the design is the responsibility of the site designer to insure that the criteria are met from both the regulatory and LID perspectives.

EISA Section 438 requirements are independent of stormwater requirements under the Clean Water Act. The DUSD (IE) EISA Section 438 policy directive (Appendix C) states, “EISA Section 438 requirements are independent of stormwater requirements under the Clean Water Act and should not be included in permits for stormwater unless a state (or EPA) has promulgated regulations for certain EISA Section 438 requirements (i.e., temperature/heat criteria) that are applicable to all regulated entities under its Clean Water Act authority.”

3-7 OTHER DESIGN REQUIREMENTS

3-7.1 Regional Requirements

Regional regulatory requirements may affect the design of specific LID elements and practices as defined herein. LID implementation goals are achieved by selecting a set of LID-IMPs that can closely maintain or replicate hydrological behavior of the pre-project site for the design storm event. Most LID-IMPs are distributed small-scale controls that increase rainfall interception and slow the time of concentration. The design for LID-IMPs to be incorporated shall meet the stated goals (i.e. water volume design objectives) for compliance with EISA Section 438 per the DUSD(IE) memorandum in Appendix C.

For design of LID-IMPs to meet EISA 438 design objectives, the site designer shall refer to State and Local standards where available. In the absence of State and Local standards for design of LID-IMPs, refer to the LID National Manuals guidance prepared by the Prince George's County, Maryland, Department of Environmental Resources Programs and Planning Division (PGDER), and information provided by the US EPA.

3-7.2 Sustainable Design

Site design should incorporate sustainable development concepts to reduce energy consumption, O&M costs, reduce waste, and reduce pollution. Refer to UFC 4-030-01, *Sustainable Development* for specific design guidance.

3-7.3 Architectural Compatibility

LID-IMP facilities shall comply with DoD and Activity requirements and surrounding base architecture. Compliance with this UFC must be in accordance with other directives such as the new DoD Architectural Barriers Act (ABA) Accessibility Standard and Access for People with Disabilities Memorandum dated Oct. 31, 2008. In addition, LID design must follow applicable industry practice standards and locally restrictive building codes (e.g., earthquake zones).

3-7.4 Base Design and Development Documents

The intent of Installation Master Planning shall be incorporated into designs. The site designer shall follow published design guidelines that contain criteria relative to achieving, maintaining, and emphasizing a positive exterior visual environment applicable to military installations. The site designer shall consult the Project Manager for direction in case of conflicts. Direction to deviate from these documents should be given in writing.

3-7.5 Anti-Terrorism (AT)

The design of LID-IMP facilities shall comply with UFC 4-010-01, *DoD Minimum Antiterrorism Standards For Buildings* and UFC 4-010-02, *DoD Minimum Antiterrorism Standoff Distances For Buildings*. When conflicts arise between this document and UFC 4-010-01 or 4-010-02, UFCs 4-010-01 and 4-010-02 take precedence.

3-7.6 Airfield Criteria

The design of LID-IMP facilities shall comply with UFC 3-260-01, *Airfield and Heliport Planning and Design.* When conflicts arise between this document and UFC 3-260-01, UFC 3-260-01 takes precedence.

APPENDIX A – REFERENCES

1. U.S. EPA Technical Guidance on Implementing Section 438 of the Energy Independence and Security Act, December 2009.

2. Unified Facilities Criteria
   UFC 3-200-10N *Civil Engineering,* Final Draft
   UFC 3-201-02 *Landscape Architecture*
   UFC 4-010-01 *DoD Minimum Antiterrorism Standards For Buildings*
   UFC 4-010-02 *DoD Minimum Antiterrorism Standoff Distances For Buildings*
   UFC 4-030-01 *Sustainable Development*

3. Department of the Navy Low Impact Development (LID) Policy for Storm Water Management**,** *Assistant Secretary of the Navy (Installations and Environment) Memorandum,* November 2007

4. NAVFAC INSTRUCTIONS 9830.1: Sustainable Development Policy.

5. Low-Impact Development Design Strategies, An Integrated Design Approach, *Prince George's County, Maryland, Department of Environmental Resources, Programs and Planning Division*, June 1999.

6. Low-Impact Development Hydrologic Analysis, Prince George's County*, Maryland, Department of Environmental Resources, Programs and Planning Division*, July 1999.

7. Low Impact Development Manual for Michigan, *Southeast Michigan Council of Governments*, 2008.

8. Urban Hydrology for Small Watersheds, TR-55, *Natural Resources Conservation Services*, June 1986 (SCS 1986).

9. Sustainable Building Technical Manual: Green Building Design, Construction, and Operations, *Public Technology, Inc., and the U.S. Green Building Council, 1996.*

10. Urban Hydrology, Hydraulics, and Stormwater Quality, *A. Osman Akan and Robert J. Houghtalen*, 2003.

APPENDIX B – LOW IMPACT DEVELOPMENT BEST PRACTICES

This Best Practices appendix provides additional detail and analysis supporting the criteria and builds process action steps in the Planning, Design, and post-construction stages of project development. In addition, the appendix gives a basic level of understanding for the rationale behind the UFC criteria hydrology and methods of calculation.

The UFC criteria are predicated on standard practices in the field of stormwater management. The design storm event is typically defined by the 95th percentile storm (see also section 3-4 of this UFC). By averaging all storm events that occur within 24 hours for several years, the designer can statistically predict the intensity of a storm that is equal to or less than 95 percent of all storms. The method of calculation for this is taken to be the Natural Resource Conservation Service (NRCS), formerly the Soil Conservation Service (SCS) method TR-55. A site designer can easily hand calculate the necessary information for small sites using formulas given in the criteria. For larger sites, computer calculations and simulation modeling are encouraged.

By design, LID methods do not control runoff in excess of the pre-development condition, but are intended to bypass larger storm volumes to flood control measures as defined by the conventional stormwater management techniques. LID is in addition to the requirements of the stormwater permits required. There are other regulatory requirements that also affect the design of stormwater management, quality, and control that are specific to local regions and areas not covered in this document.

ACRONYMS AND ABBREVIATIONS

Item	Definition
ARC	Antecedent Runoff Condition
Bio	Biological
BMP	Best Management Practice
CN	Curve Number
CWA	Clean Water Act
DoD	Department of Defense
e.g.	for example
EISA	Energy Independence and Security Act
EPA	United States Environmental Protection Agency
Eq.	Equation
FEC	Facilities Engineering Command
hr	hour
HSG	Hydrologic Soil Group
I&E	Installations and Environment
I&F	Installations and Facilities
i.e.	as such
I_a	Initial Abstraction
IMP	Integrated Management Practice
in/hr	inches per hour
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
DoD	Department of Defense
MWR	Morale, Welfare, and Recreation
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
O&M	Operations and Maintenance
OMSI	Operation and Maintenance Support Information
PGDER	Prince George's County Department of Environmental Resources
pH	Measure of the acidity of a solution
PWD	Public Works Department
SCS	USDA Soil Conservation Service
sec/hr	seconds per hour
sq ft	square feet
SWM	Stormwater Management
Tc	Time of Concentration
TR-55	NRCS Technical Release 55 (formerly SCS)
UFC	Unified Facilities Criteria
USDA	United States Department of Agriculture

APPENDEX B: CHAPTER 1 - BACKGROUND

Since 2004, LID techniques for controlling stormwater runoff have been considered for many projects based on-site requirements and constraints. LID strategies provide a decentralized hydrologic source control for stormwater. LID implementation is based on selecting LID-IMPs that are distributed small-scale controls that can closely maintain or replicate hydrological behavior of the pre-project site for a defined design storm event. The use of LID was pioneered in the 1990s by Prince George's County, Maryland Department of Environmental Resources (PGDER) under a grant from the Environmental Protection Agency (EPA).

LID differs from conventional SWM principles in that it does not store and release stormwater. LID uses infiltration, evaporation, plant transpiration, and reuse of rainwater to keep the additional stormwater generated due to the developed condition contained on-site.

The application of LID to infrastructure development program is practical and achievable, but it will require a change of thinking on the part of the site designer. The LID-IMPs fall into five categories, as follows:

1) Site Utilization: Begin the site process by reducing the impervious footprint if possible. Narrower streets, vertical construction, parking structures, and the removal of curb, gutter, and paved swales are a few of the ways to reduce impervious surfaces. It is crucial to mimic the pre-development hydrologic conditions in order for LID to be effective. Choose rougher surfaces, disconnect impervious areas, and increase the time of concentration (Tc). Retain as much of the natural tree cover as practical, and place the impervious structures in areas of the poorest soil types where possible.
2) Filtration: Include filtration practices in the site design. Vegetative buffers, filter strips, vegetative swales, check dams, sediment traps, and overland flow will provide natural water quality treatment and increase the time of concentration (Tc).
3) Interception/Infiltration: The infiltration techniques of LID are the backbone of the runoff volume reduction. Depression storage, bio-infiltration, pervious pavements, open pavers, rain gardens, infiltration trenches, and tree boxes are gaining wide acceptance as tools in the SWM toolbox. Interception can also play a major role in reducing runoff volumes. Interception techniques include deep mulch beds, tree cover, and soil amendments.
4) Retention of Stormwater Volumes: Retention can play an important part in successful LID implementation. Retention seeks to hold runoff from localized impervious surfaces for subsequent treatment after the rainfall event. Rain barrels, storage and release cisterns, and parking lot storage that slowly drain to infiltration zones are examples of retention techniques. DoD discourages the construction of detention ponds
5) Structural Solutions: Structural solutions represent the last line of defense in the LID-IMPs. Structural solutions will increase the facility construction cost and must be balanced with mission requirements. In urban and industrial areas, sensitive environments, or known contaminated sites, structural solutions are often the only solution. These techniques are engineered solutions for the particular facility and can include green roofs, rainwater reuse systems, parking structures, and irrigation storage systems.

The site designer is encouraged to contact the Project Manager, Environmental Technical point of contact, State and local regulatory officials to verify the requirements of applicable stormwater programs. Table 1 has a link to NPDES specific State program statuses as granted by EPA. Table 1 also has additional useful links on LID topics by EPA.

A list of LID design reference material is included at the end of Chapter 4. Additional information may be found on the following link to the WBDG LID Resource Page: http://www.wbdg.org/resources/lidtech.php

Table 1: U.S. EPA Websites related to LID

U.S. Environmental Protection Agency

Low Impact Development (LID) is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treats stormwater as a resource rather than a waste product. Many practices have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements. By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed. Applied on a broad scale, LID can maintain or restore a watershed's hydrologic and ecological functions. LID has been characterized as a sustainable stormwater practice by the Water Environment Research Foundation and others.

Low Impact Development (LID)
http://www.epa.gov/nps/lid/

Stormwater Program
http://cfpub.epa.gov/npdes/home.cfm?program_id=6

Authorization Status for EPA's Stormwater Construction and Industrial Programs
http://cfpub.epa.gov/npdes/stormwater/authorizationstatus.cfm

State Program Status
http://cfpub.epa.gov/npdes/statestats.cfm?view=specific

Managing Wet Weather with Green Infrastructure
http://cfpub.epa.gov/npdes/home.cfm?program_id=298

APPENDIX B: CHAPTER 2 - PLANNING

2-1 THE PLANNING COMPONENT

Successful implementation of LID begins during the planning process, which is one of the first steps. During the planning phase, the exact configuration of LID-IMPs and the ways in which LID will shape the site design is not expected to be determined. This section will provides the organizational tools and steps to build upon in considering LID in the final project.

Each step progresses further into the details of the planning process. For example, budget planning at an early stage may only develop Step 1, then move on to Cost Analysis. Master Planning would necessarily move through Step 4, and preliminary design through Step 6.

2-1.1 ORGANIZING THE PLANNING PROCESS AND TIMELINE

Step 1: *Define project objectives and goals at a macro-level*

1) Identify the LID objectives and legal requirements for the project (e.g., stormwater permits, state erosion control and flood requirements, EISA Section 438). Estimate runoff volume, peak runoff rate, duration, frequency, and water quality.
2) Make assumptions on existing stormwater infrastructure in terms of how well it functions with respect to each of these aspects.
3) Evaluate the goals and feasibility for control of runoff volume, duration, and water quality, as well as on-site use of stormwater (e.g. irrigation, flushing toilets).
4) Prioritize and rank basic objectives.
5) Identify applicable local regulations or codes.
6) Determine Typical LID-IMPs required to meet objectives as best as possible (i.e. infiltration, filtration, discharge frequency, volume of discharges, and groundwater recharge) taking into consideration available space, underground utilities, soil infiltration characteristics, slope, drainage patterns, water table protected areas, setbacks, easements, topographic features, and other site features that should be protected such as floodplains, steep slopes, and wetlands.

   Consider non-structural site planning techniques:
   - Minimize total site impervious area.
   - Use alternative roadway layouts that minimize imperviousness.
   - Reduce road widths and drive aisles where safety considerations allow.
   - Limit sidewalks to one side of roads.
   - Reduce on-street parking
   - Use permeable paving materials where it does not reduce the functionality and is permitted.
   - Minimize directly connected impervious areas.
   - Disconnect roof drains and direct drainage to vegetated areas.
   - Site layout to direct flows from paved areas to stabilized vegetated areas.
   - Site layout to break up flow directions from large paved surfaces.

LID Planning Steps:
Define Project Goals
Evaluate Site
Develop LID Strategies
Assume LID Concept Design
Target O&M Strategy

- Site development to encourage sheet flow through vegetated areas.
- Locate impervious areas so that they drain to permeable areas.
- Maximize overland sheet flow.
- Maximize use of open swale systems.
- Increase (or augment) the amount of vegetation on the site.
- Use site fingerprinting. Restrict ground disturbance to the smallest possible area
- Reduce construction on highly permeable soils.
- Locate impervious areas to avoid removal of existing trees.
- Maintain existing topography and associated drainage divides to encourage dispersed flow paths.
- Locate new buildings, parking, and ponds in areas that have lower hydrologic function, such as clayey or disturbed soils.

2-2 COST ANALYSIS

One of the most difficult challenges is to properly allocate resources for projects so that they are successful and fulfill the mission as programmed. LID requirements can add a new level of complexity to the project that must be addressed during planning. While it may be too early in the process to determine the exact final design configuration of the LID-IMPs, the information to determine a level of effort required to implement LID can be used. (LID-IMP design is discussed in Appendix B, Chapter 4).

The three resources that must be addressed for LID are:
1) Implementation cost (may be less than traditional)
2) Operation & Maintenance costs (lifecycle)
3) Time impacts to design and permitting process

Information on the project mission must be gathered including; geographical location, site requirements, available sites, programmed space requirements related to increased impervious area, and the ability of the installation to maintain the LID-IMP. These set points will also help to determine the proper resource allocations to apply for the implementation of the LID site. LID is a method of SWM that focuses on the macro vision for site development. LID is implemented on every square foot of the site at the point of rainfall onward. LID-IMPs used in conjunction with conventional SWM will create a treatment train to hold, infiltrate, and filter the stormwater runoff. The LID site will contain less channelization of stormwater, less impervious pavement, more trees, more open ditches (less curb and gutter), and more planting buffers (rainwater filters). Many parameters must be weighted in the design of a LID site. Design must match the particular regional conditions.

Many of these site conditions affect the design of LID. Regional differences in weather patterns, soil types, groundwater conditions, existing development status, and current stormwater patterns will greatly influence the actual design and layout of the LID site and the choice of the LID-IMPs. However, <u>one of the most important parameters will be the ratio of increased impervious surface area to the available land area or change in land cover</u>.

Optimal LID implementation on a suitable site may result is a reduction in project cost. Classic LID design should reduce the amount of disturbed land, reduce impervious surface area, eliminate curb and gutter, reduce the size of pipes and holding ponds, increase the area planted in low maintenance tree cover, and reduce high maintenance structural planting beds and

grass. Building a large facility on a small site will cost more to implement LID than building a small building on a large site. The small site will require the selection of IMPs that are structural in nature and are more expensive to build and maintain, while the small building on the large site can use the more organic LID-IMPs that are less costly and more easily maintained.

2-3 EPA LID GUIDANCE

The following EPA manuals are referenced as sources: “Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices” and “Low Impact Development (LID) A Literature Review”. These manuals were based on the PDGR document “Low-Impact Development Design Strategies; An Integrated Design Approach”, and is geared toward general site development. Sites on military bases may have additional constraints that will influence which LID-IMPs may be used.

Other Federal Directives and Executive Orders that affect LID planning and design must be identified and considered.

APPENDIX B: CHAPTER 3 - STORMWATER MANAGEMENT

Human development increases impervious surfaces. Buildings, roads, sidewalks, and parking lots quickly shed rainwater and increase the percentage of rainfall that ends up as runoff. The resulting increase in runoff volume and the peak flows create negative consequences such as stream degradation and flooding risk. The principal objective of LID is to retain this increase in runoff on-site. LID techniques allow the developed site to mimic the pre-development hydrologic conditions.

LID builds on the conventional SWM philosophies and carries them a step further. LID processes begin at the point where the rain falls. Considering incorporating LID concepts, tools, and approaches requires assessment of the following at a minimum:

- Will the concept closely mimic the hydrology of pre-development condition thereby meeting certain regulatory requirement and/or resource protection goals?
- Will the concept mitigate adverse effects from increased stormwater runoff from the project?
- Can the drainage conveyance structures be optimized and reduce the overall cost of the project?
- What might be the hurdles for public acceptance? If required for the project to move forward, can these be reasonably achieved?

Implementing LID alone on the project may not suffice in meeting all regulatory requirements. LID must be used in combination with applicable BMPs in order to continue to produce effective SWM benefits.

3-1 HYDROLOGIC CYCLE

Dr. David Maidment in his *Handbook of Hydrology* states:

> "The hydrologic cycle is the most fundamental principle of hydrology. Water evaporates from the oceans and the land surface, is carried over earth in atmospheric circulation as water vapor, precipitates again as rain or snow, is intercepted by trees and vegetation, provides runoff on the land surface, infiltrates into soils, recharges groundwater, discharges into streams, and ultimately, flows out into the oceans from which it will eventually evaporate once again. This immense water engine, fueled by solar energy, driven by gravity, proceeds endlessly in the presence or absence of human activity."

Of the total precipitation that occurs, a portion of it is lost through the following:
(i) interception due to land cover
(ii) evapotranspiration
(iii) surface depression storage
(iv) infiltration

Only the excess precipitation results in runoff that reaches receiving water bodies, such as streams and lakes. The process of infiltration is responsible for the largest portion of rainfall losses in pervious areas. LID techniques seek to mimic pre-development hydrologic condition in the post-development phase.
An understanding of the dynamics and inter-relationships in the hydrologic cycle is essential in preserving the pre-development hydrology. A comparison of pre-development and post-

development hydrologic conditions is evaluated for four basic measures – runoff volume, peak rate of runoff, flow frequency/duration, and water quality. These four evaluation measures are discussed below:

Runoff Volume: LID techniques, if implemented properly into site design, will result in 'no net increase' in runoff for a specified design storm event.

Peak Rate of Runoff: LID is designed to maintain pre-development hydrologic conditions for all storms smaller than the design storm event. If additional controls are required, either to meet the state or local regulations and/or flooding issues for unusual storm events, conventional SWM facilities may be designed and implemented.

Flow Frequency/Duration: LID techniques mimic pre-development hydrologic conditions if implemented properly. The flow frequency/duration should be almost the same.

Water Quality: Because of the very nature of decentralized hydrologic source control, the nonpoint source pollution is greatly reduced, thereby, increasing the water quality of the receiving water bodies.

Table 2 compares and summarizes concepts of stormwater management and LID techniques. For designs with LID-IMPs, it is appropriate to analyze the site as discrete units and rationalize on a case-by-case basis. When calculating the runoff potential from LID sites one should consider land cover, impervious areas, its connection with centralized collection system, soil type and texture, and antecedent moisture condition. These should all be considered on a site-specific basis.

3-2 STORMWATER DISPOSAL VS. STORMWATER MANAGEMENT

The main principle of incorporating LID elements into site planning design is to ensure that there is no net increase in runoff volume for the design storm. As detailed in Chapter 2 of this manual, there are a number of techniques that can be employed in eliminating the increase.

The main processes or practices that affect elimination of an increase in runoff volume for the design storm include infiltration at decentralized locations, increasing the length and time of flow over pervious areas, and disconnecting impervious areas that drain to stormwater collection systems. These help to retain the increase in runoff from new development on-site.

Conventional SWM facilities are primarily designed to divert unusual storm event runoff volumes and to control flooding and downstream impacts due to this increased runoff, but also provide water quality benefits.

Table 2: Summary of Concepts of SWM and LID Techniques.

Concepts of SWM	Concepts of LID Techniques
End-of-pipe stormwater treatment.	Stormwater is treated at or very close to the source/origination of runoff.
Centralized collection system	Decentralized system
Reroute stormwater away from the site quickly and efficiently	Mimics the pre-development hydrologic condition. The goal of LID is to retain the same amount of rainfall within the development site as that was retained on the site prior to the project
Many of the stormwater management facilities are designed to control or attenuate peak runoff	LID techniques reduce the size of stormwater management facilities.
SWM facilities are designed to treat first-flush i.e. first ½ inch of runoff from impervious areas of development.	LID techniques may suffice to treat the first-flush on-site without a need for separate treatment options.

Table 2 above contrasts conventional SWM methods that use “end-of-pipe” treatment and LID techniques that may reduce land requirements associated with conventional treatment and may make the overall design more aesthetically pleasing if incorporated early on during the planning and design phase. LID may reduce the overall costs of a project and reap benefits in protecting the environment and natural habitats.

Table 3 summarizes how conventional SWM and LID technology alter the hydrologic regime for on-site and off-site conditions.

Table 3: Comparison of Conventional SWM and LID Technologies

Hydrologic Parameter	Conventional SWM	LID
	On-Site	
Impervious Cover	Encouraged to achieve effective drainage	Minimized to reduce impacts
Vegetation/Natural Cover	Reduced to improve efficient site drainage	Maximized to maintain pre-development hydrology
Time of concentration (Tc)	Shortened, reduced as a by-product of drainage efficiency	Maximized and increased to approximate pre-development conditions
Runoff Volume	Large increases in runoff volume not controlled	Controlled to pre-development conditions
Peak Discharge	Controlled to pre-development design storm (2 year & 10 year)	Controlled to pre-development conditions for all storms
Runoff Frequency	Greatly increased, especially for small, frequent storms	Controlled to pre-development conditions for all storms
Runoff Duration	Increased for all storms, because volume is not controlled	Controlled to pre-development conditions
Rainfall Abstractions (interception, infiltration, depression storage)	Large reduction in all elements	Maintained to pre-development conditions
Groundwater Recharge	Reduction in recharge	Maintained to pre-development conditions
	Off-Site	
Water Quality	Reduction in pollutant loadings but limited control for storm events that are less than design discharges	Improved pollutant loading reductions, full control for storm events that are less than design discharges
Receiving Streams	Severe impacts documented – channel erosion and degradation, sediment deposition, reduced base flow, and habitat suitability decreased, or eliminated	Stream ecology maintained to pre-development
Downstream Flooding	Peak discharge control reduces flooding immediately below control structure, but can increase flooding downstream through cumulative impacts & superpositioning of hydrographs	Controlled to pre-development conditions

Source: Low-Impact Development Design Strategies, prepared by Prince George's County, Maryland.

3-3 WATER QUALITY AND POLLUTION PREVENTION

LID or decentralized hydrologic source control, use LID-IMPs that are distributed small-scale controls, closely maintaining or replicating the hydrology of pre-development site conditions. LID-IMPs address additional regulatory requirements or other resource protection goals. Similarly, in meeting the regulatory requirements, BMPs can be designed to act as effective, practicable means of minimizing the impacts of development associated with water quality and quantity control.

Because of the very nature of decentralized hydrologic source control, the nonpoint source pollution is greatly reduced, thereby, increasing the water quality of the receiving water bodies.

3-4 DESIGN INPUTS

If possible, design inputs for successful implementation of LID techniques into a site development project obtain the following:

a. Detailed land cover and land-use information
b. Topographic contours, preferably at an interval that allows the flowpaths to be distinguished (Generally 1' interval contours minimum supplemented by spot elevations).
c. Soil borings, minimum of three borings, 15-foot deep. These borings should reveal nature and condition of the shallow subsurface soils at this location, as well as defining the groundwater table, usability of on-site material for select fill, and through compositional analysis should determine both vertical and horizontal hydraulic conductivities.
d. Existing site drainage outfall conditions and characteristics including water level elevation and water quality
e. Watershed reports and master plans
f. Flooding issues, past or present
g. Installation Appearance Guide

3-5 PRECIPITATION DATA

The intensity-duration-frequency (IDF) curves for the United States were recently revised and published by the National Oceanic and Atmospheric Administration (NOAA), and are called Atlas-14 curves. These curves should be used when determining the precipitation depth/intensity for required duration and/or frequency. Other sources such as State drainage manuals have IDF curve data as well.

Long-term rainfall records for regional weather stations can be obtained from many sources, including the NOAA data center, at http://www.nesdis.noaa.gov. Table 8 provides a summary of rainfall analysis for selected locations.

3-6 LOW-IMPACT DESIGN ELEMENTS FOR STORMWATER MANAGEMENT

The LID concept encourages innovation and creativity in management of site planning impacts. As mentioned earlier, the implementation of LID techniques must be carefully evaluated for opportunities and constraints on a case-by-case basis. Many of the techniques are site-specific. Table 4 summarizes the specific use of LID techniques, requirement, and applicability. Table 5 summarizes hydrologic functions of LID practices.

Table 4: Summary of LID Techniques, Constraints, Requirements and Applicability

	Maintenance	Max. depth	Proximity to building foundations	Water Table/Bedrock	Slopes	Soils	Space required
Bioretention	Low requirement, property owner can include in normal site landscape maintenance	2- to 4-ft depth depending on soil type	Minimum distance of 10 ft down gradient from buildings and foundations recommended	2- to 4-ft clearance above water table/bedrock recommended	Usually not a limitation, but a design consideration.	Permeable soils with infiltration rates > 0.27 inches/hr are recommended. Soil limitations can be overcome with use of underdrains.	Minimum surface area range: 50 to 200 ft^2. Minimum width 5 to 10 ft. Minimum Length 10 to 20 ft. Minimum depth 2 to 4 ft.
Dry Well	Low requirement	6- to 10-ft depth depending on soil type	Minimum distance of 10 ft down gradient from buildings and foundations recommended	2- to 4-ft clearance above water table/bedrock recommended	Usually not a limitation, but a design consideration. Must locate down gradient of building foundations.	Permeable soils with infiltration rates > 0.27 inches/hr are recommended.	Minimum surface area range: 8 to 20 ft^2. Minimum width 2 to 4 ft. Minimum Length 4 to 8 ft. Minimum depth 4 to 8 ft.
Filter/Buffer Strip	Low requirement, routine landscape maintenance	Not applicable	Minimum distance of 10 ft down gradient from buildings and foundations recommended	Generally not a constraint.	Usually not a limitation, but a design consideration.	Permeable soils perform better, but soil not a limitation.	Minimum length of 15 to 20 ft.
Swales: Grass, Infiltration, Wet	Low requirement, routine landscape maintenance	Not applicable	Minimum distance of 10 ft down gradient from buildings and foundations recommended	Generally not a constraint.	Swale side slopes: 3:1 or flatter. Longitudinal slope: 1.0% minimum; maximum based on permissible velocities.	Permeable soils provide better hydrologic performance, but soils not a limitation. Selection of type of swale, grassed, infiltration or wet is influenced by soils.	Bottom width: 2 ft minimum, 6 ft maximum
Rain Barrels	Low requirement	Not applicable	Not a factor	Generally not a constraint.	Usually not a limitation, but a design consideration.	Not a factor	Not a factor
Cistern					Not a factor	Not a factor	Not a factor
Infiltration Trench	Moderate to high	6- to 10-ft depth depending on soil type	Minimum distance of 10 ft down gradient from buildings and foundations recommended	2- to 4-ft clearance required	Usually not a limitation, but a design consideration. Must locate down gradient of building foundations.	Permeable soils with infiltration rates > 0.52 inches/hr are recommended.	Minimum surface area range: 8 to 20 ft^2. Minimum width 2 to 4 ft. Minimum Length 4 to 8 ft.

Source: Low-Impact Development Design Strategies, prepared by Prince George's County, Maryland

Table 5: Summary of Hydrologic Functions of LID Practices

Hydrologic Functions	Bioretention	Dry Well	Filter/Buffer Strip	Swales: Grass, Infiltration, Wet Wells	Rain Barrels	Cistern	Infiltration Trench
Interception	High	None	High	Moderate	None	None	None
Depression Storage	High	None	High	High	None	None	Moderate
Infiltration	High	High	Moderate	Moderate	None	None	High
Ground Water Recharge	High	High	Moderate	Moderate	None	None	High
Runoff Volume	High	High	Moderate	Moderate	Low	Moderate	High
Peak Discharge	Moderate	Low	Low	Moderate	Moderate	Moderate	Moderate
Runoff Frequency	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Water Quality	High	High	High	High	Low	Low	High
Base Flow	Moderate	High	High	Moderate	Moderate	None	Low
Stream Quality	High	High	High	Moderate	None	Low	High

Source: Low-Impact Development Design Strategies, prepared by Prince George's County, Maryland.

APPENDIX B: CHAPTER 4 - LID DESIGN

4-1 INTRODUCTION

LID strategies provide decentralized hydrologic source control for stormwater. LID implementation centers around selecting IMPs which are distributed small-scale controls that can closely maintain or replicate hydrological behavior of the natural system for a design storm event.

The principal goal of designing LID-IMPs is to maintain existing pre-development hydrology resulting in no net increase in stormwater runoff from major renovation and construction projects for the design storm under consideration. The designer will be required to design SWM BMPs as mandated by the State regulators, and LID-IMPs to control all regulated storm events. This section of the criteria guidance manual defines a design storm to provide consistent application of the LID criteria. Further, the guidance manual provides a few of the design considerations in designing LID-IMP features that are not discussed elsewhere in this document. LID-IMPs will control runoff volume and time of concentration (Tc) in order to mimic the pre-development hydrologic conditions, while standard BMPs will be used in conjunction with LID-IMPs depending on site conditions to handle the peak rate of discharge for flood control.

The site designer shall follow published design guidelines that contain criteria relative to achieving, maintaining, and emphasizing a positive exterior visual environment applicable to military installations.

HYDROLOGIC ANALYSIS

During a storm event, a portion of the precipitation is lost in the form of interception, depression storage, evaporation, transpiration, and infiltration. These losses are collectively referred to as *abstractions*. Only that part of the rainfall in excess of abstractions is realized as stormwater runoff. [1]

The Soil Conservation Service (SCS 1986) presented an empirical method of determining initial abstraction based on the runoff curve number (CN)[2] of the site and is given by:

EQUATION 1: Initial abstraction (inches), $I_a = 0.2*S$

Where S = potential maximum retention after runoff begins (inches) = $\frac{1000}{CN} - 10$

---

[1] Holding excess rainwater on-site that would ordinarily end up as runoff can be detrimental in some cases. Rainfall that is retained in excess of the initial abstraction can destabilize certain soils on slopes, impact sensitive coastal tidal zones, increase the need for mosquito control, and in certain riparian or usufructuary rights create an infringement. In many areas where shallow groundwater aquifers are used for supply or irrigation, excess infiltration the designer must consider contamination issues.

[2] The runoff CN method accounts for all types of losses. The value of the curve number depends on the hydrologic soil group, soil cover type, hydrologic condition, the percentage of impervious areas in the watershed, and the antecedent moisture condition of the soil.

The initial abstraction defined in Eq. 1 also represents the rainfall at which the direct runoff begins. Any rainfall over and above the initial abstraction results in direct surface runoff whether it is a virgin forest or a developed piece of land. Table 6 gives representative runoff curve numbers and the calculated initial abstractions for selected soil types. The runoff generated from a project site and the initial abstraction of the site does not have a linear relationship. For this reason, required design storage of LID-IMPs is calculated using Eq. 2 and Eq. 3 discussed later in this document in Section 4-1.4, Design Storage of LID-IMP Features.

Runoff curve numbers are determined by land cover type, hydrologic condition, antecedent runoff condition (ARD), and hydrologic soil group (HSG). Curve numbers for various land covers based on an average ARC for annual floods and Eq. 1 can be found in Urban Hydrology for Small Watersheds (Soil Conservation Service, 1986).

Table 6: Initial Abstraction for Indicated Soil Types

Existing Site Conditions	Curve Number (CN)	Initial Abstraction (inches)
Woods - good condition, HSG B	55	1.64
Woods - poor condition, HSG D	83	0.41
Pasture, grasslands - good condition, HSG B	61	1.28
Pasture, grasslands - fair condition, HSG C	79	0.53
Open space - lawns, park in fair condition, HSG B	69	0.90
Residential districts - 1/3 acre, 30% impervious, HSG B	72	0.78
Residential districts - 1/3 acre, 30% impervious, HSG C	81	0.47
Industrial area - 72% impervious, HSG B	88	0.27

4-1.1 Mimic Existing (Pre-Development) Hydrologic Conditions

From the preceding table, it can be seen that the hydrology of a naturally wooded environment in good condition provides a maximum retention that in turn increases the water quality treatment of stormwater runoff. For redevelopment the site is not set at maximum retention, but to maintain pre-development levels. However, the typical site development project results in the following adverse environmental impacts:

- Changes to existing land-use and land cover
- Changes to natural drainage patterns
- Clear cutting of the native vegetation
- Soil compaction due to the use of heavy construction vehicles on-site
- Increase in impervious area
- Drainage systems that quickly move the water downstream.

As a result, the post-development hydrologic conditions are worsened, and in many cases, the damage becomes irreversible. For this reason, it is important to consider LID and mimic pre-development hydrologic conditions. The 'pre-development' condition shall be taken to mean a typical condition of the project site just prior to project. The site designer should provide a site condition narrative to document the analysis of the pre-development condition. Apart from the potential increase in impervious area, the primary impacts due to human development are soil compaction, and increased efficiency of drainage patterns. The two land development conditions of concern are:

- Pre-Development Condition
- Post-Development Condition

In the development of the site narrative the site designer shall document the existing soil conditions, groundwater table of the project site, description of typical surrounding natural lands, and a brief history of existing development; including impervious area, lawns/meadows, forested area, wetlands, and water bodies, that comprises the existing development condition. It is recognized that there are very many different existing development conditions (including everything from leveling and fill, to existing conditions that bear no resemblance to what came before). The goal, however, is to document a return to a realistic natural pre-development condition for the particular locale and setting.

LID techniques mimic the natural systems by capturing at the minimum, all of the initial abstraction through bio-infiltration practices (such as shown by photo1 below) and/or structural solutions of reuse or footprint reduction for a design storm event.

Photo 1: Typical Bio-infiltration 'Rain Garden'.

Note curb cut inlet. Design should be based on regional plants and growing conditions.

4-1.2 Time of Concentration (Tc) For Pre- and Post-Development Conditions

In order to mimic natural hydrologic patterns the site designer needs to provide features that limit the rate at which runoff leaves the site. The post-development time of concentration (Tc) must be equal to or greater than the pre-development Tc. Maintaining Tc close to pre-development conditions is critical because the peak runoff rate and thereby the volume of runoff from individual lots, is inversely proportional to the time of concentration. The Tc shall be maintained by strategies such as reduction of impervious areas, maintaining natural vegetation, siting of impervious areas in poor draining soils, and disconnecting impervious areas.

Using traditional site planning techniques the post-development time of concentration (Tc) is invariably reduced. This is due to the curbs, channels, and pipes causing quicker drainage, resulting in higher peak flow rates. In order to mimic the natural hydrologic pattern the site designer needs to provide features that slow down the runoff from the site. To maintain the Tc use the following site planning techniques:

- Maintaining or increasing pre-development sheet flow length
- Preserving natural vegetation
- Increasing surface roughness
- Detaining flows
- Disconnecting impervious areas
- Reducing longitudinal slopes of swales and ditches.

Achieving a Tc close to pre-development conditions is often an iterative process and requires analyzing different combinations of the appropriate techniques.

4-1.3 Design Storm Event for LID Design and Implementation

Storm events are a complex natural phenomenon, and methods to predict and control their impacts rely upon empirical and mathematical modeling of the event. It is important to provide criteria to be used by the site designer that is easily understood and is based on recognized industry standards. Three principal approaches in determining the design storm event were analyzed, as follows:

Prince George's County Methodology (Soil Conservation Service, TR-55 Method):
As previously mentioned any rainfall over and above the initial abstraction will result in direct surface runoff. It is prudent to design and implement IMPs for that rainfall event that exceeds initial abstraction (Eq. 1) in the pre-development conditions. The design methodology would apply a modifying factor of 1.5 times the initial abstraction (as suggested in the Prince George's County LID manual) to serve as a practical approach to design LID-IMP features.

EPA Methodology:
See Technical Guidance on Implementing Section 438 of the Energy Independence and Security Act, *Guidance prepared by EPA*, December 2009 for Option 1 methodology.

First-Flush Water Quality Volume:
Many States and localities have adopted the conventional approach of collecting and treating the *first-flush* or *water-quality* depth of rainfall. These terms are defined by the local regulatory agency. In certain areas, this first flush depth is generally taken to be the first one inch of rainfall. In other localities with sensitive coastal or reservoir watersheds, the first-flush depth is

taken to be the first 1.5 inches of rainfall. The water quality volume is equated to the volume of stormwater runoff generated by the first-flush rainfall depth. Therefore, it would be practical to design LID-IMP features to handle the first-flush rainfall depth. The stormwater runoff quality is further improved by the design of conventional SWM practices required to meet the state regulations.

Most Local and State stormwater regulations include a first-flush or water quality depth for 2-, 5-, 10-, 25-, 50-, or 100-year regulated storm events. State and Local requirements for stormwater management shall be met before the LID requirements are satisfied. The SWM BMPs shall be designed to control all regulated storm events, as stipulated by Local and State regulations to handle the peak rate and/or volume of discharge for flood control purposes.

DOD Accepted Methodology:
DoD has chosen to use the 95th percentile design storm event in UFC 3-210-10 criteria for determining the LID design volume. When in conflict with other State or Local requirements the most stringent apply.

To control the stormwater volume in accordance with LID policy, use the methodology from TR-55, Chapter 2: "Estimating Runoff". Calculate the runoff depth for both the pre- and post-development conditions, and the difference will be the depth from which the volume to be retained on-site can be determined.

4-1.4 Design Storage of LID-IMP Features

For the selected design storm event, the LID volume is equal to or greater than the total net increase in runoff from the pre- to post-development states. Physically, the total volume of stormwater runoff generated during the post-development conditions exceeds the total volume of stormwater runoff generated from the site during the pre-development conditions. The design storage of LID-IMP features would be the difference in total volume of stormwater runoff generated between pre- and post-development conditions. The required design storage is calculated using the SCS methodology for compliance with EISA Section 438. Other methods may be specifically required by State SWM guidance to comply with State SWM program requirements. The designer is to balance the various requirements to determine the LID-SWM design that meets all policies and programs.

EQUATION 2: Total depth of increase in runoff (inches), $D = \frac{(P-0.2*S')^2}{(P+0.8*S')} - \frac{(P-0.2*S)^2}{(P+0.8*S)}$

Where, P = design storm rainfall depth (inches)

S & S' = potential maximum retention after <u>runoff</u> begins (inches) during the pre- and post-development conditions, respectively

Note: Eq. 2 is valid if P > 0.2*S. Otherwise, the term calculating the runoff depth

$$\frac{(P-0.2*S)^2}{(P+0.8*S)} = 0$$

EQUATION 3: The design storage, V_{LID} = D * A

D = total depth of increase in stormwater runoff (inches),

A = drainage area or the area of the parcel being developed (square units).

The design storage of LID-IMP features, calculated using Eq. 3, is compliant with DoD policy for stormwater runoff volume for the design rainfall event by maintaining pre-development hydrology.

Table 7 illustrates the total depth of increase in stormwater runoff for a hypothetical representative site. The depth of increase in stormwater runoff calculated will be used in designing the LID-IMP features to handle all of the net increases in stormwater runoff generated from a parcel being developed (using Eq. 3).

4-2 PREDEVELOPMENT HYDROLOGY AND NO NET INCREASE

The principal goal of designing LID-IMPs is to achieve no net increase in stormwater runoff volume and sediment or nutrient loading from major renovation and construction projects for the design storm under consideration. The design storage volume of LID-IMP features, as calculated using Eq. 3, is a minimum requirement and must be followed to ensure no net increase in stormwater runoff volume for the design storm depth. This will assure the most practical solution and provide the maximum value for achieving an improved water quality discharge downstream. In certain geographical areas on optimal sites, the site designer will be able to improve the efficiency of the LID features to handle a portion of the flood control element of stormwater. For other rainfall events, which exceed normal intensities, the runoff will be collected and conveyed to the conventional SWM facilities. The conventional SWM facilities should be designed to discharge/outfall over a 24-hour period to reduce the peak flow rate below the pre-development outflow rate. Further, outfall water quality is improved through an additional treatment from conventional SWM facilities. To design the LID-IMP features for gross increases in stormwater runoff over a range of storm events, for less frequent or high return period storm events, would be impractical. Depending on site conditions, the use of conventional SWM facilities in conjunction with LID-IMPs may be required to handle unprecedented rainfall events and to avoid any downstream flooding of facilities and roadways that might become a life safety concern.

4-3 DESIGN CONSIDERATIONS

A few of the most relevant design considerations are listed below. For a more detailed list, the reader is referred to published literature given in the References.

Develop LID control strategies:
Use hydrology as a design element. In order to minimize the runoff potential of the development, the hydrologic evaluation should be an ongoing part of the design process. An understanding of site drainage can suggest locations for both green areas and potential building sites. An open drainage system can help integrate the site with its natural features, creating a more aesthetically pleasing landscape.

a) Determine the State regulatory design storms. Regulatory requirements for design storms may also be stipulated in local ordinances, and these may limit or constrain the use of LID techniques or necessitate that structural controls be employed in conjunction with LID techniques.

b) Determine LID volumes using 95th percentile design storm and NRCS TR-55 Curve Number methodologies.
c) Evaluate current conditions. Analyze site with traditional hand methods or computer simulations. Use the results of modeling to estimate baseline values for the four evaluation measures: runoff volume, peak runoff rate, flow frequency and duration, and water quality.
d) Evaluate site planning benefits and compare with baseline values. The modeling analysis is used to evaluate the cumulative hydrologic benefit of the site planning process in terms of the four evaluation measures.
e) Evaluate the need for IMPs. If site planning is not sufficient to meet the site's LID objectives, additional hydrologic control needs may be addressed through the use of LID-IMPs. After LID-IMPs are selected for the site, a second-level hydrologic evaluation can be conducted that combines the IMPs with the controls provided by the planning techniques. Results of this hydrologic evaluation are compared with the baseline conditions to verify that the site LID objectives have been achieved. If not, additional LID-IMPs are located on the site to achieve the optimal condition.
f) Evaluate supplemental needs. If supplemental control for either volume or peak flow is still needed after the use of IMPs, selection and listing of additional management techniques should be considered. For example, where flood control or flooding problems are key design objectives, or where site conditions, such as poor soils or a high water table, limit the use of LID-IMPs, additional conventional end-of-pipe methods, such as large detention ponds or constructed wetlands, should be considered. In some cases their capacity can be reduced significantly by the use of LID upstream. It may be helpful to evaluate several combinations of LID features and conventional stormwater facilities to determine which combination best meets the stated objectives. Use of hydrologic evaluations can assist in identifying the alternative solutions prior to detailed design and construction costs.
g) For residential areas, Prince George's County, Maryland, has developed a detailed illustration of an approach for conducting a hydrologic evaluation based on the NRCS TR-55 method. Where NRCS methods (TR-20, TR-55) are accepted for hydrologic evaluation, the effect of LID features should be reflected in the curve numbers and times of concentration selected for the analysis. A full description of this process is available from Prince George's County (*Low-Impact Development Hydrologic Analysis*, Reference 2.)

LID Concept Design or Master Plan:

1) Maximize the efficiency of the existing site. Place impervious areas in poorer soils and retain existing trees where practical.
2) Sketch a design concept that distributes the LID practices appropriately around the project site. Keep in mind the multifunctional capability of LID technologies (i.e., parking lot with detention facility underground).
3) Develop a master plan that identifies all key control issues (water quality, water quantity, water conservation) and implementation areas. Specify specific LID technologies and any connections they have to stormwater overflow units and sub-surface detention facilities.

Develop landscaping plans to maximize the efficiency of the LID-IMPs and reduce maintenance:

Use hardy, native plantings.

1) In areas where soils have low infiltration rates, as determined by percolation tests, average depth of bio-infiltration practices is determined such that the volume held would infiltrate within stated limits. For example, if the State criteria indicates 72 hours and in soils with a low permeability rate (hydrologic soil group's C and D) of 0.05 inches/hour, the depth of infiltration basin = 72 hrs x 0.05 in/hr = 3.6 inches. Conservatively, the designer may opt to

restrict this depth to 3.0 inches and provide a larger area to satisfy the LID volume requirement or may want to incorporate other LID practices, such as footprint reduction of impervious surfaces, permeable pavers, etc., in conjunction with sizing of bio-infiltration facilities. (Verify all actual design parameters with State BMP manual.)

2) Flood control is based on protecting life and property. Flood control criteria are ultimately determined locally based on drainage needs and flood risk of any particular area and may go beyond LID design criteria to achieve the necessary level of flood protection.
3) If project site has limited land area for bio-infiltration practices, in order to satisfy the LID volume criteria, a combination of structural practices such as rain barrels and cisterns may be employed in addition to bio-infiltration practices. At any time the outflow from the structural practices must be controlled to the sum total of assimilating capacity of bio-infiltration practices provided downstream. For example, if a downstream bio-retention facility is of size 600 sq.ft, in soil type C with an infiltration rate of 0.15 in/hr, then the cisterns or rain barrels provided on site will discharge into bio-retention facility at a rate = 0.15 in/hr * 600 sq.ft /(12 in/ft * 3600 sec/hr) = 0.0021 cfs.
4) LID-IMP features are to be incorporated into the site plan at locations as close as possible to the origin of surface runoff from impervious areas. For example, runoff from roof drains is to be collected around the building (depending on ATFP requirements, a minimum of 10-ft offset from the face of the building is required, refer to bio-retention design manuals for more details on specifications), and runoff from parking lots will be held in traffic islands and all along the perimeter. The central idea is to mimic pre-development hydrology.
5) Prefer planting of bio-retention facilities with native vegetation; refer to local plant specialists and horticulturists.
6) Design positive overflow system to capture excess rainfall-runoff.

Develop Operation and Maintenance Procedures:
Development of Operation and Maintenance Support Information documentation (OMSI) is critical to ensure LID-IMPs are properly maintained in order to function properly. LID-IMPs should be viewed as environmental systems that have specific maintenance requirements. O&M procedures for each of the LID practices implemented in the site plan should be developed as part of the OMSI documents. Different types of LID-IMPs will have different maintenance requirements, but some general principles will apply:

1) Keep LID-IMPs and flow paths clear of debris.
2) Regular trash pickup will be required.
3) Use native, drought-tolerant plantings that can tolerate periods of saturation. If required, water vegetation regularly during dry periods. Use special care in selecting plants in areas of tidal influence.
4) Consider impact on plants by road salts.
5) Grassed areas should be mowed regularly using a longer length cut.
6) Plantings should be pruned as needed.
7) Deep raking and tilling of depression storage should be done on a yearly basis or as indicated.

4-4 GAINING ACCEPTANCE OF LID OPTIONS

Low Impact Development projects will require a higher level of communication to keep stakeholders informed during the planning and design phase. From building tenant commands to O&M personnel, communicating intent and purpose is the key to successful LID

implementation. In addition, for some period, feedback on implementation and program success will be required for all new facilities through the local Environmental Office.

4-5 CONSTRUCTION PERMIT PROCESS

Conventional SWM is a patterned response to maximize the efficiency of site landscaping and site design to achieve a reduction in the volume, duration, and pollutant loading of rainfall that ends up as runoff due to human development. The EPA's CWA defined an appropriate level of SWM to help to keep our rivers, lakes, and shorelines clean. The CWA established the base guidelines for SWM, but for the most part turned the execution of those guidelines over to the local, state, and/or municipal regulatory agencies. The States then promulgated additional or clarifying requirements to a minimum level as the EPA requirements to meet the needs of the local geographic conditions. For example, SWM techniques suitable for Florida are not necessarily appropriate to the arid Southwest. Almost all projects will require Local or State construction permit in order to begin work. As such, the LID requirements must be complementary, and will overlay the State and Local requirements for SWM. Without the regulatory acceptance and approval of the SWM plan, a project cannot be constructed. However, with the continuing development and destruction of natural settings, most of these regulatory bodies have recognized that additional measures must be taken. For the State environmental regulators to improve stormwater discharge quality they must adopt alternative management methods or build treatment systems at the outfalls to treat the water. In order to avoid those large, expensive end-of-pipe treatment systems, an example was taken from nature to begin a process of retention, detention, infiltration, and treatment at the point of intersection (the point where a raindrop hits the earth). LID has gained widespread acceptance in the commercial and municipal arenas and is beginning to show up in most of the Local and State regulations as an appropriate response to assist with traditional SWM. As the States adopt and change their requirements, DoD's LID policies will increasingly align with the State's SWM requirements.

4-6 CONCLUSIONS

The methods for calculating, modeling, and sizing stormwater runoff are based on the *design storm*. The design storm is a designation that defines a unit depth of rainfall in order to quantify the volume of rainfall generated for a given site. This data is needed in order to calculate the impact of development on a particular piece of land.

The site designer shall use higher of either the 95th percentile rainfall depth, or the required water quality depth (as locally legislated) as the design storm event when calculating the LID volumes. This will result in a practical and reasonable approach (as being suggested by the EPA in their preliminary findings) in determining LID volumes. The design storm event is based on the regional 95th percentile, annual 24-hour rainfall depth averaged over several years (a minimum of 10-year daily, 24-hour precipitation events would be used). The 'design storm' will be used to calculate pre- and post-development LID volumes in order to determine the amount of excess runoff that must be controlled on-site so that the site contributes no net increase downstream. LID integrated management techniques will be encouraged throughout the site design to ensure control and water quality objectives.

Three practical design methodologies were evaluated in this guidance manual to compare and contrast the methodologies. The first two that were evaluated used accepted practices within the engineering community and demonstrated acceptable results. The third methodology examined was based on regulatory guidance regarding water quality volumes.

DoD has chosen to adopt the EPA's 95th percentile methodology to determine the design storm. Choosing the 95th percentile storm event as the LID design storm would result in a conservative design of LID-IMP features. Table 7 compares the three analysis methods for a few sample locations, by soil and type. Table 8 provides a summary of rainfall analysis for selected locations. Additional references for sources of rainfall data include NRCS TR20 manual rainfall maps and Air Force 14th Weather Squadron rainfall data for installations.

DoD criteria also recommend the use of industry standard methodologies for determining the LID volumes, such as TR-55 (Soil Conservation Services, 1986) or other recognized modeling software.

Table 7: Analysis Method Comparison

Existing Site Conditions	Existing Site Composite CN	Method 1.	Method 2.	Method 3.	Selected Design Storm Rainfall Depth (inches)	Developed Conditions[2] Composite CN	Depth of increase in Stormwater Runoff (inches)
Woods - good condition, HSG B	55	2.45	1.63[a]	1.00	1.63	76.5	0.25
Woods - poor condition, HSG D	83	0.61	1.45[b]	1.00	1.45	90.5	0.32
Pasture, grasslands - good condition, HSG B	61	1.92	1.63[a]	1.00	1.63	79.5	0.32
Pasture, grasslands - fair condition, HSG C	79	0.80	1.45[b]	1.00	1.45	88.5	0.33
Open space - lawns, park in fair condition, HSG B	69	1.35	1.63[a]	1.00	1.63	83.5	0.37
Residential districts - 1/3 acre, 30% impervious, HSG B	72	1.17	1.63[a]	1.00	1.63	85.0	0.38
Residential districts - 1/3 acre, 30% impervious, HSG C	81	0.70	1.45[b]	1.00	1.45	89.5	0.33
Industrial area - 72% impervious, HSG B	88	0.41	1.63[a]	1.00	1.63	93.0	0.30

Method 1: Design Rainfall Depth Based on Initial Abstraction (inches)

Method 2: Region1 - 95 Percentile Rainfall Depth (inches);

Method 3: First-Flush Rainfall Depth (inches)

1. In this example, regional refers to: a - Norfolk region; b- Cincinnati Region.

2. The developed conditions composite curve number is calculated as equal to existing composite CN plus a 50% of maximum full development potential of the parcel. A full development potential is where the entire parcel is developed with impervious surface resulting in a composite curve number of 98. Here, it is assumed 50% of maximum full development and calculated as = existing CN+0.5*(98-existing CN).

Table 8: Summary of Rainfall Analysis (1978-1997)

Description	State	Weather Station ID	Applicable Unit Identification Code						Annual Rainfall Depth (in)	99th Percentile	98th Percentile	95th Percentile	90th Percentile	75th Percentile	Rainy Days (>0.1")	Years of Available Record (1978-1997)
YUMA WSO AP	Arizona	029660	62974 (1 mi.)						3.38	2.20	1.46	0.98	0.73	0.43	8	17
BOULDER CREEK LOCAT RANCH	California	041005	44269 (mi.)						51.36	5.14	4.64	3.70	2.50	1.50	44	20
EL CENTRO 2 SSW	California	042713	45211 (1 mi.)						2.83	2.30	1.91	1.30	1.00	0.58	5	20
FAIRFIELD 3 NNE	California	042935	45653 (1 mi.)						21.55	3.26	2.48	1.80	1.30	0.90	31	20
FRESNO AIR TERMINAL	California	043257	44259 (27 mi.)						11.80	1.51	1.31	0.99	0.80	0.51	28	20
HETCH HETCHY	California	043939	64495 (36 mi.)						31.42	3.27	2.73	1.96	1.59	0.90	42	20
LOS ANGELES WSO ARPT	California	045114	44267 (17 mi.)	67399 (80 mi.)					13.95	2.56	2.30	1.64	1.23	0.77	23	20
MONTEREY NWSFO	California	045802	45210 (5 mi.)						20.10	1.70	1.47	1.37	1.14	0.85	31	2
SAN DIEGO WSO AIRPORT	California	047740	62473 (1 mi.)	00681 (30 mi)					11.69	1.74	1.58	1.28	1.01	0.60	23	20
VICTORVILLE PUMP PLANT	California	049325	3594A (60 mi.)	62204 (30 mi.)					6.47	1.73	1.60	1.12	0.90	0.60	12	19
COLORADO SPRINGS WSO AP	Colorado	051778	3455A (0 mi.)						17.06	2.11	1.59	1.12	0.85	0.48	37	20
JACKSONVILLE WSO AP	Florida	084358	57061 (18.75 mi.)	68931 (18 mi.)	68248 (25 mi.)	46134 (17.5 mi.)			52.35	3.46	2.86	2.12	1.59	0.87	74	20
KEY WEST WSO AIRPORT	Florida	084570	44222 (2 mi.)						39.68	3.76	2.95	1.92	1.41	0.76	59	20
MIAMI WSCMO AIRPORT	Florida	085663	30931 (2.5 mi.)						59.17	3.53	2.94	2.20	1.62	0.86	82	20
PANAMA CITY 5 NE	Florida	086842	44223 (9.5 mi.)	44224 (97 mi.)					56.51	4.24	3.30	2.40	1.80	1.10	63	20
TALLAHASSEE WSO AP	Florida	088758	67004 (83 mi.)						62.14	4.26	3.58	2.37	1.76	1.07	76	20
TAMPA WSO AIRPORT	Florida	088788	47030 (8 mi.)						46.24	3.22	2.70	1.92	1.48	0.88	66	20
SAVANNAH WSO AIRPORT	Georgia	097847	00263 (32 mi.)	44227 (35 mi.)					49.54	3.17	2.80	2.03	1.52	0.85	70	20
GUAM WSMO	Guam	914229	62395 (5 mi.)						95.12	4.24	3.27	2.20	1.45	0.70	143	14
HOKULOA 725.2	Hawaii	511540	44251 (mi.)						33.02	5.11	4.00	2.64	1.70	0.80	40	20
HONOLULU WSFO AP 703	Hawaii	511919	62742 (3 mi.)	47771 (9.5 mi.)					19.07	3.72	3.08	2.11	1.31	0.61	29	20
KEKAHA 944	Hawaii	514272	30614 (mi.)						20.08	4.83	3.86	2.80	1.91	0.90	24	20
CHICAGO OHARE WSO AP	Illinois	111549	65113 (23 mi.)						36.24	2.57	1.90	1.49	1.09	0.65	67	20
EVANSVILLE WSO AP	Indiana	122738	44204 (58 mi.)						43.72	2.78	2.16	1.74	1.25	0.78	71	20
NEW ORLEANS WSMO AIRPORT	Louisiana	166660	44218 (9 mi.)						65.10	4.38	3.33	2.48	1.81	1.06	77	20
SHREVEPORT AP	Louisiana	168440	45603 (11 mi.)						52.06	3.94	3.32	2.33	1.76	1.01	66	20
PORTLAND WSFO AP	Maine	176905	44214 (24 mi.)						42.49	2.88	2.23	1.55	1.17	0.71	71	20
BALTIMORE WSO ARPT	Maryland	180465	44201 (15.5 mi.)	0417A (14 mi.)					40.29	2.36	1.94	1.53	1.16	0.71	71	20
PATUXENT RIVER	Maryland	186915	00019 (0 mi.)	47370 (33 mi.)					24.97	2.90	2.58	1.80	1.30	0.80	36	20
BILOXI 9 WNW	Mississippi	220797	62604 (4 mi.)						60.53	5.64	4.04	2.74	2.07	1.20	59	9
TRENTON STATE COLLEGE	New Jersey	288880	3806A (30 mi.)						38.50	2.80	2.60	1.90	1.40	0.90	54	20
ALBUQUERQUE WSFO AIRPORT	New Mexico	290234	65460 (3 mi.)						9.74	1.15	1.06	0.88	0.65	0.39	25	20
MOREHEAD CITY	North Carolina	315830	00146 (16 mi.)	67001 (34 mi.)					38.57	4.10	3.30	2.40	1.70	1.00	46	20
HARRISBURG CAPITAL CITY	Pennsylvania	363699	68378 (6 mi.)						32.91	2.40	2.18	1.57	1.11	0.65	60	8
HARRISBURG WSO CITY OFFICE	Pennsylvania	363710	68378 (4.5 mi.)						30.58	2.05	1.84	1.32	1.08	0.70	56	8
MIDDLETOWN HARRISBURG INTL AP	Pennsylvania	365703	68378 (10 mi.)						34.91	2.46	2.25	1.39	1.10	0.69	62	7
PHILADELPHIA WSO AP	Pennsylvania	366889	45727 (2.5 mi.)						40.68	2.46	2.05	1.60	1.18	0.70	70	20
BLOCK ISLAND WSO AP	Rhode Island	370896	44210 (29 mi.)						33.37	2.54	2.08	1.52	1.23	0.74	56	16
NEWPORT ROSE	Rhode Island	375215	44211 (1.5 mi.)						32.86	2.80	2.30	1.79	1.30	0.80	46	20
CHARLESTON WSO AIRPORT	South Carolina	381544	69229 (4 mi.)						50.79	3.76	3.14	1.97	1.49	0.82	73	20
MEMPHIS WSFO	Tennessee	405954	44221 (18 mi.)						53.19	3.37	2.83	2.14	1.70	0.96	70	18
CORPUS CHRISTI WSO AP	Texas	412015	45974 (27 mi.)	68891 (11 mi.)	44215 (10 mi.)				32.44	4.40	3.42	2.50	1.73	0.91	42	20
NORFOLK WSO AIRPORT	Virginia	446139	62470 (5.7 mi.)						44.36	2.67	2.26	1.63	1.23	0.73	74	20
WASHINGTON NATL WSO AP	Virginia	448906	00025 (2.5 mi.)	00029 (1.5 mi.)	44252 (9.5 mi.)	44200 (22 mi.)	48429 (11 mi.)	45967 (25 mi.)	38.37	1.94	1.76	1.37	1.12	0.69	70	20
WILLIAMSBURG 2 N	Virginia	449151	44247 (11 mi.)						34.17	2.50	2.20	1.61	1.30	0.80	50	20
SEATTLE TACOMA AP WBAS	Washington	457473	44255 (17 mi.)						37.11	1.76	1.40	1.03	0.79	0.50	87	20
SEATTLE EMSU WSO	Washington	457458	44219 (mi.)						36.04	1.82	1.44	1.00	0.78	0.47	84	20
FRANKLIN 2 N	West Virginia	463215	31188 (5 mi.)						24.08	1.80	1.70	1.30	1.00	0.70	41	17

4-7 RESOURCE INDEX

1. *BMP Modeling Concepts and Simulation* (USEPA, 2006): www.epa.gov/nrmrl/pubs/600r06033/epa600r-06033toc.pdf
2. *Low-Impact Development Hydrologic Analysis* (Prince George's County, MD, Dept. of Environmental Resources, 1999): www.epa.gov/nps/lid_hydr.pdf
3. A Design Guide for Implementers and Reviewers Low Impact Development Manual for Michigan (Southeast Michigan Council of Governments, SEMCOG 2008): www.semcog.org
4. Urban Hydrology for Small Watersheds, TR-55 (Soil Conservation Services, 1986)
5. Technical Guidance on Implementing Section 438 of the Energy Independence and Security Act (February 2009)

Acknowledgements:

This document would not be possible without the guidance and assistance of Mr. Leonard Harrell and Mr. Paul Kidd of NAVFAC Atlantic's Capital Improvements Business Line, and the LID team throughout the NAVFAC FECs that generously assisted with time and suggestions.

Document prepared by:

URS Group, Inc.

277 Bendix Road, Suite 500

Virginia Beach, Virginia 23452

(757) 499-4224

Under contract to the National Institute of Building Sciences (NIBS).

APPENDIX C – DUSD (IE) Policy Memo 19 JAN 2010

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION, TECHNOLOGY AND LOGISTICS

JAN 19 2010

MEMORANDUM FOR ACTING ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS AND ENVIRONMENT)
ACTING ASSISTANT SECRETARY OF THE NAVY (INSTALLATIONS AND ENVIRONMENT)
ACTING ASSISTANT SECRETARY OF THE AIR FORCE (INSTALLATIONS, LOGISTICS, AND ENVIRONMENT)

SUBJECT: DoD Implementation of Storm Water Requirements under Section 438 of the Energy Independence and Security Act (EISA)

Reducing the impacts of storm water runoff associated with new construction helps to sustain our water resources. In October 2004, DoD issued Unified Facilities Criteria on Low Impact Development (LID) (UFC 3-210-10), a storm water management strategy designed to maintain the hydrologic functions of a site and mitigate the adverse impacts of storm water runoff from DoD construction projects. Using LID techniques on DoD facility projects can also assist in fulfilling environmental regulatory requirements under the Clean Water Act. Since 2004, DoD has implemented LID techniques for controlling storm water runoff on a number of projects.

EISA Section 438 (Title 42, US Code, Section 17094) establishes into law new storm water design requirements for Federal development and redevelopment projects. Under these requirements, Federal facility projects over 5,000 square feet must "maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow." Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance* (October 5, 2009), directed the U.S. Environmental Protection Agency (EPA) to issue EISA Section 438 guidance. DoD shall implement EISA Section 438 and the EPA *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act*, using LID techniques in accordance with the policy outlined in the attachment.

EISA Section 438 requirements are independent of storm water requirements under the Clean Water Act and should not be included in permits for storm water unless a State (or EPA) has promulgated regulations for certain EISA Section 438

requirements (i.e., temperature/heat criteria) that are applicable to all regulated entities under its Clean Water Act authority.

The attached policy will be incorporated into applicable DoD Unified Facilities Criteria within six months. My points of contact are Thadd Buzan at (703) 571-9079 and Ed Miller at (703) 604-1765.

Dorothy Robyn
Deputy Under Secretary of Defense
(Installations and Environment)

Attachment:
As stated

DoD Policy on Implementing Section 438 of the Energy Independence and Security Act (EISA)

1. EISA Section 438 requirements apply to projects that construct facilities with a footprint greater than 5,000 gross square feet, or expand the footprint of existing facilities by more than 5,000 gross square feet. The project footprint consists of all horizontal hard surfaces and disturbed areas associated with the project development, including both building area and pavements (such as roads, parking, and sidewalks). These requirements do not apply to internal renovations, maintenance, or resurfacing of existing pavements.

2. The overall design objective for each project is to maintain predevelopment hydrology and prevent any net increase in storm water runoff. DoD defines "predevelopment hydrology" as the pre-project hydrologic conditions of temperature, rate, volume, and duration of storm water flow from the project site. The analysis of the predevelopment hydrology must include site-specific factors (such as soil type, ground cover, and ground slope) and use modeling or other recognized tools to establish the design objective for the water volume to be managed from the project site.

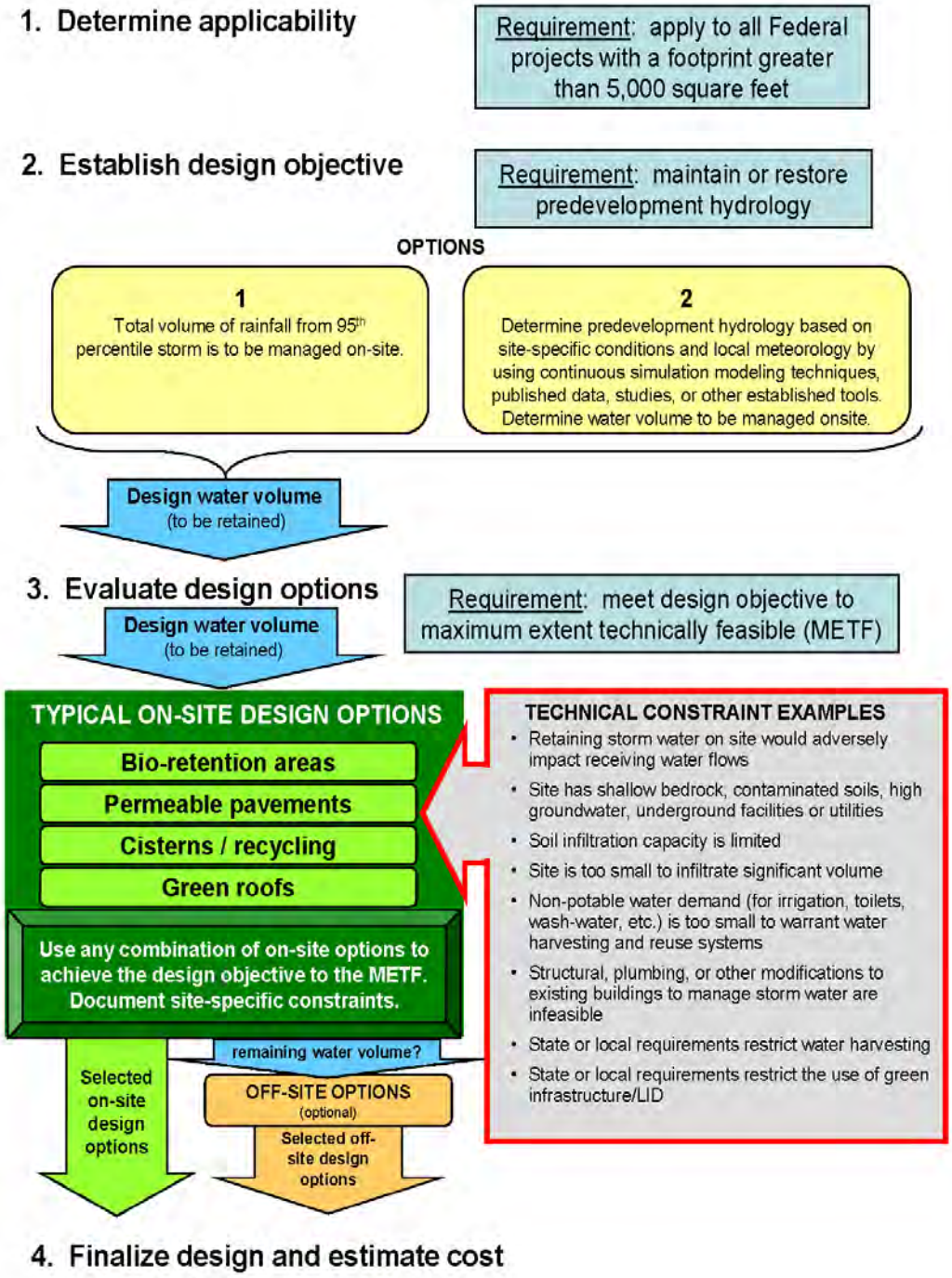
3. Project site design options shall be evaluated to achieve the design objective to the maximum extent technically feasible. The "maximum extent technically feasible" criterion requires full employment of accepted and reasonable storm water retention and reuse technologies (e.g., bio-retention areas, permeable pavements, cisterns/recycling, and green roofs), subject to site and applicable regulatory constraints (e.g., site size, soil types, vegetation, demand for recycled water, existing structural limitations, state or local prohibitions on water collection). All site-specific technical constraints that limit the full attainment of the design objective shall be documented. If the design objective cannot be met within the project footprint, LID measures may be applied at nearby locations on DoD property (e.g., downstream from the project) within available resources.

4. Prior to finalizing the design for a redevelopment project, DoD Components shall also consider whether natural hydrological conditions of the property can be restored, to the extent practical.

5. Estimated design and construction costs for implementing EISA Section 438 shall be documented in the project cost estimate as a separate line item. Final implementation costs will be documented as part of the project historical file. Post-construction analysis shall also be conducted to validate the effectiveness of as-built storm water features.

The following flowchart illustrates the DoD implementation process for EISA Section 438, consistent with the U.S. Environmental Protection Agency's *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act* (December 2009) (http://www.epa.gov/owow/nps/lid/section438/.

Flowchart for EISA §438 Implementation



PR APPENDIX D
Army Low Impact Development Technical User Guide

This page intentionally left blank.

Army Low Impact Development Technical User Guide

4 January 2013

Office of the Assistant Chief of Staff for Installation Management

Army Low Impact Development Technical User Guide

4 January 2013

Office of the Assistant Chief of Staff for Installation Management

Prepared by:

U.S. Army Corps of Engineers
Baltimore District

U.S. Army Corps of Engineers
Engineer Research and Development Center

With Support From:

The Low Impact Development Center, Inc.

EXECUTIVE SUMMARY

The purpose of the Army Low Impact Development Technical User Guide is to assist installation and activity personnel to better understand processes related to planning, designing and constructing appealing and sustainable low impact development (LID) features, known as best management practices (BMPs), to manage stormwater. Low impact development integrated across a project site and especially into installation level planning brings about a decentralized approach to the management of stormwater runoff.

Low Impact Development is a stormwater management strategy designed to maintain site hydrology and mitigate the adverse impacts of stormwater runoff and nonpoint source pollution. Implementation of LID is based on "mimicking" the natural or pre-development hydrology and is recognized as the preferred means to manage stormwater on Army construction projects and is required by Federal legislation, Office Secretary of Defense and Army policy.

It is our hope that the information contained in this Low Impact Development Technical User Guide be used by the many different disciplines involved with the planning, design and execution of Army construction projects including: Garrison Commanders, Director Public Works, Master Planners, Engineers and Designers, Construction Inspectors, Contract Officer Representatives, Stormwater Managers, and Facility Maintenance Personnel to assist them in meeting Army sustainability goals.

Page Intentionally Left Blank

TABLE OF CONTENTS

EXECUTIVE SUMMARY I

1 INTRODUCTION 1-1

1.1 LEGISLATION AND POLICY 1-1
1.1.1 EISA Section 438 1-1
1.1.2 Executive Orders (EO) 13514 1-1
1.1.3 OSD EISA Section 438 Implementation Memorandum 1-2
1.1.4 Army Sustainable Design and Development Memorandum 1-2
1.1.5 LEED™ Construction Requirements 1-2
1.2 LOW IMPACT DEVELOPMENT PHILOSOPHY 1-3
1.2.1 LID Fundamentals 1-3
1.2.2 Benefits of LID 1-4
1.3 STORMWATER MANAGEMENT REGULATIONS 1-5
1.3.1 National Pollutant Discharge Elimination System (NPDES) 1-5
1.3.2 Additional Regulations, Policies, and Resources 1-6
1.4 ARMY STORMWATER MANAGEMENT USING LID 1-6

2 LID BMPS FOR ARMY INSTALLATIONS 2-1

2.1 INTRODUCTION 2-1
2.2 THE HYDROLOGIC CYCLE 2-1
2.2.1 Impacts to the Hydrologic Cycle from Development 2-5
2.3 INTRODUCTION TO NON-STRUCTURAL AND STRUCTURAL LID BMPS 2-11
2.4 LID NON-STRUCTURAL BMPS 2-11
2.4.1 Minimize Total Disturbed Area 2-11
2.4.2 Preserve Natural Flow Pathways and Patterns 2-13
2.4.3 Protect Riparian Buffer Areas 2-15
2.4.4 Protect Sensitive Areas 2-17
2.4.5 Cluster Development 2-19
2.4.6 Minimize Soil Compaction 2-20
2.4.7 Reduce Impervious Surfaces 2-22
2.4.8 Site Fingerprinting 2-25
2.5 STRUCTURAL LID BMPS 2-26
2.5.1 Bioretention 2-26
2.5.2 Vegetated Swale 2-29
2.5.3 Vegetated Filter Strip 2-33
2.5.4 Permeable Pavements 2-37
2.5.5 Rainwater Harvesting 2-42
2.5.6 Green Roofs 2-44
2.5.7 Infiltration Practices 2-47
2.5.8 Level Spreaders 2-52
2.5.9 Constructed Filter 2-56
2.5.10 Soil Restoration 2-59
2.5.11 Reforestation and Afforestation 2-61
2.5.12 Riparian Buffer Restoration 2-63

2.6 LID BMP SELECTION 2-66
2.7 TREATMENT TRAINS 2-68

3 IMPLEMENTING LID ON AN ARMY INSTALLATION 3-1

3.1 INTRODUCTION 3-1
3.2 LID AND INSTALLATION MASTER PLANNING 3-1
3.2.1 Army Land Uses 3-4
3.3 SITE PLANNING AND SITE DESIGN WITH LID 3-6
3.3.1 MILCON Execution and LID 3-7
3.3.2 LID Site Planning and Design Step 1: Site Inventory 3-10
3.3.3 Site Planning and Design Step 2: Opportunities and Constraints 3-16
3.3.4 Site Planning and Design Step 3: Preliminary Calculations 3-17
3.3.5 Site Planning and Design Step 4: Non-Structural LID BMPs 3-18
3.3.6 Site Planning and Design Step 5: Structural LID BMPs 3-20
3.3.7 Site Planning and Design Step 6: Evaluate LID BMPs 3-24
3.3.8 Site Planning and Design Step 7: Recalculate for Final Review 3-24

4 HYDROLOGIC MODELING AND SIMULATION 4-1

4.1 INTRODUCTION 4-1
4.2 DESIGN CALCULATIONS 4-1
4.2.1 Option 1 4-3
4.2.2 Option 2 4-4
4.3 STANDARD HYDROLOGIC MODELING AND SIMULATION TOOLS FOR OPTION 1 4-5
4.3.1 Rational Method 4-5
4.3.2 SCS Runoff Curve Method 4-7
4.3.3 NRCS WinTR-55 4-10
4.3.4 EPA SWMM 4-15
4.4 STANDARD HYDROLOGIC MODELING AND SIMULATION TOOLS FOR OPTION 2 4-17
4.4.1 The Retention Volume Simulation Model (RVSM) 4-17
4.4.2 EPA HSPF 4-19
4.5 STORMWATER MANAGEMENT TECHNOLOGIES CASE STUDIES 4-21
4.5.1 Introduction 4-21
4.5.2 Data Needs 4-22
4.5.3 Fort Drum Case Study 4-23
4.5.4 Fort Hood Case Study 4-30
4.5.5 Fort Benning Case Study 4-36
4.5.6 Fort Meade Case Study #1: AWG Headquarters Complex 4-43
4.5.7 Fort Meade Case Study #2: Vehicle Maintenance Facility 4-51
4.5.8 Fort Meade Case Study #3: DPW Building 4-57

5 DESIGN AND CONSTRUCTION CONSIDERATIONS FOR COMMON STRUCTURAL LID BMPS 5-1

5.1 INTRODUCTION 5-1
5.2 BIORETENTION 5-2
5.2.1 Description 5-2

5.2.2 Types of Bioretention 5-3
5.2.3 Planning Considerations 5-5
5.2.4 Design Criteria & Specifications 5-8
5.2.5 Materials 5-22
5.2.6 Construction Considerations 5-23
5.2.7 Maintenance 5-25
5.2.8 Benefits 5-27
5.3 VEGETATED SWALES 5-28
5.3.1 Description 5-28
5.3.2 Types of Vegetated Swales 5-29
5.3.3 Planning Considerations 5-32
5.3.4 Design Criteria and Specifications 5-32
5.3.5 Components of a Vegetated Swale 5-35
5.3.6 Materials 5-38
5.3.7 Construction Considerations 5-38
5.3.8 Maintenance 5-40
5.3.9 Benefits 5-41
5.4 VEGETATED FILTER STRIP 5-42
5.4.1 Description 5-42
5.4.2 Planning Considerations 5-42
5.4.3 Design Criteria & Specifications 5-43
5.4.4 Materials 5-49
5.4.5 Construction Considerations 5-49
5.4.6 Maintenance 5-50
5.4.7 Benefits 5-51
5.5 PERMEABLE PAVEMENTS 5-51
5.5.1 Types of Permeable Pavement 5-51
5.5.2 Planning Considerations 5-55
5.5.3 Design Criteria & Specifications 5-58
5.5.4 Components of Permeable Pavement Section 5-58
5.5.5 Materials 5-60
5.5.6 Construction Considerations 5-61
5.5.7 Maintenance 5-62
5.5.8 Benefits 5-63
5.6 RAINWATER HARVESTING 5-64
5.6.1 Description 5-64
5.6.2 Types of Rainwater Harvesting Systems 5-64
5.6.3 Planning Considerations 5-66
5.6.4 Design Criteria & Specification 5-68
5.6.5 Materials 5-74
5.6.6 Construction Considerations 5-77
5.6.7 Maintenance 5-78
5.6.8 Benefits 5-79
5.7 GREEN ROOFS 5-80
5.7.1 Description 5-80
5.7.2 Types of Green Roofs 5-80

5.7.3 Planning Considerations 5-82
5.7.4 Design Criteria & Specifications 5-83
5.7.5 Components of Green Roofs 5-84
5.7.6 Materials 5-88
5.7.7 Construction Considerations 5-89
5.7.8 Maintenance 5-90
5.7.9 Benefits 5-91

6 REFERENCES 6-1

7 GLOSSARY 7-1

LIST OF TABLES

Table 2-1. Minimize Total Disturbed Area 2-12
Table 2-2. Preserve Natural Flow Pathways and Patterns 2-14
Table 2-3. Protect Riparian Buffer Areas 2-16
Table 2-4. Protect Sensitive Areas 2-18
Table 2-5. Cluster Development 2-20
Table 2-6. Minimize Soil Compaction 2-21
Table 2-7. Reduce Impervious Surfaces 2-23
Table 2-8. Site Fingerprinting 2-25
Table 2-9. Bioretention 2-29
Table 2-10. Vegetated Swale 2-33
Table 2-11. Vegetated Filter Strip 2-36
Table 2-12. Permeable Pavements 2-42
Table 2-13. Rainwater Harvesting 2-44
Table 2-14. Green Roofs 2-47
Table 2-15. Best Uses for Infiltration Practices 2-51
Table 2-16. Infiltration Practices 2-52
Table 2-17. Level Spreaders 2-55
Table 2-18. Constructed Filter 2-57
Table 2-19. Soil Restoration 2-61
Table 2-20. Reforestation and Afforestaton 2-63
Table 2-21. Riparian Buffer Restoration 2-66
Table 2-22. Climatic Considerations for LID BMP Selection 2-67
Table 2-23. LID Structural Practices & Hydrologic Objective Effectiveness 2-67
Table 4-1. 95th Percentile Storm Events for Select U.S. Cities 4-3
Table 4-2. Possible Modeling and Simulation Tools and Methods 4-4
Table 4-3. Win TR-55 Capabilities and Limitations 4-12
Table 4-4. Win TR-55 Reports 4-14
Table 5-1. Bioretention Types 5-4
Table 5-2. Typical Bioretention Material Specifications 5-22
Table 5-3. Suggested Maintenance Activities for Bioretention 5-28
Table 5-4. Vegetated Swale Design Guidance 5-35
Table 5-5. Suggested Maintenance Activities for Vegetated Swales 5-41
Table 5-6. Manning's Roughness Coefficients (n) 5-46
Table 5-7. Maimum Vegetated Filter Strip Slopes for Various Soil Types 5-46

Table 5-8. Filter Strip Length Correction Factors 5-48
Table 5-9. Vegetated Filter Strip Material Specifications 5-49
Table 5-10. Suggested Maintenance Activities for Vegetated Filter Strips 5-50
Table 5-11. Typical Permeable Pavement Material Specifications 5-60
Table 5-12. Suggested Maintenace Activities for Permeable Pavement 5-63
Table 5-13. Rain Water Harvesting System Material Specifications 5-75
Table 5-14. Advantages and Disadvantages of Various Cistern Materials 5-76
Table 5-15: Suggested Maintenance Tasks for Rainwater Harvesting Systems 5-79
Table 5-16. Extensive Green Roof Material Specification 5-88
Table 5-17. Suggested Maintenance Activities for Extensive Green Roofs 5-91

LIST OF FIGURES

Figure 1-1. Key Elements of LID 1-4
Figure 2-1. The Hydrologic Cycle 2-2
Figure 2-2. Stormwater Flow and Runoff 2-3
Figure 2-3. Representative Annual Precipitation 2-3
Figure 2-4. Average Annual Runoff in the Contiguous United States 2-4
Figure 2-5. Precipitation Pathways in Forested Area 2-5
Figure 2-6. Pre-Development and Post-Development Hydrology 2-6
Figure 2-7. Impacts of Development on Stream Channels 2-8
Figure 2-8. Cross-Section of a Bioretention Area 2-27
Figure 2-9. Schematic of a Vegetate Swale 2-31
Figure 2-10. Vegetated Filter Strip 2-34
Figure 2-11. Diagram of a Vegetated Filter Strip 2-35
Figure 2-12. Cross-Section of Vegetated Filter Strip with an Optional Earthen Berm 2-35
Figure 2-13. Cross Section of Permeable Pavement 2-38
Figure 2-14. Cross Section of an Extensive Green Roof 2-46
Figure 2-15. Dry Well Schematic 2-48
Figure 2-16. Infiltration Berm 2-49
Figure 2-17. Schematic of a Typical Level Spreader 2-53
Figure 2-18. Level Spreader with an Inflow Pipe 2-54
Figure 2-19. Level Spreader with a Perforated Outflow Pipe 2-54
Figure 2-20 . Profile of a Healthy Soil 2-60
Figure 2-21. Treatment Train - Permeable Pavers and Vegetated Swale 2-69
Figure 3-1. Overview of Installation Master Planning Process 3-2
Figure 3-2. Real Property Master Planning 3-3
Figure 3-3. Scales of Master Planning 3-4
Figure 3-4. Site Planning and Design Process 3-9
Figure 3-5. Steps for Site Planning and Design for LID 3-10
Figure 3-6. Watershed Inventory of Natural Resources 3-11
Figure 3-7. Site Inventory 3-11
Figure 3-8. Site LID Opportunities and Constraints 3-17
Figure 3-9. Site Concept Plan Using Existing Natural Conditions 3-19
Figure 3-10. Concept Design with Non-Structural LID BMPs 3-19
Figure 3-11. Detailed Site Design Using Non-Structural LID BMPs 3-20
Figure 3-12. Conventional Stormwater Management 3-21

Figure 3-13. Stormwater Mnanagement with LID BMPs 3-22
Figure 4-1. Implementation of EISA Section 438 4-2
Figure 4-2. Rational Method Hydrographs 4-6
Figure 4-3. SCS 24-Hour Rainfall Distribution 4-11
Figure 4-4. Approximate Geographical Boundaries for SCS Rainfall Distribution 4-11
Figure 4-5. Example Win TR-55 Hydrograph Plot 4-15
Figure 4-6. RVSM Water Balance 4-18
Figure 4-7. Fort Drum, NY Location Map 4-24
Figure 4-8. Fort Drum, NY Installation Area 4-24
Figure 4-9. Fort Drum, NY Project Site - Existing Landuse Conditions 4-25
Figure 4-10. Fort Drum Runoff Computations 4-26
Figure 4-11. Fort Drum, NY Project Site - Post-Project Landuse Conditions 4-27
Figure 4-12. Fort Drum, NY - 95th Percentile Storm Depth (Inches) 4-28
Figure 4-13. Fort Drum LID BMP Computations 4-29
Figure 4-14. Fort Hood, TX Vicinity Map 4-30
Figure 4-15. Fort Hood, TX Installation Area 4-31
Figure 4-16. Fort Hood, TX Project Site - Existing Landuse Conditions 4-32
Figure 4-17. Fort Hood Runoff Computations 4-32
Figure 4-18. Fort Hood, TX Project Site - Post-Project Landuse Conditions 4-33
Figure 4-19. Fort Hood, TX - 95th Percentile Storm Depth (Inches) 4-34
Figure 4-20. Fort Hood LID BMP Computations 4-35
Figure 4-21. Fort Benning, GA Vicinity Map 4-36
Figure 4-22. Fort Benning, GA Installation Area 4-37
Figure 4-23. Fort Benning, GA Project Site - Existing Landuse Conditions 4-38
Figure 4-24. Fort Benning Runoff Computations 4-39
Figure 4-25. Fort Benning, GA Project Site - Post-project Landuse Conditions 4-40
Figure 4-26. Fort Benning, GA - 95th Percentile Storm Depth (Inches) 4-41
Figure 4-27. Fort Benning, GA LID BMP Computations 4-42
Figure 4-28. Fort Meade, MD Vicinity Map 4-43
Figure 4-29. Fort Meade, MD Installation Area 4-44
Figure 4-30. Pre-Project Landuse Conditions 4-45
Figure 4-31. Post-Project Landuse Conditions 4-46
Figure 4-32. Pre-Project and Post-Project Curve Numbers 4-46
Figure 4-33. Runoff Computations 4-48
Figure 4-34. Proposed LID BMPs Implemented 4-49
Figure 4-35. LID BMP Computations 4-50
Figure 4-36. Pre-Project Landuse Conditions 4-52
Figure 4-37. Post-Project Landuse Conditions 4-53
Figure 4-38. Pre-Project and Post-Project Curve Numbers 4-53
Figure 4-39. Runoff Computations 4-54
Figure 4-40. Proposed LID BMPs Implemented 4-55
Figure 4-41. LID BMP Computations 4-56
Figure 4-42. Pre-Project Landuse Conditions 4-58
Figure 4-43. Post-Project Landuse Conditions 4-59
Figure 4-44. Pre-Project and Post-Project Curve Numbers 4-59
Figure 4-45. Runoff Computations 4-61

Figure 5-1. Typical Bioretention Applications 5-6
Figure 5-2. Design Components of an "Offline" Bioretention with Limited Infiltration 5-9
Figure 5-3. Design Componenets of an "Online" Infiltration Bioretention 5-10
Figure 5-4. Combination Infiltration and Underdrain Bioretention System 5-11
Figure 5-5. Bioretention Sizing Chart 5-12
Figure 5-6. Typical Components of a Bioretention System 5-13
Figure 5-7. Use of Underdrain for Bioretention with Little or No Infiltration 5-20
Figure 5-8. Typical Design Details of a Bio-Swale 5-38
Figure 5-9. Vegetated Filter Strip Components 5-45
Figure 5-10. Vegetated Filter Strip Length Determination 5-47
Figure 5-11. Cross Section of Permeable Concrete Paver 5-59
Figure 5-12. Linked Rainwater Harvesting Cisterns 5-71
Figure 5-13. Various Layers of a Green Roof 5-85
Figure 5-14. Cross Section of an Intensive Green Roof 5-87
Figure 5-15. Runoff Reduction Benefits from Green Roods 5-92

LIST OF APPENDICES

APPENDIX A: LID REFERENCES
APPENDIX B: CURRENT STATE NPDES AND REGULATORY PROGRAMS
APPENDIX C: GREEN STREETS
APPENDIX D: STANDARD HYDROLOGIC MODELING AND SIMULATION REFERENCE TABLES
APPENDIX E: USING LID TO MEET TMDLS AND OTHER REGULATORY REQUIREMENTS

Page Intentionally Left Blank

1 INTRODUCTION

The Army Low Impact Development Technical User Guide provides guidance for the planning and design of Low Impact Development (LID) on construction projects in order to comply with stormwater requirements and resource protection goals that effect Army construction.

1.1 LEGISLATION AND POLICY

Army installations have traditionally been required to comply with a number of federal regulatory programs associated with non-point source stormwater discharges. Recent Federal legislation, Executive Order, Secretary of Defense and Secretary of the Army policy require the implementation of LID as a means to manage stormwater.

The Department of Defense (DoD) definition of LID is as follows:

> Low Impact Development (LID) is a stormwater management strategy designed to maintain site hydrology and mitigate the adverse impacts of stormwater runoff and nonpoint source pollution.
>
> LID actively manages stormwater runoff by mimicking a project site's pre-development hydrology using design techniques that infiltrate, store, and evaporate runoff close to its source of origin. LID strategies provide decentralized hydrologic source control for stormwater runoff. (UFC 3-210-10)

1.1.1 EISA Section 438

In December 2007, Congress enacted the Energy Independence and Security Act (EISA) of 2007. EISA Section 438 establishes strict stormwater runoff requirements for federal development and redevelopment projects. The provision reads as follows:

> **"***Storm water runoff requirements for federal development projects.* The sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the pre-development hydrology of the property with regard to the temperature, rate, volume, and duration of flow."

1.1.2 Executive Orders (EO) 13514

Executive Order 13423, Strengthening Federal Environmental Energy and Transportation Management (2007) and Executive Order 13514, Environmental Energy and Economic Performance (2009) both have goals for the reduction of potable water and a zero carbon footprint. EO 13514 enhances previous EOs on water and energy and requires adherence to EISA Section 438. This EO also directed the EPA to develop the *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act* (EPA, 2009), which provides federal agencies with a

foundation for developing policies and procedures to comply with the regulations (see Chapter 4 and Appendix A).

1.1.3 OSD EISA Section 438 Implementation Memorandum

The Office of the Under Secretary of Defense (OSD) memorandum, *DoD Policy on Implementing Section 438 of the Energy Independence and Security Act (EISA)*, January 2010 is the DoD Policy on Implementing Section 438 of EISA. This memorandum states that DoD shall implement EISA Section 438 and the EPA Technical Guidance using LID techniques. The overall design objective for each project is set to maintain predevelopment hydrology and prevent any net increase in storm water runoff. DoD defines "predevelopment hydrology" as the pre-project hydrologic conditions of temperature, rate, volume, and duration of storm water flow from the project site.

1.1.4 Army Sustainable Design and Development Memorandum

The Department of Army memorandum, *Sustainable Design and Development Policy Update*, October 27 2010, establishes the mandatory policy requirements for stormwater facility construction, regardless of funds source. The memorandum requires stormwater management to comply with EISA Section 438 and be consistent with the EPA Technical Guidance by incorporating LID. All master planning, project development and project site planning should follow guidance as detailed in ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) Standard 189.1 Section 5, and incorporate LID criteria, maximize use of the existing topography including slope, hydrology, flora and soils, and minimize site clearing and soil grubbing activities to the greatest extent possible.

1.1.5 LEED™ Construction Requirements

LEED is a green building certification system that was developed and is maintained by the U.S. Green Building Council (USGBC). The USGBC and LEED promote sustainable building and development practices through a suite of rating systems that recognize projects that implement strategies for better environmental and health performance.

> The LEED system provides numerous opportunities to use LID within the building footprint, the site plan, and the infrastructure to achieve the desired rating system level. This includes retaining runoff on-site, harvesting stormwater and runoff, and using green design techniques.

The Sustainable Design and Development Policy Update (described above in Section 1.1.4) requires that starting with the FY13 military construction program, all vertical construction will incorporate sustainable design principles into site selection, design and construction. All such construction, to include comprehensive building renovations, will be certified at the LEED-NC/MR SILVER level or higher from the Green Building Certification Instituate (GBCI) and will be built following guidance as detailed in ASHRAE Standard 189.1. Integrating LID into the building envelope can help achieve several credits in the Sustainable Sites and Water efficiency categories. A detailed description of each of the credits and how to achieve them is included in Appendix A.

1.2 LOW IMPACT DEVELOPMENT PHILOSOPHY

LID is a rapidly growing concept in stormwater management that began in Prince George's County, Maryland, in the early 1990's. LID was developed to address runoff issues associated with new residential, commercial, and industrial suburban development in Prince George's County, to protect the natural resources of the county (Prince George's County, MD, 1999). LID presents a paradigm shift from treating stormwater as something to be moved quickly from the site to managing stormwater as a valuable resource on a site.

> LID Design for EISA Section 438
>
> LID design is based on "mimicking" the pre-project hydrology of a site by replicating the natural hydrology of the site to manage stormwater runoff. LID design utilizes the existing features on a site to plan for non-structural and structural LID BMPs.

Hydrology is an organizing principle that is integrated into site planning and even installation level planning. Development increases impervious areas and impacts natural hydrology, causing erosion, sedimentation, habitat loss, and water quality degradation. Managing stormwater through the use of integrated small scale LID BMPs provides for infiltration, filtration, evaporation, detention and storage to control stormwater runoff discharge, volume, frequency; maintain water temperatures; and provide pollution prevention opportunities. The primary goal of LID is to mimic a site's pre-development hydrology by managing stormwater runoff close to its source. LID integrated across a project site, and especially into installation level planning, brings about a decentralized and holistic approach to the management of stormwater runoff. Further detail about hydrologic impacts of development and LID can be found in Chapter 2.

1.2.1 LID Fundamentals

The LID approach is based on managing stormwater at the source by the use of planning techniques, known as non-structural LID BMPs, and microscale controls, known as structural LID BMPs, that are distributed throughout the site in order to maintain the pre-project hydrologic function of the site. This is unlike conventional approaches that typically convey and manage runoff in large ponds located at the base of drainage areas. Primary consideration must be given to these key elements:

> LID Principles
>
> - Maintain pre-project hydrologic functions through natural processes.
> - Maintain drainage patterns and watershed timing.
> - Minimize development impacts through non-structural practices.
> - Use distributed BMPs to meet hydrologic goals.

- Maintain pre-project hydrologic functions through preserving the natural landscape. Reduce land clearing and grading activities that impact the hydrology of the site. Direct runoff to natural areas and promote infiltration and recharge to natural features.

- Maintain drainage patterns and watershed timing. Provide a customized site-design that incorporates a holistic approach to ensure hydrologic function on site and within the watershed. Minimize development impacts through non-structural LID practices.

- Use distributed LID BMPs to meet hydrologic goals. Employ a series of small scale controls (micromanagement) on site that work together to alleviate hydrologic impacts.

- Maintain the small-scale controls to ensure efficiency and effectiveness in terms of both water quantity and quality functions, to include pollution prevention. Educate maintenance crew and the public about the functions of LID to ensure proper maintenance and the longevity of controls (UFC 3-210-10, 2010).

Understanding the goal and key elements of LID provides a background for planners, designers, engineers and stormwater managers to begin the site planning process to achieve stormwater management requirements.

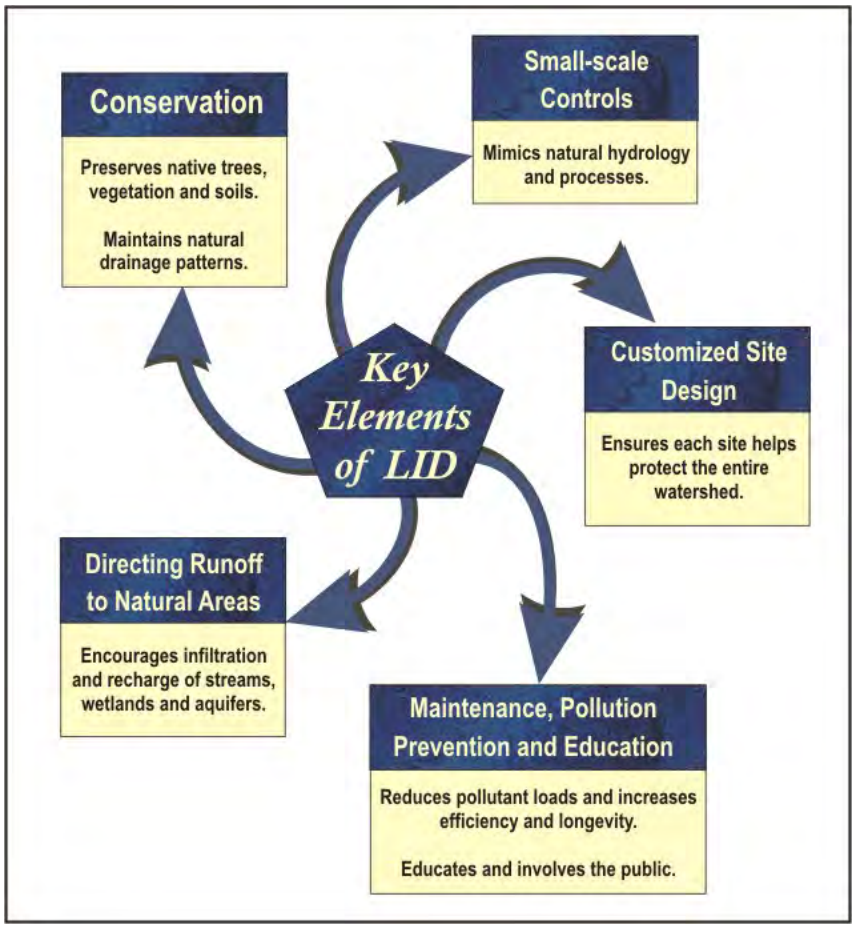


Figure 1-1. Key Elements of LID
(Source: Whole Building Design Guide, 2010)

1.2.2 Benefits of LID

There are a multitude of benefits from integrating LID into a project to include environmental, economic, social, water quality and watershed-scale benefits. Environmental benefits include preserving and protecting the natural ecosystem, protecting habitat, recharging groundwater, and protecting surface waters for both water quantity and water quality. Economic benefits include a

reduced infrastructure and utility maintenance costs (streets, curbs, gutters, sidewalks, storm sewer), minimized cost for clearing and grading, and reduced permit fees (i.e., Clean Water Act requirements). Social benefits include reduced risk of flooding, aesthetically pleasing LID features, improved water quality for drinking and recreational water bodies, and increased groundwater recharge that may be used for drinking water. Improved water quality and maintaining the natural hydrology of the site prevents habitat degradation, lowers strain on stormwater infrastructure, preserves quality of drinking water, and lowers risk of floods.

1.3 STORMWATER MANAGEMENT REGULATIONS

Army installations are subject to federal, state, and local stormwater management regulations for construction projects. The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The National Pollutant Discharge Elimination System (NPDES) Section 402 program focuses on point and non-point sources of stormwater runoff and pollution. The state and local requirements for stormwater management vary throughout the country. Incorporating LID into construction projects and across Army installations may help meet the requirements set forth in the NPDES program.

> Army installations must comply with an often complex set of federal, state, and local regulations that can have very different goals, objectives, and requirements. LID can be used as a standalone strategy or in conjunction with other stormwater approaches to meet these requirements.

1.3.1 National Pollutant Discharge Elimination System (NPDES)

As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Since nonpoint source runoff enters these conveyance systems, land development activities are covered as point sources. Industrial, municipal, and other facilities (Army facilities) must obtain permits if their discharges go directly to surface waters. The NPDES program is focused on a municipal program, construction program, and an industrial program, all of which present opportunities to include LID strategies and techniques. This program is administered by either the EPA or the State; many States have been authorized by EPA to operate the NPDES stormwater program.

For construction projects, construction site operators engaged in clearing, grading, and excavating activities that disturb one (1) acre or more, including smaller sites in a larger common plan of development or sale, are to obtain coverage under an NPDES permit for their stormwater discharges. Construction site operators are required to develop a Storm Water Pollution Prevention Plan (SWPPP) to include erosion and sediment controls. LID practices, non-structural and structural, can be used to manage stormwater quantity and quality during the construction process.

Municipal stormwater discharges and industrial discharges are also regulated through the NPDES program. Army facilities may require a permit for these activities as determined by

State regulations. LID practices can be employed to help meet the requirements of these stormwater permits by reducing stormwater discharge.

Table B-1 in Appendix B is a list of current state NPDES and regulatory programs.

1.3.2 Additional Regulations, Policies, and Resources

The planning, design, and maintenance of buildings, infrastructure, training areas, and open space is based on numerous policies, Army regulations (AR), Unified Facilities Criteria (UFC), and Public Works Technical Bulletins (PWTB). These documents provide the framework for Army construction, including LID BMPs. Listed below are some of the key documents that will be referenced in this Technical User Guide:

AR 420-1, Facilities Management
PWTB 200-1-62, Low Impact Development for Sustainable Installations
UFC 1-200-01, Design: General Building Requirements
UFC 2-100-01, Installation Master Planning
UFC 3-210-01A, Area Planning, Site Planning, and Design
UFC 3-210-05FA, Landscape Design and Planting Criteria
UFC 3-210-06A, Site Planning and Design
UFC 3-210-10, Low Impact Development
UFC 4-010-01, Design: DoD Minimum Antiterrorism Standards for Buildings
UFC 4-030-01, Sustainable Development

Appendix A includes further LID references.

1.4 ARMY STORMWATER MANAGEMENT USING LID

Incorporation of LID BMPs into the Army's construction program is the methodology used to meet requirements of Section 438 of EISA and DoD and Army policy regarding stormwater management. The Army Guidance, "Army Stormwater Management Using Low Impact Development", provides a framework for planning and implementing LID in Army construction projects.

2 LID BMPS FOR ARMY INSTALLATIONS

2.1 INTRODUCTION

The purpose of this chapter is to provide a background on hydrology and the impacts of development on the hydrologic cycle and what LID non-structural and structural BMPs can be employed to address hydrologic impacts on an Army installation.

The goal of LID and requirements of EISA Section 438 is to maintain the hydrologic function of the watershed by preserving or restoring the hydrologic function of the development project; therefore it is important to understand the natural hydrology of a site and the potential development impacts to the hydrologic cycle. The effects of development on a watershed can be extremely complex and often difficult to predict.

> As hydrology is the organizing principle, or foundation, of LID planning and design, it is important to understand the natural hydrologic cycle and how it is altered by development.
>
> LID requires an understanding of the land use and construction impacts on the hydrologic functionson the site and within the watershed to appropriately apply non-structural and structural LID BMPs.

Conventional approaches to stormwater management have been based on the application of prescriptive approaches that address peak flow rates from specific storm events to maintain watershed hydrologic functions and the use of BMPs to filter urban non-point source pollution. This management scheme does not address many of the other components of the hydrologic cycle that are essential to maintaining or restoring watershed hydrologic functions. LID design requires the designer to understand the hydrologic cycle, the impacts of construction on the elements of this cycle before the planning and design of any project, and how the application of BMPs protect and recreate the hydrologic processes.

2.2 THE HYDROLOGIC CYCLE

The hydrologic cycle is the continuous cycle of water between the atmosphere and the earth's surface and subsurface (Figure 2-1). Water condenses in the air and falls to the earth's surface as precipitation. Precipitation may be stored in lakes and oceans, runoff the ground surface to streams and open waterbodies, be intercepted by vegetation or infiltrate the ground to groundwater. Water returns to the atmosphere by evaporation from waterbodies and ground surfaces or by evapotranspiration from vegetation.

Each component of the hydrologic cycle functions differently across the country, within a watershed, and at the site level. Figure 2-2 depicts the annual precipitation across the country for the year 2010, showing great variability between the coasts, the plains, and the dry southwest regions of the country. Figure 2-3 is an illustration of the amount of runoff that results from the precipitation; runoff is the water from a precipitation event that is not lost to evaporation, interception, infiltration or transpiration. Runoff can occur as overland flow, subsurface flow, and saturated overland flow. When a surface is impervious or the surface storage of depressions in the landscape or the infiltration rate of the soil is exceeded, overland flow begins, also known

as Horton overland flow (Figure 2-2). Runoff can also flow through the soils near the surface as subsurface flow. When the subsurface soils are saturated, the runoff can reemerge with the surface runoff and become saturated overland flow. Compare Figure 2-3 and Figure 2-4, and you will notice the variance between precipitation and runoff across the United States. The relationship between precipitation and runoff is not direct as precipitation may infiltrate soils and groundwater, be intercepted by vegetation or fall directly into a surface water. Areas with higher amounts of impervious surfaces and minimal opportunity for infiltration, evaporation and interception generally have greater runoff.

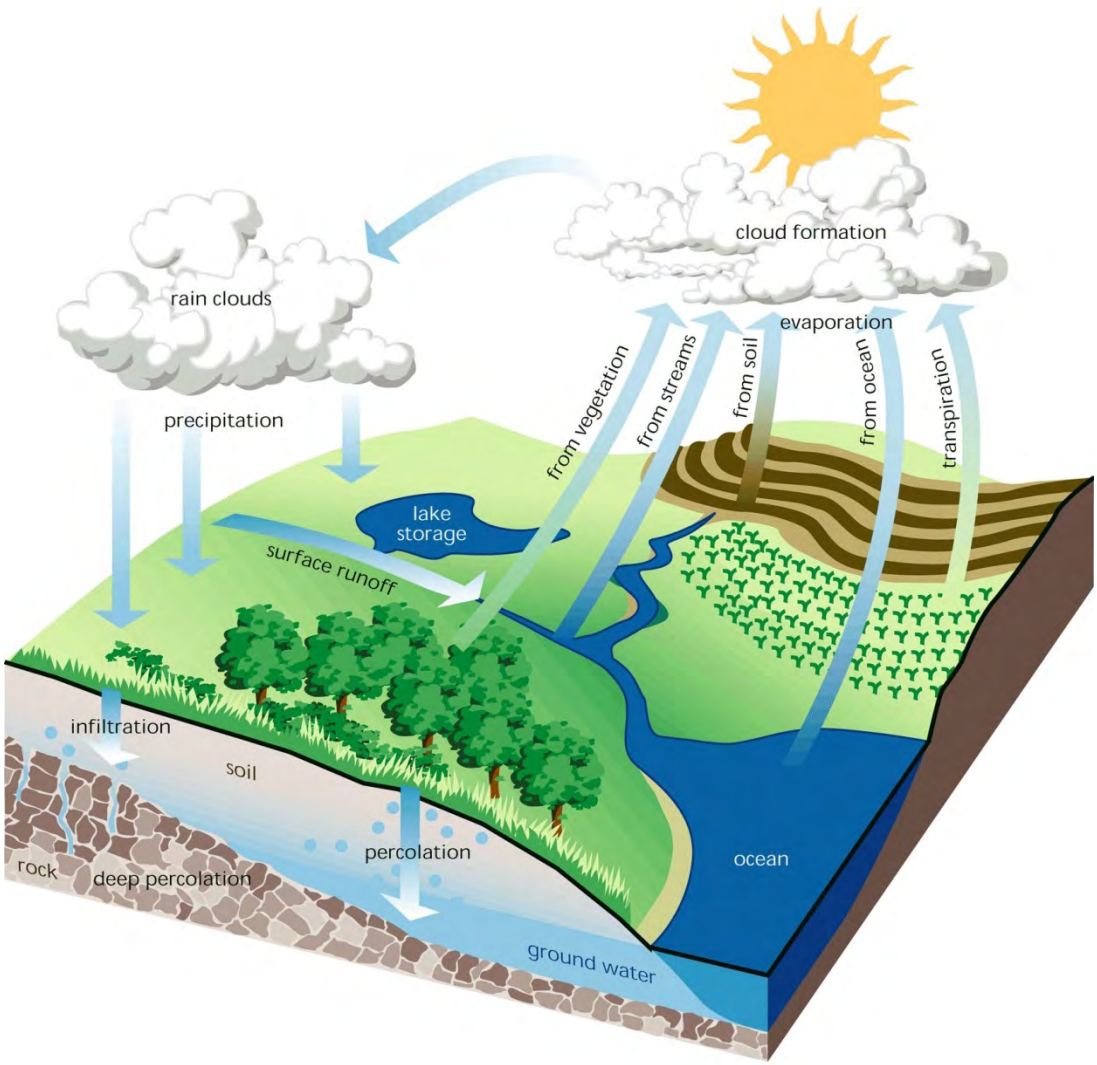


Figure 2-1. The Hydrologic Cycle
(Source: Federal Interagency Stream Restoration Working Group (FISRWG), 1998)

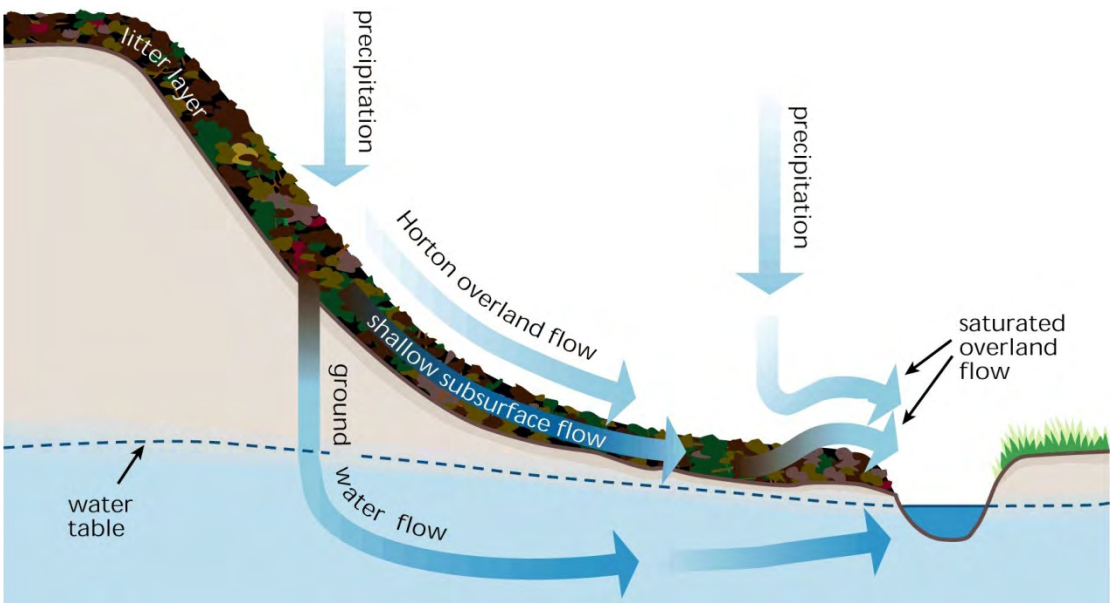


Figure 2-2. Stormwater Flow and Runoff
(Source: FISRWG, 1998)

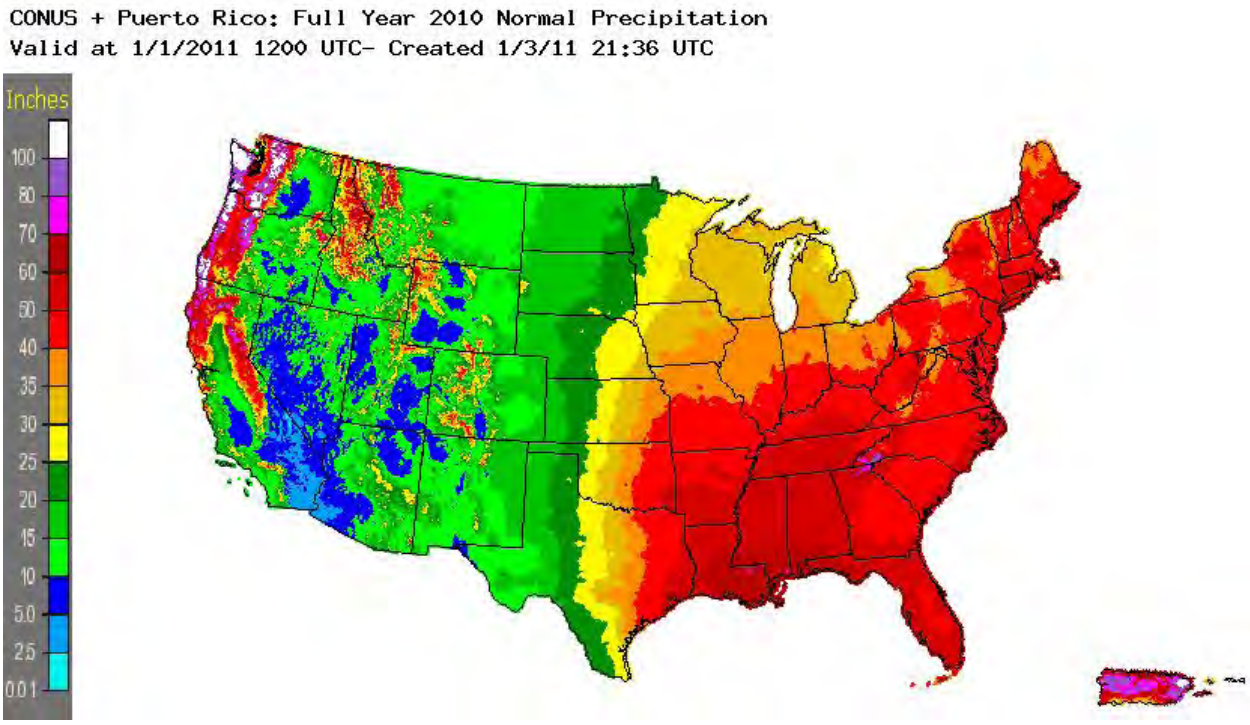


Figure 2-3. Representative Annual Precipitation
(Source: USGS, 2011)

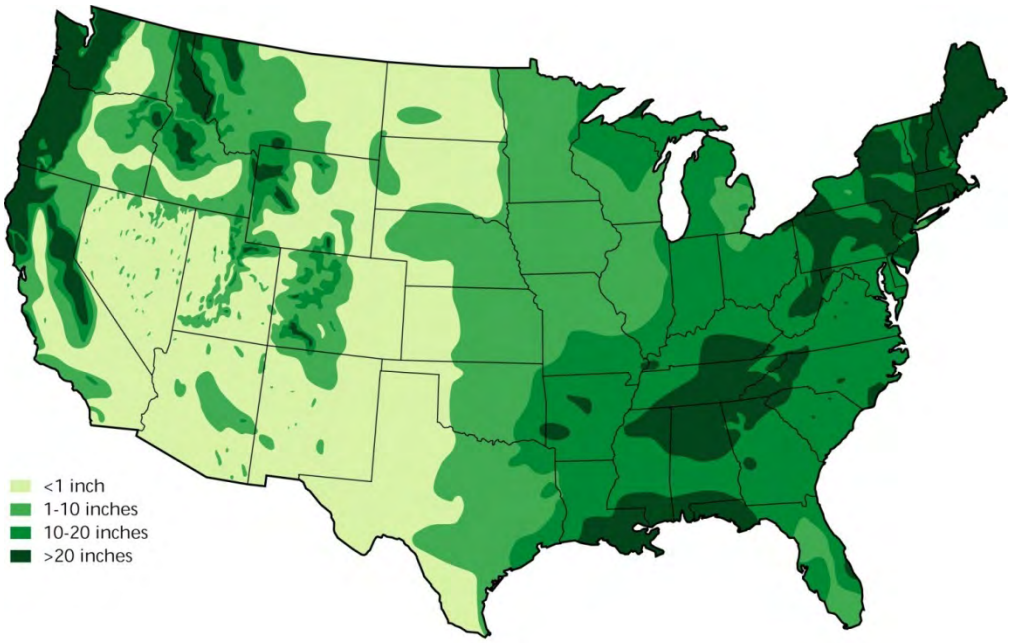


Figure 2-4. Average Annual Runoff in the Contiguous United States
(Source: USGS, 1986)

Precipitation that does not runoff the ground surface to a receiving waterbody, may be intercepted by vegetation or infiltrate soils (Figure 2-5). Water can be intercepted in the canopy of trees and shrubs, throughfall to the understory, or be absorbed by the soils to then be taken up by plant roots or infiltrate to groundwater. The infiltration rate, or capacity, of the soil is dependent on many factors including soil texture, porosity and storage capacity. Soils that are coarse textured, such as sandy soils, have a high porosity, while clays and silty soils have a low porosity. The infiltration rate is also dependent on the vegetative cover and the compaction of the soil. Plant roots help keep soil pores and pathways for infiltration open in soils. Once water enters the soil it can be held and taken up by plant roots or held in the soil through capillary action. If there is not sufficient moisture in the soil then the plants will wilt and likely expire because there is not enough water to meet the transpiration, or uptake, requirements of the plants. When the soil is saturated or when the water holding properties of the soil are exceeded, the water begins to flow downward until it meets a saturated zone of groundwater. It flows through shallow subsurface flow or into an aquifer and then moves, or flows, downgradient towards a water body, spring or seep.

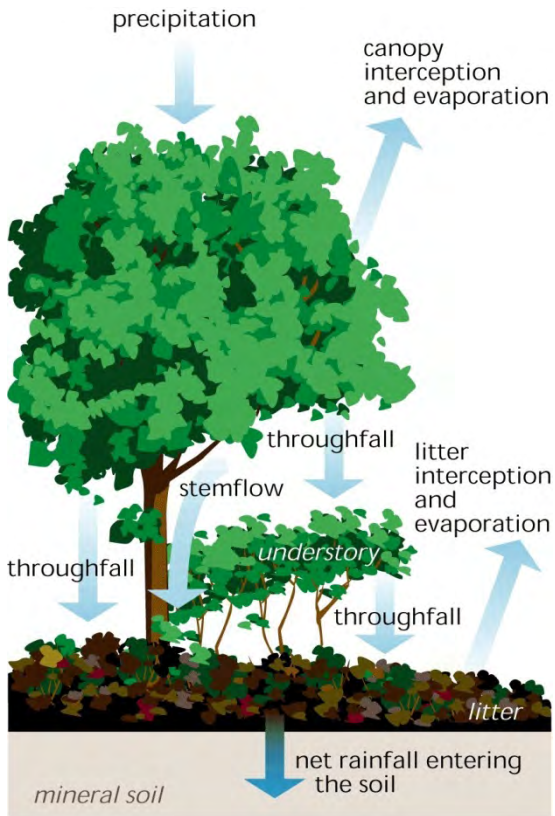


Figure 2-5. Precipitation Pathways in Forested Area
(Source: FISRWG, 1998)

Water returns to the atmosphere through evaporation and evapotranspiration. Evaporation can occur from surface areas, lakes, streams, and surface depressions. Evapotranspiration occurs when water is released from vegetation into the atmosphere, as seen in Figure 2-5.

2.2.1 Impacts to the Hydrologic Cycle from Development

A planner and designer must understand the regional, watershed, and site conditions in order to maintain the hydrologic functions for the project. The understanding of these changes to the hydrologic cycle, or relationships between losses and runoff, is critical when analyzing and design LID sites. When a site is developed and there is an increase in impervious surface, there is a shift in the hydrologic cycle: infiltration and evapotranspiration of precipitation decreases and stormwater runoff increases (Figure 2-6). Rainfall that once was absorbed and infiltrated into the ground now runs off the surface. The addition of impervious surfaces in the form of buildings, roadways, parking lots, and other impermeable surfaces reduces infiltration and increases runoff. These impervious surfaces are often "directly connected" to collection and conveyance systems (gutters, pipes, and channelized ditches) which compounds the problem.

> Land use cover change significantly affects the volume of runoff and the resultant energy of stormwater flows that will adversely affect receiving waters.

For example, the construction of a parking lot in a wooded area may require the removal of trees, grading and compaction of soil, and installation of impervious pavement for the lot. The impacts

on the hydrologic cycle from altering pervious surface to impermeable surface includes reduce evapotranspiration, reduced infiltration and increase in runoff. The increased volume of the runoff will leave the site at higher velocities as pavement is smoother and offers less resistance than the forest floor. Peak flows within the area may be increased by the construction of channels and pipes that convey flows off of the site without allowing for infiltration or dissipation. Increased flow with higher velocities will erode stream channels downstream. The stormwater also conveys pollutants, such as oils and grease from roads and parking areas or fertilizers from lawns to the receiving waters.

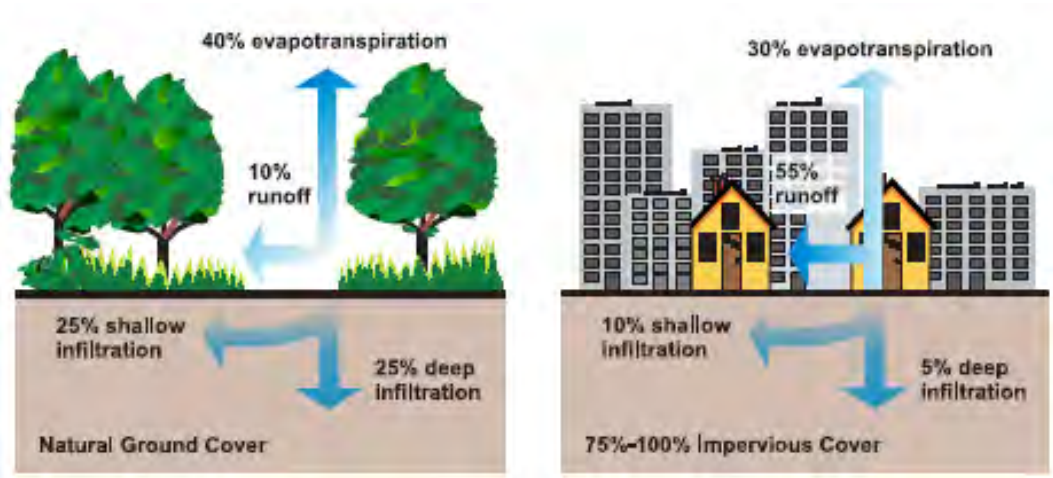


Figure 2-6. Pre-Development and Post-Development Hydrology
(Source: EPA Technical Guidance Manual, 2009)

All of these changes to the natural or pre-developed conditions have significant consequences to the environment. The traditional focus of stormwater management programs has been to remove the stormwater from the site at a high rate for flood risk management purposes. As a result, there are fewer opportunities for evapotranspiration, depressional storage, and infiltration, the volume of runoff. The combination of increased flow rates and volumes also has secondary impacts on the receiving stream system, such as erosion and sedimentation. Finally, the land use and other activities result in accumulation and washoff of pollutants from the surfaces, resulting in water quality degradation. The following sections will describe the impacts of development on the hydrologic cycle and water resources in detail.

2.2.1.1 Changes to Stream Morphology

Stream systems and channel geometry, or morphology, of the stream are the result of various forces acting on the channel over many years. Over time, channels should achieve a state of equilibrium from the forces and develop a “stable” cross section. These forces include flow volumes, durations, velocities, and sediment loads. A change in surrounding land use that alters the hydrology on a site by increasing impervious surface, changing flow patterns, or directing stormwater to a single outfall will increase volume and velocity of the stormwater discharge and increase sediment loads resulting in significant downstream effects (Figure 2-7). The increase in forces puts pressure on the channel to sustain the increased flows at higher velocities with higher

sediment loads resulting in a change in channel morphology (physical shape and character of the stream), as described below:

- Stream Widening and Bank Erosion: Increased runoff and higher stream flow velocities strain the existing stream channel to convey the increased amount of flow due to the change in land use. More frequent small and moderate runoff events undercut and scour the lower parts of the streambank, causing the steeper banks to slump and collapse during larger storms. Higher flow velocities further increase streambank erosion rates. A stream can widen many times its original size from the increased bank erosion and scour due to post development runoff. The sediment from the bank can be transported downstream to an estuary, lake, wetlands, or other sensitive environmental area.
- Stream Downcutting: Higher flows will also cause downcutting of the streambed. Downcutting is a result of erosion occurring in the streambed itself, which results in a deeper stream. This causes instability in the stream profile, or elevation along a stream's flow path, which increases velocity and triggers further channel erosion both upstream and downstream.
- Loss of Riparian Tree Canopy: As streambanks are gradually undercut and slump into the channel, the trees that had protected the banks are exposed at the roots. This leaves them more likely to be uprooted during major storms, further weakening bank structure.
- Changes in the Channel Bed Due to Sedimentation: Due to channel erosion and other sources upstream, sediments are deposited in the stream as sandbars and other features, covering the channel bed, or substrate, with shifting deposits of mud, silt, and sand.
- Increase in Floodplain Elevation: The floodplain elevation of a stream typically increases following development in a watershed, due to higher peak flows. This problem is compounded by building and filling in floodplain areas, which can cause flood heights to rise even further. Property and structures that had not previously been subject to flooding may now be at risk.

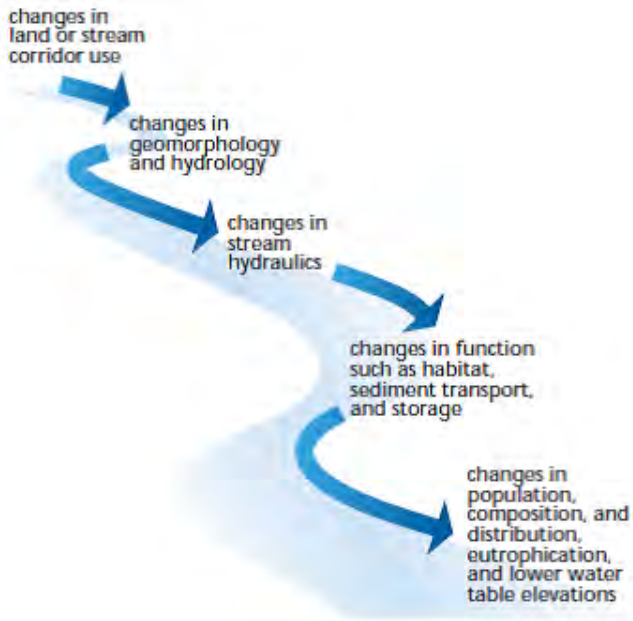


Figure 2-7. Impacts of Development on Stream Channels
(Source: FISRWG, 1998)

2.2.1.2 Impacts to Aquatic Habitat

The habitat value of streams diminishes due to development in a watershed, which impacts the integrity of stream hydrology and morphology. The following impacts on habitat can include:

- Degradation of Habitat Structure: Higher and faster flows can scour channels and wash away entire biological communities. Streambank erosion and the loss of riparian vegetation reduce habitat for many fish species and other aquatic life, while sediment deposits can smother bottom-dwelling organisms and aquatic habitat.

- Loss of Pool-Riffle Structure: Streams draining undeveloped watersheds often contain pools of deeper, more slowly flowing water that alternate with "riffles" or shoals of shallower, faster flowing water. These pools and riffles provide valuable habitat for fish and aquatic insects. As a result of the increased flows and sediment loads from urban watersheds, the pools and riffles are lost to erosion and sediment deposition and replaced with more uniform, and often shallower, streambeds that provide less varied aquatic habitat.

- Reduce Baseflows: Increased impervious cover reduces infiltration of rainfall to recharge groundwater. During drier periods in an undeveloped watershed, streams will have baseflow from groundwater and subsurface flow. With reduced infiltration to the groundwater, baseflows are reduced. This adversely affects in-stream habitats, especially during periods of drought.

- Increased Stream Temperature: Runoff from warm impervious areas, storage in impoundments, loss of riparian vegetation, and shallow channels can all cause an increase

in temperature in urban streams. Increased temperatures can reduce dissolved oxygen levels and disrupt the food chain. Certain aquatic species can only survive within a narrow temperature range. Thermal problems are especially critical for many streams which straddle the borderline between coldwater and warmwater stream conditions.

When there is a reduction in various habitats and habitat quality, both the number and the variety, or diversity, of organisms (wetland plants, fish, macroinvertebrates, etc.) are also reduced. Sensitive fish species and other life forms disappear and are replaced by those organisms that are better adapted to the poorer conditions. The diversity and composition of the benthic, or streambed, community have frequently been used to evaluate the quality of urban streams.

2.2.1.3 Water Quality Impacts

Urban stormwater runoff can generate nonpoint source pollution, which is considered the primary cause of water quality impairment. Development and impervious areas concentrate and increase the amount of nonpoint source pollutants, as there is limitied opportunity for filtration and absorption of pollutants as seen in pervious and vegetated areas. As stormwater runoff moves across the land surface, it picks up and carries away both natural and human-made pollutants, depositing them into streams, rivers, lakes, wetlands, coastal waters and marshes, and underground aquifers. Some of the more common water quality impacts are as follows:

- Reduced Oxygen in Streams: As organic matter (leaves, grass clippings, pet waste) is washed off and transported by stormwater, dissolved oxygen levels in receiving waters can be rapidly depleted. The decomposition process of organic matter uses dissolved oxygen (DO) in the water, which is essential to fish and other aquatic life. If the DO deficit is severe enough, fish kills may occur and stream life can weaken and die. In addition, oxygen depletion can affect the release of toxic chemicals and nutrients from sediments deposited in a waterway. Note: there are also a number of non-stormwater discharges of organic matter to surface waters, such as sanitary sewer leakage and septic tank leaching.

- Nutrient Enrichment: Runoff from urban watersheds contains increased nutrients such as nitrogen or phosphorus compounds. Increased nutrient levels are a problem as they promote weed and algae growth in lakes, streams, and estuaries. Algae blooms block sunlight from reaching underwater grasses and deplete oxygen in bottom waters. In addition, nitrification of ammonia (a compound of nitrogen) by microorganisms consumes dissolved oxygen and forms nitrates that can contaminate groundwater supplies. Sources of nutrients in the urban environment include washoff of fertilizers and vegetative litter, animal wastes, sewer overflows and leaks, septic tank seepage, detergents, and the dry and wet fallout of materials in the atmosphere.

- Microbial Contamination: The level of bacteria, viruses, and other microbes found in urban stormwater runoff often exceeds public health standards for water contact recreation such as swimming and wading. Microbes can contaminate shellfish beds, limiting their harvest for both wildlife and human consumption, and increase the costs for

treating drinking water. The main sources of these contaminants are sewer overflows, septic tanks, pet waste, and excessive urban wildlife such as pigeons, waterfowl, squirrels, and raccoons.

- Hydrocarbons: Oils, greases, and gasoline contain a wide array of hydrocarbon compounds, some of which have shown to be carcinogenic, tumorigenic, and mutagenic in certain species of fish. In addition, large quantities of oil can impact drinking water supplies and affect recreational use of waters. Oils and other hydrocarbons are washed off roads and parking lots, primarily due to engine leakage from vehicles. Other sources include the improper disposal of motor oil in storm drains and streams, spills at fueling stations, and restaurant grease traps.

- Other Toxic Materials: Besides oils and greases, urban stormwater runoff can contain a wide variety of other toxicants and compounds including heavy metals such as lead, zinc, copper, and cadmium, and organic pollutants such as pesticides, PCBs, and phenols. These contaminants are of concern because they are toxic to aquatic organisms and can bioaccumulate in the food chain. In addition, they also impair drinking water sources and human health. Many of these toxicants accumulate in the sediments of streams and lakes. Sources of these contaminants include industrial and commercial sites, urban surfaces such as rooftops and painted areas, vehicles and other machinery, improperly disposed household chemicals, landfills, hazardous waste sites, and atmospheric deposition.

- Sedimentation: Erosion from construction sites, exposed soils, street runoff, and streambank erosion are the primary sources of sediment in urban runoff. Excessive sediment can be detrimental to aquatic life by interfering with photosynthesis, respiration, growth, and reproduction. Sediment particles transport other pollutants that are attached to their surfaces including nutrients, trace metals, and hydrocarbons. High turbidity due to sediment increases the cost of treating drinking water and reduces the value of surface waters for industrial and recreational use. Sediment also fills ditches and small streams and clogs storm sewers and pipes, causing flooding and property damage. Sedimentation can reduce the capacity of reservoirs and lakes, block navigation channels, fill harbors, and silt estuaries.

- Increased Stream Temperatures: As runoff flows over impervious surfaces such as asphalt and concrete, it increases in temperature before reaching a stream or pond. Water temperatures are also increased due to shallow ponds and impoundments along a watercourse as well as fewer trees along streams to shade the water. Since warm water can hold less dissolved oxygen than cold water, this “thermal pollution” further reduces oxygen levels in depleted urban streams. Temperature changes can severely disrupt certain aquatic species, such as trout and stoneflies, which can survive only within a narrow temperature range, as described above in Section 2.2.1.2.

2.3 INTRODUCTION TO NON-STRUCTURAL AND STRUCTURAL LID BMPS

LID BMPs can be employed to alleviate the pressures of development on a receiving water body by slowing flows, supporting infiltration or small-scale temporary storage of increased stormwater runoff volume, and filtrating stormwater runoff to reduce pollutant loads. LID BMPs include a variety of non-structural and structural techniques that can be used individually or collectively to maximize stormwater management goals, particularly for maintaining pre-development hydrology with regard to temperature, rate, volume and duration of flow. This section provides a toolbox of non-structural and structural LID BMPs for use on Army installations. The applicability, use, design features, and maintenance of the LID BMPs described below are extremely dependent on the climatic conditions, site conditions, land use and installation requirements, such as Anti-Terrorism Force Protection (ATFP) requirements. When developing a plan for a site specific project, each installation will select LID BMPs that are appropriate for the climate and site conditions and meet the regulatory requirements for the project, including EISA Section 438, with consideration of watershed protection goals.

> Structural and Non-Structural LID Practices
>
> - Non-Structural LID practices are planning and site design strategies that minimize development impacts.
> - Structural LID practices are BMPs that are distributed throughout the site to manage the volume and rate of runoff and to address water quality requirements.

2.4 LID NON-STRUCTURAL BMPS

The primary goal of non-structural LID BMPs is to prevent stormwater runoff from the site. Non-structural LID BMPs take broader planning and design approaches, which are less "structural" in their form and focus on conservation and minimizing impacts. Many non-structural LID BMPs apply to an entire site and often to an entire community and can even be applied to the Installation Master Plan. In doing so, LID places an emphasis on non-structural stormwater management measures, seeking to maximize their use prior to utilizing structural LID BMPs. A definition of each of non-structural LID BMPs, their purpose, and potential use on an Army installation are described below.

2.4.1 Minimize Total Disturbed Area

2.4.1.1 Definition

Minimizing the total disturbed area for a construction project is a site planning strategy that is designed to reduce the amount of disturbance to the site from the building footprint and orientation itself, including roads and parking lots, to ground disturbed during construction. This applies to the final site design and the construction phasing of the project.

2.4.1.2 Purpose

This strategy reduces the change in land cover and compaction of existing open space so the amount of change in the hydrologic function of the site is limited. This strategy will preserve as much of the hydrology of the site as possible.

2.4.1.3 Use on Army Installation

Minimizing total disturbed area for a project can be accomplished in residential, commercial, industrial and recreational areas, with limited applications for some training areas, ultra urban, retrofit and highway or road projects (Table 2-1). This practice may have limited utility on small or infill sites. By incorporating this non-structural BMP during site planning, reduced grading and ground disturbance as well as the preservation of existing vegetation can be incorporated into the project, which will result in less impact to the hydrologic function of the site. Areas of high value, such as high infiltration soils or mature vegetation, should be undisturbed to maintain the site hydrology. While minimizing the amount of disturbed area, also consider area where potential structural LID BMPs may be used. ATFP requirements, including standoff distances for parking and roadways and unobstructed views clear of vegetation, must be followed, which may require additional clearing and limit the amount of space that can be left undisturbed.

This planning activity can greatly reduce impacts of construction and to maintain the hydrologic function of the site in terms of both stormwater quantity and quality. There are also aesthetic benefits that may include the preservation of green corridors and natural features around an installation. These benefits come with potentially reduced construction costs by reducing the amount of construction activities that are associated with disturbing land, such as grading, tree clearing and even stockpiles or staging areas. This practice, however, may have increased costs for construction phasing. Costs savings may also be realized by the reduction in maintenance of cleared areas and the reduced need for BMPs to mitigate hydrologic changes. Photo 2-1 shows the reduction of clearing around a building to reduce the disturbed area and protect adjacent woodlands.

Table 2-1. Minimize Total Disturbed Area

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	High
Commercial	Yes	**Groundwater Recharge**	High
Ultra Urban	Limited	**Peak Rate**	High
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Limited	**TSS**	High
Highway/Road	Limited	**TP**	High
Recreational	Yes	**NO3**	High
Training Area	Limited	**Temperature**	High
Additional Considerations			
Cost		Low	
Maintenance		Low	
Winter Performance		High	

(Adapted from: South East Michigan Council of Governments (SEMCOG), 2008)

Photo 2-1. Minimal Disturbance to Protect Adjacent Woodlands
(Source: SEMCOG, 2008)

2.4.2 Preserve Natural Flow Pathways and Patterns

2.4.2.1 Definition

Preserving natural flow patterns and pathways during and after construction is a non-structural LID BMP. This is a site planning strategy to maintain existing drainage patterns, areas of sheet flow, areas of the site that have depression storage, existing grades, ditches, and channels as much as possible.

2.4.2.2 Purpose

Maintaining flow patterns is a critical non-structural practice. It is used to maintain watershed timing of runoff, peak runoff discharge rates and runoff volume to these areas so that the increased energy from the runoff does not erode the area to be protected. The length, slope, and surface characteristics of the flowpath should be maintained to the greatest extent possible in order to reduce the peak runoff time during a storm event. The strategy will also help maintain flows to sensitive areas, such as wetlands, soils with high infiltration rates, or upland vegetated areas that are sensitive to changes in hydrology.

2.4.2.3 Use on Army Installations

Protecting natural flow pathways and patterns can be incorporated into most projects and land use areas, with the exception of ultra urban areas that may already have or require stormwater infrastructure (Table 2-2). This site planning strategy can also be applied during installation master planning as it can be used to reduce the need for large scale drainage infrastructure to accommodate concentrated flows and can help preserve the capacity of existing systems by maintaining flow patterns. Land buffers around the larger drainage courses may be required to preserve natural flow patterns as some larger natural streams adjust their pathways horizontally to accommodate flows from urbanization or as a natural process. The preservation of natural

flow pathways and patterns also helps protect riparian corridors and habitat areas, provides open space, and can increase the green infrastructure aesthetics of an installation. If protection of natural flow pathways and patterns are not an option or isn't sufficient for stormwater management goals, modify and/or increase these drainage flow paths.

Maintaining natural flow pathways and patterns can lessen the need for increased stormwater infrastructure and large stormwater BMPs, which is a cost savings from conventional stormwater management systems. When natural flow pathways are protected and the hydrology of the surrounding area is not significantly altered by land use changes, maintenance costs should be relatively minimal. Caution must be taken if discharge to these features is increased, which can cause erosion, downcutting, and degradation of the natural flow pathway. Periodic inspections of the pathways should assess erosion, bank stability, sediment and debris accumulation, and vegetative conditions, including the presence of invasive species to ensure the continued function of the flow pathways. Photo 2-2 shows grading to a natural area of shallow concentrated flow. The disturbed area is planted with a tall grass that roughens the surface and absorbs runoff so that the energy and volume of runoff to the natural system is reduced.

Table 2-2. Preserve Natural Flow Pathways and Patterns

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low/Med
Commercial	Yes	**Groundwater Recharge**	Low
Ultra Urban	No	**Peak Rate**	Med/High
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	Low/Med
Highway/Road	Yes	**TP**	Low/Med
Recreational	Yes	**NO3**	Low
Training Area	Yes	**Temperature**	Low
Additional Considerations			
Cost		Low	
Maintenance		Low/Med	
Winter Performance		Low/Med	

(Adapted from: SEMCOG, 2008)

Photo 2-2. Native Prairie Vegetation in Natural Flow Pathway
(Source: SEMCOG, 2008)

2.4.3 Protect Riparian Buffer Areas

2.4.3.1 Definition

Riparian buffers are vegetated areas, natural or re-established, along water courses that protect the integrity of the habitat and hydrologic functions of that water course.

2.4.3.2 Purpose

The purpose of protecting riparian buffer areas is to protect the habitat functions, hydrologic functions, and physical integrity of the receiving waters. This includes sensitive wetland areas and floodplains. Width and type of vegetation of the riparian buffer varies with climate, region, topography, watershed hydrology, surrounding land uses and several other factors. Riparian buffers protect the receiving waters by dissipating energy and slowing the velocity of runoff, reducing the temperature of runoff and the stream by providing shade, and filtering sediments and nutrient loads from overland runoff.

2.4.3.3 Use on Army Installations

Protection of riparian buffers can be applied during the project planning phase in most land use areas, though may be limited in circumstances where land for development and mission requirements is inadequate (Table 2-3). The optimal width of a riparian buffer varies by region, site conditions, and the condition of the receiving water body for maximum stormwater management and water quality benefits. The development footprint of the project area may extend into a riparian buffer area, which may limit the application of this LID BMP. Several states and counties, however, require the conservation of a buffer for certain water bodies, further protecting the integrity of the natural hydrology of a site and the receiving water body.

In some circumstances, a riparian buffer may need to be revegetated or re-established where it may have degraded due to changes in adjacent land uses. Flows from storm drain systems and channels can be disconnected into the buffer and/or lessened with integration of structural LID BMPs (see Section 2.5), so that the increased energy and thermal loading from the stormwater infrastructure can be dissipated by the vegetation. Photo 2-3 shows a buffer that has been preserved in an agricultural setting. Protecting the riparian buffer area is a low cost BMP that provides significant water quality benefits and preserves the hydrologic function of the site and the receiving water bodies (Table 2-3).

Table 2-3. Protect Riparian Buffer Areas

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low/Med
Commercial	Yes	**Groundwater Recharge**	Low/Med
Ultra Urban	Limited	**Peak Rate**	Low/Med
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	High
Highway/Road	Limited	**TP**	High
Recreational	Yes	**NO3**	Medium
Training Area	Yes	**Temperature**	High
Additional Considerations			
Cost		Low/Med	
Maintenance		Low	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

Photo 2-3. Riparian Buffer Area
(Source: Iowa Pathways)

2.4.4 Protect Sensitive Areas

2.4.4.1 Definition

Natural areas with high habitat value and function, water supply areas, areas of special geologic concern, culturally significant areas, and natural areas with high stormwater management functions, such as sandy soils, must be identified and protected from pollutants and erosive flows associated with runoff from developed areas. Other areas include, but are not limited to, riparian buffers, wetlands, hydric soils, floodplains, steep slopes, woodlands, and other valuable habitat, such as critical habitat and rare, threatened and endangered species habitat.

2.4.4.2 Purpose

The overarching objective of LID is to accommodate development while protecting the natural resources and function of the site. Avoiding impacts to especially sensitive natural resources minimizes the loss of ecological and hydrologic function on the site. The loss of the ecological

and hydrologic functions of many sensitive areas cannot be completely mitigated or replaced because of their complexity.

2.4.4.3 Use on Army Installation

Protection of sensitive areas can be accomplished in most land use areas (Table 2-3). Sensitive areas should be identified and mapped early in the planning process to avoid impacts. Small or infill sites may have limited ability to avoid disturbance of sensitive areas. Federal and local regulations may prohibit disturbance of many of these sensitive areas, such as wetlands, habitat for endangered species, and riparian areas. Design and construction that affects sensitive areas can severely impact project schedules due to regulatory requirements. Protecting sensitive areas is a low cost BMP that provides significant water quality benefits and preserves the hydrologic function of the site and the receiving water bodies (Table 2-3). Photo 2-4 shows pathways and a picnic area designed around an existing wetland and forested area. The design shows that the area can be developed while protecting and taking advantage of the natural features.

Table 2-4. Protect Sensitive Areas

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low/Med
Commercial	Yes	**Groundwater Recharge**	Low/Med
Ultra Urban	Limited	**Peak Rate**	Low/Med
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	High
Highway/Road	Limited	**TP**	High
Recreational	Yes	**NO3**	Medium
Training Area	Yes	**Temperature**	High
Additional Considerations			
Cost		Low/Med	
Maintenance		Low	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

Photo 2-4. Protection of Existing Native Woodlands and Wetlands, Kalamazoo, MI
(Source: Fishbeck, Thompson, Carr & Huber, Inc.)

2.4.5 Cluster Development

2.4.5.1 Definition

Cluster development refers to the concentrated development of buildings and residential lots on a portion of a larger site through avoidance of sensitive areas and reducing the lot size or reconfiguring the lot footprint.

2.4.5.2 Purpose

Cluster development is a technique that allows the site planner to avoid sensitive areas, focus development on less permeable soils, and maintain natural drainage patterns.

2.4.5.3 Use on Army Installation

Cluster development is most commonly used for residential development and some commercial areas, with limited application in ultra urban, industrial, recreational areas and training areas (Table 2-5). It is primarily achieved by decreasing lot sizes, which allows residences to be constructed in close proximity to one another, preserving open space for conservation. By clustering development, the total disturbed area and total impervious area will be minimized, sensitive and natural resource areas may be conserved and the natural hydrologic function of the site can be preserved. This will minimize the need for stormwater infrastructure and large conventional stormwater BMPs. Clustering reduces the amount of land that must be cleared and graded during construction, and reduces the amount of open lawn that must be maintained, which is a cost savings. Photo 2-5 shows a cluster development designed to preserve existing woodlands and wetlands.

Table 2-5. Cluster Development

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	High
Commercial	Yes	**Groundwater Recharge**	High
Ultra Urban	Limited	**Peak Rate**	High
Industrial	Limited	**Stormwater Quality Functions**	
Retrofit	No	**TSS**	High
Highway/Road	No	**TP**	High
Recreational	Limited	**NO3**	High
Training Area	No	**Temperature**	High
Additional Considerations			
Cost		Low	
Maintenance		Low/Med	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

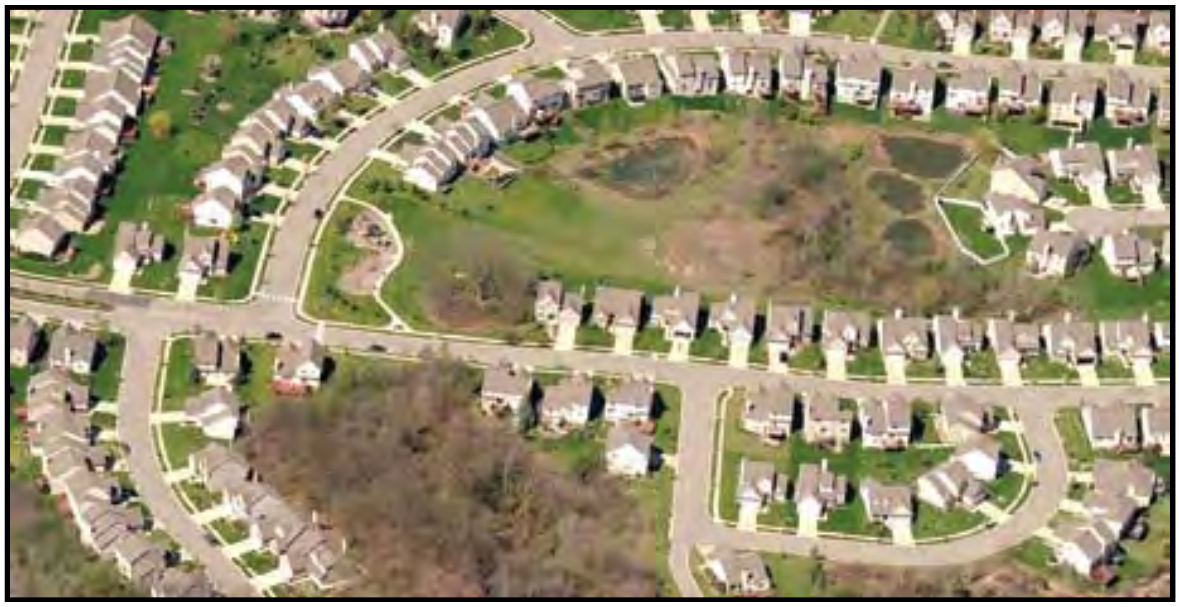


Photo 2-5. Aerial View of Cluster Development in Ann Arbor, MI
(Source: Atwell LLC)

2.4.6 Minimize Soil Compaction

2.4.6.1 Definition

Soil compaction occurs during the land development process when heavy construction vehicles are used in undeveloped areas, soils are cleared or graded, and when materials are stockpiled in staging areas. Soil compaction can also occur from activities such as heavy equipment traffic, high pedestrian use, and even heavy rainfalls. The porous spaces in the soils that hold air and water and allow for water to infiltrate through the soils are consolidated when compacted,

resulting in reduced water storage and infiltration, which leads to increased runoff from the soil surface and even reduced plant growth. Minimizing soil compaction is the practice of preventing loss of soil structure and function through avoiding and minimizing ground disturbance during construction and land use activities.

2.4.6.2 Purpose

Minimizing soil compaction will prevent the loss of water storage and infiltration capacity of the soils, an important process of the hydrologic function of a site and a watershed. Water that is not stored or infiltrating the soils will runoff the soil surface, greatly reducing groundwater recharge, pollutant removal opportunities, increasing the volume of discharge to the receiving stream, and space for healthy plant root growth (see Section 2.2.1 for further discussion of impacts).

2.4.6.3 Use on Army Installation

Soil compaction can be minimized at any land development site, with limited applicability where land use requires impervious surfaces such as a road or ultra urban area (Table 2-6). During the site planning process for construction and earth moving activities, the areas of heavy equipment traffic and use, stockpiles and grading should be minimized. Plans should clearly identify "no disturbance areas", where existing soils and vegetation are to be preserved; "minimal disturbance areas", where existing vegetation may be removed and light traffic is permitted, but soils and vegetation are to be restored immediately following construction; and "construction traffic areas", which are to be cleared and graded, and are appropriate sites for construction vehicles and storage areas. Areas for parking personal vehicles and construction vehicles should also be identified to avoid soil compaction. After construction, disturbed soils can be partially restored by aeration and the addition of compost and other soil amendments. Minimizing soil compaction is a low cost BMP that provides significant benefits for stormwater quantity and quality functions. Photo 2-6 shows a construction site where heavy equipment is limited to areas designated for clearing and grading and adjacent areas are left undisturbed.

Table 2-6. Minimize Soil Compaction

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Med/High
Commercial	Yes	**Groundwater Recharge**	Med/High
Ultra Urban	Limited	**Peak Rate**	Low/Med
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Limited	**TSS**	Med/High
Highway/Road	Limited	**TP**	Med/High
Recreational	Yes	**NO3**	Low
Training Area	Yes	**Temperature**	Med/High
Additional Considerations			
Cost		Low/Med	
Maintenance		Low	
Winter Performance		Low/Med	

(Adapted from: SEMCOG, 2008)

Photo 2-6. Construction Site Disturbance Showing Grading and Soil Compaction.
(Source: SEMCOG, 2008)

2.4.7 Reduce Impervious Surfaces

2.4.7.1 Definition

Reducing impervious surfaces includes minimizing the area of streets, parking lots, and driveways as well as the surface area of the building roof. Disconnecting large areas of imperviousness or contiguous developed areas with parcels of perviousness is also a consideration when reducing impervious surfaces. Greater amount of impervious surface leads to higher volumes of stormwater runoff, as there is less opportunity for stormwater to infiltrate the ground surface.

2.4.7.2 Purpose

Reducing impervious surfaces decreases stormwater runoff volume and increases opportunities for infiltration and evapotranspiration. Breaking up large areas of imperviousness with pervious areas, also called disconnection, provides an opportunity to reduce runoff velocity, promote settling of suspended pollutants, and reduce runoff volume by promoting storage and infiltration.

2.4.7.3 Use on Army Installations

Reducing impervious surfaces can be applied in most land use areas; streets and parking lots are typically the largest impervious component in most developments (Table 2-7). Road widths should be reduced to the minimum legally required or necessary for anticipated use. Street lengths can be reduced by clustering development. Parking lot sizes can be reduced by application of alternative lot layouts and stall geometries, such as the angled parking and parallel parking shown in Photo 2-7, or shared parking. Not all angled parking can reduce parking lot sizes and may result in fewer parking spaces; the planner and designers should consider various degrees for angled parking to determine what best meets the needs for the project. Use of these

techniques can result in reduced material cost, reduced maintenance requirements, and reduced need for stormwater management controls. Impervious cover can be further reduced by using permeable paving materials in driveways, parking stalls, and other low-traffic areas; this structural BMP is further discussed in Section 2.5.4.

Building roofs are another opportunity to reduce impervious surface and disconnect impervious surfaces, by installing green roofs or directing downspouts to pervious areas such as bioretention areas, as shown in Photo 2-8. Existing buildings can be retrofitted to convey runoff from rooftop downspouts to nearby vegetated areas. Setbacks should be observed to prevent infiltrating runoff from flooding basements or undermining foundations. In planning new developments, care should be taken to avoid creating situations that allow rooftop runoff to flow directly to paved areas and then to gutters or storm drains. This can be avoided by grading the site to encourage sheet flow from paved areas to adjacent pervious areas.

Table 2-7. Reduce Impervious Surfaces

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	High
Commercial	Yes	**Groundwater Recharge**	High
Ultra Urban	Limited	**Peak Rate**	High
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Limited	**TSS**	Medium
Highway/Road	Yes	**TP**	Low
Recreational	Yes	**NO3**	Low
Training Area	Limited	**Temperature**	Medium
Additional Considerations			
Cost		Low	
Maintenance		Low	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

Photo 2-7. Use of Reduced Parking Footprint in On Street Areas
(Source: Institute of Transportation Engineers)

Photo 2-8. Downspout Disconnection to a Vegetated Area
(Source: Prince George's County, MD Department of Environmental Resources)

2.4.8 Site Fingerprinting

2.4.8.1 Definition

Site fingerprinting is a technique used to minimize site disturbance during construction. The smallest possible disturbance area is delineated and flagged to prevent traffic or materials storage on areas designated for conservation.

2.4.8.2 Purpose

Site fingerprinting preserves existing trees and soils, maintaining as much of the existing hydrology and infiltration capacity of the site as possible.

2.4.8.3 Use on Army Installation

Site fingerprinting can be accomplished during construction on most sites with limited application on ultra urban and highway sites (Table 2-8). The size of the construction envelope can be minimized by limiting planned disturbance areas to the developed footprint and necessary equipment access routes. Material stockpiles should be located within the development envelope and soil and vegetation protection areas should be clearly delineated and flagged to prevent inadvertent construction traffic, as seen in Photo 2-10. Existing topography and drainage should be maintained to reduce hydrologic impacts.

Table 2-8. Site Fingerprinting

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low/Med
Commercial	Yes	**Groundwater Recharge**	Low/Med
Ultra Urban	Limited	**Peak Rate**	Low/Med
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	High
Highway/Road	Limited	**TP**	High
Recreational	Yes	**NO3**	Medium
Training Area	Yes	**Temperature**	High
Additional Considerations			
Cost		Low/Med	
Maintenance		Low/Med	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

Photo 2-9. Protection of Vegetation on a Construction Site
(Source: SEMCOG, 2008)

2.5 STRUCTURAL LID BMPS

LID Structural BMPs

- Small scale controls that mimic natural processes are used to restore and maintain hydrology.
- The sizing and location of practices is often iterative. Matching practices with the appropriate land uses is essential.

Non-structural LID BMPs should be employed to the maximum extent possible so structural LID BMPs can then be implemented to restore or maintain site hydrology where impacted. The planning and selection of BMPs is performed after the amount of disturbance to the site is minimized by maximizing non-structural LID BMPs in site planning. The location and selection of the practice is often iterative in nature. The variability of site factors (e.g. climatic conditions, drainage area, runoff volume and rate, land use, maintenance, force protection requirements, etc.) influence the location, size, and operation of the BMPs. The stormwater management goal or objective for the site must also be considered when selecting a structural LID BMP as some perform multiple functions for water quantity and water quality.

The following sections describe structural LID BMPs and include a definition, purpose and application or use on an Army installation for each BMP. Detailed information on construction, specifications, and maintenance are included in Chapter 5.

2.5.1 Bioretention

2.5.1.1 Definition

Bioretention is a flat-bottomed, shallow landscaped depression or basin used to collect and hold stormwater runoff; allowing pollutants to settle and filter out as the water infiltrates into the ground or to an underdrain, depending on soil conditions. Stormwater runoff enters the basin, where it temporarily ponds within the shallow depression and subsequently filters down through

the various layers in the bioretention area: plants, mulch or ground cover, engineered soil media, a gravel base layer with a possible underdrain, or infiltrates into the underlying soils (see Figure 2-8).

Bioretention is designed to treat runoff from small drainage areas, typically ½ acre or less. Bioretention BMPs are classified into three types by size of contributing drainage area: bioretention cells treat approximately ½ acre to five acres, micro-bioretention treats approximately 10,000 square feet up to ½ acre, and rain gardens treat less than 10,000 square feet and typically infiltrate to groundwater. Further details are found in Chapter 5.

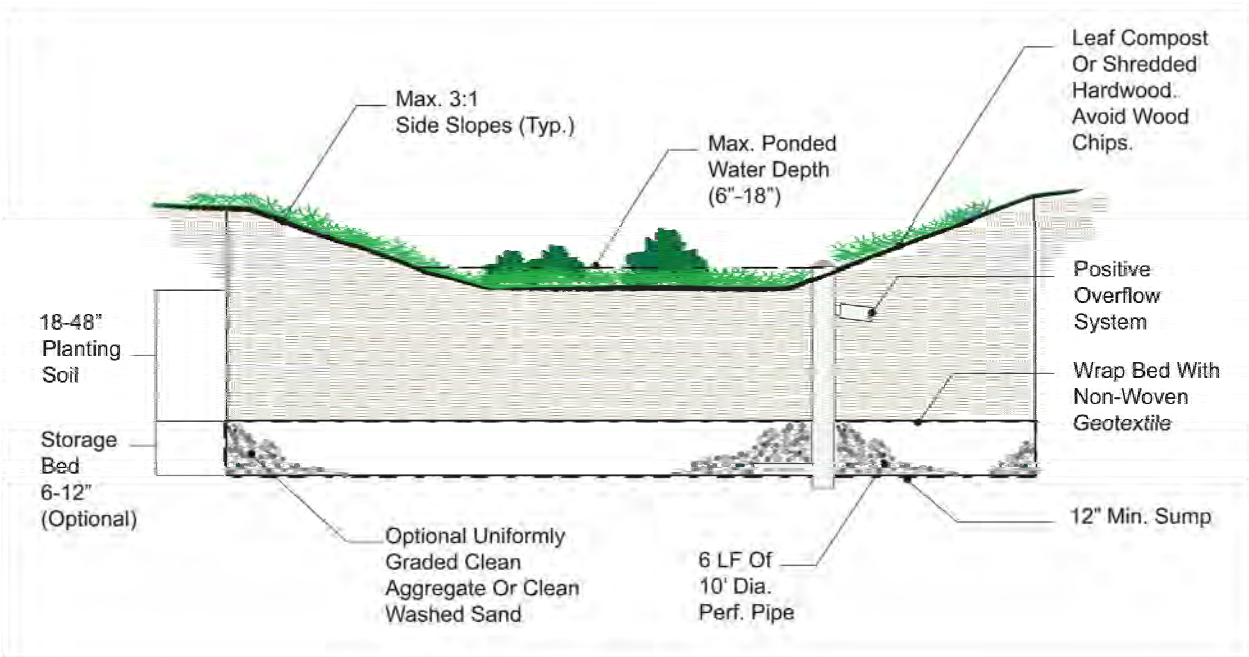


Figure 2-8. Cross-Section of a Bioretention Area

2.5.1.2 Purpose

Bioretention BMPs are multifunctional, as they manage stormwater runoff quantity and quality. Stormwater runoff is conveyed to a bioretention BMPs through curb cuts or sheetflow from an impervious area where small volumes of runoff are absorbed and treated through storage in the soil media and uptake by plants. Larger volumes of runoff are detained in the system and are then drained into an underdrain or are infiltrated into the ground, if the conditions permit. The soil media is designed with a high flow through rate but absorbs and/or adsorbs pollutants and helps reduce the thermal loading of stormwater. They can be designed for infiltration, filtration, or a combination of both. This is highly dependent on the subsurface soil conditions and the drainage infrastructure.

The bioretention BMP components make use of the chemical, biological and physical properties of soil, water, and plants to remove pollutants from stormwater runoff. Bioretention BMPs are used to remove a wide range of pollutants, such as suspended solids, nutrients, heavy metals, hydrocarbons, and bacteria from stormwater runoff.

Photo 2-10. Bioretention in a Parking Lot
(Source: Larry Coffman, 2008)

2.5.1.3 Use on Army Installation

Bioretention BMPs can be applied to almost all Army land uses (Table 2-9), as the size, function and design is flexible to work in a variety of site conditions. The design is directed by the climatic conditions, site soils, geology, and groundwater, land use that it is designed to treat, and the hydrologic requirements. Bioretention can either infiltrate to groundwater or filter to an underdrain, or a combination of both. Sites with high pollutant runoff, such as industrial sites, may require use of an underdrain and a liner to avoid contaminating groundwater. Infiltration may be limited by the soil types requiring an underdrain to quickly drain the collected stormwater runoff.

Bioretention BMPs are commonly located in or adjacent to parking lots, roads, medians and sidewalks or within small pockets in residential neighborhoods, commercial and industrial developments, training areas and institutional areas (Photo 2-10 and Photo 2-11) serving as a means to successfully accomplish disconnection of impervious surfaces, a non-structural LID BMP (see Section 2.4.7). Bioretention can also be used to retrofit existing stormwater BMPs. Bioretention can be used in brownfields or geologic conditions, such as karst topography, where infiltration should not be encouraged and the use of underdrains and liners are necessary to avoid groundwater contamination of areas with known water quality concerns. Where space is limited, a series of smaller bioretention BMPs can be installed.

Table 2-9. Bioretention

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Med/High
Commercial	Yes	**Groundwater Recharge**	Med/High
Ultra Urban	Limited	**Peak Rate**	Medium
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	High
Highway/Road	Yes	**TP**	Medium
Recreational	Yes	**TN**	Medium
Training Area	Yes	**Temperature**	High
Additional Considerations			
Cost		Medium	
Maintenance		Medium	
Winter Performance		Medium	

(Adapted from: SEMCOG, 2008)

Photo 2-11. Bioretention
(Source: USACE Savannah District)

2.5.2 Vegetated Swale

2.5.2.1 Definition

A vegetated swale is a broad, shallow stormwater channel that is often used as a pretreatment device for other BMPs or to reduce the timing of and volume of runoff. Vegetated swales are

densely planted with a variety of grasses, shrubs, and/or trees designed to slow, filter, and, in some cases, infiltrate stormwater runoff from adjacent areas. Where slopes are steeper, check dams may be used to improve attenuation and infiltration performance. The maximum drainage area for a vegetated swale is typically 5 acres. There are three types of vegetated swales: grass swale, wet swale and bio-swale. Chapter 5 describes each type of swale in detail.

2.5.2.2 Purpose

Vegetated swales are designed to slow runoff, promote infiltration, and filter pollutants and sediments while conveying runoff from the source to a receiving waterbody or stormwater infrastructure or to infiltrate to groundwater. Vegetated swales are a cost-effective and environmentally friendly method to managing stormwater than the standard curbs and gutter conveyance systems. Often used as a pretreatment system, vegetated swales are typically heavily vegetated with a variety of native, close-growing plants; include soils that are conducive to plant growth. Bio-swales involve placement of soil media, similar to bioretention, to encourage pollutant and nutrient uptake and plant growth. As vegetated swales convey water, opportunity for infiltration may be limited during various storm events so it is recommended to install check dams or discharge to another LID BMP to promote maximum infiltration. Check dams at pipe inlets, driveway crossings, and/or periodically along swales or other pretreatment devices can be installed in order to reduce erosion, and improve its pollutant removal efficiency.

Swales can be modified to increase the infiltration and water quality efficiency of the conveyance system. Aggregates can be added below the surface to help absorb the runoff volume. Figure 2-9 is a schematic of a vegetated swale with an underlying aggregate layer. Other common variations include a vegetated swale with infiltration trench, a grass swale, and linear wetland swales. Common variations are depicted in Photos 2-12, 2-13, and 2-14.

Photo 2-12. Vegetated Swale with Infiltration Trench
(Source: USDA NRCS)

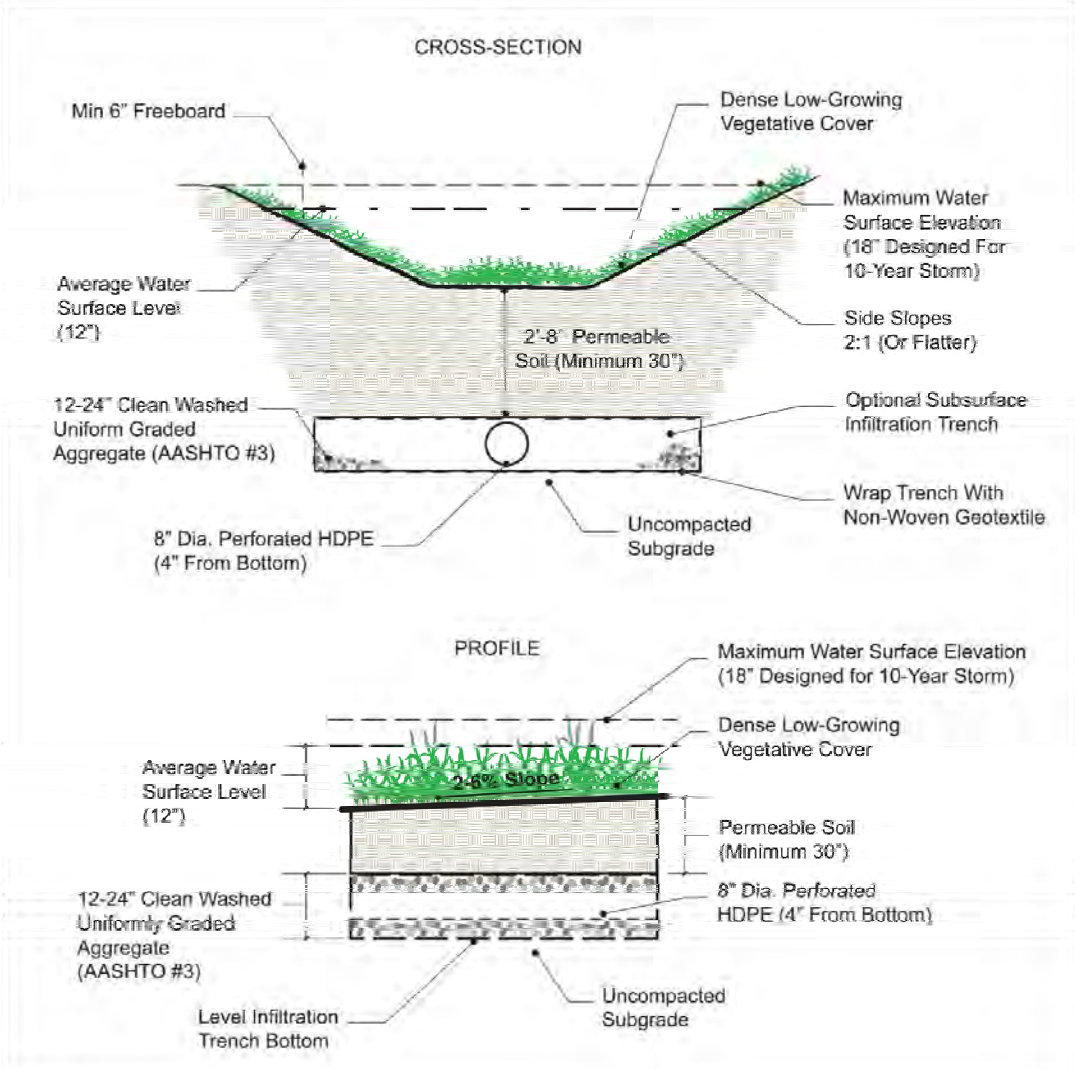


Figure 2-9. Schematic of a Vegetate Swale
(Source: Pennsylvania Stormwater IMP Manual, 2006)

Photo 2-13. Wet Swale
(Source: Hubbell, Roth & Clark, Inc.)

Photo 2-14. Grass Swale
(Source: PA Stormwater IMP Manual, 2006)

2.5.2.3 Use on Army Installation

Vegetated swales are highly versatile and can be well integrated into a variety of landscape settings, including residential, commercial/industrial areas, and training areas (Table 2-10). Swales can be used along road rights-of-ways, for yard drainage, and conveyance between BMPs. Use in ultra-urban settings is possible but limited, and potential retrofit applications depend on space and topographic limitations. On sites with little to no slope, for example, vegetated swales may not move water fast enough. Vegetated swales are a cost-effective and environmentally friendly alternative to traditional curbs and gutters along roads. Care needs to be taken when designing a vegetated swale so that excessive stormwater flows do not exceed the

capacity of the vegetated swale and cause erosion or downcuts. Swales must be designed to have an appropriate slope for the setting so that water does not stand in the swale for long periods to avoid attracting mosquitos and other vectors.

Table 2-10. Vegetated Swale

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low/Med
Commercial	Yes	**Groundwater Recharge**	Low/Med
Ultra Urban	Limited	**Peak Rate**	Low/Med
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Limited	**TSS**	Med/High
Highway/Road	Yes	**TP**	Low/High
Recreational	Yes	**TN**	Medium
Training Area	Yes	**Temperature**	Medium
Additional Considerations			
Cost		Low/Med	
Maintenance		Low/Med	
Winter Performance		Medium	

(Adapted from: SEMCOG, 2008)

2.5.3 Vegetated Filter Strip

2.5.3.1 Definition

A vegetated filter strip is a densely vegetated strip of gently sloping area that receives runoff from an adjacent impervious area as sheet flow (Figure 2-10). The vegetated filter strip slows the velocity of runoff and allows for removal of sediments and other pollutants as the runoff flows through the filter strip. The runoff may flow from the vegetated filter strip to another structural LID BMP, a vegetated area, or a receiving waterbody. Vegetated filter strips are most effective in treating runoff from isolated impervious areas such as rooftops, parking lots and smaller impervious areas.

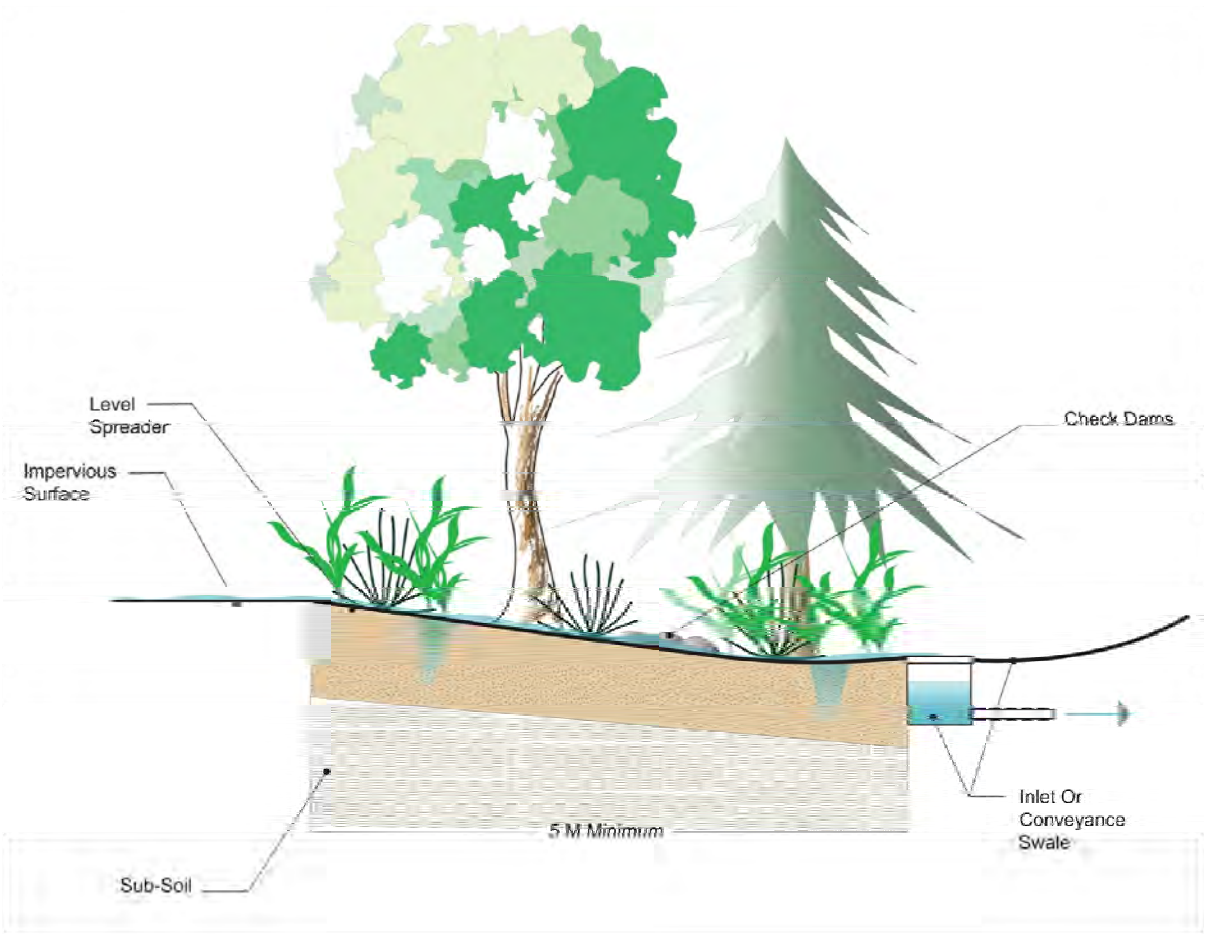


Figure 2-10. Vegetated Filter Strip
(Source: Landmark Design Group)

2.5.3.2 Purpose

Vegetated filter strips are used to minimize flow velocities and filter sediments and associated nutrients, and other pollutants from sheet flow runoff from impervious surfaces. When treating runoff from roofs or curbed impervious areas, a more structural approach, such as a gravel trench, is required. For smaller storms, vegetated filters also provide some runoff volume reduction benefits by infiltration. Usually, a vegetated filter strip is used as a pretreatment component to reduce sediments and particulate pollutant load before runoff reaches the primary stormwater BMP, such as bioretention, vegetated swale, or infiltration trench; the dense vegetation, grasses and/or woody plants, of the filter strip slows runoff to allow for sediments and particulates to settle out. A level spreading device, such as a stone drop, can be placed at the edge of the impervious or pervious surface being treated to prevent sediment deposition at the entry point. Natural spreader materials, such as earthen berms, are generally recommended, though they can be more susceptible to failure. Stormwater runoff flows through the vegetated filter strip to either a BMP, receiving waterbody or vegetated or wooded area, as seen in Figure 2-11. Figure 2-12 illustrates an optional earthen berm that temporarily slows the flow of water to

encourage infiltration and can allow discharge through a pipe. When creating a filter strip, existing natural areas, such as forests and meadows, should never be unduly disturbed.

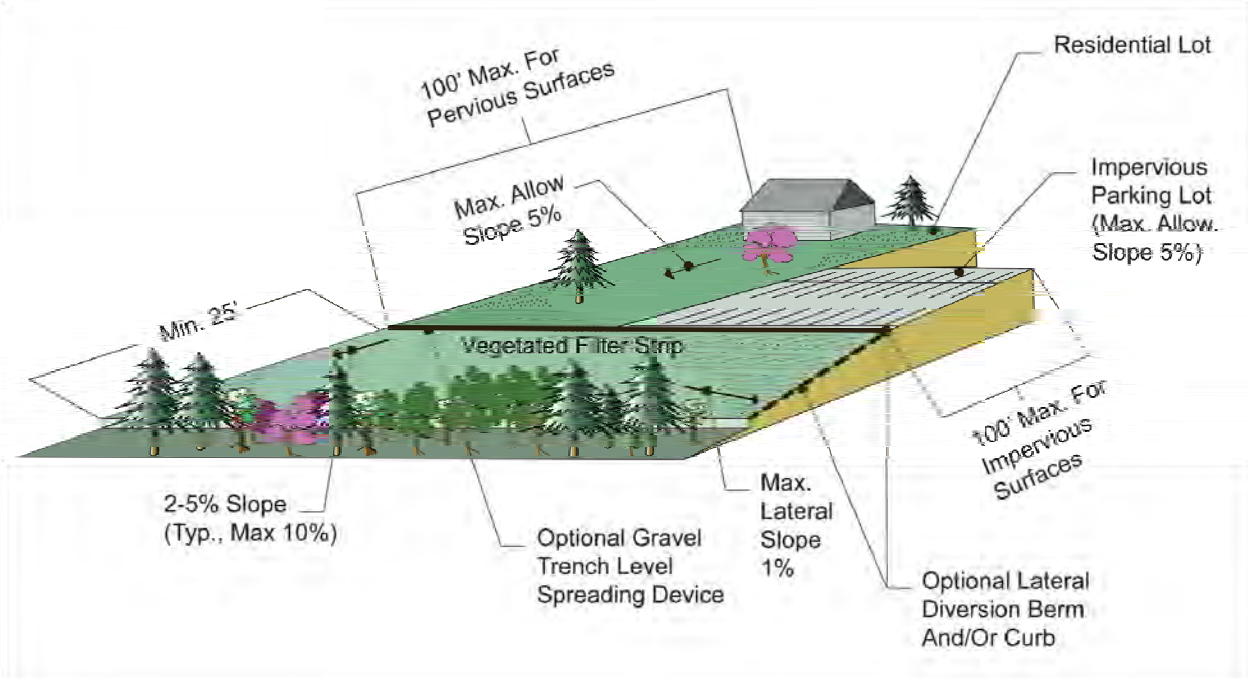


Figure 2-11. Diagram of a Vegetated Filter Strip
(Source: SEMCOG, 2008)

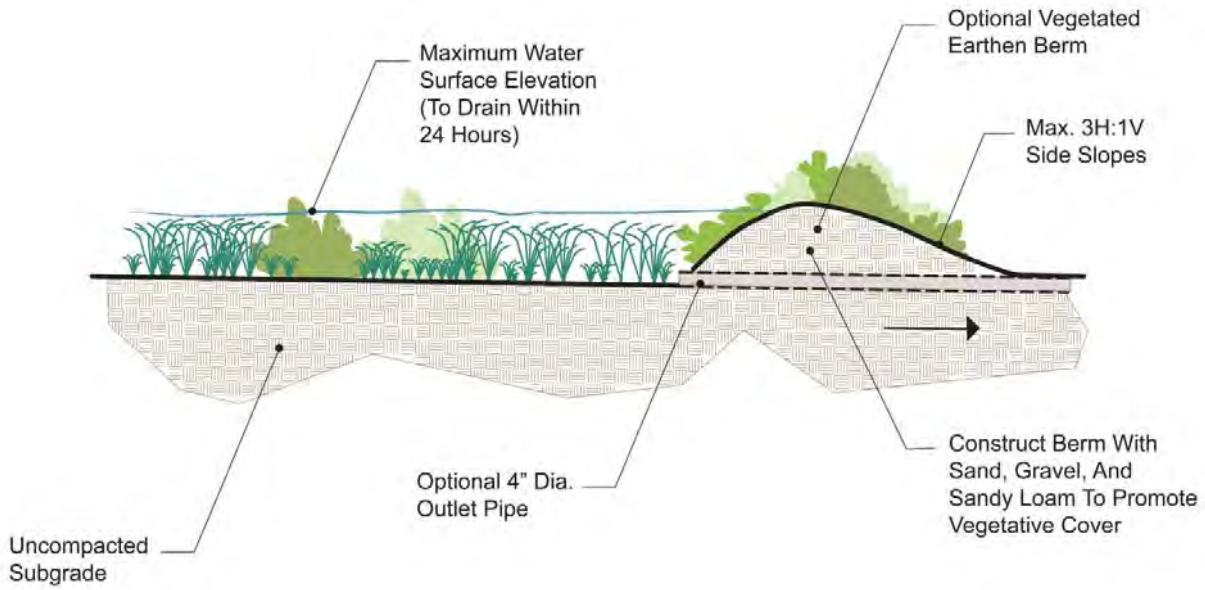


Figure 2-12. Cross-Section of Vegetated Filter Strip with an Optional Earthen Berm
(Source: SEMCOG, 2008)

2.5.3.3 Use on Army Installation

Vegetated filter strips can be applied in many land use types, including residential, commercial, industrial, training areas and road/highway transportation projects, as space and slopes are available (Table 2-11). Frequently, vegetated filter strips are designed where runoff is directed from a parking lot into a stone trench, a grass strip, and a longer naturally vegetative strip. Vegetated filter strips treat runoff from roads, disconnected rooftops, and other impervious surfaces (see Photo 2-15). For ultra-urban areas and some redevelopment areas, they might not be appropriate due to a lack of space. Because vegetated filter strips should be constructed as part of a larger stormwater treatment system, space requirements for additional BMPs should also be considered. Using vegetated filter strips as pretreatment practices to other BMPs is highly recommended. Access for stormwater runoff to sheet flow across the vegetated filter strip from upslope impervious areas is necessary for the proper function and effectiveness of a vegetated swale.

Table 2-11. Vegetated Filter Strip

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low
Commercial	Yes	**Groundwater Recharge**	Low
Ultra Urban	Limited	**Peak Rate**	Low
Industrial	Limited	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	Med/High
Highway/Road	Yes	**TP**	Med/High
Recreational	Yes	**NO3**	Med/High
Training Area	Yes	**Temperature**	Med/High
Additional Considerations			
Cost		Low	
Maintenance		Low Varies dependent on type of vegetation	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

Photo 2-15. Vegetated Filter Strip Along Roadway
(Source: SEMCOG, 2008)

2.5.4 Permeable Pavements

2.5.4.1 Definition

Permeable pavements are similar to conventional pavements but have pores or voids that allow stormwater runoff to filter through the pavement surface into an underlying stone reservoir, where it is temporarily stored then either infiltrated or directed to another BMP or permeable area. Permeable pavements provide high volume control and groundwater recharge benefits, as well as moderate peak rate control. The contributing drainage area is typically limited to the paved area.

2.5.4.2 Purpose

Permeable pavements are alternative paving surfaces that encourage filtration and/or infiltration that reduces the volume and velocity of stormwater runoff. There are various methods of installing pavement that allows stormwater to infiltrate while still providing the structural benefits of pavement. The four main design variations are: 1) porous asphalt, 2) pervious concrete, 3) permeable concrete pavers, and 4) reinforced turf or gravel. All four variations typically consist of a surface pavement layer, an underlying stone aggregate reservoir layer, and a filter layer or fabric installed on the bottom (Figure 2-13).

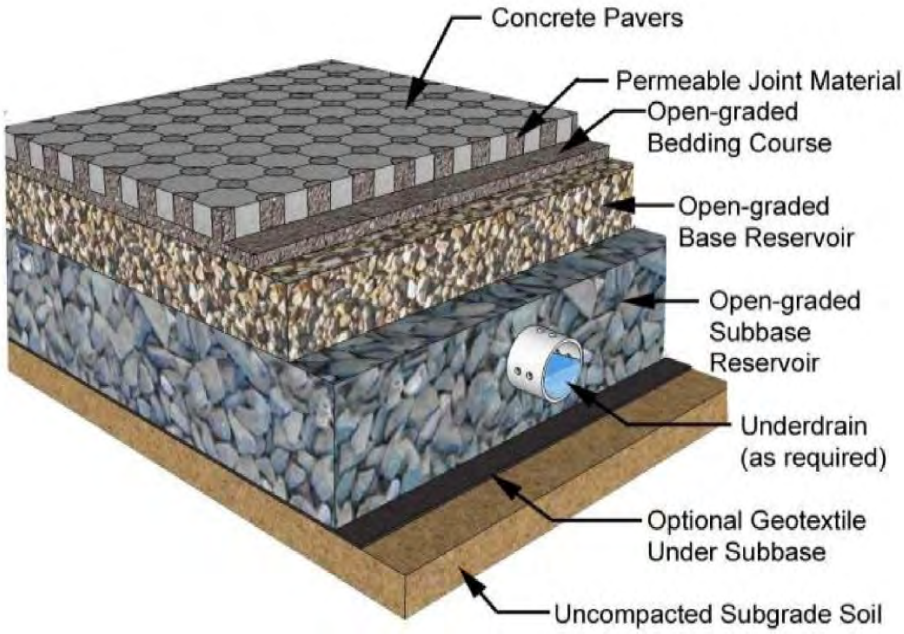


Figure 2-13. Cross Section of Permeable Pavement
(Source: Interlocking Concrete Pavement Institute)

The reservoir layer serves to retain stormwater and support the design traffic loads for the pavement, and its thickness is determined by both a structural and hydrologic design analysis. In low-infiltration soils, some or all of the filtered runoff is collected in an underdrain and returned to the storm drain system. If infiltration rates in the native soils allow, permeable pavement can be designed without an underdrain, to enable full infiltration of runoff. Permeable pavements designed for infiltration should be constructed on uncompacted subgrades; therefore, extensive coordination with the geotechnical engineer is necessary to determine an adequate pavement section for the subsoil conditions. A combination of these methods can be used to infiltrate a portion of the filtered runoff.

While the contributing drainage area is typically limited to the actual pavement surface area, it may also be used to accept runoff from small adjacent impervious areas, such as impermeable driving lanes or rooftops. However, careful sediment control is needed to avoid clogging of the down-gradient permeable pavement.

Photo 2-16. Permeable Pavement Parking Lot with Bioretention
(Source: Hawkins Partners, Inc., 2009)

Photo 2-17. Permeable Pavers
(Source: Leigh Ann Campbell)

Photo 2-18. Permeable Concrete Pavers in Street in Dowagiac, MI
(Source: Pokagon Band of Potawatomi Indians)

Photo 2-19: Porous Asphalt Pathway at Grey Towers National Historic Site, Milford PA
(Source: SEMCOG, 2008)

Photo 2-20. Pervious Pavement Basketball Court
(Source: Philadelphia Water Department)

2.5.4.3 Use on Army Installation

Photos 2-16, 2-17, 2-18, 2-19 and 2-20 depict various applications of the difference variations of permeable pavement. Because permeable pavement does not normally require any additional space to install but instead is used in lieu of traditionally impervious materials, it is applicable for a variety of commercial, institutional, and residential sites, and certain types of roadways and can be used to reduce the effective impervious cover of a development site (Table 2-12). Permeable pavement overlays can be used to slow runoff velocities, reduce runoff volumes and reduce the sediments and pollutants in runoff. The permeable pavement design should include methods to infiltrate, detain, or convey larger storms (e.g., 2-yr, 10-yr) to the storm drain system without the runoff backing up into the surface layers. An underdrain or connection to another BMP can receive runoff from the permeable pavements and can handle periods of excess runoff with larger storms and can be applied to meeting the EISA Section 438 requirements. Permeable pavement should not be hydraulically connected to foundations of structures or road beds. Infiltration from permeable pavement is not recommended in designated hotspots where contamination of groundwater and water supplies is a risk. It is also not recommended to install permeable pavements with underlying expansive soils due to the possibliltiy of heaving the pavements. Permeable pavement is not intended to treat sites with high sediment or trash/debris loads, as sediments and trash can clog the pores prohibiting filtration and resulting in an impervous surface.

Maintenance requirements for permeable pavements may limit their use in certain areas. Porous asphalt and concrete require regular maintenance with a conventional street sweeper to prevent clogging and malfunction. In areas of higher sediment and dust loads a vacuum-type sweeper or high-pressure hosing (for porous asphalt & concrete) may be required for cleaning. Turf pavers can require mowing, fertilization, and irrigation and aeration. In cold weather regions plowing of pavers is possible but it requires use of skids. Areas adjacent to pervious pavement should be fully stabilized with vegetation to prevent sediment-laden runoff from clogging the surface, and sand and salt should not be applied.

Table 2-12. Permeable Pavements

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low
Commercial	Yes	**Groundwater Recharge**	Low
Ultra Urban	No	**Peak Rate**	Low
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	Low
Highway/Road	Yes	**TP**	Low
Recreational	Yes	**NO3**	Low
Training Area	Yes	**Temperature**	Low
Additional Considerations			
Cost		Low	
Maintenance		Low	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

2.5.5 Rainwater Harvesting

2.5.5.1 Definition

Rainwater harvesting involves the collection and storage of rainwater for future use. Rainwater harvesting applies to collection from rooftops and on a large-scale from other impervious surfaces, such as parking lots. Collected rainwater is stored in tanks, barrels, or cisterns for later use in non-potable applications or irrigation.

2.5.5.2 Purpose

Rainwater harvesting serves multiple functions in managing stomrwater runoff and promoting water conservation. Collecting runoff from roofs and impervious surfaces reduces the peak flows and runoff volumes to the receiving waterbodies, which alleviates erosive forces downstream. Stormwater runoff collected from rooftops is sodium and chlorine free, low in salt content, and high in nitrogen, and relatively clean that can be used for irrigation and for non-potable uses such as flushing toilets and urinals. Harvested water can also be discharged into the stormwater system or for infiltration if discharged to pervious area or a BMP; in these cases, rainwater harvesting serves mainly to reduce runoff volumes and peak flows.

The complexity of the rainwater harvesting system will depend on the objective of the application. A barrel can collect water from a roof, as shown in Photo 2-21, and store the water until ready for use for irrigation, non-potable purposes or released. More complex systems may contain water quality treatment, pumps and other devices for storing the collected water and directing for non-potable uses, as seen in Photo 2-22. The sizing of the systems varies across the country based on the climatic conditions, water demand, surface area, and allowable use of the collected water according to the applicable plumbing code.

Photo 2-21. Rain Barrels for Rainwater Harvesting from Roof
(Source: U.S. Army Fort Bragg)

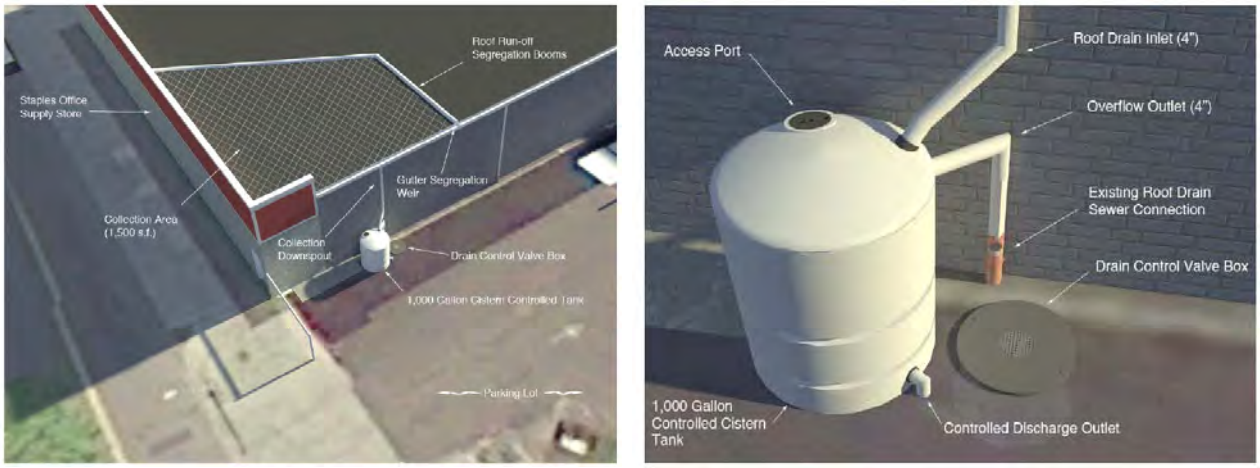


Photo 2-22. Cistern for Rainwater Harvesting

2.5.5.3 Use on Army Installation

Rainwater harvesting systems can be applied to many types of buildings, structures and even parking lots to reduce the volume of runoff from impervious areas (Table 2-13). Rain barrels or cisterns can easily be retrofit to existing buildings or parking garages. Rainwater harvesting systems can vary in size depending on available space, climatic conditions (i.e., average rainfall), and site requirements for stormwater runoff management or non-potable water and irrigation needs. This structural LID BMP is particularly beneficial in ultra urban areas where space is limited for other types of LID BMPs and in areas of low infiltration where use of other LID BMPs may be limited. Rainwater harvesting system design can be as simple as a rain barrel with a spigot (Photo 2-21) or as complex as a large tank with water quality treatment, a pumping

system, and real time controls to direct the release of the runoff (Photo 2-22). Plumbing codes often dictate the level of treatment and if the water can be used for potable or non-potable uses. Common uses of the harvested rainwater include flushing of toilets and urinals inside buildings, landscape irrigation, exterior washing (e.g. car washes, building facades, sidewalks, street sweepers, fire trucks, etc.), and fire suppression (sprinkler) systems. Cisterns and rain barrels also have value for promoting environmental stewardship and education.

Table 2-13. Rainwater Harvesting

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	High
Commercial	Yes	**Groundwater Recharge**	Low
Ultra Urban	Yes	**Peak Rate**	Low
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	High
Highway/Road	No	**TP**	Medium
Recreational	Yes	**NO3**	Medium
Training Areas	Yes	**Temperature**	High
Additional Considerations			
Cost **- Rain barrel** **- Cistern** **- Manufactured product**		 - Low - Medium - Varies	
Maintenance		Medium	
Winter Performance		Medium	

(Adapted from: SEMCOG, 2008)

2.5.6 Green Roofs

2.5.6.1 Definition

Green roofs (also known as living roofs and eco roofs) consist of a layer of vegetation installed on top of a conventional flat or slightly sloped roof that absorb rainwater in the soil media to be uptaken and transpired by vegetation or discharged to another BMP or stormwater system. Green roofs include waterproofing material, root permeable filter fabric, growing media, and specially selected plants. Types of green roofs include intensive and extensive, ranging from deep, heavier growing media to shallower, lighter growing media.

2.5.6.2 Purpose

Green roofs capture and temporarily store stormwater as it hits the top of a building, reducing the amount of runoff from the building roof. Stormwater is held in the soil media and uptaken and transpired by plants to reduce the amount of runoff or slowly released to the stormwater system when stormwater exceeds the green roof storage capacity, reducing peak runoff rates. Depending on the objective of the green roof and the building structure, either an intensive green

roof or extensive green roof may be installed. Intensive systems that have a deep growing media (typically greater than 4 inches), are limited to flat roofs, require a high degree of maintenance, and are often 'park-like' in appearance (Photo 2-23 and 2-24). Extensive systems, on the other hand, have a shallow substrate layer, are limited to herbs, grasses, mosses, and drought tolerant succulents such as sedum, have a higher mitigation of stormwater runoff, and are much lighter and less expensive than intensive vegetated roofs. Figure 2-14 is a cross section of a single layer extensive roof system.

Photo 2-23. Green Roof at the Pentagon Remote Delivery Facility
(Source: CAPT Robin Brake, 2008)

Photo 2-24. Green Roof at the California Academy of Sciences
(Source: Inhabitat)

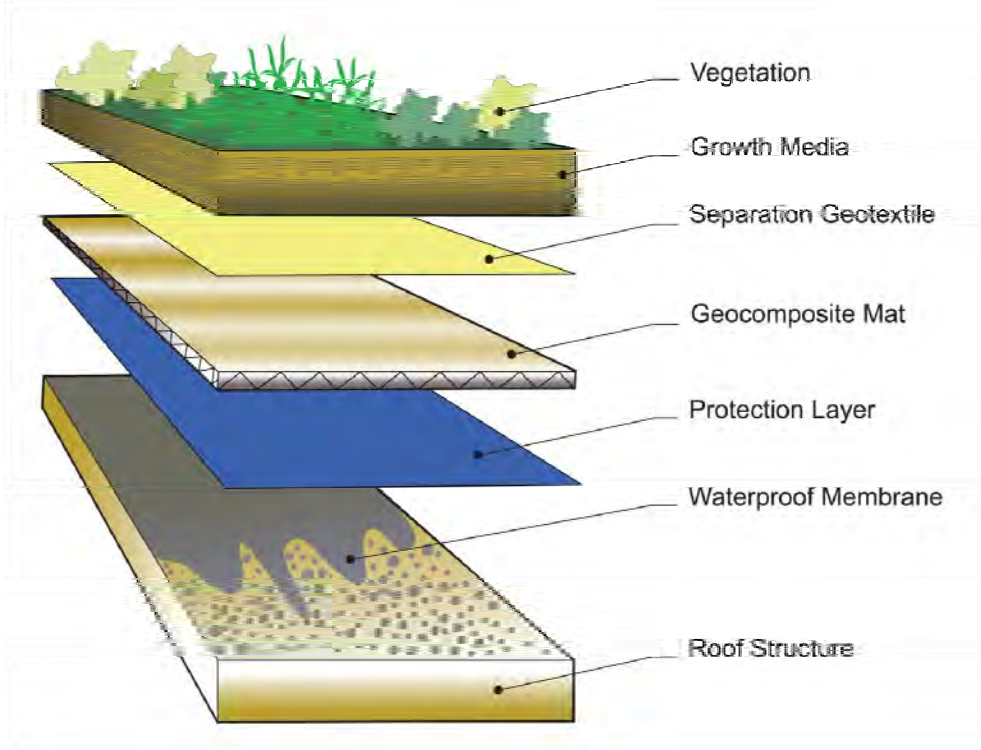


Figure 2-14. Cross Section of an Extensive Green Roof
(Source: SEMCOG, 2008)

2.5.6.3 Use on Army Installation

Green roofs are ideal for use on commercial, industrial, institutional, municipal and multi-family residential buildings, and are particularly well suited for use on ultra-urban development and redevelopment sites (Table 2-14). Roofs need to be flat or with minimal slope and buildings should be able to withstand the weight of the green roof media and vegetation. While extensive vegetative roofs are the most common due to their lower costs and maintenance requirements and their higher mitigation of stormwater runoff, intensive roofs can be utilized for gardening or therapeutic reasons. All green roofs should be sized to capture a portion of stormwater to reduce the overall stormwater runoff volume from the site. The required size will depend on several factors, including the growing media's porosity and hydraulic conductivity and the underlying drainage material. Irrigation and inspections are required during the vegetated roof's establishment period and in times of drought. Once plants are established, it is crucial to maintain the roof once or twice a year for extensive roofs. For intensive green roofs, a higher level of maintenance and service will be required throughout the year.

When designing a green roof, designers must not only consider the stormwater capacity of the green roof, but also the structural capacity of the roof and the building. For example, a conventional rooftop typically must be designed to support an additional 15 to 30 pounds per square foot (psf) for an extensive green roof. The roof's pitch, roof type, roof access, building codes, and construction costs are also common site constraints that must be considered. For

green roof retrofits, key factors to consider include the age, area, structural capacity, and accessibility of the existing roof, as well as the building owner's capability to maintain it. Designers and reviewers should fully understand manufacturer specifications for each system component prior to installing. Further details are found in Chapter 5.

Table 2-14. Green Roofs

Applications		Stormwater Quantity Functions	
Residential	Limited	**Volume**	Med/High
Commercial	Yes	**Groundwater Recharge**	Low
Ultra Urban	Yes	**Peak Rate**	Medium
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	Medium
Highway/Road	N/A	**TP**	Medium
Recreational	Yes	**TN**	Medium
Training Area	Limited	**Temperature**	High
Additional Considerations			
Cost		High	
Maintenance		Medium	
Winter Performance		Medium	

(Adapted from: SEMCOG, 2008)

2.5.7 Infiltration Practices

2.5.7.1 Definition

Infiltration practices are natural or constructed land areas located in permeable soils that capture, store, and infiltrate the volume of stormwater runoff into the surrounding soil. They are applicable to most drainage basins ranging in size from less than an acre to greater than 5 to 10 acres. There are several types of infiltration practices to meet the site conditions and needs for a project area.

2.5.7.2 Purpose

Infiltration practices serve to capture and temporarily store stormwater before allowing it to infiltrate into the underlying soil through the bottom and sides of the trench or subsurface area, and then either be partitioned into groundwater recharge. They are designed to rapidly treat and infiltrate the water so that the facility is ready to receive runoff from the next storm event or through the process of transpiration. By doing so, it serves to mitigate potential flooding events by decreasing peak runoff flow rates and the volume of stormwater runoff, reducing stormwater pollutants, and increasing groundwater recharge.

Variations of infiltration practices include the following:

- **Dry wells** (also known as seepage pits, French drains, and Dutch drains) are structural subsurface chambers or excavated pits backfilled with a coarse stone aggregate that are typically designed to handle stormwater runoff from smaller drainage areas less than one acre in size (Figure 2-15).

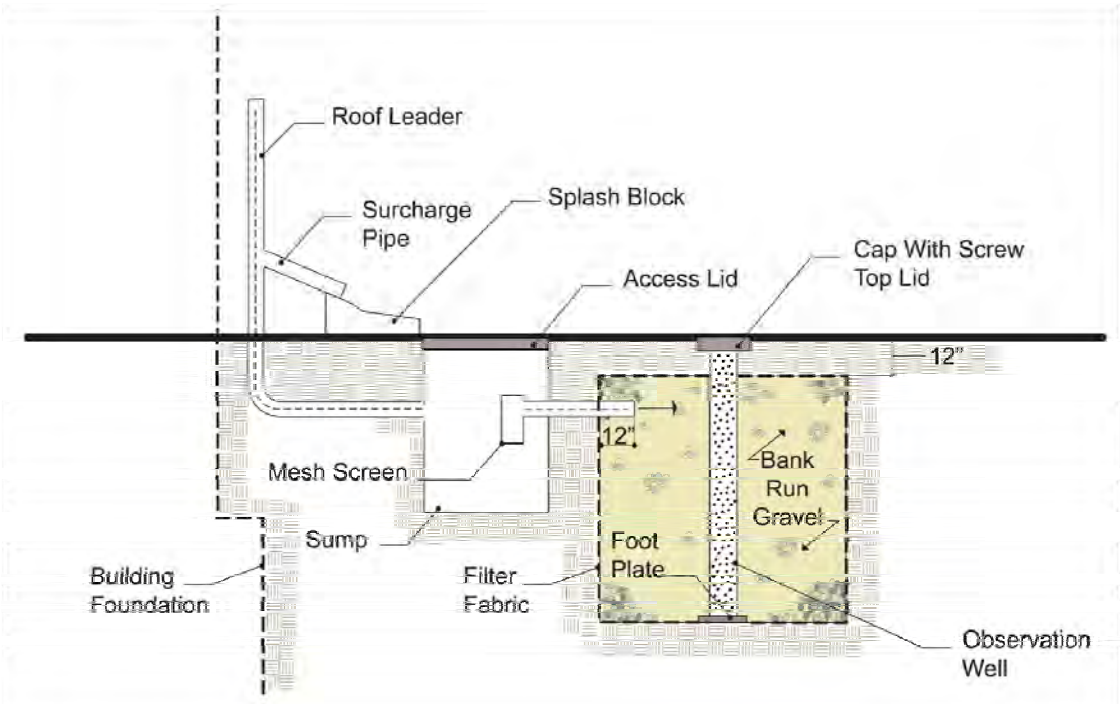


Figure 2-15. Dry Well Schematic
(Source: SEMCOG, 2008)

- **Infiltration basins** are either natural or constructed shallow surface impoundments that often include a flat, densely vegetated floor situated over naturally permeable soils, with typical permeable soil depths ranging from 2 to 12 feet (Photo 2-25). They serve to temporarily capture, store, and infiltrate runoff over a period of days, and are best suited for larger drainage areas with land slopes of less than 20 percent.

Photo 2-25. Infiltration Basin
(Source: SEMCOG, 2008)

- An **infiltration berm** is a mound of compacted earth with sloping sides that helps manage stormwater and prevent erosion by using the existing topography on the site. Berms may function independently in grassy areas or may be incorporated into the design of other stormwater BMPs, such as bioretention and constructed wetlands. Berms may also serve various stormwater drainage functions, including creating a barrier to flow, retaining flow for volume control, and directing flows.

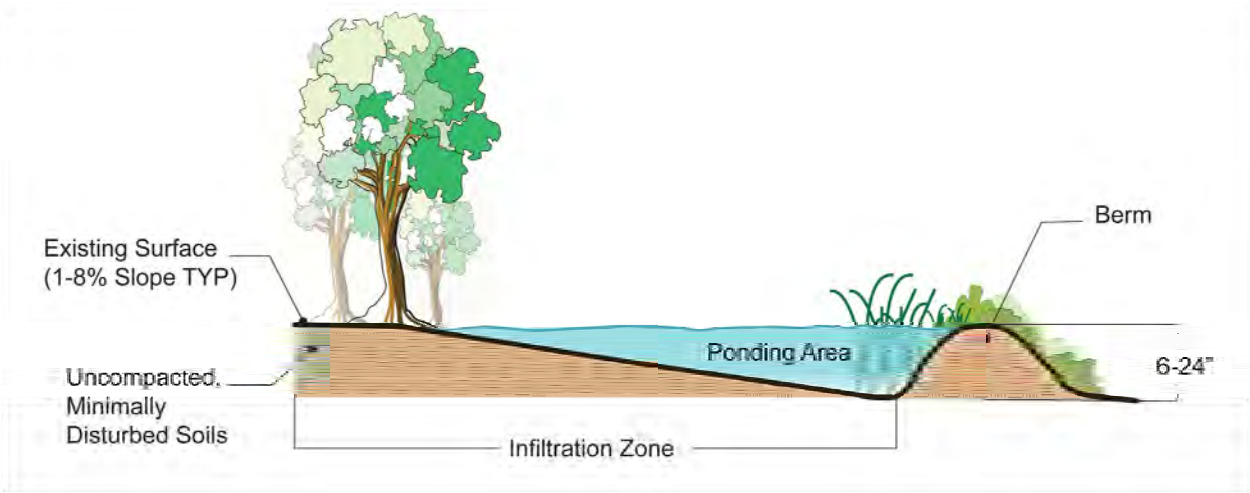


Figure 2-16. Infiltration Berm
(Source: SEMCOG, 2008)

- **Infiltration trenches** are linear, narrow excavations typically filled with stone and lined with geotextile (Photo 2-26), that are designed to create an underground reservoir for stormwater runoff in drainage areas less than five acres in size.

Photo 2-26. Infiltration Trench
(Source: Tony Parker, Classic Landscapes, 2007)

- **Subsurface infiltration beds** generally consist of a rock storage or alternative bed below ground surfaces, typically under parking lots, lawns, and playfields, for temporary storage and infiltration of stormwater runoff. Photo 2-27 shows the installation of a subsurface infiltration bed.

Photo 2-27. Installation of a Subsurface infiltration Bed
(Source: Cardno JFNew)

2.5.7.3 Use on Army Installation

While all of the varying infiltration practices achieve the same goal of capturing, storing, and infiltrating stormwater runoff into the surrounding soil, they are can be applied in a variety of

situations at varying scales (Table 2-15). In order for any infiltration practice to function properly, the underlying soils must be well-suited for infiltration and the water table or bedrock must be located well below the base. The infiltration practice should be protected from sediment loads and erosive velocities by using pretreatment BMPs. Care should be taken when locating infiltration areas near buildings or areas where seepage or overflows could affect infrastructure are important.

Table 2-15. Best Uses for Infiltration Practices

PRACTICE	BEST USE
Dry well	Treatment of small impervious areas such as driveways or rooftop downspouts as an alternative to infiltration trenches. May be appropriate on steeper slopes where trenches or other facilities cannot be installed.
Infiltration basin	Best used in situations where source-area controls will not be enough to accomplish established peak runoff or water-quality goals (e.g., urban areas).
Infiltration berm	Easily incorporated into the landscape and often used in conjunction with recreational features, such as trails or walkways.
Infiltration trench	Treatment of rooftop runoff and runoff from small impervious surfaces with light sediment loads and minimal oil and grease buildup.
Subsurface infiltration bed	Areas where space is limited; secondary treatment for runoff from impervious surfaces, such as parking lots that have pretreatment structures in place.

Infiltration practices can be applied to most land uses on an Army installation (Table 2-16). There are limitations in areas where there is a risk of groundwater contamination from hotspots, or AT/FP requirements may restrict the placement of size of the BMP. For infiltration basins, it is important that vehicles are not driven in the basin to avoid compaction, which reduces the permeability of the soil.

Table 2-16. Infiltration Practices

Applications	Residential	Commercial	Ultra Urban	Industrial	Retrofit	Highway/Road	Recreational	Training Area
Dry Well	Yes	Yes	Yes	Limited	Yes	No	Yes	Yes
Infiltration Basin	Yes	Yes	Limited	Yes	Limited	Limited	Yes	Yes
Infiltration Berm	Yes	Yes	Limited	Yes	Yes	Yes	Yes	Yes
Infiltration Trench	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Subsurface Infiltration Bed	Yes	Yes	Yes	Yes	Yes	Limited	Yes	Yes

Stormwater Quantity Functions	Volume	Groundwater Recharge	Peak Rate
Dry Well	Medium	High	Medium
Infiltration Basin	High	High	High
Infiltration Berm	Low/Medium	Low/Medium	Medium
Infiltration Trench	Medium	High	Low/Medium
Subsurface Infiltration Bed	High	High	High

Stormwater Quality Functions	TSS	TP	NO3	Temperature
Dry Well	High	High/Medium	Medium/Low	High
Infiltration Basin	High	Medium/High	Medium	High
Infiltration Berm	Medium/High	Medium	TN-Medium	Medium
Infiltration Trench	High	High/Medium	Medium/Low	High
Subsurface Infiltration Bed	High	Medium/High	Low	High

(Adapted from: SEMCOG, 2008)

2.5.8 Level Spreaders

2.5.8.1 Definition

A level spreader is an erosion control measure that is designed to mitigate the impact of high-velocity stormwater surface runoff, and can also serve to increase infiltration and reduce water pollution. While there are numerous variations, they can essentially be categorized into two types: inflow and outflow level spreaders. The applicable drainage area for a single level spreader should not exceed 5 acres.

2.5.8.2 Purpose

Level spreading devices help to reduce the erosive nature of stormwater runoff by uniformly diffusing both high and low flows over a wide area. They can also serve to promote infiltration

and improve water quality by evenly distributing flows over a stabilized vegetated surface. Typically, it is constructed at a zero percent grade across the slope consisting of a permanent linear structure in order to disperse concentrated flow widely over a vegetated buffer, filter strip, bioretention cell, or wetland (Figure 2-17). While level spreaders themselves do not remove pollutants, by dispersing runoff to a buffer or bioretention cell, pollutants can be effectively removed.

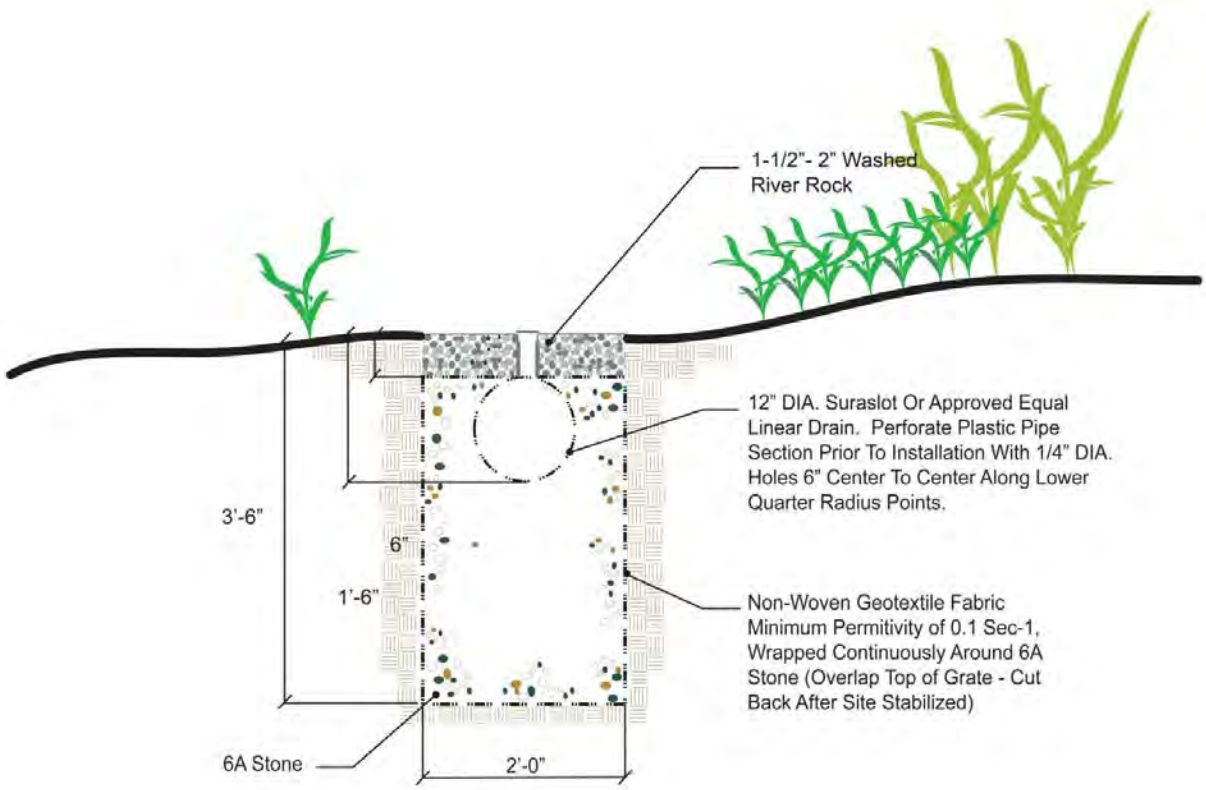


Figure 2-17. Schematic of a Typical Level Spreader
(Source: InSite Design Studio)

There are two main categories of level spreaders. Inflow level spreaders (e.g., concrete sills, curbs, earthen berms) help to evenly distribute flow into another structural practice, such as filter strips or a vegetated swale (Figure 2-18). Outflow level spreaders (e.g., perforated pipe in a shallow aggregate trench) help to reduce the erosive potential of low to moderate flows while also enhancing natural infiltration opportunities (Figure 2-19). For outflow level spreaders, the total amount of runoff volume reduced is dependent on the length of the level spreader, the soil type and density of receiving vegetation, as well as the downhill length and slope and the design runoff.

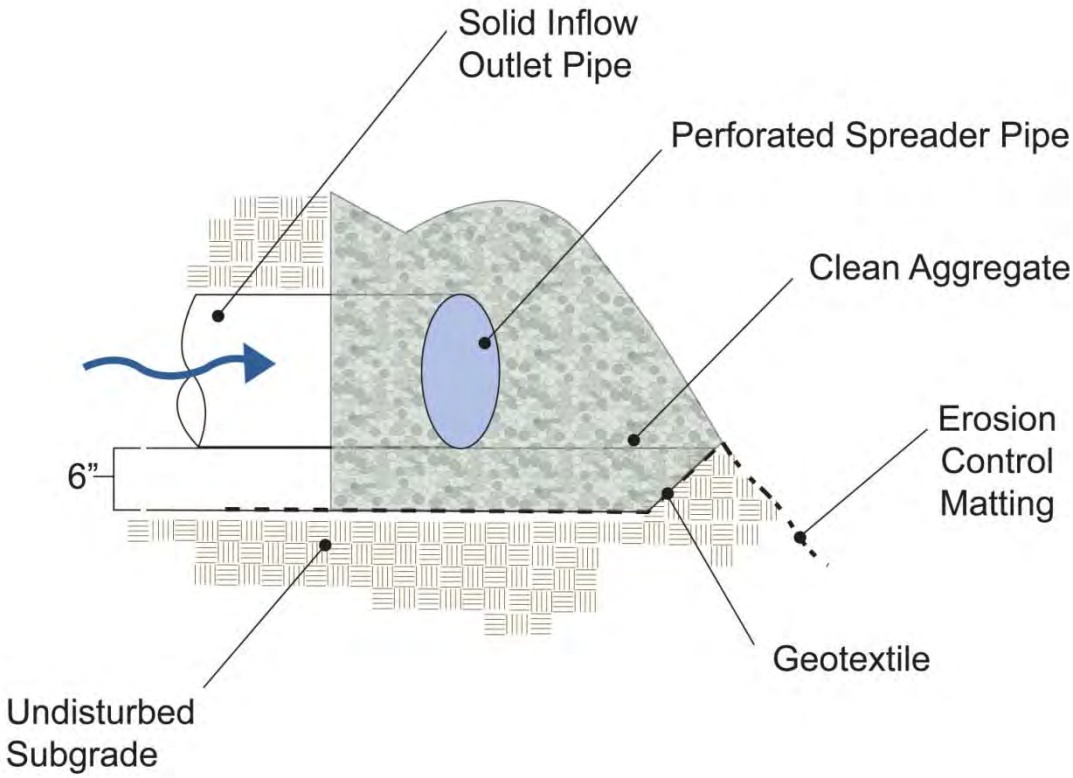


Figure 2-18. Level Spreader with an Inflow Pipe
(Source: SEMCOG, 2008)

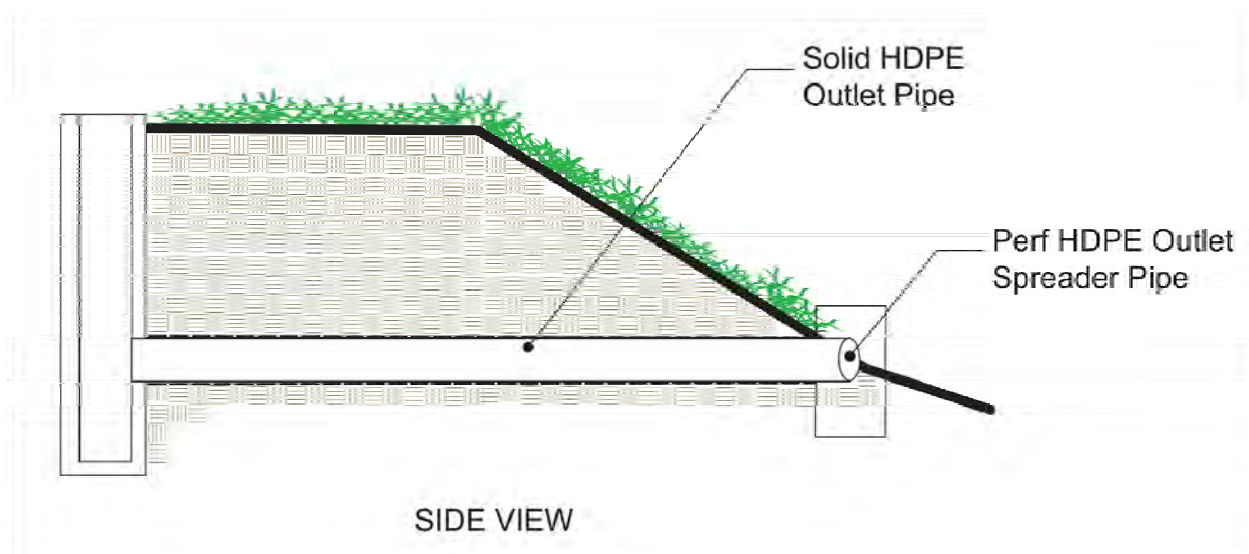


Figure 2-19. Level Spreader with a Perforated Outflow Pipe
(Source: SEMCOG, 2008)

Both inflow and outflow level spreader systems typically consist of pre-treatment (forebay), principal treatment (e.g., level spreader with grassed buffer), and an emergency spillway (reinforced grassy swale downslope of spreader) device. The forebay helps to remove some of

the sediment and debris that normally accumulate behind these systems, while also dissipating the energy, thus reducing the velocity prior to entering the level spreader. If the flow from a drainage area exceeds the capacity of a level spreader, another BMP such as a detention basin may be used before the level spreader to attenuate the flow to an appropriate rate. Level spreaders are not applicable where slopes exceed 5 for wooded areas or 10 for thick ground cover/grass, nor are they applicable where highly erodible soils are present or when there is little/no vegetation.

2.5.8.3 Use on Army Installation

A level spreader can be used in a variety of applications, from residential and commercial (to manage stormwater from disconnected rooftops, driveways, sidewalks, and parking lots) to highway/road projects (Table 2-17). Level spreaders are often used in conjunction with other LID BMPs or conventional stormwater BMPs. The primary requirement is that there must be adequate area with an acceptable slope to receive the outflow. Because of this, level spreaders are generally not applicable in ultra-urban settings. Photo 2-28 shows a level spreader at the edge of a wetland area that disperses stormwater from the paved paths across the one side of the wetland.

Table 2-17. Level Spreaders

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low
Commercial	Yes	**Groundwater Recharge**	Low
Ultra Urban	No	**Peak Rate**	Low
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	Low
Highway/Road	Yes	**TP**	Low
Recreational	Yes	**NO3**	Low
Training Area	Yes	**Temperature**	Low
Additional Considerations			
Cost		Low	
Maintenance		Low	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

Photo 2-28. Level Spreader at the Edge of a Wetland Area
(Source: Lee R. Skabelund, Kansas State University, 2006)

2.5.9 Constructed Filter

2.5.9.1 Definition

Constructed filters are precast or cast in place structures or excavated areas containing a layer of sand, compost, organic material, peat, or other media that filter and treat stormwater runoff. The maximum drainage area is typically less than one half acre.

2.5.9.2 Purpose

These are typically shallow and small-scale facilities that are used to provide water quality treatment and reduce velocities of stormwater runoff for small impervious drainage areas such as parking lots, walks, and roofs. Constructed filter systems typically contain a high flow rate media that requires some type of pretreatment to reduce the potential for clogging. Pre-cast systems often contain pretreatment chambers to prevent large amounts of debris, sediment, or oil and grease from entering the constructed filter. They are often designed with bypass systems for large storm events which could overload or erode the media.

2.5.9.3 Use on Army Installation

Constructed sand filters can be used at infill sites or areas where there is a limited amount of space to treat the runoff from impervious areas (Table 2-18). The media in these systems is highly sensitive to clogging and usually requires a significant amount of maintenance. Filters that use peat and sand or surface sand filters, require frequent inspection to make sure vegetation

does not grow in the media and reduce the filtration capacity. These facilities do not significantly reduce the amount of runoff volume from a site unless there is a sandy soil below the filter where it can infiltrate to groundwater. Photo 2-29 shows a two chambered sand filter. The part of the sand filter with the grate (on the left) allows water to enter a chamber where debris, heavy sediments, and oils and grease are filtered out. The chamber with the cover (on the right) includes the sand filter media. Photo 2-30 is a picture of a surface sand filter. Note the grass area around the filter and the stone on the surface to reduce the amount of sediment and debris entering the system and reduce the velocity of the flows. The flows enter the system through the outfalls at the side and rear of the facility and leave the facility through the grate inlet at the front. The system contains an underdrain that discharges to the stormwater system.

Table 2-18. Constructed Filter

Applications		Stormwater Quantity Functions	
Residential	Limited	**Volume**	Low/High
Commercial	Yes	**Groundwater Recharge**	Low/High
Ultra Urban	Yes	**Peak Rate**	Low/High
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	High
Highway/Road	Yes	**TP**	Medium
Recreational	Yes	**TN**	Medium
Training Area	Yes	**Temperature**	Low
Additional Considerations			
Cost		Med/High	
Maintenance		High	
Winter Performance		Medium	

(Adapted from: SEMCOG, 2008)

Photo 2-29. Two Chambered Sand Filter
(Source: Wayne County, MI Department of Public Works)

Photo 2-30. Surface Sand Filter
(Source: City of Portland, OR)

2.5.10 Soil Restoration

2.5.10.1 Definition

Soil restoration is a practice used to deeply till compacted soils and restore their porosity by amending them with compost or other acceptable organic material.

2.5.10.2 Purpose

Soil restoration can be used to increase the water retention capacity, soil porosity and soil structure, reduce erosion, and immobilize/degrade pollutants (depending on soil media makeup), and ultimately reestablish the long term capacity of the soil for infiltration (see Section 3.3.1.2 for further information about soils). Soil restoration is suitable for any pervious area where soils have been or will be compacted by the grading and construction process. This practice is particularly well suited when existing soils have low infiltration rates and when the pervious area will be used to filter runoff (downspout disconnections and grass channels). The area or strip of amended soils should be hydraulically connected to the stormwater conveyance system.

Soil restoration is not recommended where existing soils have high infiltration rates: where the water table or bedrock are located within 1.5 feet of the soil surface; on slopes of 10 percent or greater or where the downhill slope runs towards a building foundation; where existing soils are seasonally wet or saturated; where existing tree roots would be harmed; or where the contributing impervious surface area exceeds the surface area of the amended soils. Soil restoration can be applied to the entire pervious area of a development or be applied only to select areas of the site to enhance the performance of runoff reduction. Figure 2-20 illustrates the profile of healthy soil. The top layer, or “O Horizon”, provides organic matter from dead leaves and decomposing as nutrients for the plants and to retain surface moisture. The A horizon is the topsoil layer that contains organic material, organisms, and the root zones of plants. This is the most biologically productive area of the soil and provides pathways for air and water. The B zone is the mineral zone where sands, silts, clays and rocks occur. The C zone is primarily composed of weathered rocks and minerals. Photo 2-31 shows a compacted soil where the root zones of the turf, or sod cannot penetrate the upper soil horizons.

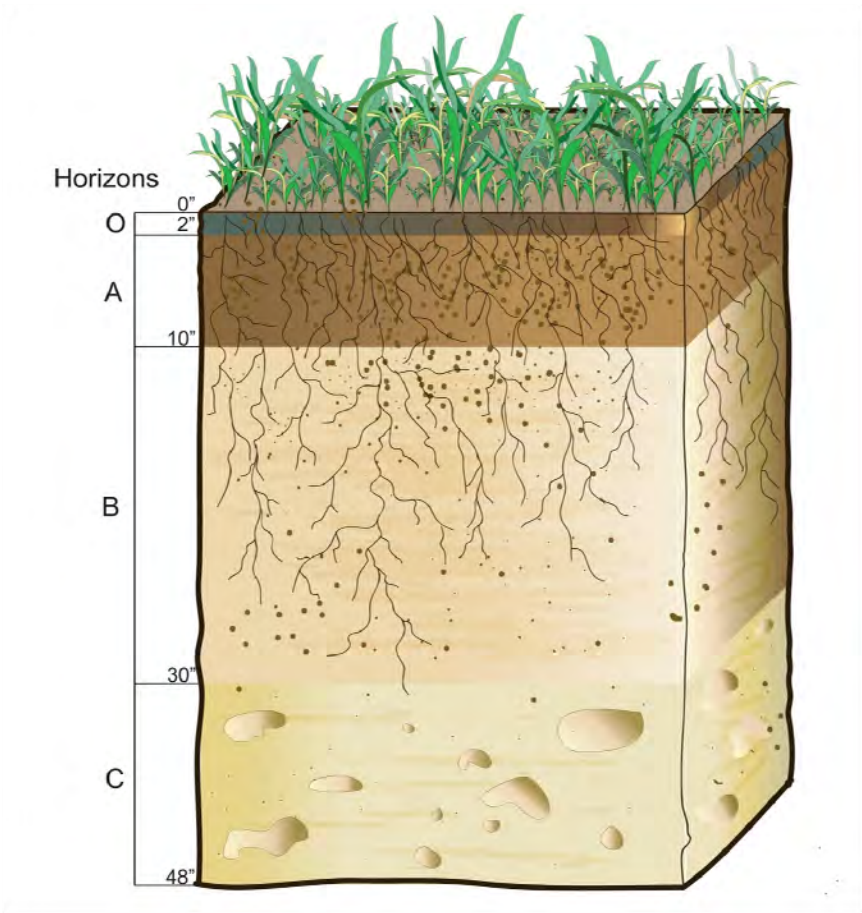


Figure 2-20. Profile of a Healthy Soil
(Source: USDA NRCS)

Photo 2-31. Compacted Soils
(Source: Low Impact Development Center, Inc.)

2.5.10.3 Use on Army Installation

Soil restoration can occur anywhere to alleviate soil compaction, and is applicable to multiple land uses (Table 2-19). Soil restoration can be used to reduce runoff from compacted lawns and to enhance the runoff reduction performance of other BMPs such as downspout disconnections, grass channels, filter strips, detention basins, or a reforested area. Soil restoration is particularly important in training areas, where vehicular movement and heavy traffic have compacted soils, reducing infiltration and in some cases creating an impervious surface. Prior to any modifications, a soil test is required to ascertain the soil properties at the proposed amendment areas to determine potential drainage problems and what, if any, soil amendments are needed. Areas should be marked so that heavy vehicles do not compact the soils.

Table 2-19. Soil Restoration

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Medium
Commercial	Yes	**Groundwater Recharge**	Low
Ultra Urban	Yes	**Peak Rate**	Medium
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	High
Highway/Road	Limited	**TP**	High
Recreational	Yes	**NO3**	Medium
Training Area	Yes	**Temperature**	Medium
Additional Considerations			
Cost		Medium	
Maintenance		Low	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

2.5.11 Reforestation and Afforestation

2.5.11.1 Definition

Reforestation refers to the reestablishment of forested cover in areas where development has removed forest. Afforestation is the establishment of forests on grasslands or other areas that were previously unforested.

2.5.11.2 Purpose

Reforestation and afforestation can be effective tools for reducing the quantity of stormwater runoff. In addition to intercepting and absorbing stormwater runoff, trees help filter pollutants and can greatly improve slope stability. Site reforestation involves planting trees on existing turf or barren ground at a development site with the goal of establishing a mature forest canopy that will intercept rainfall and maximize infiltration. The method used for reforestation must achieve 75 percent forest canopy cover within ten years. Reforestation areas are planted with a variety of understory trees and shrubs and overstory trees in order to encourage biodiversity. Photo 2-32 is

a recently planted reforestation area with tubes around the whip stock to prevent animals from feeding on the bark and to prevent sun scorch.

Photo 2-32. Recently Planted Reforestation Area
(Source: USDA)

2.5.11.3 Use on Army Installation

Reforestation and aforestation can be applied to cleared sites, in developments or parks, along roadsides, or in parking lots (Table 2-20). There may be opportunities in training areas for reforestation in areas where training no longer occurs or if there are changes in training activities. There are several reforestation programs that Army installations participate in, making this LID BMP especially effective at managing both stormwater and natural resources. Establishing a forested buffer along stream corridors can filter pollutants and reduce flood hazards. Reforestation areas can be used to improve air quality and reduce urban heat island effects.

Table 2-20. Reforestation and Afforestaton

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low/Med/High
Commercial	Yes	**Groundwater Recharge**	Low/Med/High
Ultra Urban	Limited	**Peak Rate**	Low/Med
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	High
Highway/Road	Limited	**TP**	High
Recreational	Yes	**TN**	Med/High
Training Area	Yes	**Temperature**	Medium
Additional Considerations			
Cost		Low/Medium	
Maintenance		Low	
Winter Performance		Medium	

(Adapted from: SEMCOG, 2008)

2.5.12 Riparian Buffer Restoration

2.5.12.1 Definition

Riparian buffer restoration refers to natural or constructed low-maintenance ecosystems adjacent to surface waterbodies. The riparian vegetation slows and dissipates stormwater runoff entering the receiving waterbody by absorbing the energy and volume of the stormwater runoff (Photo . The riparian vegetation also acts as a filter to remove pollutants from both overland stormwater flow and shallow groundwater flow.

2.5.12.2 Purpose

Riparian buffers provide water quality, habitat, and erosion control benefits, by slowing the velocity of the stormwater runoff and absorbing some of the ruoff volume. The specific restoration strategy, however, is dependent upon the overarching goal (e.g., a riparian buffer restored for water quality benefits can differ from one restored for habitat purposes). Photo 2-33 is an illustration of a stream buffer with dense vegetation that slows and filters runoff from the adjacent field.

Photo 2-33. Riparian Buffer in Agricultural Setting
(Source: USDA)

For water quality and erosion control, a riparian buffer is most effective when used as part of a sound land management system that includes nutrient management and runoff, sediment, and erosion control practices. Riparian buffer zones require considerations for water quality as well as existing vegetation should be evaluated to determine a restoration strategy and identify desirable, undesirable, and sensitive species, and care should be taken to evaluate the soil which will greatly influence the plant selection. Depending on existing site conditions, the soils, topography, or hydrology may first need to be restored. Where steep slopes or highly erodible soils are present, the buffer may need to be expanded to ensure soil stability. Photo 2-34 shows a steep and eroded bank adjacent to a stream without a buffer. Photo 2-35 shows the restored buffer and stream bank.

Photo 2-34. Eroded Streambank
(Source: FISRWG, 1998)

Photo 2-35. Restored Buffer and Streambank
(Source: FISRWG, 1998)

2.5.12.3 Use on Army Installation

Army installations may have significant stream networks and waterways that are subject to impacts from training activities and development. Table 2-21 indicates that restoration of

riparian buffers can be applied in all settings; on some installations the local or state government may require a riparian buffer of a certain width. Maintaining an adequate buffer from trails, temporary access roads, and grading is imperative to protect the integrity of the stream. Buffers are also valuable habitat corridors.

Table 2-21. Riparian Buffer Restoration

Applications		Stormwater Quantity Functions	
Residential	Yes	**Volume**	Low/Med
Commercial	Yes	**Groundwater Recharge**	Low/Med
Ultra Urban	Yes	**Peak Rate**	Low/Med
Industrial	Yes	**Stormwater Quality Functions**	
Retrofit	Yes	**TSS**	Med/High
Highway/Road	Limited	**TP**	Med/High
Recreational	Yes	**NO3**	Med/High
Training Areas	Yes	**Temperature**	Med/High
Additional Considerations			
Cost		Low/Medium	
Maintenance		Low	
Winter Performance		High	

(Adapted from: SEMCOG, 2008)

2.6 LID BMP SELECTION

Site conditions, including climate, and stormwater management requirements highly influence the selection of LID BMPs for the project. Table 2-22 lists a selection of structural and non-structural LID BMPs and their effectiveness in each climate. Table 2-23 lists a selection of non-structural and structural LID BMPs and the hydrologic objective they meet; volume control is the most important objective for compliance with EISA Section 438. Hydrologic modeling and simulation tools for the selection and sizing of LID BMPs are presented in Chapter 4. Further details about the most common structural LID BMPs are presented in Chapter 5.

Table 2-22. Climatic Considerations for LID BMP Selection

LID BMP	TROPICAL (MEGATHERMAL)	DRY (ARID AND SEMIARID)	TEMPERATE (MESOTHERMAL)	CONTINENTAL (MICROTHERMAL)	POLAR
Reduce Impervious Surface	●	◉	◉	◉	○
Site Fingerprinting	●	●	●	●	◉
Bioretention	●	◉	●	◉	○
Vegetated Swales	●	◉	●	◉	○
Vegetated Filter Strips	●	◉	●	◉	○
Permeable Pavements	●	◉	◉	○	○
Rainwater Harvesting	●	○	●	●	○
Soil Restoration	●	◉	◉	◉	○
Reforestation	●	○	◉	◉	○

KEY	
●	High Effectiveness (Recommended)
◉	Medium Effectiveness (Recommended with Reservation)
○	Low Effectiveness (Not Recommended)

Table 2-23. LID Structural Practices & Hydrologic Objective Effectiveness

LID PRACTICE / DEVICE	PEAK FLOW CONTROL	VOLUME REDUCTION	WATER QUALITY IMPROVEMENT	WATER CONSERVATION
Reduce Impervious Surfaces	●	●	●	
Bioretention	●	●	●	
Vegetated Swales	●	●	●	
Permeable Pavement	●	●	●	
Rainwater Harvesting	●	●		●
Green Roof	●		●	
Infiltration Trench	●	●	●	
Constructed Filter	●		●	
Reforestation	●	●		

(Adapted from: WBDG Design Guide: Low Impact Technologies)

2.7 TREATMENT TRAINS

LID BMPs can provide excellent stormwater runoff volume reduction, peak flow reduction, and pollutant removal for small storm events. Treatment of larger events, however, may require the use of supplemental stormwater treatment structures designed to detain larger runoff volumes. Both large and small events can be effectively handled by creating a treatment train that uses a series of LID BMPs and conventional BMPs as needed.

Non-structural and structural LID BMPs are the first elements in the treatment train, where they can provide capture and treatment of runoff from even the smallest rain events. They are constructed with overflows, which allow runoff from larger events to flow to secondary BMPs. These secondary BMPs are typically larger, and are focused on large-scale detention and retention. Examples of such secondary practices would be extended detention ponds and infiltration basins or storage vaults. These practices are generally constructed with a focus on peak flow reduction and flood control for the 10- to 100- year 24-hour peak storm events.

The requirements for the use of conventional end-of-pipe needs to be determined by a detailed hydrologic and hydraulic analysis because of the complexity of the storage, discharge, and conveyance relationships that occurs when multiple BMPs are placed in a series.

A treatment train consisting of multiple LID BMPs can also be used to maximize stormwater runoff volume reduction and water quality performance. This is particularly useful in conjunction with non-structural practices. For example, a roof downspout is disconnected, allowing runoff to flow over a permeable area. Any excess runoff that is not infiltrated by this permeable area can then be collected in a vegetated swale and conveyed to a bioretention cell. Photo 2-36 illustrates the use of a level spreader in combination with a vegetated swale. Figure 2-21 shows the use of permeable pavement in a parking lot that can discharge to a vegetated swale as well. Each element of this treatment train provides water quality improvement, volume reduction, and reduces runoff velocity. BMPs also have different effectiveness for treating pollutant loads and can be used in combinations. For example, compost amended soils may have a high affinity for removing soluble metals from roofs and bioretention cells with additional detention storage may reduce nitrogen loads from roofs.

Appendix C includes a discussion of Green Streets, which is an initiative that encourages use of LID BMPs and treatment trains in several cities. Case studies of Green Streets are also included in Appendix C.

Photo 2-36. Treatment Train - Level Spreader and Vegetated Swale

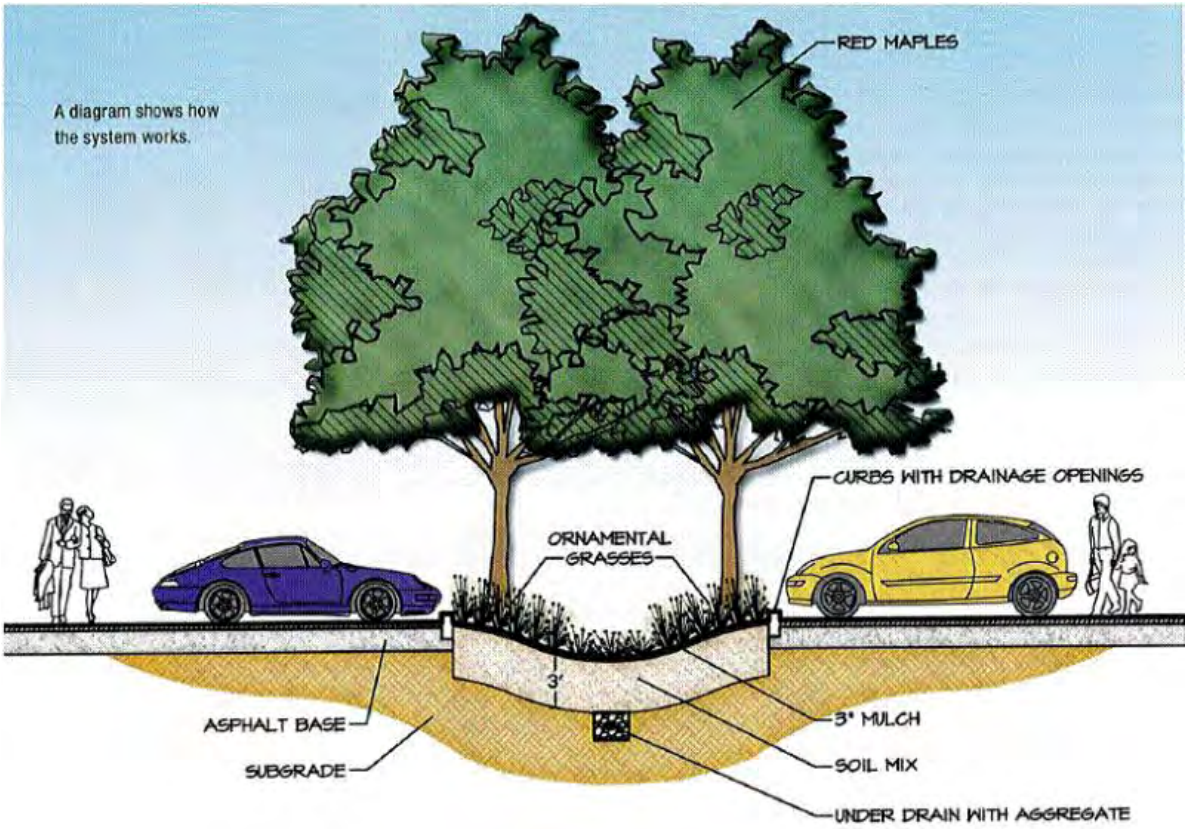


Figure 2-20. Treatment Train - Permeable Pavers and Vegetated Swale

This page intentionally left blank.

3 IMPLEMENTING LID ON AN ARMY INSTALLATION

3.1 INTRODUCTION

Implementation of LID on an Army installation can be achieved at various levels, from master planning, Installation Design Guides and through planning charrettes and site planning and design for specific projects. This chapter will take the user through LID implementation from the master planning level down to the site specific final design of a LID BMP. For the purposes of meeting the stormwater requirements and EISA Section 438, the site planning sections will guide planners, designers, engineers and stormwater managers through the steps of planning their site to effectively choose LID BMPs that meet the stormwater volume requirements. The master planning and site planning processes require a basic understanding of Army Land Uses and activities and a fundamental knowledge of Army planning and site design Uniform Facilities Criteria (UFC's), Public Works Technical Bulletins (PWTB's), Directives, and Regulations, which are referenced throughout this chapter and listed in Section 1.3.3.

3.2 LID AND INSTALLATION MASTER PLANNING

Army master planning is a continuous analysis of present and future development needs of an installation in a sustainable and energy efficient manner. Through the master planning process, a vision is established for the installation with goals and objectives, which is an opportunity to imbed LID into the future development and management of the installation. Figure 3-1 and Figure 3-2 illustrate the master planning process, from the vision plan for the installation through the Installation Design Guide (IDG), short-term and long-term development planning and project site requirements; from installation scale planning to site planning. While strategizing the layout of land uses and connectivity of resources with functional relationships, water resources and stormwater infrastructure should also be considered. The identification and understanding of the existing natural features, installation land uses, and infrastructure, and the potential hydrologic response of planned development and opportunities to restore hydrologic functions are critical in creating a sustainable installation. This concept can be carried through in the IDG and Area Development Plans (ADP).

An IDG provides design standards and guidelines for the visual aesthetics of an installation, to include both the built and natural environment, to create a comprehensive and sustainable installation character. The IDG includes standards and general guidelines for the design issues of site planning; architectural character, colors and materials; vehicular and pedestrian circulation; and landscape elements. LID should be incorporated into the standards and guidelines for site planning for all land uses, especially for buildings, roads, parking lots and landscape elements. These LID standards and guidelines will carry through to short-term and long-term project requirements and ADPs.

The ADP process uses urban design principles to integrate incompatible land uses and functional requirements within the existing manmade and natural environment. Army land uses can have certain requirements depending on their purpose and security, such as training areas, communications facilities, and other military operations. Integrating the land uses within a functional area for an ADP can present challenges not only with the requirements but also the site

constraints. As many of the land uses can require impervious area, the hydrologic functions of the area need to be considered in the ADP. This is a great opportunity to identify constraints and opportunities for preserving the hydrologic function of the watershed and area by using both non-structural and structural LID BMPs. Identifying these opportunities and including LID in the requirements for project specific plans will help minimize the hydrologic impacts and ensure compliance with EISA Section 438. The remainder of the chapter will take the user through the details of site planning with LID.

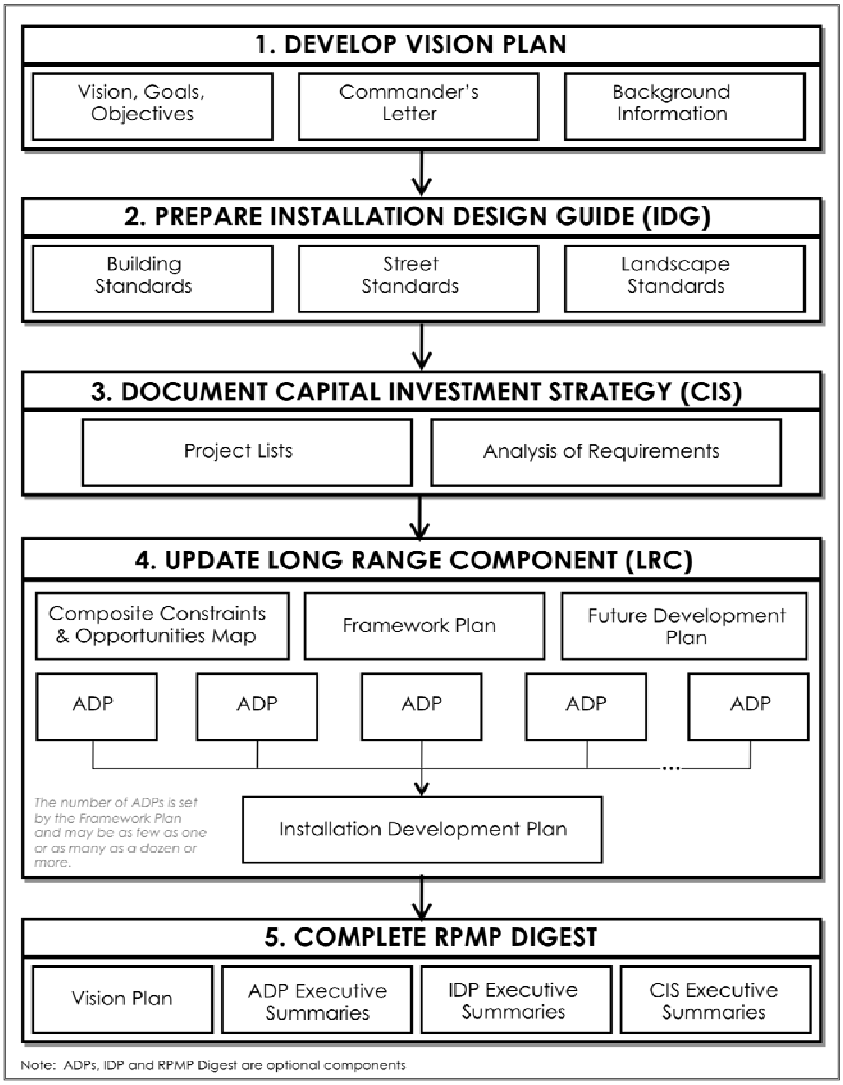


Figure 3-1. Overview of Installation Master Planning Process
(Adapted from: AR 210-20, 2005)

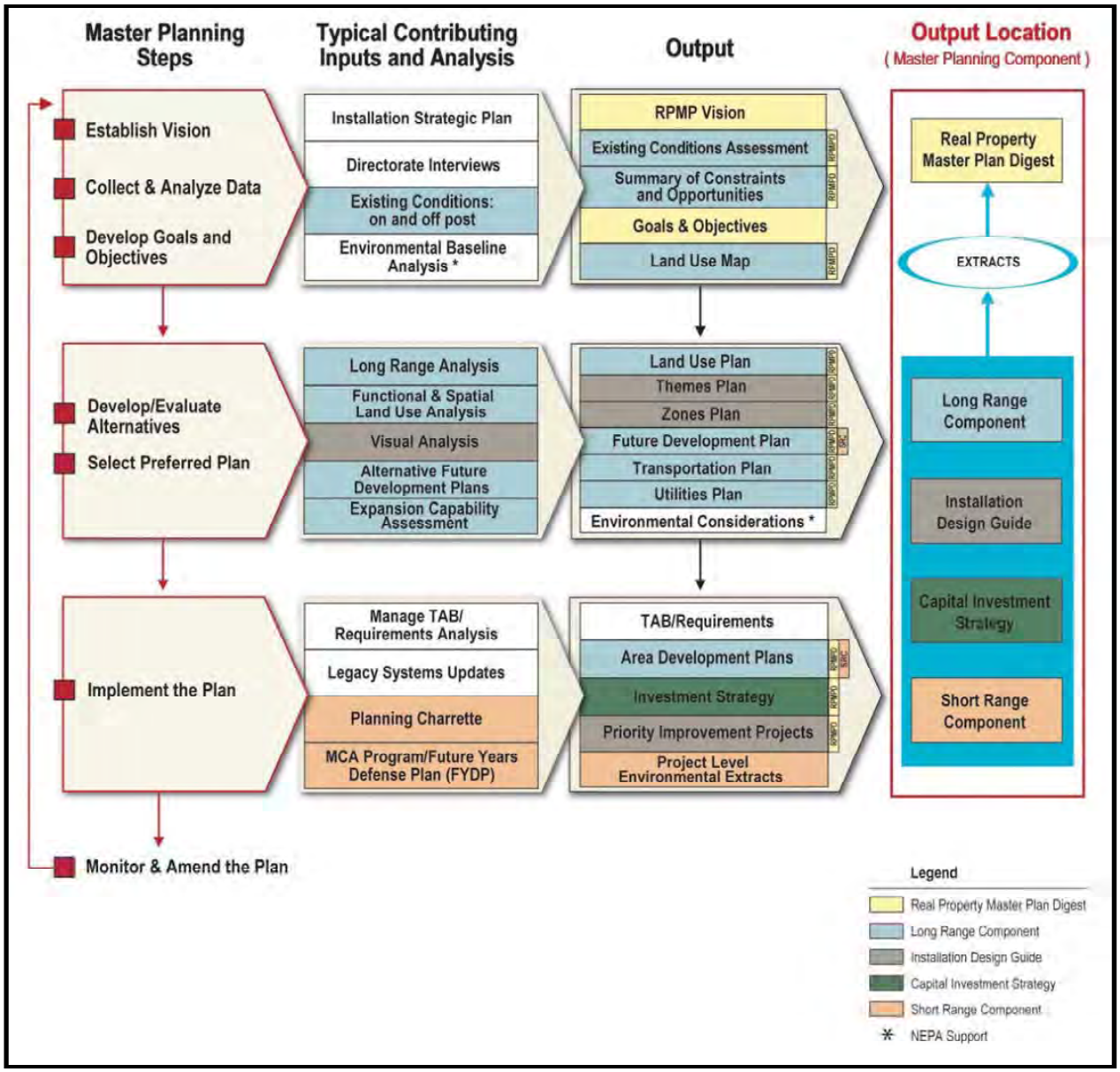


Figure 3-2. Real Property Master Planning
(Source: RPMPTM, 2008)

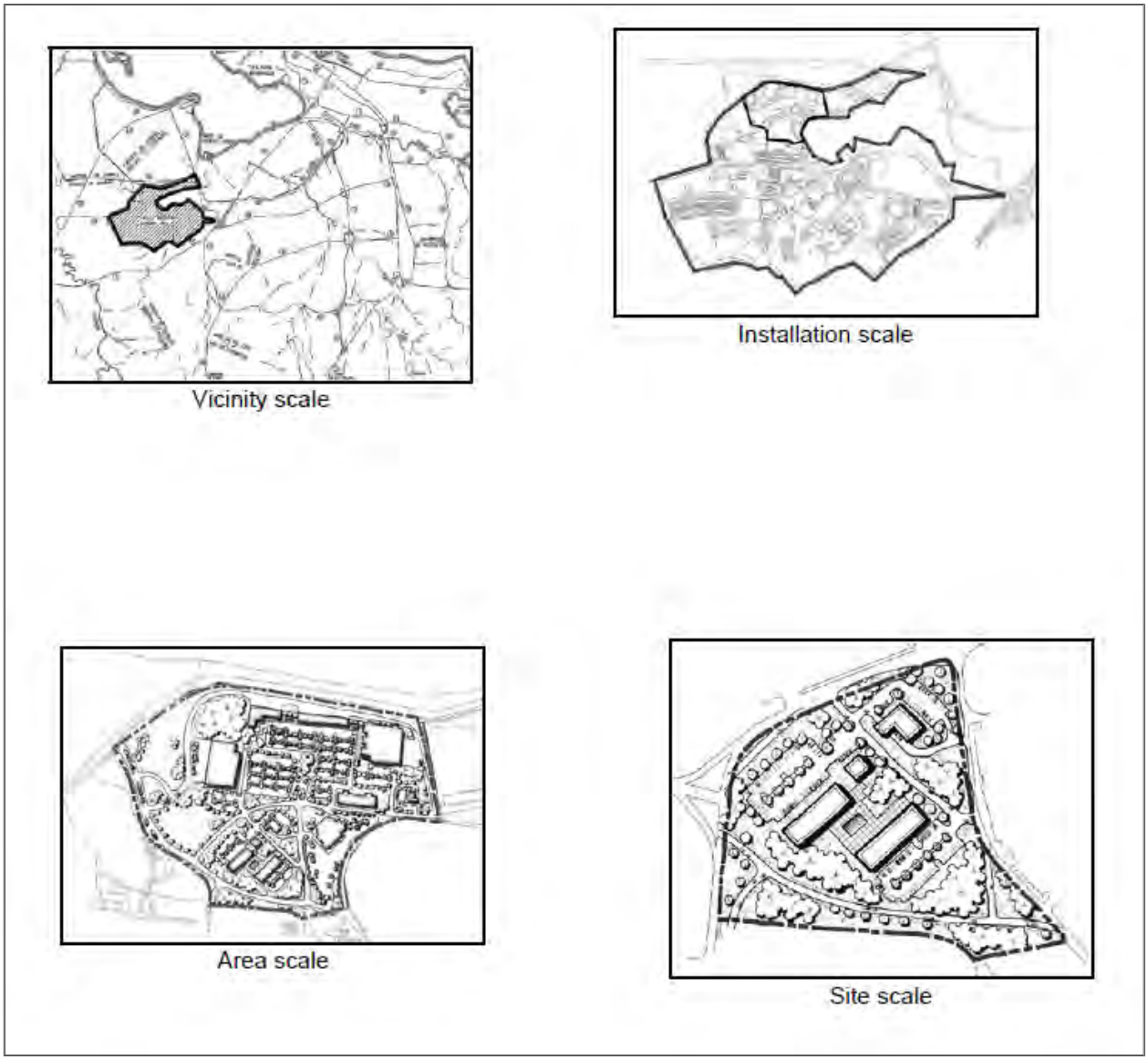


Figure 3-3. Scales of Master Planning
(UFC 3-210-01A, 2004)

3.2.1 Army Land Uses

For the purpose of integrating LID in the planning process and selecting LID BMPs for specific sites, Army land uses can be grouped into five categories based on similarity in land cover type (e.g. parking, open space, buildings), intensity of use, and hydrologic characteristics. This grouping allows planners and site designers to develop consistent and predictable non-structural and structural LID BMP implementation strategies for the installation. The land use categories are adapted from UFC 2-200-02AN (2005) as follows:

1. **Industrial**: Industrial sites are often highly impervious areas, such as roofs, parking, and storage areas that are densely developed with a variety of activities that potentially produce pollutants and high volumes of runoff. These may include areas for manufacturing, supply

and storage, maintenance activities, motor pools, and handling and storage of hazardous materials. Pollutants from industrial activities, such as vehicle washing and repair, are industrial activities and must be treated under separate permits and strategies. Specific land uses include:

- Operations
- Supply/Storage
- Maintenance
- Manufacturing and Production
- Research, Development, and Testing
- Utilities
- Airfield Hangers and Maintenance Areas

2. **Professional/Institutional/Community**: These land uses contain large impervious areas including rooftops and sizable areas for parking, roads, and pedestrian circulation. These facilities include both commercial services such as the Post Exchange and commissary and community services of a non-commercial nature such as the library, chapel, and craft workshops. They also include medical and dental facilities, such as hospitals, clinics, and supporting laboratory facilities. Specific land uses are:

    - Administration
    - Commercial Services
    - Community Facilities
    - Medical and Dental

3. **Residential**: Residential land uses include both troop and family housing areas. Troop areas consist of living quarters for enlisted personnel, non-commissioned officers, and commissioned officers, as well as supporting service, administrative, storage, and supply facilities related to housing. These can be detached houses with large yards, multi-family or barracks with large buildings, parking, and assembly areas, or townhouse type developments. There may be large open spaces between buildings, for assembly areas and for lower density developments. Residential also includes roadways and trails. Specific land uses are:

    - Troop Housing
    - Family Housing

4. **Ranges and Training**: Ranges and Training facilities include classroom buildings and other indoor facilities, as well as outdoor maneuver and range areas. They can have large open spaces as well as building and parking structures. These may include large impervious areas for parking and storage, cleared areas for operations, temporary and permanent roads and trails ranging from dirt to asphalt or concrete surfaces, permanent and temporary buildings and structures. A detailed description of the planning and design of ranges and training areas has been previously published (PWTB 200-1-62, 2008). Specific land uses include:

- Assembly Areas
- Bivouac Areas
- Driver Training Sites
- Drop Zones
- Maneuver Corridors
- Urban Operations (MOUT)
- Multi-Purpose Range Complex
- Parking Areas
- Secondary Roads
- Small Arms Ranges
- Tank Trails

5. **Open Space and Water**: Open space and water areas generally have much less impervious surfaces and may be used for passive and active recreation, reserved areas designated to separate incompatible uses or protect fragile ecosystems, and as a safety measure around operational or training uses. Parking and access roads may be included Specific uses include:

    - Reserved Land/Buffer
    - Recreation
    - Water Areas

The relationship between these land uses on an Army installation is important to the function and circulation for installation activities. It is also important to understand how the siting of these land uses interact with the natural environment and hydrology, both on the installation and within the watershed. Developing these relationships allow for holistic planning for LID that preserves the natural hydrology and environment while achieving the installation mission. Integrating LID BMPs on some of these land uses may be limited due to the types of activities, for example, infiltration practices may be limited on industrial land uses to avoid groundwater contamination, however, a bioretention cell with an underdrain may perform better. The following sections will describe the site planning process in seven steps for the implementation of LID BMPs to meet the requirements of EISA Section 438.

3.3 SITE PLANNING AND SITE DESIGN WITH LID

Site planning for LID involves a shift in the traditional approach for managing stormwater. When planning for a built environment, preventing increased stormwater runoff and maintaining the pre-development hydrology of the site is required by EISA Section 438. Any unavoidable increase in stormwater should be viewed as a resource that can be managed on-site with an opportunity to infiltrate the soils and/or be treated for pollutants by working with the natural site conditions, such as topography and soils. Using non-structural and structural LID BMPs through treatment trains, or in combination with conventional stormwater infrastructure when necessary, will minimize the impacts of the project on the hydrologic function of the site. Maintenance of the LID BMPs needs to be included in the parameters of the site, to ensure sustainability of the site hydrology.

3.3.1 MILCON Execution and LID

Site specific planning under the Military Construction (MILCON) process requires implementation of LID BMPs to comply with EISA Section 438. UFC 3-210-01A (Area Planning, Site Planning, and Design) and UFC 3-210-06A (Site Planning and Design) provide guidance on the site planning and design process and the "Army Standard Operating Procedure: Integrating Low Impact Development into MILCON Process" provides guidance on integrating LID into the early stages of project development and programming. Figure 3-4 illustrates the site planning and design process.

The site planning process begins with planning charrettes and the development of DD Form 1391 or DA Form 4283 where project requirements, site location and costs for the project are determined and carried through to the approval process. The DD Form 1391 is a planning document used to develop project scope and associated costs to complete the project as identified in the "Primary" and "Supporting Facilities" and "Project Description" sections of the 1391. The project 1391 is completed during the Planning Charrette process and is managed by the USACE. Tab J of the 1391 should be used to identify LID related criteria including the square footage of impermeable surface being added to the project site; and a description of LID features planned for incorporation within the project and used to manage the increased runoff from the additional impermeable surface. During this early stage of project planning, LID should be identified as a project requirement, as identified in the Master Plan, IDG and/or ADP.

The Project Definition Report (PDR) is a validation of the scope of work in the DD Form 1391. The PDR is developed and completed during the project Design Charrette process and contains the data for the parametric design (15%). Paragraph 2.1.6 (Site Development/Civil) of the PDR describes site development features that will be used to address LID implementation for the project. A project parametric design (Code 3) consists of a Project Definition Report (PDR) and a completed ENG Form 3086 detailed cost estimate based on the scope of work in the PDR. Identifying LID requirements in the early phases of planning ensures that LID will be carried through to be included in the cost estimate and design process. Figure 3-5 identifies seven steps for optimal LID BMP selection to ensure compliance with EISA Section 438 that should be followed during the planning process from DD Form 1391 developmen through the PDR, Parametric Design and ENG Form 3086.

For a local DPW funded project using Sustainment, Restoration and Modernization program funds (O&M), the process of identifying LID requirements should be determined the same way as outlined in the Project Definition Report (PDR), paragraph 2.1.6. It is imperative that sufficiently detailed LID requirements be identified in the PDR because the 3086 cost estimate is developed to determine the project cost.

For Design-Build projects, it is important to have the installation IDG, ADP and Master Plan updated to identify installation LID policy and preferred LID BMPs for meeting EISA Section 438 requirements. The installation DPW will indicate their preference for certain LID BMPs for a project as they work with the USACE project team who will get the Design-Build project awarded. The USACE project team will identify LID features and submit a concept plan (35% design) or fully developed LID BMP design to be submitted with the RFP. The installation IDG, ADP and Master Plan can be referred to in the request for proposal that will include either the LID BMP

concept plan of full LID BMP design to contract with the Architect-Engineer firm. It is imperative that the project manager at the USACE review the AE designs to verify compliance with EISA Section 438. It is important for the project manager to provide construction oversight to ensure the LID BMPs are built correctly.

For Design-Bid-Build projects, the project design to include the full LID BMP designs are included in the bid package developed by the USACE project team. The USACE project team will design the site and LID BMPs to meet the EISA Section 438 requirements. It is important for the project manager to provide construction oversight to ensure the LID BMPs are built correctly.

The following sections will describe the seven steps in Figure 3-5 for integrating LID in site planning and design, which are to be followed concurrently with the site planning and design process for the development project.

LID Site Planning Goals

- Plan first,
- Prevent. Then mitigate,
- Manage stormwater as a resource – not a waste,
- Mimic the natural water cycle,
- Replicate pre-development hydrology where possible,
- Integrate natural systems,
- Disconnect. Decentralize. Distribute,
- Maximize the multiple benefits of LID,
- Use LID everywhere, and
- Make maintenance a site parameter.

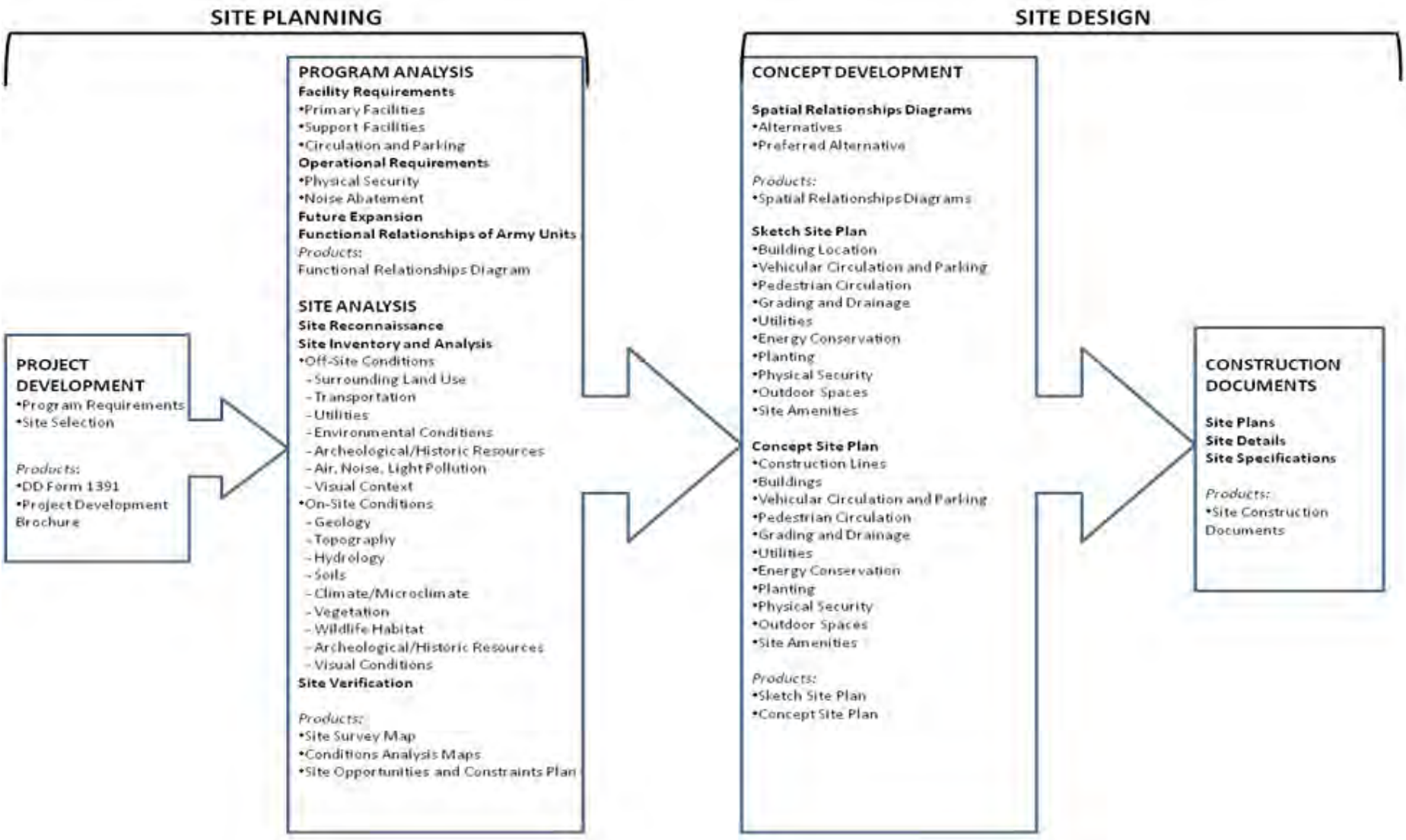


Figure 3-4. Site Planning and Design Process
(Source: UFC 3-210-06A, 2004)

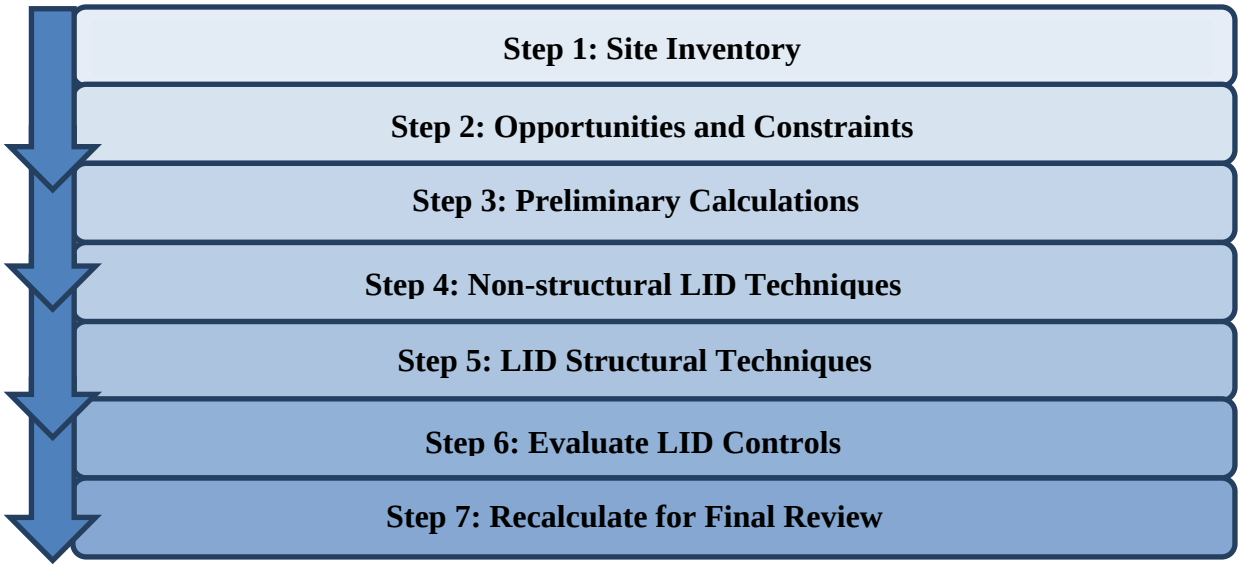


Figure 3-5. Steps for Site Planning and Design for LID

3.3.2 LID Site Planning and Design Step 1: Site Inventory

The first step to planning a site is to take a detailed inventory of what currently exists on the site and the site conditions. Incorporating LID into site design begins with a thorough assessment of the site and its natural systems which may pose challenges and/or opportunities for stormwater management and site development. Substantial guidance on the assessment of natural systems and infrastructure has been developed in UFC 3-210-01a and UFC 3-210-06a and supporting documents regarding collecting data on the natural environment, built environment, and the socio-cultural environment for site planning; in this Army LID Technical User Guide, the focus will be on collecting data with the goal of integrating LID into site planning and design.

Environmental and Man-Made Features to Consider in LID Design

- Geological Conditions
- Soils
- Hydrology
- Topography
- Natural Resources
- Land Use/Land Cover
- Facilities Infrastructure

Site conditions that influence LID BMP selection and design include geology, soils, hydrology, topography, natural resources, land use/land cover and facilities infrastructure. The site inventory should include data collection on these features, as described in the following sub-sections adapted from UFC 3-210-01a and UFC 3-210-06a, and spatial data to develop the opportunities and constraints maps in Step 2 of the LID Site Planning process. While conducting the site inventory for project planning and LID Site Planning, keep in mind that the goal is to maintain pre-development hydrology by avoiding, minimizing and/or mitigating project impacts to the hydrologic function of the site. Key environmental and man-made systems including human environment features and their importance to LID design are described below.

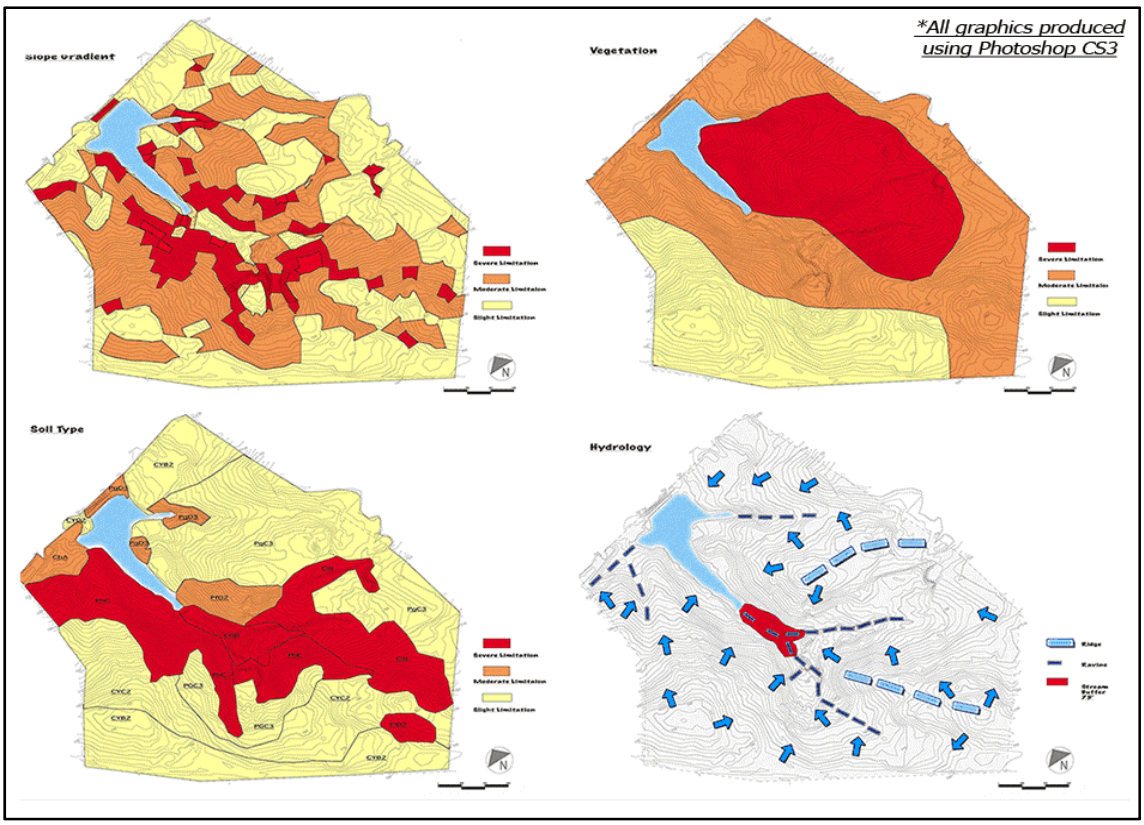


Figure 3-6. Watershed Inventory of Natural Resources
(Source: Birtice A. Garner IV, The University of Georgia)

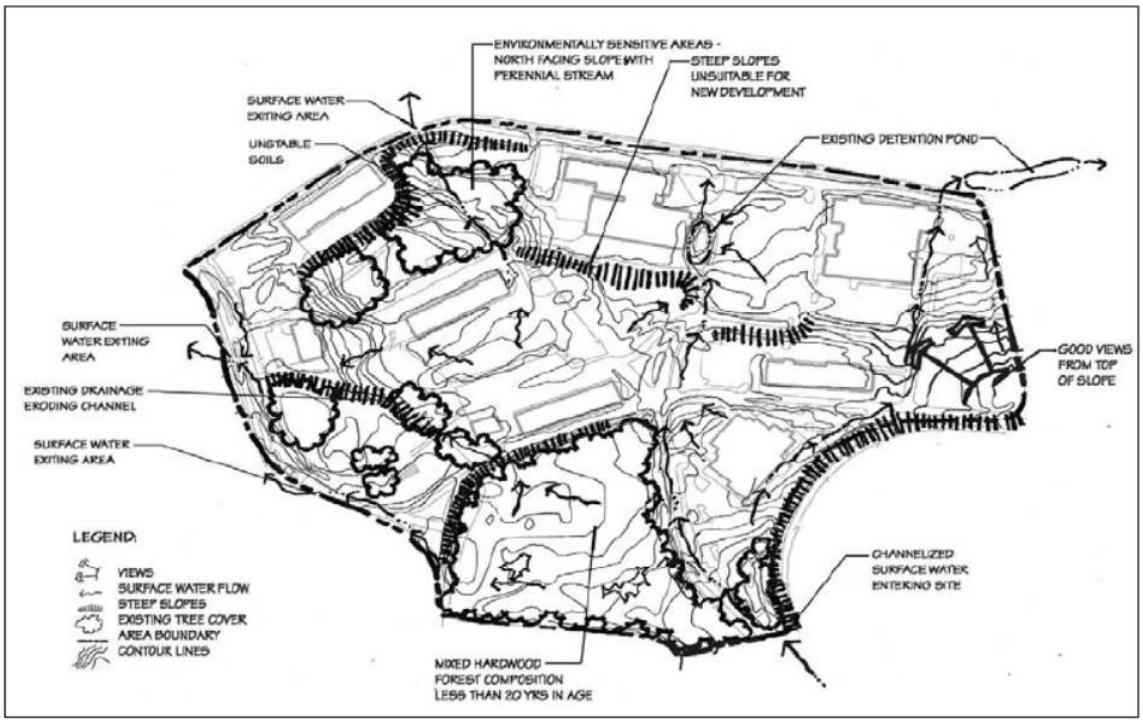


Figure 3-7. Site Inventory
(Source: UFC 3-210-01A, 2004)

3.3.2.1 Geologic Conditions

The geologic conditions of the site that should be inventoried include underlying geologic formations, depth to bedrock, substrate drainage, and areas that are sensitive to erosion from groundwater, such as limestome or Karst topography. This data can be collected from the U.S. Geologic Service (USGS) or from state resource agencies. If the project is in an area of concern (e.g. limiting formations, limestone or karst topography) field investigations, borings, and geologic assessments should be conducted. Understanding the geologic conditions of the site is important for LID site planning, as it may restrict the use of on-site infiltration – shallow bedrock will limit infiltration and karst topography or high water tables may allow for polluted runoff to enter the groundwater before sufficient filtration can occur.

3.3.2.2 Soils

The soils on the site are a key element in LID planning, as the characteristics of the soil will influence the selection and design of LID BMPs. Soils have varying infiltration capacity and permeability, which influences the amount of runoff from the site; as such soils are divided into four hydrologic soil groups (NRCS, 2007):

- **Hydrologic Soil Group A**: Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission (greater than 0.30 in./hr.).

- **Hydrologic Soil Group B**: Soils in this group have moderately low runoff potential and moderate infiltration rates when thoroughly wet. Water transmission through the soil is unimpeded with a moderate rate of water transmission (0.15 to 0.30 in/hr). Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments. Group B soils consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately course textures.

- **Hydrologic Soil Group C**: Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted with a layer that impedes downward movement of water; the rate of water transmission is moderate (0.05-0.15 in/hr). Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

- **Hydrologic Soil Group D**: Soils in this group have high runoff potential when thoroughly wet due to very low infiltration rates; these soils have a very low rate of water transmission (0.00 to 0.05 in/hr). Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters [20 inches] and all soils with a water table within 60 centimeters [24 inches] of the surface are in this group, although some may have a dual classification, as described in the next section, if they can be adequately drained.

During the site inventory, soils can be identified using soil surveys, which can be found on the internet at the NRCS Soil Data Mart website: *http://soildatamart.nrcs.usda.gov/* or the Web Soil Survey website: *http://websoilsurvey.nrcs.usda.gov/*. These resources provide detailed information about the soils on site, including spatial data, drainage class, ability to transmit water (hydraulic conductivity), approximate depth to groundwater, and general properties and qualities. For the purposes of LID site planning, the hydraulic conductivity and the hydrologic soil group are key characteristics, as they dictate the runoff potential of the soils on site. This needs to be considered when selecting LID BMPs that will infiltrate the natural soils, or if they will require soil amendments, addition of soil media, or an underdrain where water cannot infiltrate. Depth to groundwater must also be considered to avoid polluting groundwater from limited filtration. Once a concept plan is developed, additional borings at proposed LID BMP locations may be required to determine the infiltration rates for the design of the LID BMP.

Some of the limitations include soils with low permeability, high shrink-swell soils, or soils susceptible to frost heaving, soils susceptible to wind erosion, soils with high organic material, soils with high water tables or confining (compacted) layers, soils with high erosion potential, or soils that are unstable for grading as steeper slopes. Soils with high infiltration rates should be protected from construction activities and development because they have the ability to infiltrate larger volumes of water after development.

3.3.2.3 Hydrology

Hydrology on the site includes surface waters, such as streams and wetlands, and groundwater as well as precipitation data. It is important to understand where the site is positioned in the watershed, to consider upstream effects and potential downstream impacts from the project. In order to meet EISA Section 438, the pre-development hydrology of the site must be maintained, so understanding the existing hydrology and functions of the site is critical. The capacity and the function of the drainage infrastructure surrounding the site is also an important factor.

An inventory of the hydrology of the site should include:

- Precipitation data
- Location and functions of surface waters, including streams and wetlands
    - Drainage area – subbasins and larger watershed information
    - Flow direction
    - Interaction with groundwater
    - Surface area
    - Classification (i.e, perennial, intermittent or ephemeral stream)
    - Waterbody impairments (i.e., TMDL)
- Groundwater supplies and depth
- Floodplain areas and flooding concerns
- Drainage basin and watershed characteristics and mapping

Much of this information can be found in the installation Master Plan, the Integrated Natural Resources Management Plan, and other installation documents provided by the installation DPW. Other sources of information include National Oceanic and Atmospheric Administration precipitation data (www.noaa.gov), the US Fish and Wildlife Service National Wetlands Inventory (http://www.fws.gov/wetlands/), Federal Emergency Management Agency floodplain maps, and state and local agencies.

Planning for LID BMP selection and placement, requires an understanding of the hydrology and functions on the site and within the watershed. The LID BMPs should work with the existing hydrology, so the natural hydrology of the site is maintained and continues to function without adversely impacting existing water resources and downstream resources.

3.3.2.4 Topography

Topography on the site, and the surrounding area, strongly influences the direction of runoff across the site. Topographic data will show slopes, potential drainageways, low points and depressions where water may flow or be stored. This data may be available at the installation DPW or the installation spatial data office. If topography is not readily available on the installation, contour lines and digital elevation models (DEM) are available from USGS and state and local agencies. For detailed topography, a survey may be conducted on the site.

Understanding the topography of the site will help with the location of LID BMPs. It is best to use the existing topography and minimize grading when possible, to maintain the natural flow paths down slopes and drainageways. Placement of a LID BMP at the bottom of a slope or along a drainageway works with the natural landscape and will minimize ground disturbance and stormwater infrastructure requirements. LID BMPs such as vegetated swales, bioretention and level spreaders can and should be designed to take advantage of the existing slopes, depressions and flat open space.

3.3.2.5 Natural Resources

Natural resources on the site and in the surrounding area can play a significant role in planning for LID. An inventory of the vegetative communities and habitat areas will identify any sensitive ecological areas that may need protection. Sensitive areas could include wetlands, old growth forests, rare, threatened and endangered species habitat, riparian zones, and habitat corridors. The vegetative cover and soils on the site will influences the movement of water across the site, as vegetation can slow the runoff and aid in infiltration into the soils; this information is necessary to determine the curve number for hydrologic simulation as discussed in Chapter 4. Natural resources data can be found in the Installation Natural Resources Management Plan or by conducting a survey of flora and fauna. State and local resource agencies can also supply information regarding rare species and sensitive habitats.

Natural areas can provide buffers to streams and wetlands, dissipate stormwater runoff sheetflow, and provide pollutant removal benefits from runoff. Protecting these natural areas coincides with several non-structural LID BMP, and can provide great ecological and hydrologic benefits at minimum costs.

3.3.2.6 Land Use/Land Cover

Existing land use and land cover on and surrounding the project site play a significant role in the movement of stormwater across the area. *Land use* refers to the activity, economic purpose, intended use, and/or management strategy placed on the land cover type(s) by human agents or land managers. *Land cover* refers to the characteristics and surface cover of Earth's surface, as represented by vegetation, water, bare earth, impervious surfaces, and other physical features of the land. Areas of forested lands and open areas will slow the movement of water and allow for infiltration, while areas of impervious surface restrict infiltration and typically convey water to stormwater infrastructure. A change in land use on the site from pervious to impervious surface will significantly impact the hydrology of the site and the surrounding area, by reducing the opportunity for infiltration and altering the natural flow paths and velocity of stormwater. Understanding the relationship between the existing and proposed changes to land use and the hydrology of the area will allow for effective planning and implementation of LID BMPs to preserve the pre-development hydrology of the site. The cumulative impacts of land uses and changes to land use upstream of the site should also be considered to plan for changes in hydrology on a comprehensive level. Land use and land cover data may be found at the installation DPW and/or GIS office or from a state agency. Future land use and land cover changes can be determined from the Installation Master Plan.

Preserving open space and vegetated areas, minimizing grading, and maintaining existing natural drainageways and flowpaths are appropriate non-structural LID BMPs to include during the planning phases. Incorporating structural LID BMPs will work with most land uses, as there are great opportunities for LID BMPs in parking lots.

3.3.2.7 Facilities Infrastructure

Mapping of the existing facilities infrastructure, to include stormwater infrastructure, utility lines, roads, and other man-made features, are necessary to determine opportunities for LID BMPs. This map is available at the installation DPW office and/or GIS office.

There may be opportunities to retrofit stormwater infrastructure with a LID BMP or to reduce a planned conventional stormwater system by incorporating LID BMPs. Understanding the existing and proposed networks of roads and pipes, allow for an opportunity to take a comprehensive look at where incorporation of LID BMPs can create a more natural hydrologic regime on site and in the surrounding area.

3.3.3 Site Planning and Design Step 2: Opportunities and Constraints

Using all of the data collected in the Site Inventory step, maps of geology, soils, hydrology, topography, land use/land cover, and facility infrastructure can be overlayed to identify areas of opportunities and constraints for planning a development project with non-structural and structural LID BMPs (Figure 3-8). This analysis can and should extend outside of the site to include watershed and installation scale factors or influences. This data analysis process must consider and incorporate the potential for change in the hydrologic function during future development activities.

The opportunities and constraints map should consider the all of the existing physical conditions on the site, both natural and man-made, within the context of the development program. Identifying the opportunities and constraints provide the foundation for making decisions on the site layout and the location of non-structural and structural LID BMP practices. When planning the development project and integrating LID, restricting development on areas with mature vegetation and soils with high infiltration rates, and maintaining drainage patterns to those areas is an example of a non-structural LID BMP that could reduce the amount and size of structural LID BMPs and any necessary stormwater infrastructure. The opportunities and constraints map will provide a guide for the configuration of the development project and illustrate opportunities for the integration of LID. Opportunities for LID include, for example, preserving riparian buffers, using the existing topography to locate swales or bioretention, allowing for infiltration where soils permit and risk of groundwater pollution is low and retrofits to existing stormwater infrastructure and impervious surfaces. Constraints for LID include steep or unstable slopes, risks of contamination to groundwater by using infiltration associated with a shallow water table, impermeable soils that would limit infiltration, risks of flooding would influence LID BMP selection, and some ATFP requirements.

Figure 3-8 shows an opportunity and constraints map that addresses the physical features of the site. It includes recommended buffers, potential areas for development, and flow patterns that should be preserved. LID focuses on maintaining existing flow patterns and volumes, as well as buffers to protect the hydrologic function of the resource.

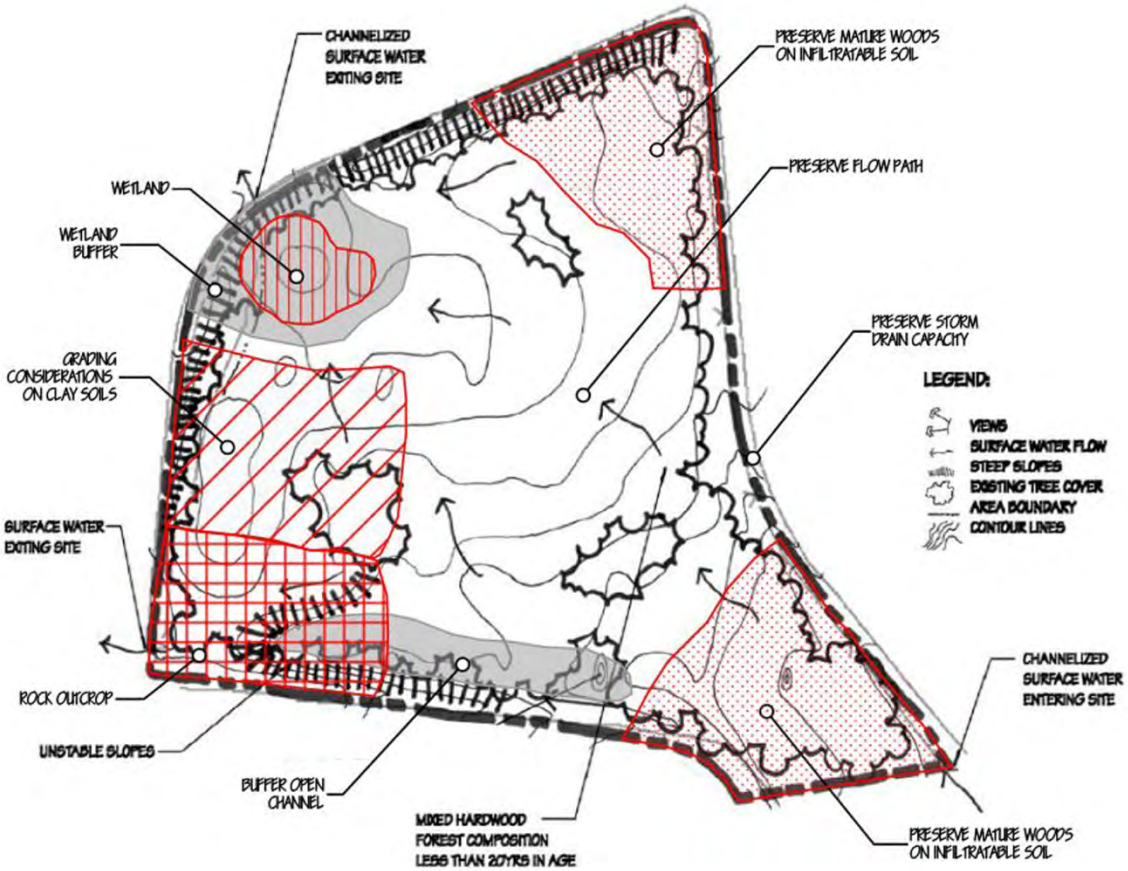


Figure 3-8. Site LID Opportunities and Constraints
(Source: UFC 3-210-01A, 2004)

3.3.4 Site Planning and Design Step 3: Preliminary Calculations

The requirements of the development project with regards to building space, parking, and other associated needs are identified during the planning charrette and DD-1391 development for the project and will direct the configuration of the site and provide an estimate of ground disturbance. As the focus of EISA Section 438 is to maintain pre-development runoff volume, runoff rate, and the temperature of runoff, the existing hydrologic conditions and the post-development hydrologic conditions must be calculated to demonstrate the difference in stormwater runoff pre- and post-development. A volume of stormwater runoff will be calculated from the hydrologic analysis using one of two options that will be the required volume of runoff to be managed on site using LID BMPs. The project engineer or a hydrologist can perform these preliminary calculations and follow them through the project as LID BMPs are incorporated.

The two options for estimating the required volume of runoff that needs to be retained on-site using LID BMPs to comply with EISA Section 438 are described in detail in Chapter 4, along with a hydrologic simulation tool to assist in the calculations. One option is to retain the runoff from the 95th percentile rainfall event. The second is to conduct a detailed hydrologic analysis of the site to

compare the pre-and post-development hydrologic conditions. Both methods require some assessment of the post-development runoff characteristics in order to determine the appropriate mix and type of LID BMPs to meet the requirements. Other federal and state regulatory requirements and infrastructure capacity requirements must also be satisfied. This may require the use of more than one method of analysis to determine the hydrologic, hydraulic, and water quality management approach for the project.

Once the initial volume requirements or pre-development conditions for the base are determined, a concept plan that includes LID strategies and techniques can be developed.

3.3.5 Site Planning and Design Step 4: Non-Structural LID BMPs

At this point in the site planning and design process, the project requirements and site conditions are known and site design can begin. Using the opportunities and constraints maps with the project requirements and the stormwater runoff volume requirements, conceptual designs can be created using non-structual LID BMPs. The method of developing non-structural site planning and design strategies is an iterative process with an objective to develop a plan with the least impact on the hydrologic function.

The opportunities and constraints map identifies sensitive environmental areas and illustrates areas to preserve. The development footprint should occur outside of stream and wetland buffers, areas with steep slopes, soils with high infiltration rates, and mature vegetation. The width and conditions of the buffers are dependent on many local and regional environmental factors, including but not limited to habitat type, soil erosion factors, and receiving waters conditions. Flow patterns and flow lengths should be maintained wherever possible. Opportunities to connect or enhance buffers and corridors should also be identified. The development area can be then be distinguished. Figure 3-9 illustrates how to use the site conditions, such as the topography, to orient development to preserve drainageways, which helps mimic the pre-development hydrology; the road and buildings are aligned parallel to the contours so that grading is reduced and stormwater runoff flows can be disconnected or sheet flow into vegetated areas. Figure 3-10 shows opportunities for non-structural LID BMPs that work with the site conditions and the development requirements for the site: riparian and wetland buffers are preserved as are existing flowpaths and mature woods with infiltratable soils. Figure 3-11 illustrates clustered development to maximize the use of space while minimizing impacts to the natural hydrology.

Planning and site design requirements, including ATFP, ASHRAE, LEED, Installation Design Guides, and Technical Manuals must also be met and incorporated into the design.

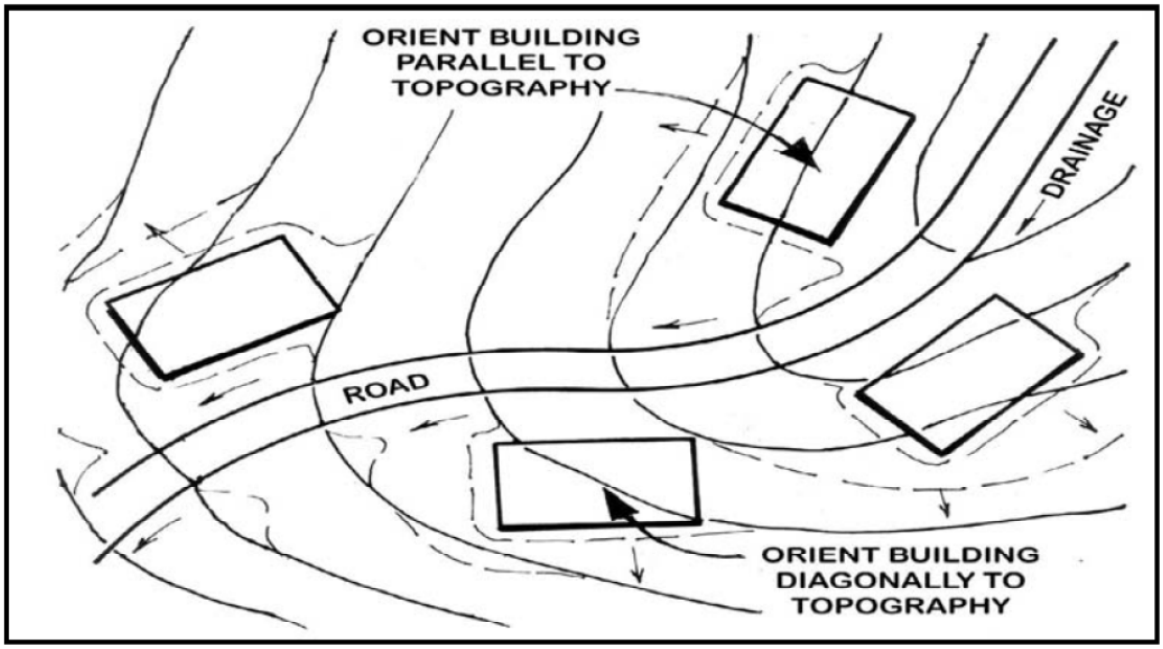


Figure 3-9. Site Concept Plan Using Existing Natural Conditions
(Source: UFC 3-210-01A, 2004)

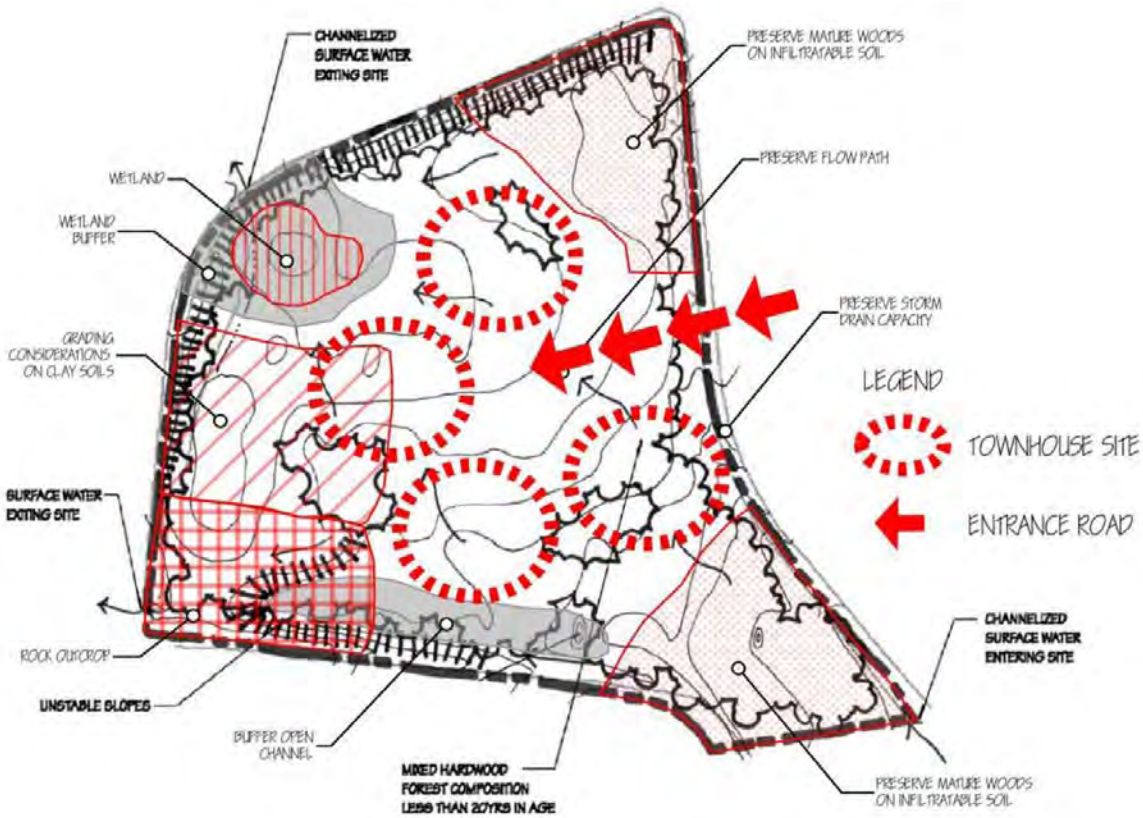


Figure 3-10. Concept Design with Non-Structural LID BMPs
(Source: UFC 3-210-01A, 2004)

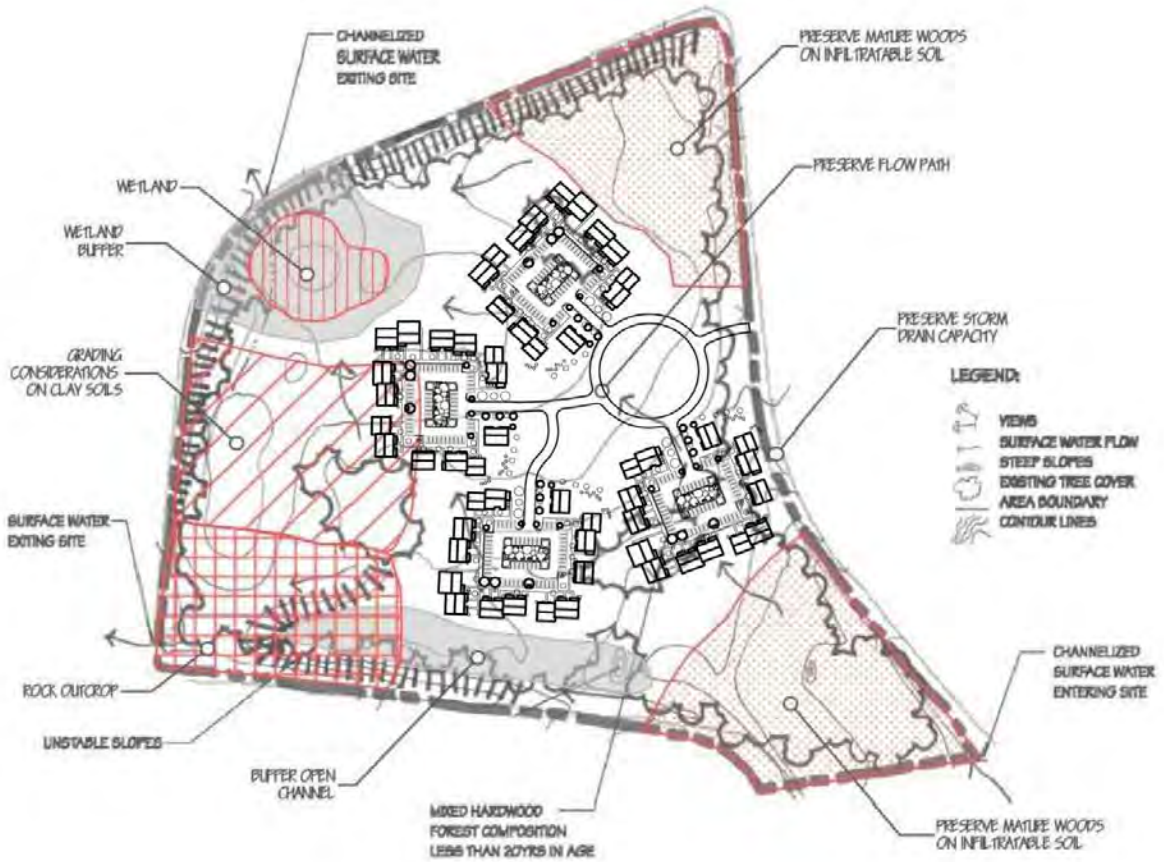


Figure 3-11. Detailed Site Design Using Non-Structural LID BMPs
(Source: UFC 3-210-01A, 2004)

3.3.6 Site Planning and Design Step 5: Structural LID BMPs

Non-structural LID BMPs can go far to maintain pre-development hydrology, though may likely not alleviate all hydrologic impacts alone. Applying structural LID BMPs on-site with the non-structural LID BMPs can provide cumulative benefits to meet the requirements of EISA Section 438. An overview of structural LID BMPs is found in Chapter 2 and design and construction specifications for the most common structural LID BMPs is found in Chapter 5. Structural LID BMPs may be combined with other LID BMPs or can tie into a conventional stormwater system.

Figure 3-12 shows a conventional stormwater management system that collects runoff into a pipe and carries it directly to a stormwater pond to store before discharging the water off-site. Figure 3-13 illustrates how non-structural and structural LID BMPs can reduce the need for portions of the conventional stormwater system by incorporating BMPs without altering the configuration of the development. Permeable pavers are used in the parking lot, bioretention is used in the parking lot island, and a bioswale is located where a drainageway may already exist. However, due to limiting factors such as a high groundwater table or soils with low infiltration an underdrain may need to be installed to collect water from the LID BMP and discharge to the stormwater system, as seen by the pipes in Figure 3-13. The use of the non-structural LID BMPs, reforestation and riparian buffer, eliminates the need for a portion of the stormwater system, the pond and pipes. The level spreader slows the flow of runoff to the natural stream as do the bioretention and permeable pavers that

discharge to the pipe; this prevents erosive forces on the stream channel and maintains the natural hydrology and aquatic habitat.

Photo 3-1 and Photo 3-2 show how a typical street within military housing can include structural LID BMPs such as permeable paving and the addition of a vegetated "bump-out" along the road, which can also include a bioretention cell or rain garden. This example shows how a street could use LID BMPs such as reduced road widths to reduce pervious surface and permeable pavements to reduce the runoff volume without impacting the land use or density of development.

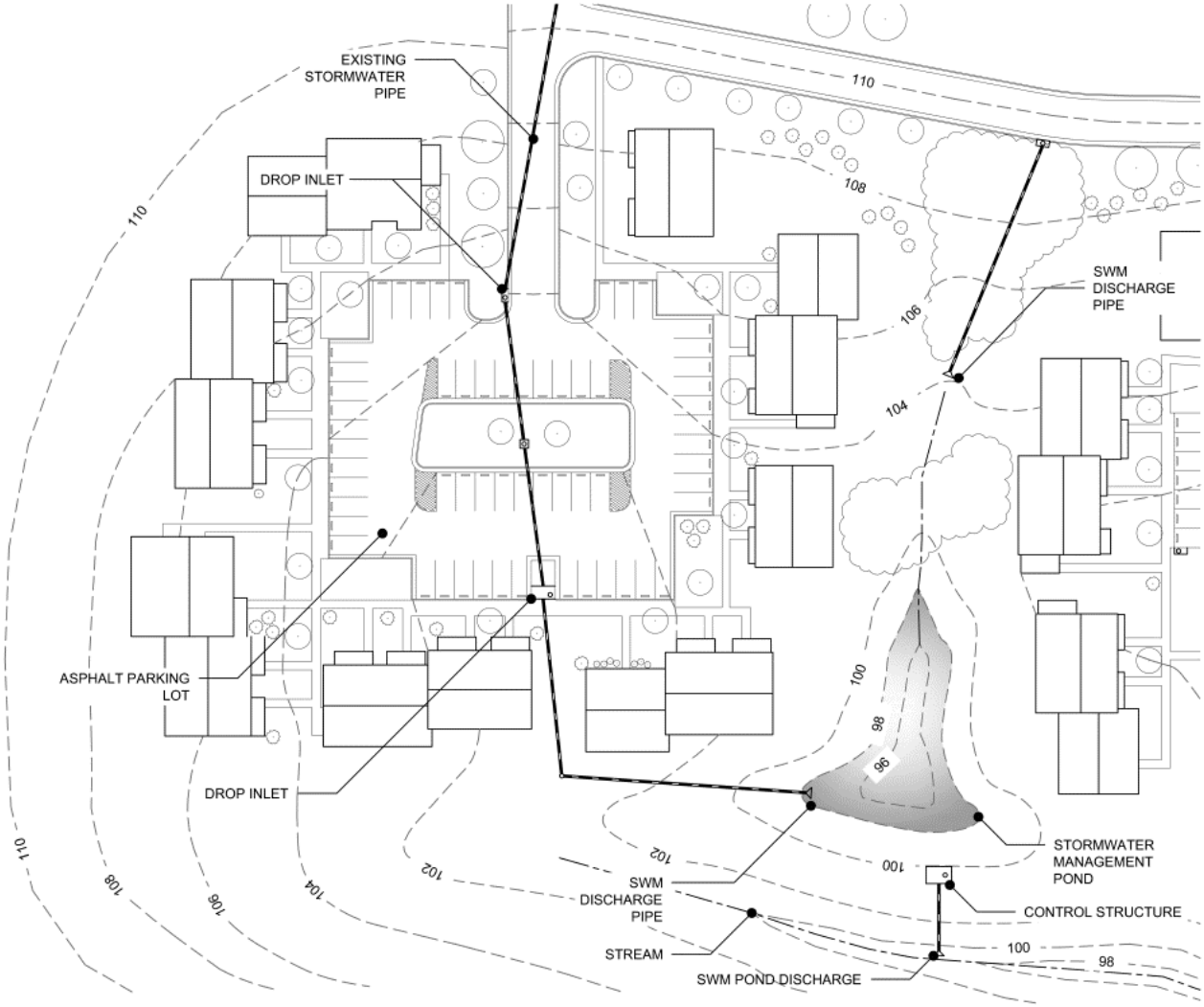


Figure 3-12. Conventional Stormwater Management
(Source: Low Impact Development Center, Inc.)

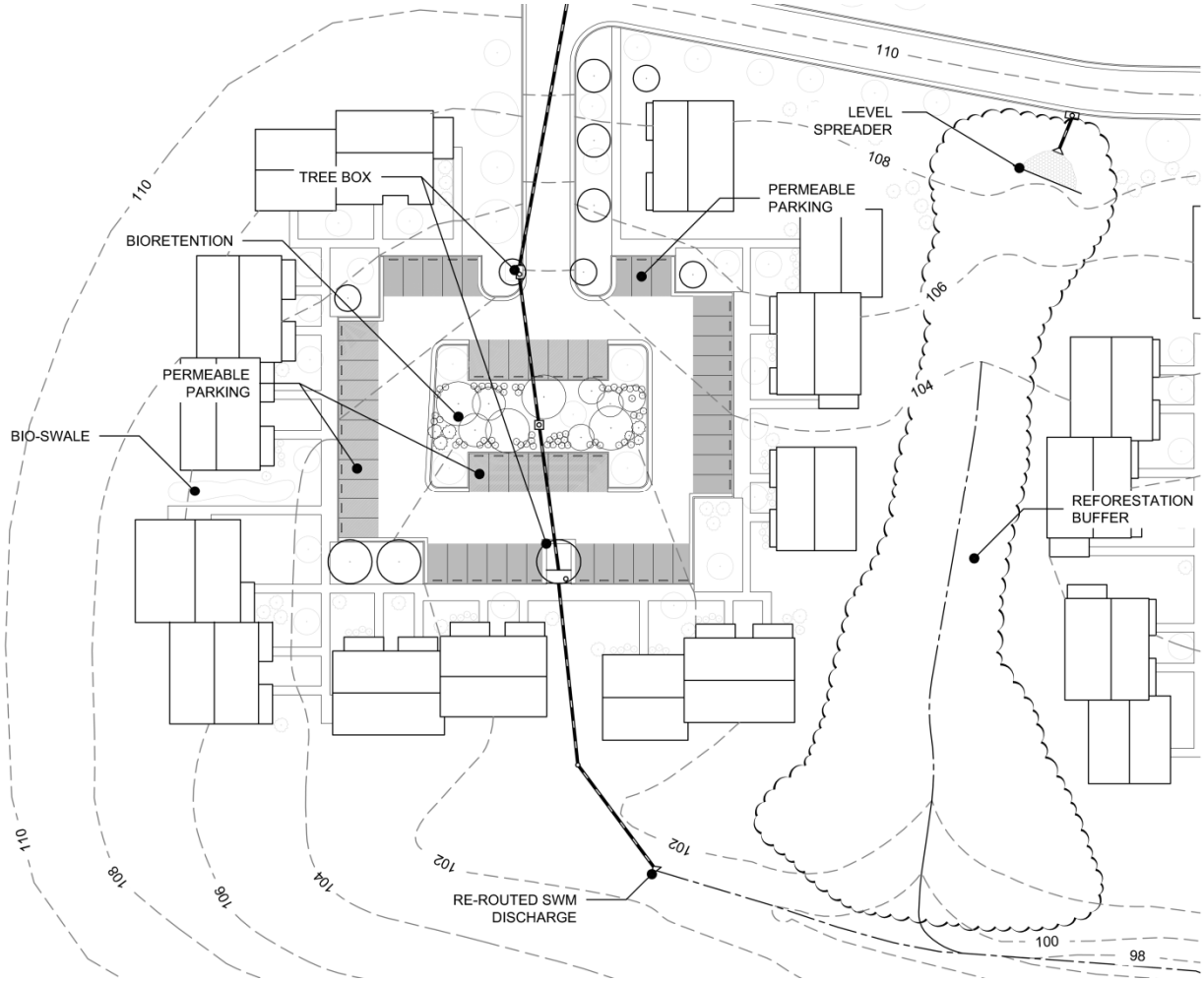


Figure 3-13. Stormwater Mnanagement with LID BMPs
(Source: Low Impact Development Center, Inc.)

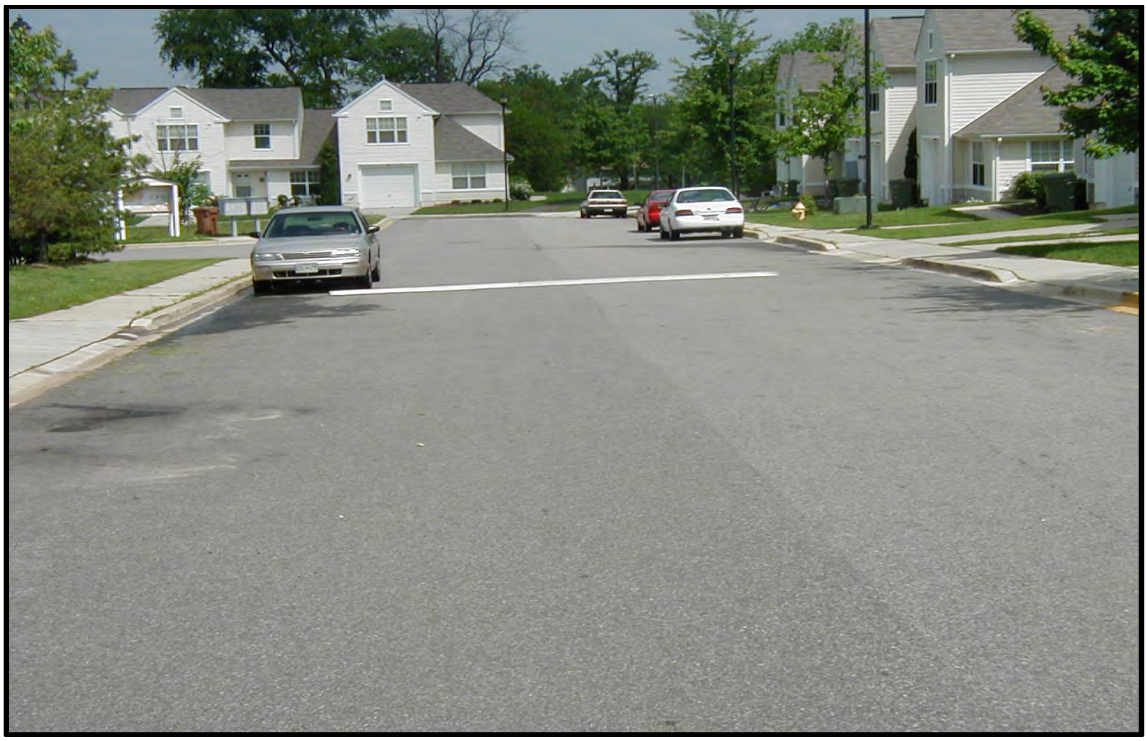


Photo 3-1. Typical Street for Military Housing
(Source: UFC 3-210-10, 2004)

Photo 3-2. Street wtih Structural LID BMPs for Military Housing
(Source: UFC 3-210-10, 2004)

3.3.7 Site Planning and Design Step 6: Evaluate LID BMPs

Once the combination of non-structural and structural LID BMPs is selected and the conceptual designs are complete, the site plan must be reevaluated to determine the effectiveness of meeting the EISA Section 438 volume requirements and any other federal and state requirements. This can be accomplished through repeating the hydrologic analysis from Step 3 for the option that was selected and using the simulation provided in Chapter 4. The results of the hydrologic analysis may indicate that additional LID BMPs are necessary or larger structural LID BMPs. In some instances the volume of stormwater may be too large for the LID BMPs to manage or there may be some other limiting factors on the site. In those instances, additional end-of-pipe, or offsite stormwater controls may be required. Once the site plan team is confident that the type, arrangement and size of LID facilities is appropriate for the land use and can meet the requirements final calculations, construction documents, and be developed.

3.3.8 Site Planning and Design Step 7: Recalculate for Final Review

Once the design for the development to include non-structural and structural LID BMPs is complete, a final review to indicate compliance with EISA Section 438 is conducted. The site design process is iterative in nature and will require repeating Steps 4 through 6 using different configurations and LID BMPs to effectively maintain or mimic pre-development hydrology. The site design must also manage stormwater to meet all state and federal requirements. The final review will include documentation of the site planning and design process to illustrate compliance with EISA Section 438. If it is found that it is technically not feasible to meet the requirements of EISA Section 438, the limiting factors and basis for this conclusion must be documented.

A final site hydrologic and hydraulic report is prepared for regulatory requirements, construction review, and to document compliance with EISA Section 438, ASHRAE 189, and LEED. Final construction details, standards, and specifications are then prepared for construction and project documentation. Details for design, construction and maintenance specifications for structural LID BMPs are found in Chapter 5. It is important to note that the design specifications are clear to ensure structural LID BMPs are constructed properly to ensure function and success.

4 HYDROLOGIC MODELING AND SIMULATION

4.1 INTRODUCTION

This chapter is intended to discuss simple, reliable hydrologic methods and models to quickly estimate volume control requirements, and to allow screening, selection, and approximate sizing of LID BMPs to achieve stormwater volume reduction goals to meet EISA Section 438. The methods and models presented have been used in numerous studies and are generally accepted by regulating authorities.

The purpose of water quantity and water quality modeling is to establish a means for the designer to visualize how water flows through a site, how much runoff is generated in a given sub-catchment, and determine how much water can be captured by a given BMP. This chapter will discuss background information about the design calculations set forth by the EPA Technical Guidance Manual, various hydrologic models to use for each design option and go through case studies applying hydrologic modeling and simulation.

For the purposes of the hydrologic analysis, the site design process is divided into three stages:

1) hydrologic analysis, in which the 95th percentile rainfall event is established, and the corresponding runoff volume for the developed and predevelopment condition are calculated;
2) site design, in which LID site design strategies are implemented to minimize increases in runoff volume resulting from development; and
3) application of BMPs to capture unavoidable runoff.

Standard hydrologic modeling and simulation reference tables are located in Appendix D, for reference to parameters described in this chapter.

4.2 DESIGN CALCULATIONS

The EPA Technical Guidance Manual for complying with EISA Section 438, *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act* (2009), provides a four step process to implement EISA Section 438 (Figure 4-1). Step 1 is to determine the applicability of the project of being over 5,000 square feet. Step 2 is to establish the design objective and analytical options; two (2) options are provided to meet the performance objective of preserving or restoring the hydrology of the site. Both options require the design, construction, and maintenance of stormwater management practices that manage rainfall on-site and prevent the off-site discharge of stormwater to the METF. Option 1 requires the management of all rainfall less than or equal to the 95th percentile rainfall event Option 1 is a statistical determination of estimating the design retention volume between pre-development and post development conditions. Option 2 requires a detailed hydrologic analysis that uses site-specific and local conditions to demonstrate compliance. Option 2 encompasses continuous modeling techniques which call for a comparison of runoff volume between pre-development and post development conditions over a period of time (multiple storm events) using a period of record rainfall. Step 3 is a description of the

representative design considerations and options for management of on-site stormwater; applying LID is the recommended design option to manage the required volume of stormwater determined in step 2. Step 4 is to finalize the site design and the cost estimate.

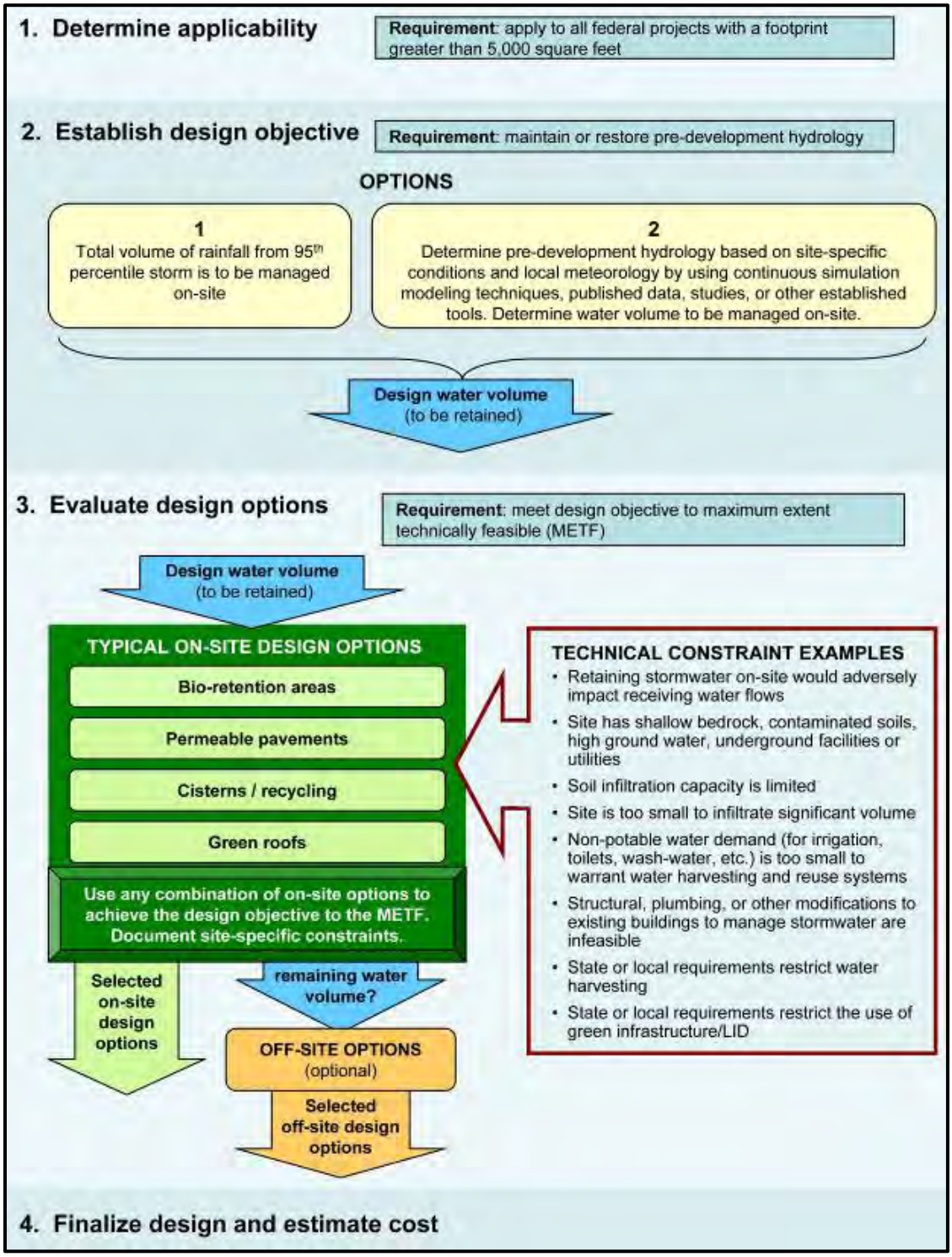


Figure 4-1. Implementation of EISA Section 438
(Source: EPA Technical Guidance Manual, 2009)

4.2.1 Option 1

Option 1 specifies the use of the 95th percentile rainfall event as the basis for the design storm calculation, Table 4-1; the difference in pre and post project volume of rainfall from 95th percentile storm is to be managed on-site. The 95th percentile rainfall event represents a daily rainfall volume, which on average will equal or exceed 95 percent of all daily rainfalls over a given period; at least 20-30 years. In more technical terms, the 95th percentile rainfall event is defined as the measured precipitation depth accumulated over a 24-hour period for the period of record that ranks as the 95th percentile rainfall depth based on the range of all daily event occurrences during this period. The 24-hour period is typically defined as 12:00:00 am to 11:59:59 pm. In general, at least a 20-30 year period of rainfall record is recommended for such an analysis. This raw data is readily available and collected by most airports across the country. Small rainfall events that are on tenth of an inch or less are excluded from the percentile analysis because this rainfall generally does not result in any measureable runoff due to absorption, interception, and evaporation by permeable, impermeable, and vegetated surfaces. Many stormwater modelers and hydrologists typically exclude rainfall events that are one tenth of an inch or less from calculations of rainfall events of any storm from their modeling analyses of rainfall event frequencies. The retention volumes for Option 1 are derived by taking the difference between estimating the pre- and post development runoff volumes for the 95% rainfall. However, this approach does not consider the effect of having series of multiple 24-hour rainfalls. This can be significant, particularly in climates with a greater average number of rainfall days per year, because the LID practices may take days or even weeks to dissipate the captured rainfall. Locations where it is not uncommon to have clusters of several days of rainfall either a dissipation time of more than 24 hours should be used with Option 1 or a continuous simulation as suggested for Option 2 of the EPA Technical Guidance Manual can be used.

Table 4-1. 95th Percentile Storm Events for Select U.S. Cities

City	95th Percentile Event Rainfall Total (in)	City	95th Percentile Event Rainfall Total (in)
Atlanta, GA	1.8	Kansas City, MO	1.7
Baltimore, MD	1.6	Knoxville, TN	1.5
Boston, MA	1.5	Louisville, KY	1.5
Buffalo, NY	1.1	Minneapolis, MN	1.4
Burlington, VT	1.1	New York, NY	1.7
Charleston, WV	1.2	Salt Lake City, UT	0.8
Coeur D'Alene, ID	0.7	Phoenix, AZ	1.0
Cincinnati, OH	1.5	Portland, OR	1.0
Columbus, OH	1.3	Seattle, WA	1.6
Concord, NH	1.3	Washington, DC	1.7
Denver, CO	1.1		

(Source: Hirschman and Kosco, 2008)

4.2.2 Option 2

Option 2 of the EPA Technical Guidance Manual is a hydrologic analysis of pre-development site conditions to establish the base runoff characteristics. The designer compares the runoff characteristics resulting from the proposed development with those of the base runoff conditions. LID practices are incorporated and sized into the site plan such that the character of the post development runoff volume matches that of the base runoff conditions. The dissipation rate is an essential parameter for simulating the performance and determining the appropriate retention volume of LID practices. The relationship of the dissipation rate to the retention volume for LID practices is similar to the relationship between discharge rate and detention volume. However, the important difference between dissipation and discharge, other than how they occur, is that dissipation is much slower and is considered in terms of volume per day verses discharges, which are volume per second or per hour. The result is that a LID practice will take several days or even weeks to dissipate the retained water from a single rainfall. Therefore it is not unusual for another rainfall to occur before all the water from the previous rainfall has been dissipated.

The following is a discussion of possible modeling and simulation tools and methods that can be used to evaluate pre and post development site conditions, Table 4-1. The following sections discuss models of varying scales and capabilities to help guide planners, designers, surveyors, and construction engineers in selecting the proper tools for evaluating a particular site. The models are separated by those that would be most applicable for Option 1: Retain the difference between the pre and post project 95th Percentile Rainfall Volume, and those most applicable for Option 2: Site-Specific Continuous Hydrologic Simulation and Analysis. In addition, not all of these models have been used in the case studies due to time and financial limitations.

Table 4-2. Possible Modeling and Simulation Tools and Methods

MODEL/METHOD	EISA OPTION	FEATURES
Rational Method	1	Computes peak water depths and volumes
SCS CN Method	1	Computes peak water depths and volumes
NRCS WinTR-55 (Model)	1	Computes temporally varying water runoff and volume
EPA SWMM (Model)	1	Computers temporally varying water and constituent runoff and volume
RVSM (Model)	2	Computes long-term runoff based on a 50 year period of record of precipitation
HSPF (Model)	2	Computes long-term temporally varying water and constituent runoff and volume

4.3 STANDARD HYDROLOGIC MODELING AND SIMULATION TOOLS FOR OPTION 1

4.3.1 Rational Method

4.3.1.1 Introduction

The rational method is the most widely used method for the analysis of runoff response from small catchments. It has particular application to urban storm drainage, where it is used to calculate peak runoff rates for the design of storm sewers and small drainage structures (Ponce, 1989). The popularity of the rational method is attributed to its simplicity, although reasonable care is necessary in order to use the method correctly.

The rational method takes into account the following hydrologic characteristics or processes: 1) rainfall intensity; 2) rainfall duration; 3) rainfall frequency; 4) catchment area; 5) hydrologic abstractions; 6) runoff concentration; and 7) runoff diffusion.

In general, the rational method provides only a peak discharge, although in the absence of runoff diffusion it is possible to obtain an isosceles triangle shaped runoff hydrograph which can be used to compute runoff volume, Figure 4-2.

From Figure 4-2, t_r is rainfall duration, t_c is concentration time, Q_e is equilibrium flow (maximum flow possible for a specified rainfall intensity), I_e is effective rainfall intensity (Total rainfall minus all hydrologic abstractions).

The peak discharge is the product of: 1) runoff coefficient; 2) rainfall intensity; and 3) catchment area, with all the processes being lumped into these three parameters, Equation 4.1. Rainfall intensity contains information on rainfall duration and frequency. In turn, rainfall duration is related to concentration time, i.e., to the runoff concentration properties of the catchment. The runoff coefficient accounts for both hydrologic abstractions and runoff diffusion and may also be used to account for frequency. In this way, all the major hydrologic processes responsible for runoff response are embodied in the rational formula.

$$Q_p = CIA \tag{4.1}$$

Where, flow rate (Q_p) is cubic feet per second, rainfall intensity (I) is in inches per hour, catchment area (A) is in acres, and the runoff coefficient (C) is dimensionless.

The rational method does not take into account the following characteristics or processes: 1) spatial or temporal variations in either total or effective rainfall, 2) concentration time much greater than rainfall duration, and 3) a significant portion of runoff occurring in the form of streamflow. In addition, the rational method does not explicitly account for the catchment's antecedent moisture condition, although the latter may be implicitly accounted for by varying the runoff coefficient.

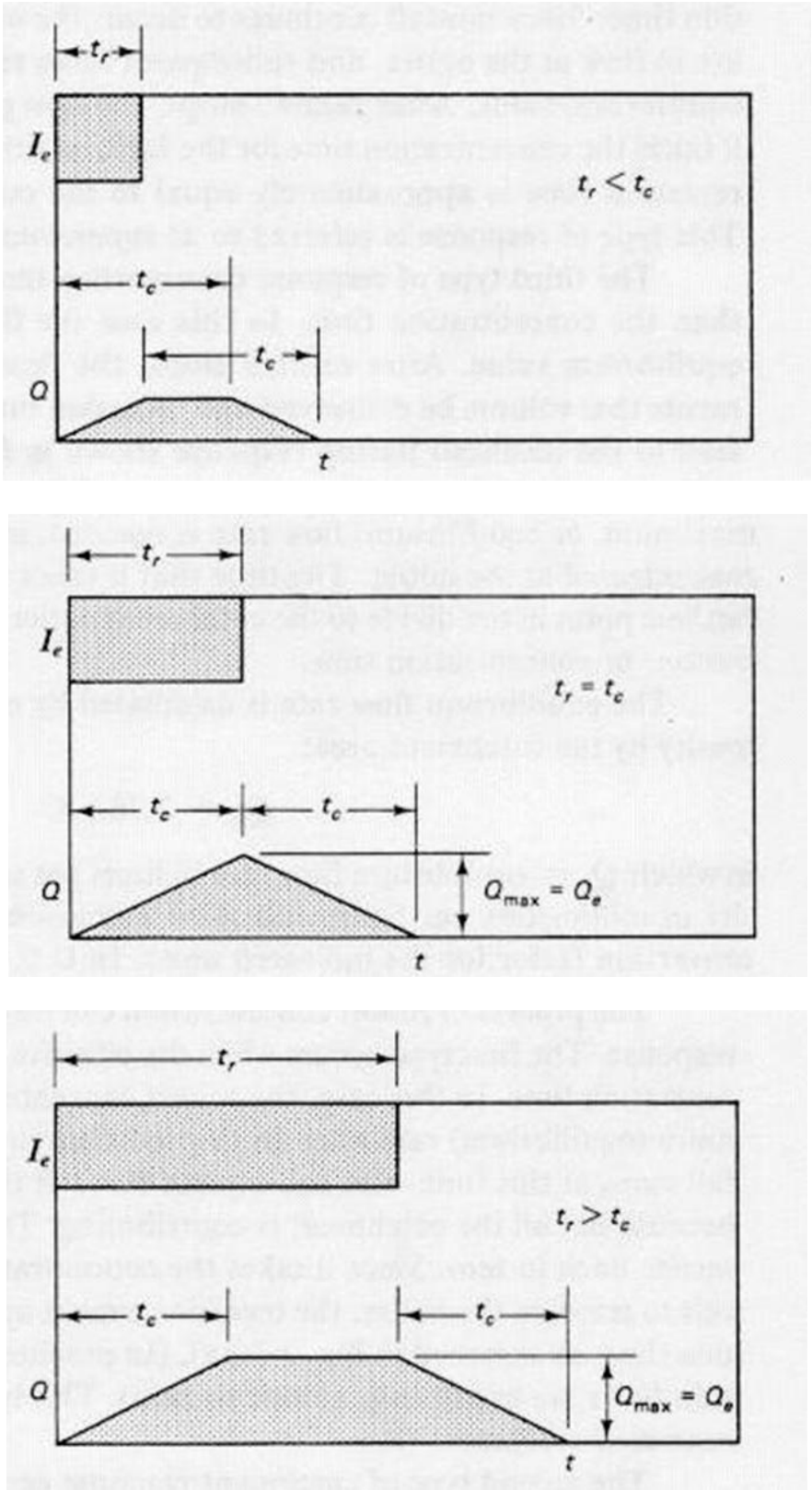


Figure 4-2. Rational Method Hydrographs
(Source: Ponce, 1989)

4.3.1.2 Methodology

The first requirement of the rational method is that the catchment be small. There is no consensus regarding the upper limit of a small catchment, however values ranging from 0.65 to 12.5 km^2 (0.2 to 4.5 mi^2) have been quoted in the literature. The current trend is to use 1.3 to 2.5 km^2 (0.5 to 0.9 mi^2) as the upper limit for the applicability of the rational method. Once the drainage boundary has been determined, the drainage area survey should also include: 1) land use and land use changes; 2) percentage of imperviousness; 3) characteristics of soil and vegetative cover that may affect the runoff coefficient; and 4) general magnitude of ground slopes and catchment gradient necessary to determine time of concentration.

Design values of runoff coefficients are usually a function of rainfall intensity and therefore of rainfall frequency. Higher values of runoff coefficient are applicable for higher values of rainfall intensity and return period, Appendix D, Tables D.1 to D.3.

With runoff coefficient, rainfall intensity, and catchment area determined, the peak discharge is calculated using Equation 4.1. The apparent simplicity of the procedure is misleading due to the range of possible runoff coefficients for each surface condition. Therefore the chosen C value is usually based on additional field information or designer's experience. The effect of frequency and/or antecedent moisture condition needs to be evaluated carefully.

4.3.2 SCS Runoff Curve Method

4.3.2.1 Introduction

The runoff curve number method is a procedure for hydrologic abstraction developed by the USDA Natural Resource Conservation Service (NRCS). In this method, runoff depth (i.e., effective rainfall depth) is a function of total rainfall depth and an abstractive parameter referred to as runoff curve number, curve number, or CN. The curve number varies in the range of 1 to 100, being a function of the following runoff producing catchment properties: 1) hydrologic soil type; 2) land use and treatment; 3) ground surface condition; and 4) antecedent moisture condition (Ponce, 1989).

The runoff curve number method was developed based on 24-h rainfall-runoff data. It limits itself to the calculation of runoff depth and does not explicitly take into account temporal variations of rainfall intensity. In the runoff curve number method, actual runoff is referred to as Q, and the potential runoff (total rainfall) is represented by P, with P being greater than or equal to Q. The actual retention after runoff begins is P minus Q. The potential retention (or potential maximum retention) is S, with S being greater than or equal to P minus Q.

The method is based on an assumption of proportionality between retention and runoff:

$$\frac{P-Q}{S}=\frac{Q}{P} \tag{4.2}$$

Where,

Q = Total runoff depth (inches)
P = Total rainfall depth (inches)
S = Maximum retention depth (inches)

This assumption states that the ratio of actual retention to potential retention is equal to the ratio of actual runoff to potential runoff. For practical applications, Equation 4.2 is improved by reducing the potential runoff by an amount equal to the initial abstraction. The initial abstraction consists mainly of interception, infiltration, and surface storage, all of which occur before runoff begins.

$$\frac{P-I_a-Q}{S}=\frac{Q}{P-I_a} \tag{4.3}$$

Where, I_a is equal to initial abstraction. In the original development of the SCS Curve Number Method, the Intial Abstraction ration (I_a /S) was assigned a value of 0.20.

Solving for Q and setting I_a = 0.2S, results in the following runoff relationship:

$$Q=\frac{(P-0.2S)^2}{(P+0.8S)} \tag{4.4}$$

Which is subject to the restriction that P is greater than or equal to 0.2S.

Since potential maximum retention varies widely, it is more appropriate to express it in terms of a runoff curve number, an integer varying in the range of 1 to 100, in the following form:

$$S=\frac{1000}{CN}-10 \tag{4.5}$$

In which CN is dimensionless and S, 1000, and 10 are given in inches.

4.3.2.2 Estimation of Runoff Curve Number (CN)

For ungaged watersheds, estimates of CN are given in tables supplied by federal agencies and local city and county departments. Tables of runoff curve numbers for various hydrologic soil-cove complexes are widely available. The hydrologic soil-cover complex describes a specific combination of hydrologic soil group, land use and treatment, hydrologic surface condition, and antecedent moisture condition. All these have a direct bearing on the amount of runoff produced by a catchment. The hydrologic soil group describes the type of soil. The land use and treatment

describes the type and condition of vegetative cover. The hydrologic condition refers to the ability of the catchment surface to enhance or impede direct runoff. The antecedent moisture condition accounts for the recent history of rainfall and consequently it is a measure of the amount of moisture stored by the catchment.

For hydrologic soil groups all the soils are classified into four hydrologic soil groups of distinct runoff producing properties. These groups are labeled A, B, C, or D. Group A consists of soils of low runoff potential having high infiltration rates even when wetted thoroughly. They are primarily deep, very well drained sands and gravels with a characteristically high rate of water transmission. Group B consists of soils with moderate infiltration rates when wetted thoroughly, primarily moderately deep to deep, moderately drained to well drainged, with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. Group C consists of soils with slow infiltration rate when wetted thoroughly, primarily soils having a layer that impedes downward movement of water or soils of moderately fine to fine texture. These soils have a slow rate of water transmission. Group D consists of soils of high runoff potential, having very slow infiltration rates when wetted thoroughly. They are primarily clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay layer near the surface, and shallow soils overlying impervious material. These soils have a very slow rate of water transmission.

The effect of the surface condition of a watershed is evaluated by means of land use and treatment classes. Land use pertains to the watershed cover, including every kind of vegetation, litter and mulch, fallow (bare soil), as well as non-agricultural uses such as water surfaces (lakes, swamps, etc.), impervious surfaces (roads, roofs, etc.), and urban areas. Land treatment applies mainly to agricultural land uses however non-agricultural best management practices could be evaluated as well. The runoff curve number method distinguishes between cultivated lands, grasslands, and woods and forests.

The runoff curve number method has three levels of antecedent moisture, depending on the total rainfall in the 5 day period preceding a storm, Appendix D, Table D.4. The dry antecedent condition (AMC I) has the lowest runoff potential. The average antecedent moisture condition (AMC II) has an average runoff potential. The wet antecedent moisture condition (AMC III) has the highest runoff potential with the catchment practically saturated from previous storms.

Tables depicting average curve number values for various soils and land use and treatment conditions can be found in Appendix D, Tables D.5 to D.7.

Since this method will be demonstrated in the case studies to follow, the steps outlined below should be used in determining the required volume of water to manage.

- Determine project boundary
- Determine hydrologic soil group for the project area by reviewing the USDA soils database
- Determine existing condition landuse areas
- Estimate the runoff curve number for each existing condition landuse

- Compute the area weighted average runoff curve number for the existing condition landuse
- Determine the post project condition landuse areas
- Estimate the runoff curve number for each post project condition landuse
- Compute the area weighted average runoff curve number for the post project conditions
- Based on a 30 to 50 year period of daily rainfall, compute the 95th percentile storm depth
- Compute the existing condition runoff depth using the SCS curve number equation (Eq. 4.4)
- Compute the post project condition runoff depth using the SCS curve number equation
- Compute the volume of water to be managed by multiplying the difference in existing and post project condition runoff depth by the total catchment area

Once the volume of water to be managed has been computed then one can evaluate various LID practices to see which one or combinations will allow one to manage the required volume on site.

4.3.3 NRCS WinTR-55

4.3.3.1 Introduction

WinTR–55 is a single-event rainfall-runoff, small watershed hydrologic model. The model generates hydrographs from both urban and agricultural areas and at selected points along the stream system. Hydrographs are routed downstream through channels and/or reservoirs.
Multiple sub-areas can be modeled within the watershed (USDA, 2009).

4.3.3.2 TR-55 Methodology

The WinTR-55 method is a collection of simplified procedures developed by the NRCS to calculate peak discharges, flood hydrographs, and stormwater detention storage volumes in small and midsize urban watersheds. It consists of two main procedures: 1) a graphical method, and 2) a tabular method. The graphical method is used to calculate peak discharges, whereas the tabular method calculates flood hydrographs by using simplified routing procedures. These methods were developed based on information obtained from the SCS TR-20 hydrologic computer model. They are designed to be used in cases where their applicability can be clearly demonstrated, in lieu of more elaborate techniques. Whereas TR-55 does not specify watershed size, the graphical method is limited to catchments with concentration times in the range of 0.1 to 10.0 hours. Likewise, the tabular method is limited to catchments with concentration times of 0.1 to 2.0 hours.

Rainfall in TR-55 is described in terms of total rainfall depth and one of four standard 24 hour temporal rainfall distributions: type I, type IA, type II, and type III, Figure 4-2.

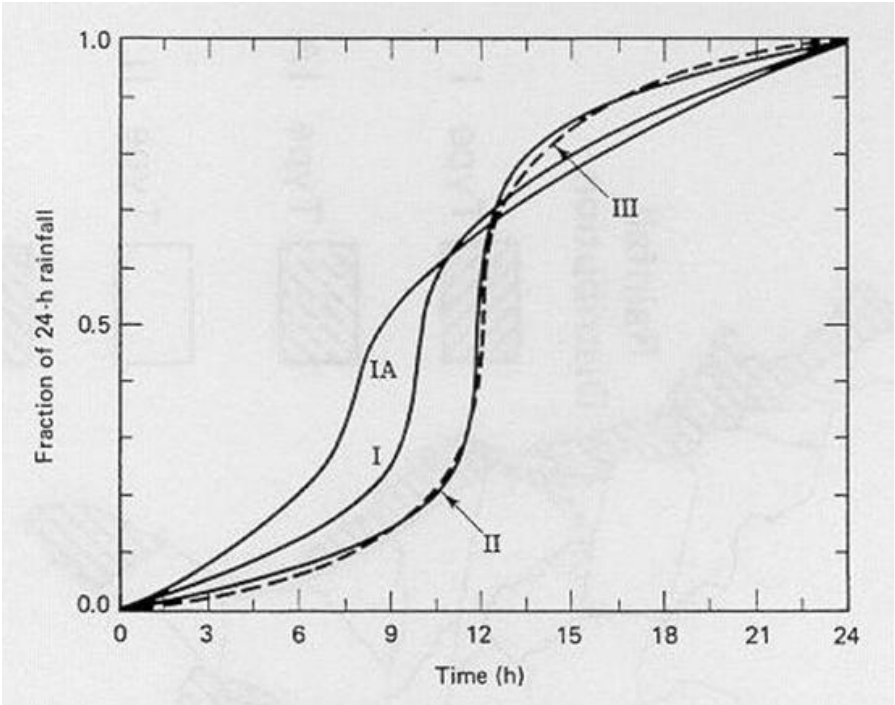


Figure 4-3. SCS 24-Hour Rainfall Distribution
(Source: Ponce, 1989)

Type I applies to California (south of the San Francisco Bay area) and Alaska; type IA applies to the Pacific Northwest and Northern California; type III applies to the Gulf Coast states; and type II applies everywhere else within the contiguous United States, Figure 4-3.

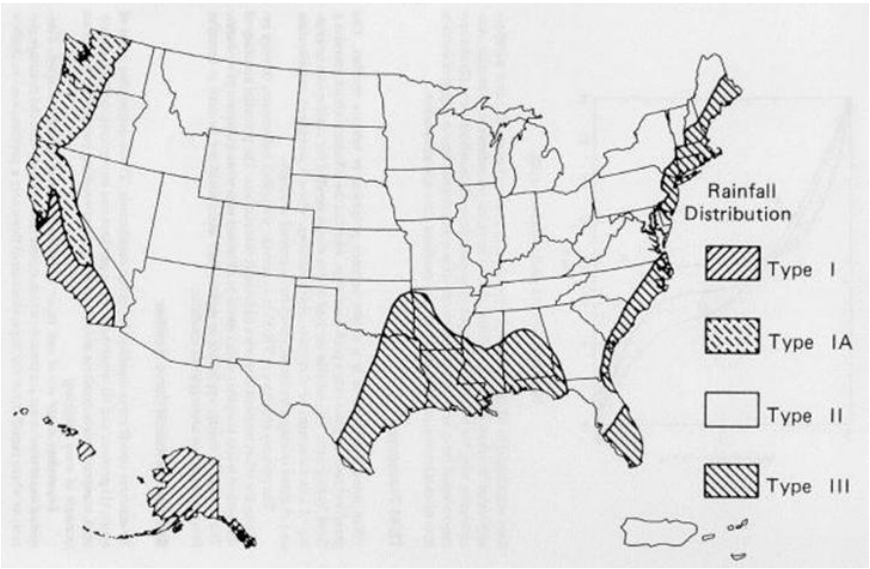


Figure 4-4. Approximate Geographical Boundaries for SCS Rainfall Distribution
(Source: Ponce, 1989)

The duration of these rainfall distributions is 24 hours. This constant duration was selected because most rainfall data is reported on a 24 hour basis. TR-55 uses the runoff curve number

method to abstract total rainfall depth and calculate runoff depth. In addition, TR-55 includes procedures to determine concentration time for the following types of surface flow: 1) overland flow; 2) shallow concentrated flow; and 3) streamflow. Shallow concentrated flow is a type of surface flow of characteristics in between those of overland flow and streamflow (i.e. rill flow and gully flow).

4.3.3.3 Model Overview

A watershed consists of sub-areas (land areas) and reaches (major flow paths in the watershed). For each sub-area, a hydrograph is generated based on land and climate characteristics. Reaches are designated as either channel reaches, through which hydrographs are routed based on physical stream characteristics, or as storage reaches, through which hydrographs are routed based on reservoir storage and outlet characteristics. Sub-area and reach hydrographs are combined as needed to represent the accumulation of flow as water moves from the upland areas down through the watershed reach network. The watershed outlet represents the location at which all runoff from the watershed is accumulated.

In modeling LID practices with Win-TR-55, the infiltration and evapotranspiration are implicitly accounted for through the weighted curve number. As LID practices are introduced into the landscape then the user must be able to quantify the reduction in infiltration and evapotranspiration volume due to the project and how much infiltration capacity needs to be introduced into the project area with the LID practice in order to mitigate this loss in volume. There are a number of capabilities and limitations associated with this model, Table 4-3.

Table 4-3. Win TR-55 Capabilities and Limitations

Variable	Limits
Minimum Area	Minimum area is 0.01 acre. Carefully examine results from sub-areas less than 1 acre.
Maximum Area	25 square miles (6,500 ha)
Number of subwatersheds	1 to 10
Time of concentration for any sub-area	0.1 hour <= Tc <= 10 hours
Number of reaches	0 to 10
Types of reaches	Channel or structure
Reach routing	Muskingum-Cunge
Structure routing	Storage-Indication
Structure types	Pipe or weir
Structure trial sizes	1 to 3
Rainfall depth	Default or user-defined 0 to 50 inches (0 to 1,270 mm)
Rainfall distributions	NRCS Type I, IA, II, III, NM60, NM65, NM70, NM75, or user-defined
Rainfall duration	24-hour
Dimensionless unit hydrograph	Standard peak rate factor 484, or user-defined
Antecedent runoff condition	2 (average)

(Source: USDA, 2009)

In order to use WinTR-55, there is a minimum data requirement that needs to be met.

These data include:

- Project Identification Data
  - User
  - State
  - County
  - Project
  - Subtitle
- Dimensionless Unit Hydrograph
- Storm Data Source
- Rainfall Distribution Identifier
- Sub-area Entry and Summary
  - Sub-area Name
  - Sub-area Description
  - Sub-area Flows to Reach/Outlet
  - Area (ac. or sq. mi.)
  - Weighted curve number (CN)
  - Time of concentration (Tc)

Once the input data has been inserted and the model has been run, the File Display window, also referred to as the Report Viewer, displays various WinTR–55 reports, Table 4.3. This window opens after a WinTR–55 run. If there are any errors in the WinTR–55 run, this window opens with the Error File displayed. The user should carefully examine the error messages, and/or modify the input data to correct the errors.

In addition to the reports, there are hydrograph plotting options for sub-areas and reaches, Figure 4-5.

Table 4-4. Win TR-55 Reports

Report Name	Description
Current data description	Lists the current user input data
Storm data	Lists the rainfall depth by rainfall return period information. Also shows Storm Data source, Rainfall Distribution, and the Dimensionless Unit Hydrograph.
Watershed Peak Table	Not available until an error-free WinTR-55 run is executed. Upon completion of an error-free WinTR-55 run, this option will give a listing of peak discharges, by reach, for each storm evaluated.
Hydrograph Peak/Peak Time Table	Not available until an error-free WinTR-55 run is executed. Upon completion of an error-free WinTR-55 run, this option gives a listing of peak discharge and time by sub-area or reach identifier, for each storm evaluated.
Structure Output Table	Not available until an error-free WinTR-55 run is executed. Upon completion of an error-free WinTR-55 run, this option gives a listing of peak flow (PF), storage volume (SV), and maximum stage (STG) for structures included in the WinTR-55 run. If there are no structures in the run, this table option is grayed out.
Sub-Area Summary Table	A listing by sub-area of drainage area, time of concentration, runoff curve number, receiving reach, and sub-area description.
Reach Summary Table	Identifies, by reach, the receiving reach, reach length, and routing method used.
Sub-Area Time of Concentration Details	A listing, by sub-area, of flow length, slope, Manning's n value, end area, wetted perimeter, velocity and travel time of concentration flow path segments along with the total time of concentration.
Sub-Area Land Use and Curve Number Details	A listing, by sub-area, of land use, hydrologic soil group, and area for each particular land use in a sub-area. Also lists the total area and weighted curve number for each sub-area.
Reach Channel Rating Details	Identifies, by reach, the reach length, Manning's n value used for that reach, friction slope, bottom width, and side slope. Also includes the computed channel rating for each reach. Channel ratings are in the WinTR-55 input data format: Stage-Flow-End Area. Rating tables also include top width and friction slope.
Structure Description	Provides a summary of the entered structure data by reach. If there are no structures in the run, this table option is grayed out.
Structure Rating Tables	Provides a summary of the computed structure ratings: stage, storage, and flow. If there are no structures in the run, this table option is grayed out.

(Source: USDA, 2009)

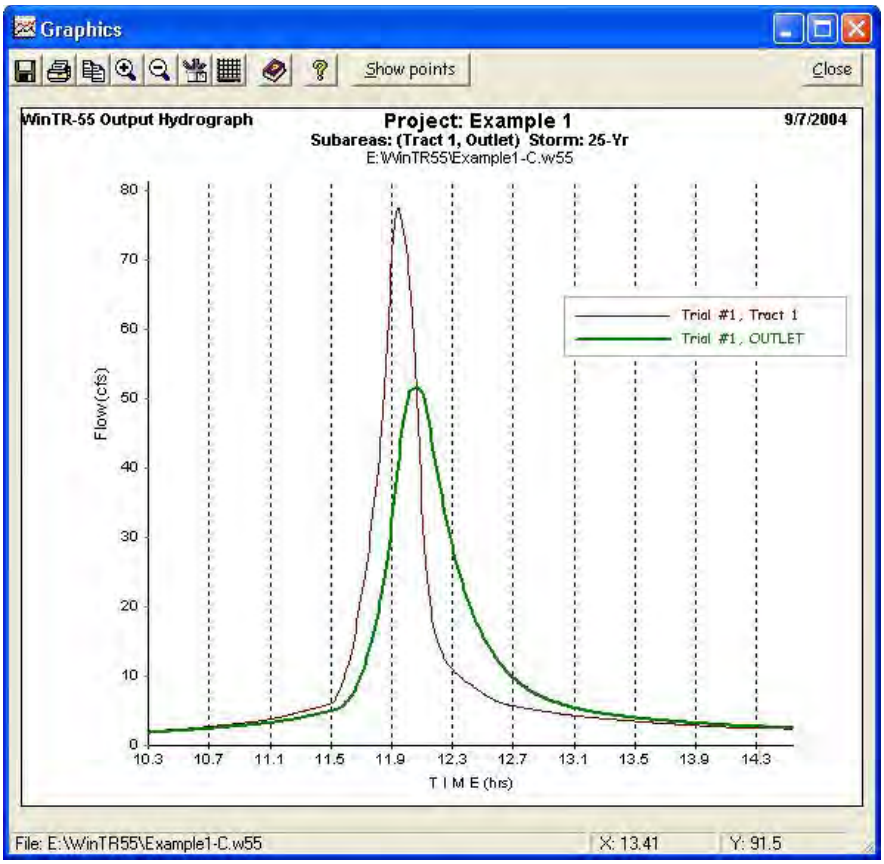


Figure 4-5. Example Win TR-55 Hydrograph Plot
(Source: USDA, 2009)

4.3.4 EPA SWMM

4.3.4.1 Introduction

The EPA Storm Water Management Model (SWMM) is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas (Rossman, 2010). The runoff component of SWMM operates on a collection of subcatchment areas that receive precipitation and generate runoff and pollutant loads. The routing portion of SWMM transports this runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators. SWMM tracks the quantity and quality of runoff generated within each subcatchment, and the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period comprised of multiple time steps.

SWMM was first developed in 1971, and has since undergone several major upgrades since then. It continues to be widely used throughout the world for planning, analysis and design related to stormwater runoff, combined sewers, sanitary sewers, and other drainage systems in urban areas, with many applications in non-urban areas as well. The current edition, Version 5, is a complete re-write of the previous release. Running under Windows, SWMM 5 provides an integrated environment for editing study area input data, running hydrologic, hydraulic and water quality simulations, and viewing the results in a variety of formats. These include color-coded drainage

area and conveyance system maps, time series graphs and tables, profile plots, and statistical frequency analyses.

4.3.4.2 Capabilities

SWMM accounts for various hydrologic processes that produce runoff from urban areas. These include:

- time-varying rainfall
- evaporation of standing surface water
- snow accumulation and melting
- rainfall interception from depression storage
- infiltration of rainfall into unsaturated soil layers
- percolation of infiltrated water into groundwater layers
- interflow between groundwater and the drainage system
- nonlinear reservoir routing of overland flow
- runoff reduction via Low Impact Development (LID) controls.

Spatial variability in all of these processes is achieved by dividing a study area into a collection of smaller, homogeneous subcatchment areas, each containing its own fraction of pervious and impervious sub-areas. Overland flow can be routed between sub-areas, between subcatchments, or between entry points of a drainage system.

SWMM also contains a flexible set of hydraulic modeling capabilities used to route runoff and external inflows through the drainage system network of pipes, channels, storage/treatment units and diversion structures. These include the ability to:

- handle drainage networks of unlimited size
- use a wide variety of standard closed and open conduit shapes as well as natural channels
- model special elements such as storage/treatment units, flow dividers, pumps, weirs, and orifices
- apply external flows and water quality inputs from surface runoff, groundwater interflow, rainfall-dependent infiltration/inflow, dry weather sanitary flow, and user-defined inflows
- utilize either kinematic wave or full dynamic wave flow routing methods
- model various flow regimes, such as backwater, surcharging, reverse flow, and surface ponding
- apply user-defined dynamic control rules to simulate the operation of pumps, orifice openings, and weir crest levels

In addition to modeling the generation and transport of runoff flows, SWMM can also estimate the production of pollutant loads associated with this runoff. The following processes can be modeled for any number of user-defined water quality constituents:

- dry-weather pollutant buildup over different land uses
- pollutant washoff from specific land uses during storm events
- direct contribution of rainfall deposition
- reduction in dry-weather buildup due to street cleaning
- reduction in washoff load due to BMPs
- entry of dry weather sanitary flows and user-specified external inflows at any point in the drainage system
- routing of water quality constituents through the drainage system
- reduction in constituent concentration through treatment in storage units or by natural processes in pipes and channels

In modeling LID practices with EPA SWMM, the infiltration and evapotranspiration are explicitly accounted for through the computation of infiltration and evapotranspiration. As LID practices are introduced into the landscape then the user will be able to better quantify the reduction in infiltration and evapotranspiration volume due to the project given the more explicit formulations and thus will be able to better determine infiltration capacity that needs to be accounted for with the LID practice in order to mitigate this loss in volume.

4.4 STANDARD HYDROLOGIC MODELING AND SIMULATION TOOLS FOR OPTION 2

4.4.1 The Retention Volume Simulation Model (RVSM)

4.4.1.1 Introduction

The RVSM simulates the pre-development conditions by modifying the runoff equation from the Curve Number Method found inTR-55 Runoff Equation (TR-55, equation 4.7) (Lemoine, 2011). Although the Curve Number Method is used in flow-based hydrology modeling, it is the closest method to being a volume-based model, because the method directly estimates a runoff volume. The method estimate runoff based on soil type and ground cover. Since the volume of rainwater retain, and not dissipated, in the soil and in depression storage of the previous day has the same effect as though it were part of the rainfall for the next day, the Runoff Equation from TR-55 can be modified to make it a continuous simulation. This modification involves adding to the rainfall volume of the current day, the rainfall retained in the soil and on the surface through depression storage from previous day less the estimate dissipation volume, Figure 4-6.

$P_a =$	$P + R_n$	**(4.6)**
$R_n =$	$Pa - Qn - Q_d$	**(4.7)**
$Q_d \approx$	I_a ..... *(Model Assumption)*	**(4,8)**
$I_a =$	**0.2S** ..... *(eq. 2-2, TR-55)*	**(4,9)**
$S =$	**(1000/CN) – 10** ..... *(eq. 2-4, TR-55)*	**(4.10)**
$Q_n =$	$(P_a - 0.2S)^2 / (P_a + 0.8S)$ ..... *(eq. 2-3, TR-55)*	**(4.11)**

P = *24-Hour Precipitation*

P_a = *Precipitation adjusted for retained moisture*

R_n = *Retained moisture*

Q_d = *Dissipation volume from infiltration, evapo-transpiration, and/or reuse*

I_a = *Initial abstraction*

S = *Potential maximum retention after runoff begins*

Qn = *Pre-Development Runoff*

NOTE: All volumes are unit volumes of inches over the catchment area.)

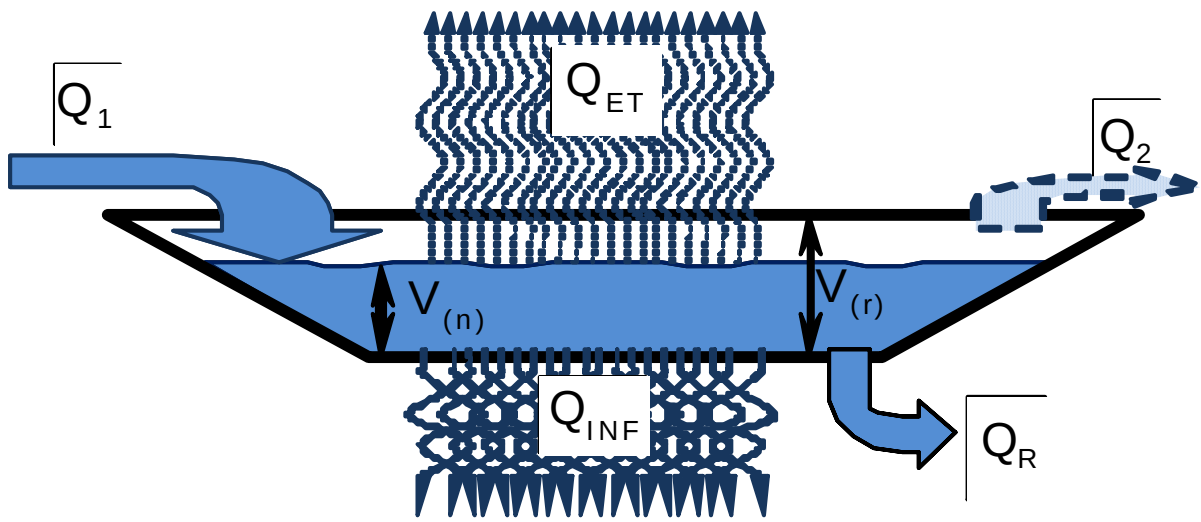


Figure 4-6. RVSM Water Balance
(Source: Lemoine, 2011)

The principle of continuity of volumes is used by the RVSM in simulating the performance of post-construction LID practices. Based on the continuity principle the retained volume is equal to the inflow volume minus the outflow volumes. The TR-55 Runoff Equation is used to calculate the inflow volume. The outflow volumes consist of; the infiltration volume, the evapo-transpiration volume, the reuse volume, and an overflow discharge volume when the LID retention capacity is exceeded. The RVSM groups the infiltration, evapo-transpiration, and reused volume into one variable called the dissipation rates.

The RVSM has four input variables: the pre-development curve number CN_n, the post-development curve number CN_d, the LID retention capacity V_r, and the dissipation rate Q_D.

Using those variables, the RVSM determines the number of occurrences when the discharge volume exceeded the 2-year runoff volume, and the number of occurrences when there is an overflow discharge of the LID practice based on the given retention capacity and dissipation rate. The goal is for the post-development discharge volume to "mimicking" the pre-development runoff volume. This goal is achieved by changing either the retention capacity or dissipation rate of the LID practice until the number of post-development discharge occurrences matches the pre-development occurrences. It is generally acknowledged that accelerated erosion occurs when the flow rate and frequency exceed the runoff from a 2-year rainfall. Therefore, the pre-development, 2-year runoff volume is used as the threshold for evaluating whether the post development discharge volume matches (mimics) the pre-development runoff volume.

4.4.1.2 RVSM for Reuse Applications

This same model can be used to evaluate the performance of reuse application. The model's dissipation rate is the reuse rate. The reuse performance is measured by counting the number of days that there was sufficient retention volume to meet the demand for the retained water. The average availability is expressed as a percentage, calculated by dividing the number of days of available retention volume by the total number of days in the data set. This percentage provides an indication of whether and how much a supplemental source of water will be needed and how much. Various scenarios can be evaluated and this information used in a cost-benefit analysis to determine the optimum size retention tank.

The RVSM is created using a spreadsheet; however, a spreadsheet template has been created that can be used at any locality simply by inserting the 24-hour rainfall data and rainfall frequency data specific to that region. Once the appropriate local data has been input into the spreadsheet template, site specific evaluations and scenarios can be performed to estimate the required retention capacity and dissipation rate for LID practices. Alternatively the RVSM can be used to generate tables, charts and equations for use in designing LID practices anywhere within the local region.

4.4.2 EPA HSPF

4.4.2.1 Introduction

HSPF simulates for extended periods of time the hydrologic, and associated water quality, processes on pervious and impervious land surfaces and in streams and well-mixed impoundments. The model uses continuous rainfall and other meteorologic records to compute streamflow hydrographs and pollutographs (Bicknell et al, 2005). HSPF simulates interception soil moisture, surface runoff, interflow, base flow, snowpack depth and water content, snowmelt, evapotranspiration, ground-water recharge, dissolved oxygen, biochemical oxygen demand (BOD), temperature, pesticides, conservatives, fecal coliforms, sediment detachment and transport, sediment routing by particle size, channel routing, reservoir routing, constituent routing, pH, ammonia, nitrite-nitrate, organic nitrogen, orthophosphate, organic phosphorus, phytoplankton, and zooplankton. The program can simulate one or many pervious or impervious unit areas discharging to one or many river reaches or reservoirs. Frequency-duration analysis can be done for any time series. Any time step from 1 minute to 1 day that divides equally into 1 day can be used. Any period from a few minutes to hundreds of years may

be simulated. HSPF is generally used to assess the effects of land-use change, reservoir operations, point or nonpoint source treatment alternatives, flow diversions, etc. Programs, available separately, support data preprocessing and postprocessing for statistical and graphical analysis of data saved to the Watershed Data Management (WDM) file.

4.4.2.2 Conceptual Model Design

To design a comprehensive simulation system, one must have a consistent means of representing the prototype; in our case, the real world. We view it as a set of constituents which move through a fixed environment and interact with each other. Water is one constituent; others are sediment, chemicals, etc. The motions and interactions are called processes.

The mathematical prototype is a continuum of constituents and processes. Simulation of such a system on a computer requires representation in a discrete fashion. In general, we do this by subdividing the prototype into "elements" which consist of "nodes" and "zones."

A node corresponds to a point in space. Therefore, a particular value of a spatially variable function can be associated with it, for example, channel flow rate and/or flow cross sectional area. A zone corresponds to a finite portion of the real world. It is usually associated with the integral of a spatially variable quantity, for example, storage in a channel reach. The relationship between zonal and nodal values is similar to that between the definite integral of a function and its values at the limits of integration.

An element is a collection of nodes and/or zones. We simulate the response of the land phase of the hydrological cycle using elements called "segments." A segment is a portion of the land assumed to have areally uniform properties. A segment of land with a pervious surface is called a "Pervious Land-segment" (PLS) and an impervious surface is called an “Impervious Land-segment” (ILS). A PLS or ILS has no nodes. In regards to stream or reservoir routing, we model a computational reach as a one dimensional element consisting of a single zone situated between two nodes. We simulate the flow rate and depth at the nodes; the zone is associated with storage.

4.4.2.3 Pervious Land Segments

A land segment is a subdivision of the simulated watershed. The boundaries are established according to the user's needs, but generally, a segment is defined as an area with similar hydrologic characteristics. For modeling purposes, water, sediment, and water quality constituents leaving the watershed move laterally to a downslope segment or to a reach/reservoir. A segment of land which has the capacity to allow enough infiltration to influence the water budget is considered pervious. In HSPF, PERLND (Pervious Land Segment) is the module that simulates the water quality and quantity processes which occur on a pervious land segment.

The primary module sections in PERLND simulate snow accumulation and melt, the water budget, sediment produced by land surface erosion, and water quality constituents by various methods. Other sections perform the auxiliary functions of correcting air temperature for use in snowmelt and soil temperature calculations, producing soil temperatures for estimating the

outflow temperatures and influencing reaction rates in the agri-chemical sections, and determining outflow temperatures which influence the solubility of oxygen and carbon dioxide.

In modeling LID practices with HSPF, the PERLND segmentation is the primary module where the infiltration and evapotranspiration are explicitly accounted for through the computation of infiltration and evapotranspiration. As LID practices are introduced into the landscape then the user will be able to better quantify the reduction in infiltration and evapotranspiration volume due to the project given the more explicit formulations found within HSPF and thus will be able to better determine infiltration capacity that needs to be accounted for with the LID practice in order to mitigate this loss in volume.

4.4.2.4 Impervious Land Segments

In an impervious land segment, little or no infiltration occurs however, land surface processes do occur. Snow may accumulate and melt, and water may be stored or may evaporate. Various water quality constituents accumulate and are removed. Water, solids, and various pollutants flow from the segments by moving laterally to a downslope segment or to a reach/reservoir.

The HSPF IMPLND (Impervious Land Segment) module simulates a number of processes with many of them similar to the corresponding sections in the PERLND module. In fact, since sections snow and air temperature components perform functions that can be applied to pervious or impervious segments, they are shared by both modules.

4.4.2.5 Streams and Reservoirs

This module simulates the processes which occur in a single reach of open or closed channel or a completely mixed lake. For convenience, such a processing unit is referred to as a RCHRES. In keeping with the assumption of complete mixing, the RCHRES consists of a single zone situated between two nodes, which are the extremities of the RCHRES.

Flow through a RCHRES is assumed to be unidirectional. Water and other constituents which arrive from other RCHRES's and local sources enter the RCHRES through a single gate. Outflows may leave the RCHRES through one of several gates or exits. A RCHRES can have up to five outflow exits. Precipitation, evaporation, and other fluxes also influence the processes which occur in the RCHRES, but do not pass through the exits.

4.5 STORMWATER MANAGEMENT TECHNOLOGIES CASE STUDIES

4.5.1 Introduction

The purpose of this section is to demonstrate the application of the SCS Curve Number method for estimating the volume of water that needs to be managed for installations from different climatic zones and for different project design purposes using the Army LID Planning Tool. The SCS CN method was chosen due to its wide spread acceptance by watershed modelers and its flexibility in describing landscape parameters and features when modeling small catchments.

During the planning process, a general project boundary is typically determined. Using this project boundary or limit of disturbance, when available, to the engineer will evaluate the natural features that direct flow either to the area of interest or away from the area of interest. Once that has been done then man-made features, such as roads, drainage ditches, etc., need to be considered since they do alter the natural flow paths. After these features have been identified then the designer will need to delineate the catchment boundary, where the project will impact hydrology or increase runoff, using their best engineering judgement. In some cases, it may not be clear exactly how far out a boundary needs to go since the actual construction area may be small and the natural and man-made features may be sufficiently far away. In these cases, one needs to keep in mind that we are looking at the difference in existing and post project runoff conditions rather than absolute runoff depths so again some engineering judgement may need to be made in regards to how far out to set the catchment boundary. The consequences of setting the boundary too far away from the project site could cause the model to not be able to discern pre and post project differences accurately and thus cause the designer to either under design or over design the LID practices. In the case of over designing, this would cause an unnecessary increase in project cost. In the case of under designing, some local flooding may occur at the 95th percentile storm that otherwise should not occur.

Finally, this section demonstrates how different LID practices can be used in the design such that the water can be retained on site rather than allowed to runoff. The case studies presented here are hypothetical and are only meant to demonstrate estimating the EISA Section 438 volume requirement and applying LID BMPs to meet EISA.

4.5.2 Data Needs

The following sites were used in evaluating various LID Best Management Plans (BMPs): 1) Fort Drum; 2) Fort Hood; 3) Fort Benning; and 4) Fort Meade. The goal was to use sites that represented varying climatic regions in order to show the robustness of the LID BMPs to be used across the whole Department of Defense (DoD). In performing the LID analysis is was necessary to gather the following data:

- Land use/Land cover: The terms land use and land cover are often used interchangeably, but each term has its own unique meaning. *Land cover* refers to the characteristics and surface cover of Earth's surface, as represented by vegetation, water, bare earth, impervious surfaces, and other physical features of the land. Identification of land cover establishes the baseline information for activities like thematic mapping and change detection analysis. *Land use* refers to the activity, economic purpose, intended use, and/or management strategy placed on the land cover type(s) by human agents or land managers. Changes in intent or management practice likewise constitute land use change. When used together the phrase Land Use/Land Cover generally refers to the categorization or classification of human activities and natural elements on the landscape within a specific time frame based on established scientific and statistical methods of analysis of appropriate source materials.

- Digital Elevation Map (DEM): A DEM is a digital representation of ground surface topography or terrain. It is also widely known as a digital terrain model (DTM). A DEM

can be represented as a raster (a grid of squares) or as a triangular irregular network. For the LID analysis a minimum of 2-foot contour intervals (1-foot intervals are better) is necessary.

- Soil Texture Map: Soil texture is a soil property used to describe the relative proportion of different grain sizes of mineral particles in a soil. Particles are grouped according to their size into what are called soil separates. At a minimum, the soil texture should be classified as sand, silt, or clay. A more detailed discussion of soil texture and possible soil amendments can be found in Chapter 3. Once the soil texture has been determined, then the hydrologic soil group (A, B, C, or D) can be ascertained and the appropriate infilatration rate (A=14.343 inches/day, B=9.743 inches/day, C=4.430 inches/day, and D=0.769 inches/day) will be determined by the planning spreadsheet.

- Facilities Map: The facilities map should show basic man-made features associated with the selected installation (e.g., buildings, roads, parking lots, sewer/storm pipe systems, etc.)

- Precipitation: Precipitation is the quantity of water falling to earth at a specific place within a specified period of time. Precipitation can be in the form of rainfall or snow. For the LID analysis, 50 continuous years of 24-hour precipitation data is recommended.

For the case studies, the SCS Curve Number method was used in the hydrologic design of selected LID practices. In performing the hydrologic analysis, the following steps must be done:

- Evaluate existing soils (analysis) and surface features across project site.

- Determine the area (sq-ft / acres) of existing and planned: building foot print, parking, sidewalks, etc.

- Determine the area (sq-ft / acres) of existing vegetation features and the planned changes to the landscape.

- Compute changes in runoff volume from existing to planned site conditions.

- Evaluate LID practices appropriate for managing the change in runoff volume.

4.5.3 Fort Drum Case Study

4.5.3.1 Background

Fort Drum, New York is located in Western New York State, approximately 80 miles north of Syracuse, NY (Figure 4-7). Fort Drum gets 39 inches of rain per year. On average, there are 160 sunny days. The July high is around 80°F and the January low is 10°F.

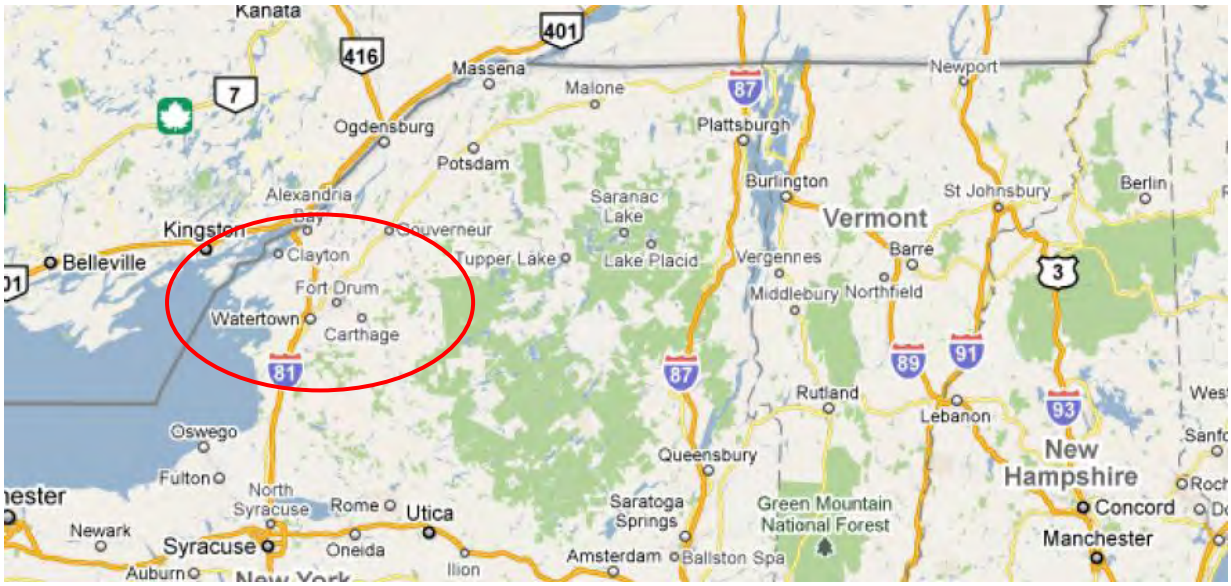


Figure 4-7. Fort Drum, NY Location Map

Fort Drum has been used as a military training site since 1908, however the Army's presence in the North Country may be traced back to the early 1800's. Today, Fort Drum consists of 107,265 acres. Its mission includes commanding active component units assigned to the installation, providing administrative and logistical support to tenant units, supporting tenant units, supporting active and reserve units from all services in training at Fort Drum, and planning and support for the mobilization and training of almost 80,000 troops annually. The Fort Drum installation can be seen in Figure 4-8.

Figure 4-8. Fort Drum, NY Installation Area

4.5.3.2 Pre-Project Conditions

For this case study, an existing housing site was selected for enlargement.

From a review of the USDA soils database, the predominant hydrologic soil group for the project site is Hydrologic Soil Group B. The existing land use consisted of Trees/Shrubs, Grassland, Lawns, and Existing Houses, Figure 4-9. By inputting the percent site area of each land use to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average pre-project CN is computed to be **61.6** (Figure 4-10).

Figure 4-9. Fort Drum, NY Project Site - Existing Landuse Conditions

4.5.3.3 Post-Project Conditions

The post project land use, Figure 4-11, consisted of Lawn, Existing Houses, New Houses, Club House, Parking Lots, and Roads. By inputting the percent site area of each land use to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average pre-project CN is computed to be **74.9** (Figure 4-10).

SIMPLIFIED RUNOFF CURVE NUMBER METHOD

PRELIMINARY SELECTION AND SIZING OF LID PRACTICES

FOR COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, EPA OPTION 1

DATE:	14-Jun-11	INSTALLATION:	Fort Drum, NY		
PLANNER:	Bill Sproul				
PROJECT NAME:	New Housing Development				
PROJECT LOCATION:	Fort Drum				
OJECT AREA (acres):	28.5	95% RAINFALL	0.94	SELECT THE SITE'S GEN. SOIL TYPE: Sandy-Loam	HSG = B

PRE-PROJECT				POST-PROJECT		
LAND COVER	% of SITE	CN		LAND COVER	% of SITE	CN
WOODED (Fair)	60.7%	60		WOODED (Fair)		
MEADOW				MEADOW		
BRUSH & WEEDS (Fair)	18.7%	56		BRUSH & WEEDS (Fair)		
LAWN	18.8%	69		LAWN	77.8%	69
ROADS & DRIVES (W*/C&G)				ROADS & DRIVES (W*/C&G)	5.7%	89
ROADS & DRIVES (W/C&G)				ROADS & DRIVES (W/C&G)		
PARKING, DRIVEWATS & SIDEWALKS				PARKING, DRIVEWATS & SIDEWALKS	4.4%	98
BUILDING ROOF	1.8%	98		BUILDING ROOF	12.1%	98
			SELECTION OF OTHER LAND COVER TYPES			
TOTAL %	100.0%			TOTAL %	100.0%	
WEIGHTED AVERAGE CNn =		61.6		WEIGHTED AVERAGE CNd =		74.9
RUNOFF VOLUME (95% RAIN) =	0.037	ACRE-FEET		RUNOFF VOLUME (95% RAIN) =	0.048	ACRE-FEE
1628 CUBIC FEE	12180	GALLONS		2095 CUBIC FEE	15672	GALLONS

MINIMUM RUNOFF RETENTION VOLUME TO COMPLY WITH EISA 438 VOLUME CONTROL REQUIREMENT

0.011 ACRE-FEET	467 CUBIC FEET	3,492 GALLONS

Figure 4-10. Fort Drum Runoff Computations

Figure 4-11. Fort Drum, NY Project Site - Post-Project Landuse Conditions

4.5.3.4 Calculate EISA Volume Requirement

The next step in the hydrologic design is to compute the 95th percentile storm. Based on an evaluation of a 50 year period of record of daily precipitation at Fort Drum, Figure 4-12, the 95th percentile storm was computed to be **0.94 inches**.

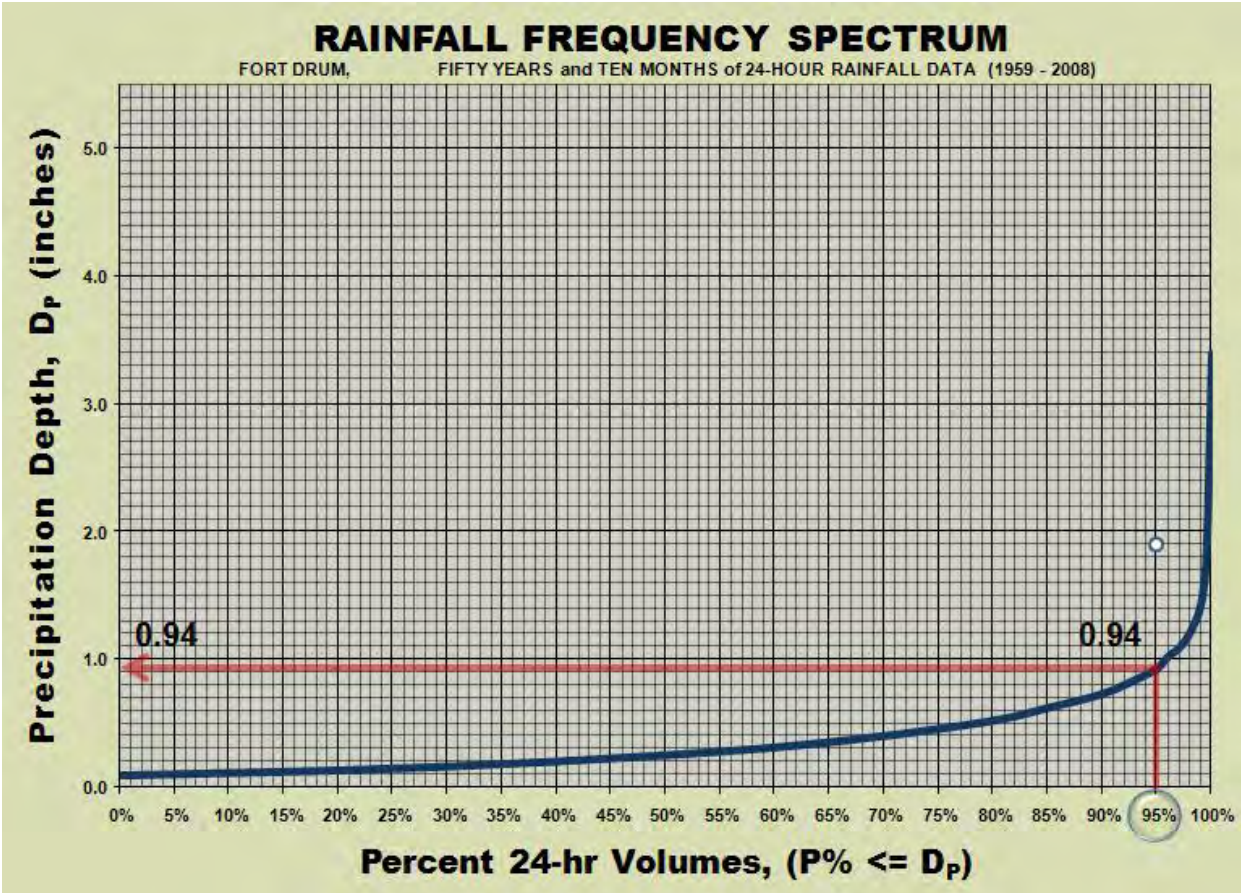


Figure 4-12. Fort Drum, NY - 95th Percentile Storm Depth (Inches)

At this point one is able to compute the peak runoff depths for both the existing and post project conditions using the SCS CN method. The peak runoff depths were computed to be 0.016 inches and 0.02 inches, respectively using the 95th percentile storm.

Once one computes the existing and post runoff depths then they are able to compute the amount of water that needs to be managed on the project site by multiplying the change in runoff depth by the site area, 28.5 acres. From this analysis, the Fort Drum project needs to manage **467 ft^3** of runoff, as computed in Figure 4-10.

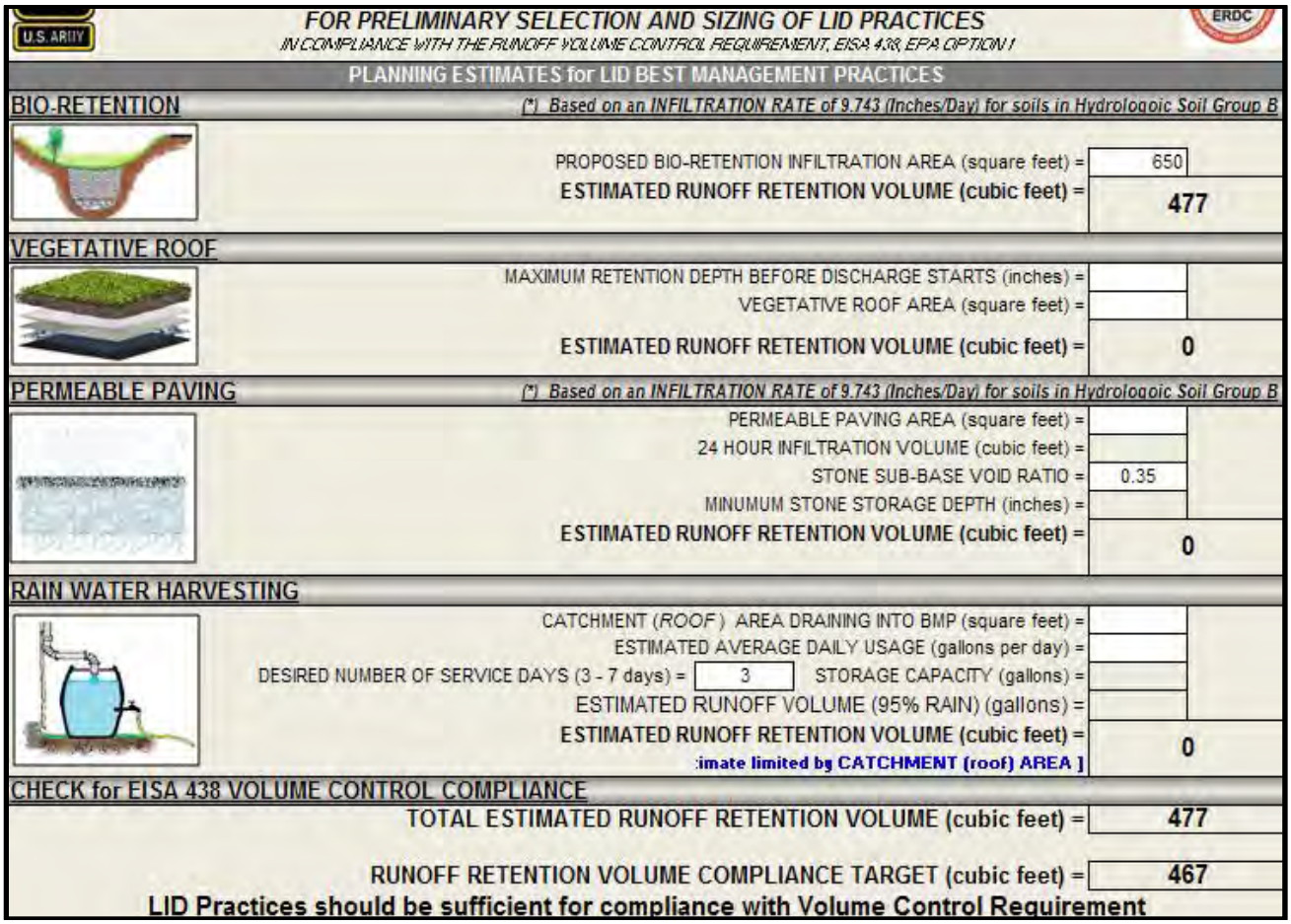
Input Parameters:
Site Area (A) = 28.5 acres
95th Storm (P) = 0.94 inches
Existing CN = 61.6
Post CN = 74.9

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \quad S = \frac{1000}{CN} - 10$$

Output:
Existing Q = 0.016 inches
Post Q = 0.02 inches

4.5.3.5 Select LID BMPs to Manage EISA Volume

The LID practice that was evaluated for this project was a bioswale, Figure 4-13. For this analysis, a Group B soil allows for 9.743 inches/day of water removed from the project site using this LID practice. Since this LID feature is an infiltration practice, it was determined that a bioswale area of 650 ft^2 (0.02 acres) was needed assuming a 24-hour dissipation time.



FOR PRELIMINARY SELECTION AND SIZING OF LID PRACTICES
IN COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, EPA OPTION I

PLANNING ESTIMATES for LID BEST MANAGEMENT PRACTICES

BIO-RETENTION — (*) Based on an INFILTRATION RATE of 9.743 (Inches/Day) for soils in Hydrologoic Soil Group B

PROPOSED BIO-RETENTION INFILTRATION AREA (square feet) = 650
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 477

VEGETATIVE ROOF

MAXIMUM RETENTION DEPTH BEFORE DISCHARGE STARTS (inches) =
VEGETATIVE ROOF AREA (square feet) =
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 0

PERMEABLE PAVING — (*) Based on an INFILTRATION RATE of 9.743 (Inches/Day) for soils in Hydrologoic Soil Group B

PERMEABLE PAVING AREA (square feet) =
24 HOUR INFILTRATION VOLUME (cubic feet) =
STONE SUB-BASE VOID RATIO = 0.35
MINUMUM STONE STORAGE DEPTH (inches) =
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 0

RAIN WATER HARVESTING

CATCHMENT (ROOF) AREA DRAINING INTO BMP (square feet) =
ESTIMATED AVERAGE DAILY USAGE (gallons per day) =
DESIRED NUMBER OF SERVICE DAYS (3 - 7 days) = 3 STORAGE CAPACITY (gallons) =
ESTIMATED RUNOFF VOLUME (95% RAIN) (gallons) =
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 0
:imate limited by CATCHMENT (roof) AREA]

CHECK for EISA 438 VOLUME CONTROL COMPLIANCE

TOTAL ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 477
RUNOFF RETENTION VOLUME COMPLIANCE TARGET (cubic feet) = 467
LID Practices should be sufficient for compliance with Volume Control Requirement

Figure 4-13. Fort Drum LID BMP Computations

Since the Total Runoff Volume Retained (477 ft^3) exceeds the EISA Volume Requirement (467 ft^3), this project is expected to comply with EISA Section 438 using the selected LID BMPs.

4.5.4 Fort Hood Case Study

4.5.4.1 Background

Fort Hood is a United States military post located outside of Killeen, Texas (Figure 4-14). Fort Hood gets 32 inches of rain per year. The number of days with any measurable precipitation is 64. On average, there are 226 sunny days per year in Fort Hood. The July high is around 96°F and the January low is 34°F.

Figure 4-14. Fort Hood, TX Vicinity Map

The post is named after Confederate General John Bell Hood. It is located halfway between Austin and Waco, about 60 miles (97 km) from each, within the U.S. state of Texas. Its origin was the need for wide-open space to test and train with World War II tank destroyers. Today, Fort Hood has nearly 65,000 soldiers and family members and serves as a home for the following units: Headquarters III Corps; First Army Division West; the 1st Cavalry Division; 13th Sustainment Command (formerly 13th Corps Support Command); 89th Military Police Brigade; 504th Battlefield Surveillance Brigade; 21st Cavalry Brigade (Air Combat); Combat Aviation Brigade, 4th Infantry Division; and the 31st Air Defense Artillery Brigade. Fort Hood also includes Carl R. Darnall Army Medical Center and the Medical and Dental Activities as tenant units.

The Fort Hood installation can be seen in Figure 4-15.

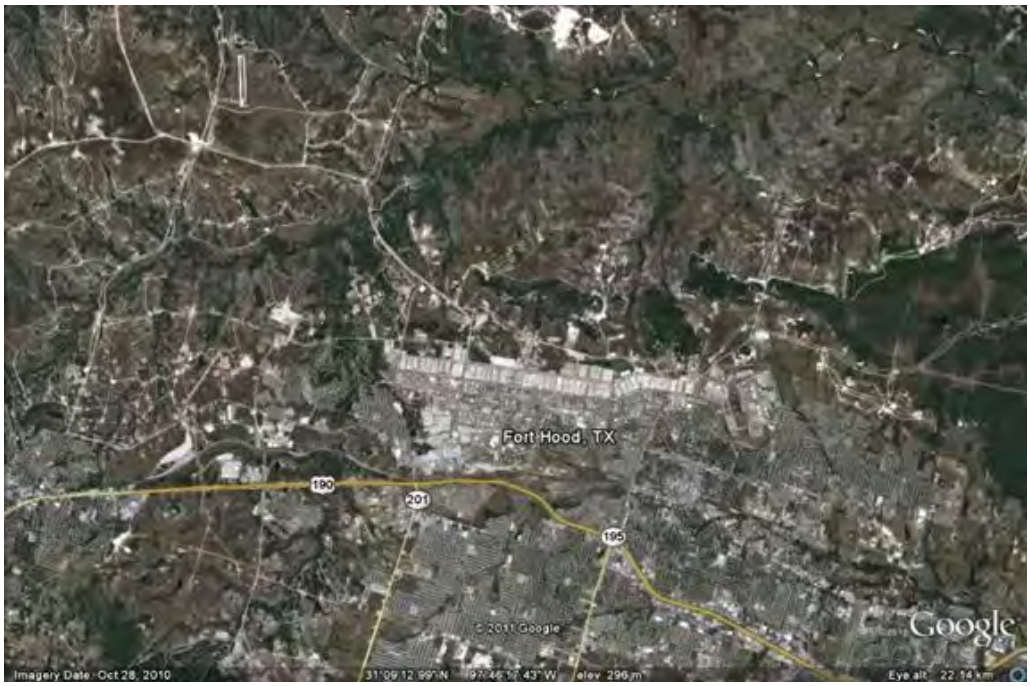


Figure 4-15. Fort Hood, TX Installation Area

4.5.4.2 Pre-Project Conditions

For this demonstration project, four new buildings were added to the project site.

From a review of the USDA soils database, the predominant hydrologic soil group for the project site is Hydrologic Soil Group C. The existing land use consisted of Lawn, and Existing Buildings, Figure 4-16. By inputting the percent site area of each land use to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average pre-project CN is computed to be **81.8** (Figure 4-17).

Figure 4-16. Fort Hood, TX Project Site - Existing Landuse Conditions

DATE:	14-Jun-11	INSTALLATION:	Fort Hood, Texas		
PLANNER:	Bill Sproul				
PROJECT NAME:	New Storage Units				
ROJECT LOCATION:	Fort Hood				
JECT AREA (acres):	13.9	95% RAINFALL	1.94	SELECT THE SITE'S GEN. SOIL TYPE: Silty-Loam	HSG = C

PRE-PROJECT				POST-PROJECT		
LAND COVER	% of SITE	CN		LAND COVER	% of SITE	CN
WOODED (fair)				WOODED (fair)		
MEADOW				MEADOW		
BRUSH & WEEDS (fair)				BRUSH & WEEDS (fair)		
LAWN	82.7%	79		LAWN	74.7%	79
ROADS & DRIVES (W*/C&G)	8.8%	92		ROADS & DRIVES (W*/C&G)	9.0%	92
ROADS & DRIVES (W/C&G)				ROADS & DRIVES (W/C&G)		
PARKING, DRIVEWATS & SIDEWALKS				PARKING, DRIVEWATS & SIDEWALKS		
BUILDING ROOF	8.5%	98		BUILDING ROOF	16.3%	98
			SELECTION OF OTHER LAND COVER TYPES			
TOTAL %	100.0%			TOTAL %	100.0%	
WEIGHTED AVERAGE CNn =		81.8		WEIGHTED AVERAGE CNd =		83.3
RUNOFF VOLUME (95% RAIN) =	0.694	ACRE-FEET		RUNOFF VOLUME (95% RAIN) =	0.772	ACRE-FE
30227 CUBIC FEE	226095	GALLONS		33647 CUBIC FEE	251678	GALLONS

MINIMUM RUNOFF RETENTION VOLUME TO COMPLY WITH EISA 438 VOLUME CONTROL REQUIREMENT

0.079 ACRE-FEET 3,420 CUBIC FEET 25,583 GALLONS

Figure 4-17. Fort Hood Runoff Computations

4.5.4.3 Post-Project Conditions

The post project land use, Figure 4-18, consisted of Lawn, Existing Buildings, and New Buildings. By inputting the percent site area of each land use to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average pre-project CN is computed to be **83.3** (Figure 4-17).

Figure 4-18. Fort Hood, TX Project Site - Post-Project Landuse Conditions

4.5.4.4 Calculate EISA Volume Requirement

The next step in the hydrologic design is to compute the 95th percentile storm. Based on an evaluation of a 50 year period of record of daily precipitation at Fort Hood, Figure 4-19, the 95th percentile storm was computed to be **1.94 inches**.

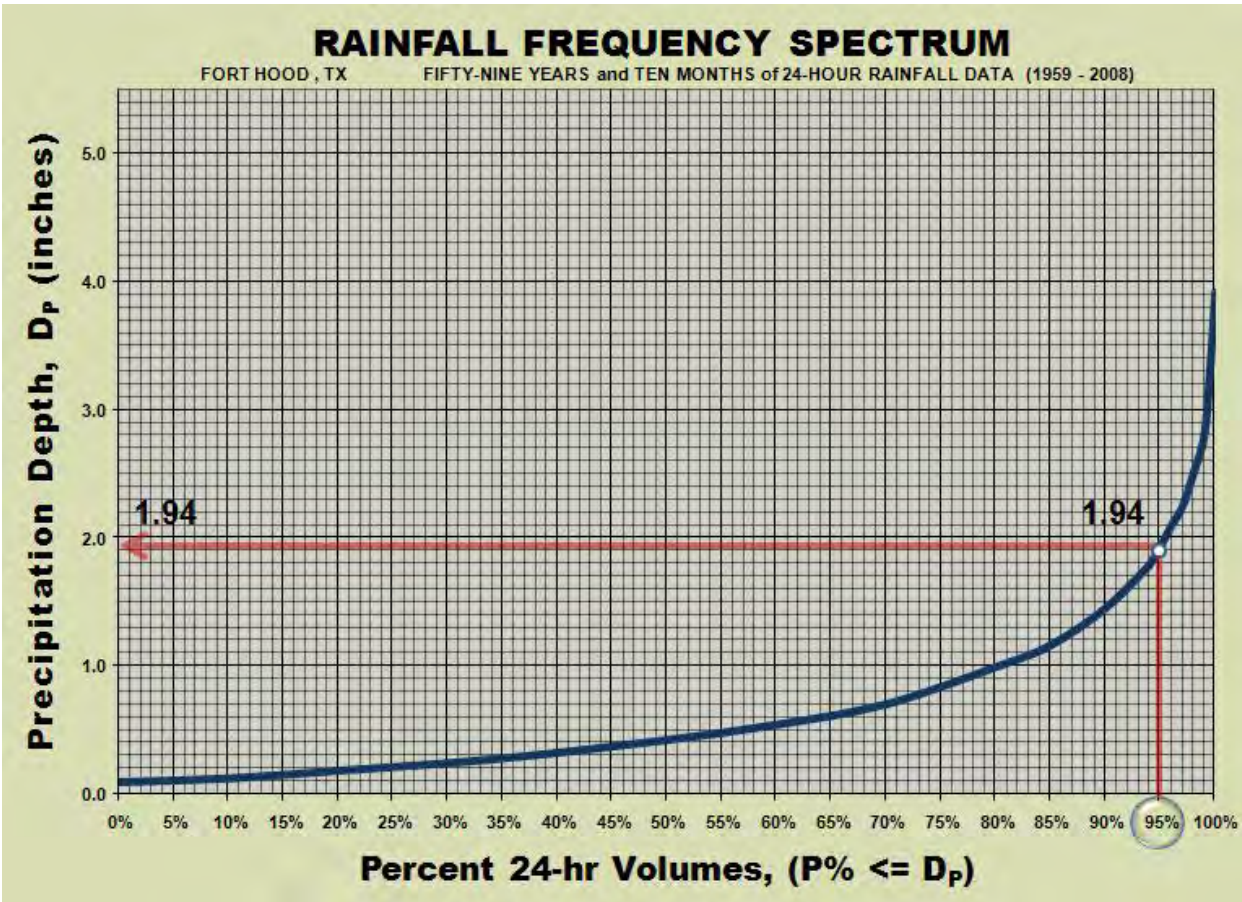


Figure 4-19. Fort Hood, TX - 95th Percentile Storm Depth (Inches)

At this point one is able to compute the peak runoff depths for both the existing and post project conditions using the SCS CN method. The peak runoff depths were computed to be 0.60 inches and 0.67 inches respectively using the 95th percentile storm.

Once one computes the existing and post runoff depths then they are able to compute the amount of water that needs to be managed on the project site by multiplying the change in runoff depth by the site area, 13.9 acres. From this analysis, the Fort Hood project needs to manage **3,420 ft^3** of runoff, as shown in Figure 4-17.

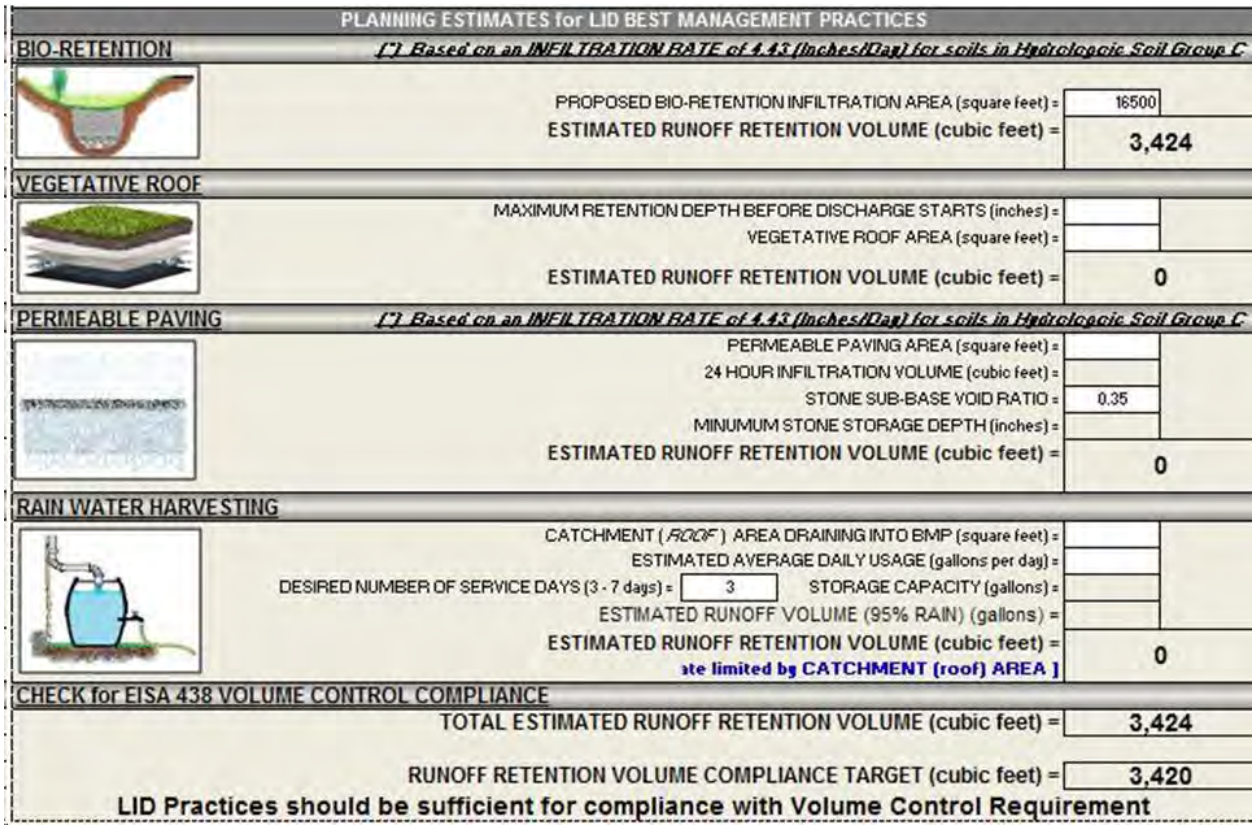
Input Parameters:
Site Area (A) = 13.9 acres
95th Storm (P) = 1.94 inches
Existing CN = 81.8
Post CN = 83.3

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \quad S = \frac{1000}{CN} - 10$$

Output:
Existing Q = 0.60 inches
Post Q = 0.67 inches

4.5.4.5 Select LID BMPs to Manage EISA Volume

The LID practice that was evaluated for this project was a series of rain gardens, Figure 4-20. For this analysis, a Group C soil allows for 4.43 inches/day of water removed from the project site using this LID practice. Since this LID feature is an infiltration practice, it was determined that a rain garden area of 16,500 ft^2 (0.38 acres) was needed assuming a 24-hour dissipation time.



PLANNING ESTIMATES for LID BEST MANAGEMENT PRACTICES		
BIO-RETENTION	[*] Based on an INFILTRATION RATE of 4.43 (inches/Day) for soils in Hydrologgic Soil Group C	
	PROPOSED BIO-RETENTION INFILTRATION AREA (square feet) =	16500
	ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	3,424
VEGETATIVE ROOF		
	MAXIMUM RETENTION DEPTH BEFORE DISCHARGE STARTS (inches) =	
	VEGETATIVE ROOF AREA (square feet) =	
	ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	0
PERMEABLE PAVING	[*] Based on an INFILTRATION RATE of 4.43 (inches/Day) for soils in Hydrologgic Soil Group C	
	PERMEABLE PAVING AREA (square feet) =	
	24 HOUR INFILTRATION VOLUME (cubic feet) =	
	STONE SUB-BASE VOID RATIO =	0.35
	MINUMUM STONE STORAGE DEPTH (inches) =	
	ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	0
RAIN WATER HARVESTING		
	CATCHMENT (ROOF) AREA DRAINING INTO BMP (square feet) =	
	ESTIMATED AVERAGE DAILY USAGE (gallons per day) =	
	DESIRED NUMBER OF SERVICE DAYS (3 - 7 days) = 3 STORAGE CAPACITY (gallons) =	
	ESTIMATED RUNOFF VOLUME (95% RAIN) (gallons) =	
	ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = ate limited by CATCHMENT (roof) AREA]	0
CHECK for EISA 438 VOLUME CONTROL COMPLIANCE		
	TOTAL ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	3,424
	RUNOFF RETENTION VOLUME COMPLIANCE TARGET (cubic feet) =	3,420
LID Practices should be sufficient for compliance with Volume Control Requirement		

Figure 4-20. Fort Hood LID BMP Computations

Since the Total Runoff Volume Retained (3,424 ft^3) exceeds the EISA Volume Requirement (3,420 ft^3), this project is expected to comply with EISA Section 438 using the selected LID BMPs.

4.5.5 Fort Benning Case Study

4.5.5.1 Background

Fort Benning is a United States military post located outside of Columbus, GA (Figure 4-21). Columbus, GA, gets 49 inches of rain per year. The number of days with any measurable precipitation is 109. On average, there are 212 sunny days per year in Columbus, GA. The July high is around 92°F and the January low is 36°F.

Figure 4-21. Fort Benning, GA Vicinity Map

Fort Benning was established is 1918 and is named for Major General Henry L. Benning. It is south of Columbus, Georgia on U.S. highway 27. It has an active duty population of 34,834. This includes both reserve components. Fort Benning covers 73,533 hectares (181,626 acres) of land with 93% in west central Georgia and the remaining 7% in east central Alabama. Major portions of land lie in 3 counties: Muscogee and Chattahoochee Counties Georgia and Russell County in Alabama. There are about 124 hectares of open water, including ponds, streams, and rivers. The Chattahoochee River divides Fort Benning between Georgia and Alabama.

The Fort Benning installation can be seen in Figure 4-22.

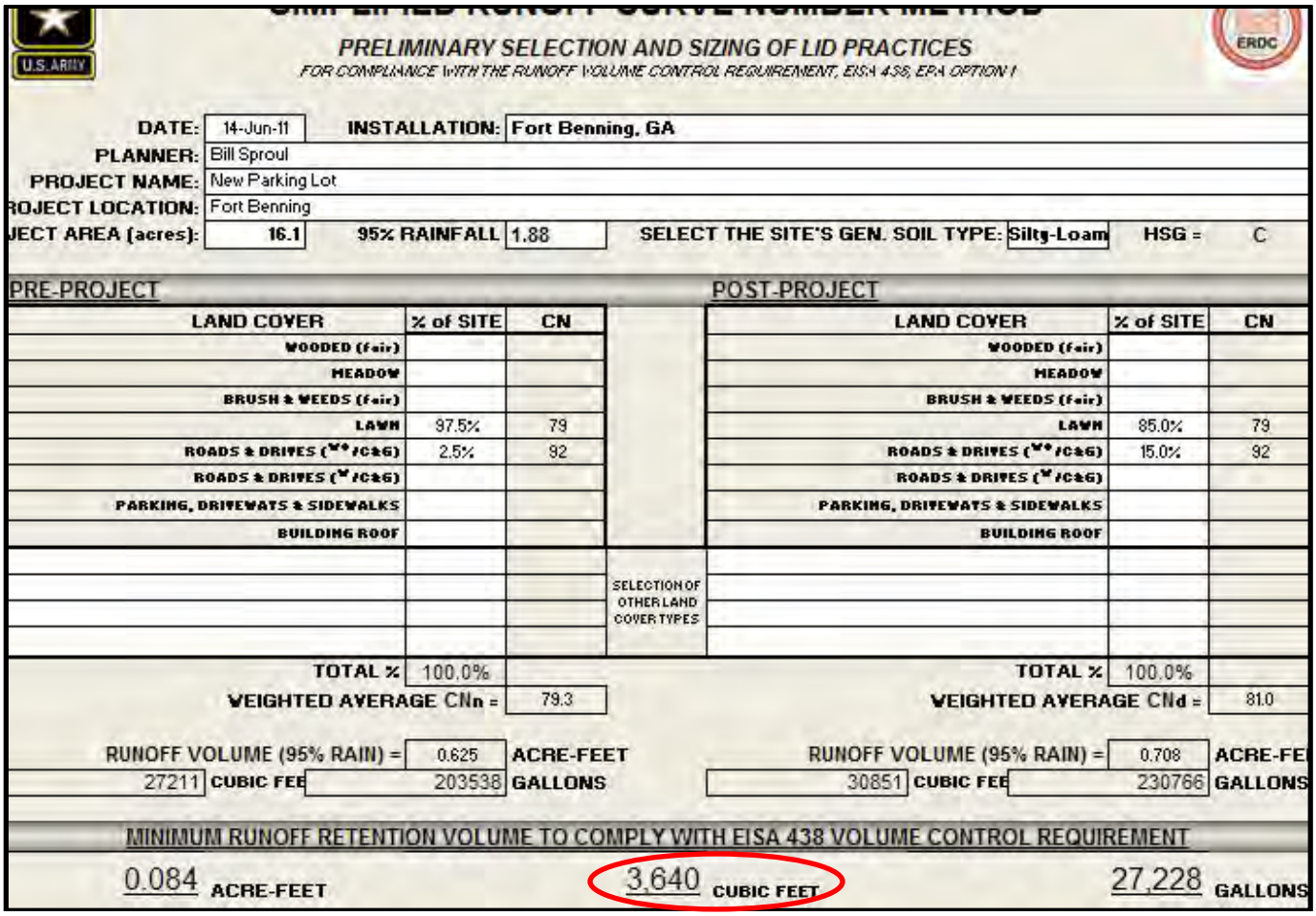
Figure 4-22. Fort Benning, GA Installation Area

4.5.5.2 Pre-Project Conditions

For this demonstration project, a new impervious parking lot was added to the project site.

From a review of the USDA soils database, the predominant hydrologic soil group for the project site is Hydrologic Soil Group C. The existing land use consisted of Grassland and Road, Figure 4-23. By inputting the percent site area of each land use to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average pre-project CN is computed to be **79.3** (Figure 4-24).

Figure 4-23. Fort Benning, GA Project Site - Existing Landuse Conditions



PRELIMINARY SELECTION AND SIZING OF LID PRACTICES

FOR COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, EPA OPTION I

DATE: 14-Jun-11 INSTALLATION: Fort Benning, GA

PLANNER: Bill Sproul

PROJECT NAME: New Parking Lot

ROJECT LOCATION: Fort Benning

JECT AREA (acres): 16.1 95% RAINFALL 1.88 SELECT THE SITE'S GEN. SOIL TYPE: Silty-Loam HSG = C

PRE-PROJECT				POST-PROJECT		
LAND COVER	% of SITE	CN		LAND COVER	% of SITE	CN
WOODED (Fair)				WOODED (Fair)		
MEADOW				MEADOW		
BRUSH & WEEDS (Fair)				BRUSH & WEEDS (Fair)		
LAWN	97.5%	79		LAWN	85.0%	79
ROADS & DRIVES (W*/C&G)	2.5%	92		ROADS & DRIVES (W*/C&G)	15.0%	92
ROADS & DRIVES (W/C&G)				ROADS & DRIVES (W/C&G)		
PARKING, DRIVEWATS & SIDEWALKS				PARKING, DRIVEWATS & SIDEWALKS		
BUILDING ROOF				BUILDING ROOF		
			SELECTION OF OTHER LAND COVER TYPES			
TOTAL %	100.0%			TOTAL %	100.0%	
WEIGHTED AVERAGE CNn =		79.3		WEIGHTED AVERAGE CNd =		81.0

RUNOFF VOLUME (95% RAIN) = 0.625 ACRE-FEET 27211 CUBIC FEE 203538 GALLONS

RUNOFF VOLUME (95% RAIN) = 0.708 ACRE-FE 30851 CUBIC FEE 230766 GALLONS

MINIMUM RUNOFF RETENTION VOLUME TO COMPLY WITH EISA 438 VOLUME CONTROL REQUIREMENT

0.084 ACRE-FEET 3,640 CUBIC FEET 27,228 GALLONS

Figure 4-24. Fort Benning Runoff Computations

4.5.5.3 Post-Project Conditions

The post project land use (Figure 4-25), consisted of Grassland, Road, and New Parking Lot. By inputting the percent site area of each land use to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average pre-project CN is computed to be **81.0** (Figure 4-24).

Figure 4-25. Fort Benning, GA Project Site - Post-project Landuse Conditions

4.5.5.4 Calculate EISA Volume Requirement

The next step in the hydrologic design is to compute the 95th percentile storm. Based on an evaluation of a 50 year period of record of daily precipitation at Fort Benning (Figure 4-26), the 95th percentile storm was computed to be **1.88 inches**.

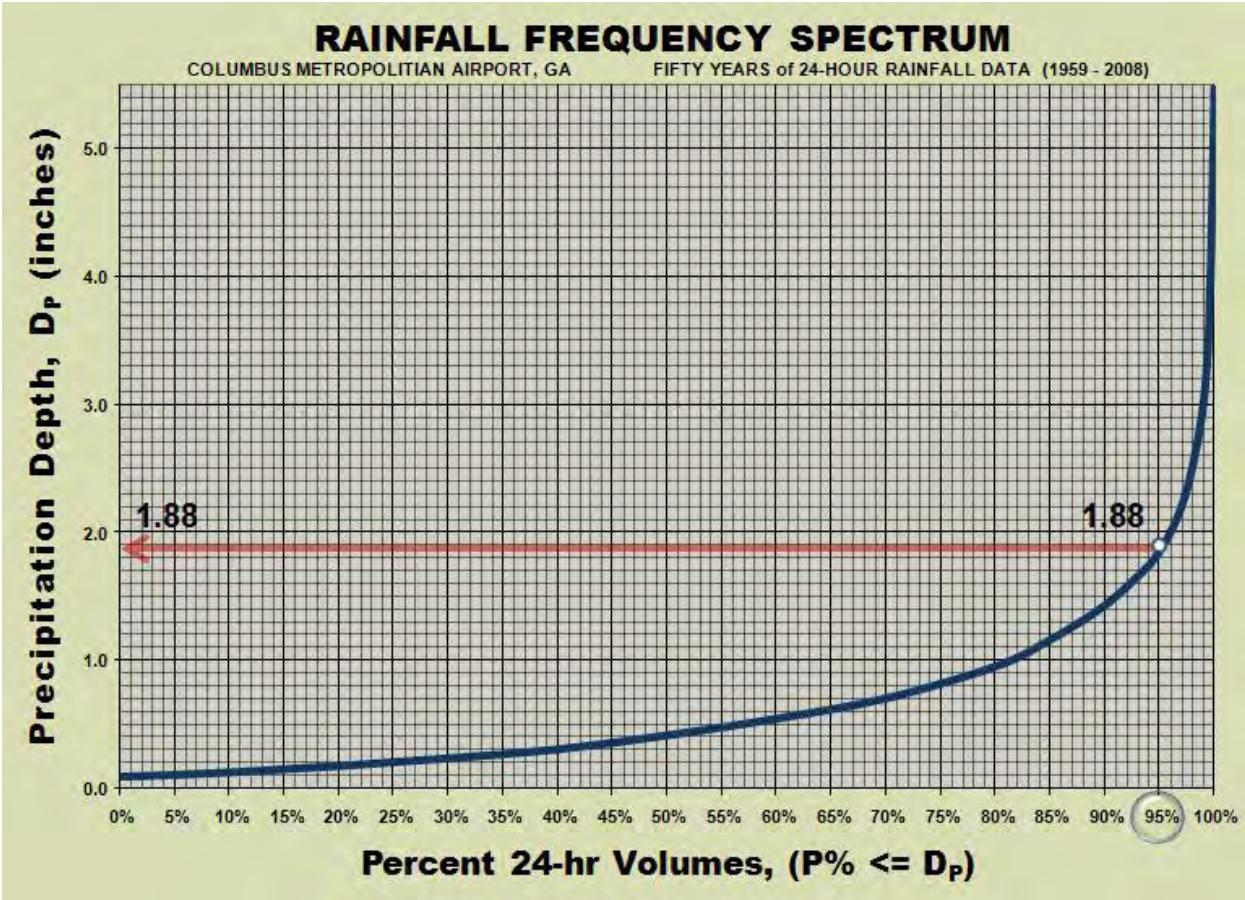


Figure 4-26. Fort Benning, GA - 95th Percentile Storm Depth (Inches)

At this point one is able to compute the peak runoff depths for both the existing and post project conditions using the SCS CN method. The peak runoff depths were computed to be 0.46 inches and 0.53 inches respectively using the 95th percentile storm.

Once one computes the existing and post project runoff depths, then they are able to compute the amount of water that needs to be managed on the project site by multiplying the change in runoff depth by the site area, 16.1 acres. From this analysis, the Fort Benning project needs to manage **3,640 ft^3** of runoff.

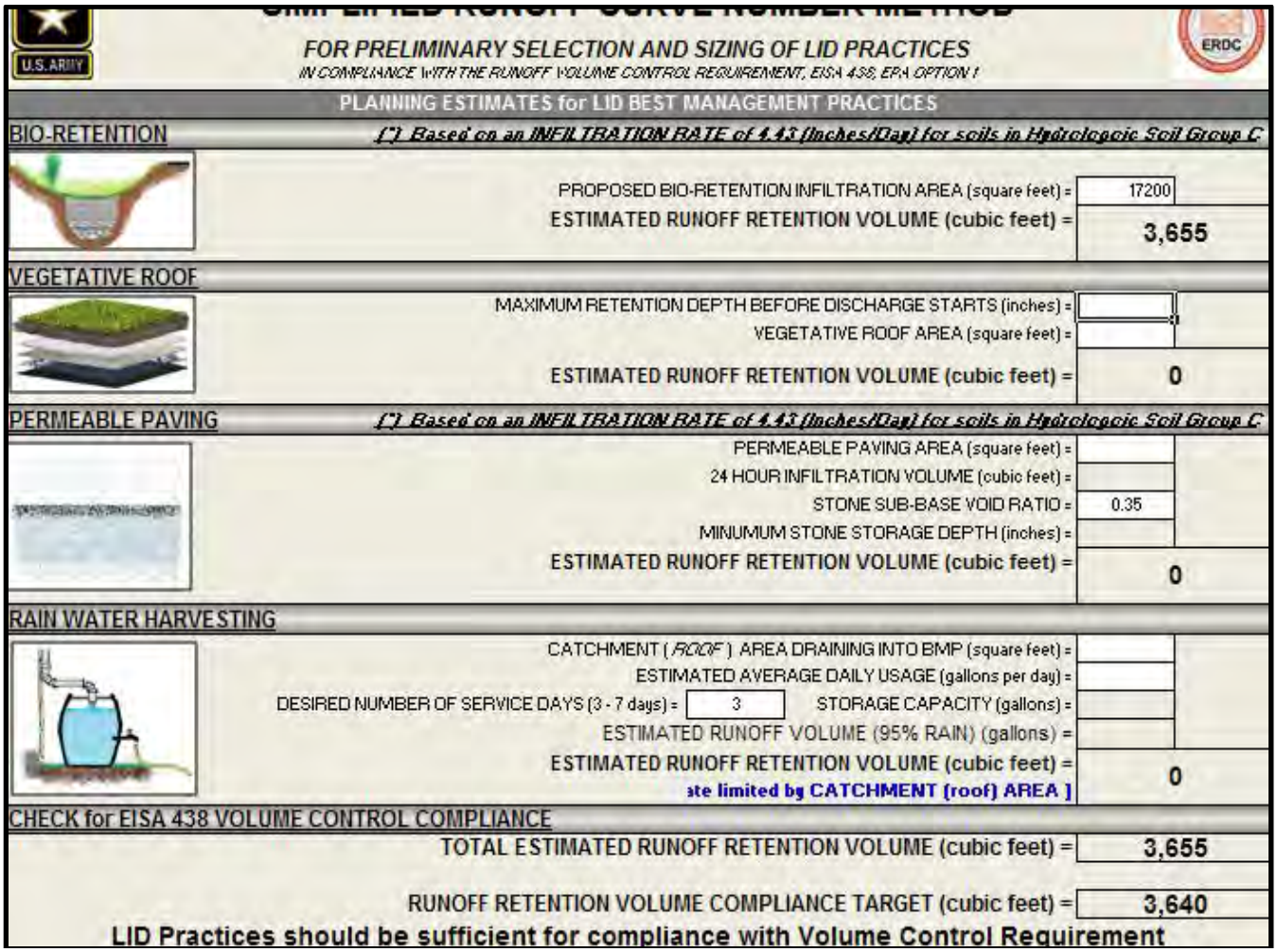
Input Parameters:
Site Area (A) = 16.1 acres
95th Storm (P) = 1.88 inches
Existing CN = 79.3
Post CN = 81.0

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \quad S = \frac{1000}{CN} - 10$$

Output:
Existing Q = 0.46 inches
Post Q = 0.53 inches

4.5.5.5 Select LID BMPs to Manage EISA Volume

The LID practice that was evaluated for this project was a bioswale, Figure 4-27. For this analysis, a Group C soil allows for 4.43 inches/day of water removed from the project site using this LID practice. Since this LID feature is an infiltration practice, it was determined that a bioswale of 17,200 ft2 (0.4 acres) was needed assuming a 24-hour dissipation time.



FOR PRELIMINARY SELECTION AND SIZING OF LID PRACTICES

IN COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, EPA OPTION 1

PLANNING ESTIMATES for LID BEST MANAGEMENT PRACTICES

BIO-RETENTION — [*] Based on an INFILTRATION RATE of 4.43 (Inches/Day) for soils in Hydrologic Soil Group C

PROPOSED BIO-RETENTION INFILTRATION AREA (square feet) = 17200

ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 3,655

VEGETATIVE ROOF

MAXIMUM RETENTION DEPTH BEFORE DISCHARGE STARTS (inches) =

VEGETATIVE ROOF AREA (square feet) =

ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 0

PERMEABLE PAVING — [*] Based on an INFILTRATION RATE of 4.43 (Inches/Day) for soils in Hydrologic Soil Group C

PERMEABLE PAVING AREA (square feet) =

24 HOUR INFILTRATION VOLUME (cubic feet) =

STONE SUB-BASE VOID RATIO = 0.35

MINUMUM STONE STORAGE DEPTH (inches) =

ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 0

RAIN WATER HARVESTING

CATCHMENT (ROOF) AREA DRAINING INTO BMP (square feet) =

ESTIMATED AVERAGE DAILY USAGE (gallons per day) =

DESIRED NUMBER OF SERVICE DAYS (3 - 7 days) = 3 STORAGE CAPACITY (gallons) =

ESTIMATED RUNOFF VOLUME (95% RAIN) (gallons) =

ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 0

ate limited by CATCHMENT (roof) AREA]

CHECK for EISA 438 VOLUME CONTROL COMPLIANCE

TOTAL ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 3,655

RUNOFF RETENTION VOLUME COMPLIANCE TARGET (cubic feet) = 3,640

LID Practices should be sufficient for compliance with Volume Control Requirement

Figure 4-27. Fort Benning, GA LID BMP Computations

Since the Total Runoff Volume Retained (3,655 ft^3) exceeds the EISA Volume Requirement (3,640 ft^3), this project is expected to comply with EISA Section 438 using the selected LID BMPs.

4.5.6 Fort Meade Case Study #1: AWG Headquarters Complex

4.5.6.1 Background

Fort Meade is a United States military post located outside of Baltimore, MD (Figure 4-28). Fort Meade, MD, gets 44 inches of rain per year. The number of days with any measurable precipitation is 109. On average, there are 215 sunny days per year in Fort Meade, MD. The July high is around 88°F and the January low is 24°F.

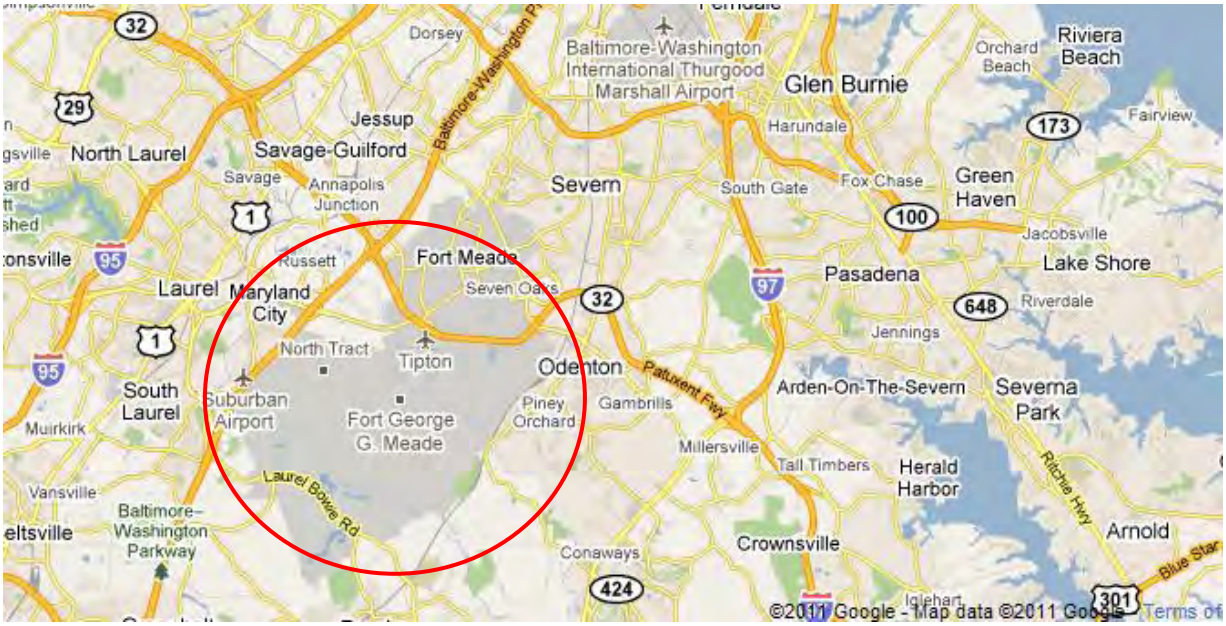


Figure 4-28. Fort Meade, MD Vicinity Map

Fort Meade became an active Army installation in 1917. Authorized by an Act of Congress in May 1917, it was one of 16 cantonments built for troops drafted for the war with the Central Powers in Europe. In August 1990, Fort Meade began processing Army Reserve and National Guard units from several states for the presidential call-up in support of Operation Desert Shield. In addition to processing reserve and guard units, Fort Meade sent two of its own active duty units, the 85th Medical Battalion and the 519th Military Police Battalion, to Saudi Arabia. In all, approximately 2,700 personnel from 42 units deployed from Fort Meade during Operation Desert Shield/Desert Storm.

The Fort Meade installation can be seen in Figure 4-29.

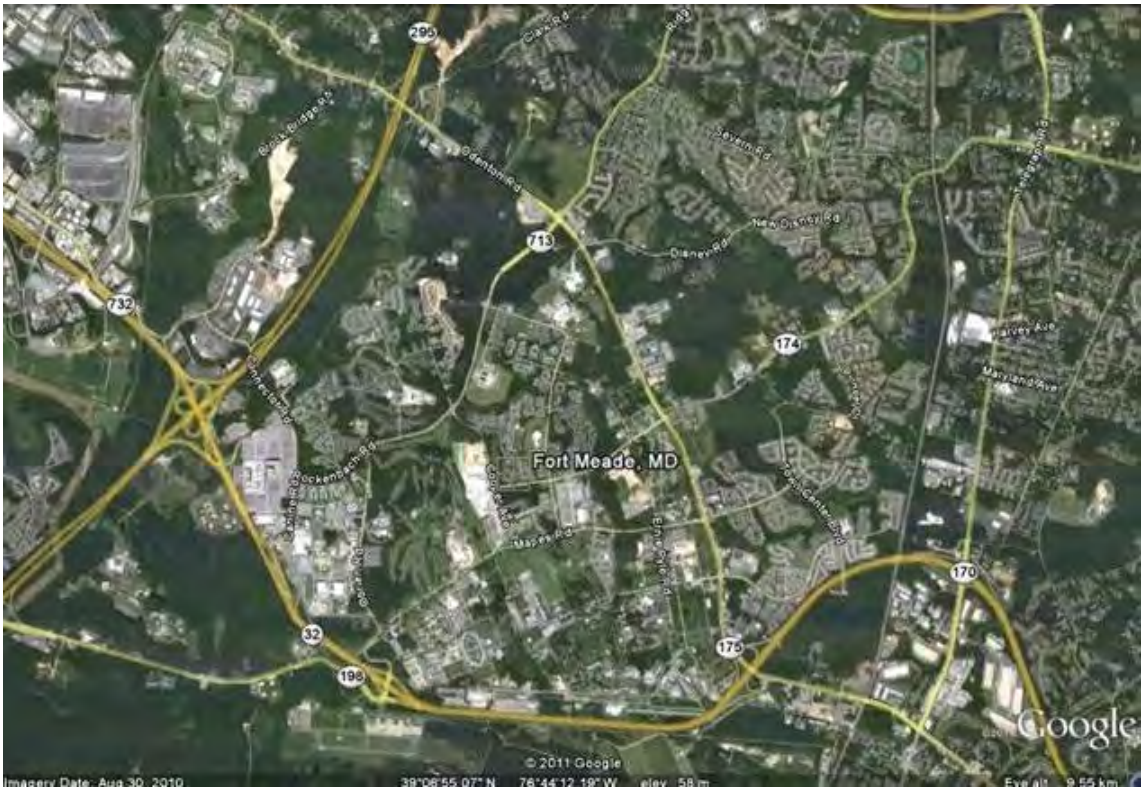


Figure 4-29. Fort Meade, MD Installation Area

4.5.6.2 Pre-Project Conditions

This project includes a proposed Headquarters Building, Visitor Control Center, and associated roads and parking.

The existing 9.30 acre site, as shown in Figure 4-30 is predominantly meadow, with a small pocket of mature woods. There are a few abandoned buildings and associated pavement to be demolished as part of this project. There are no wetlands or streams within the site limits. Groundwater is not an issue; soil borings show the water table to be at least 15 feet below the ground surface. Based on a review of the USDA soils database, the predominant hydrologic soil group for the project site is Hydrologic Soil Group B, "Sandy Loam".

By inputting the percent site area of each land use (Meadow, Woods, Building Roof, Parking/Driveways/Sidewalk) to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average pre-project CN is computed to be **62** (Figure 4-32).

Figure 4-30. Pre-Project Landuse Conditions

4.5.6.3 Post-Project Conditions

The proposed includes a 47,000 square foot Headquarters Building, a 2,900 square foot Visitor Control Center (VCC), and supporting facilities including parking, a loading dock, a maintenance drive, and a front drop off circle.

The post-project land use, Figure 4-31, consists of Grass, Building Roof, and Parking/Driveways/Sidewalks. By inputting the percent of site area of each land use to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average post-project CN is computed to be **80** (Figure 4-32).

Figure 4-31. Post-Project Landuse Conditions

LOW IMPACT DEVELOPMENT

SIMPLIFIED RUNOFF CURVE NUMBER METHOD

PRELIMINARY SELECTION AND SIZING OF STRUCTURAL LID PRACTICES

FOR COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, MODIFIED EPA OPTION 2

U.S. ARMY — ERDC

V 9.2 — PLANNING ESTIMATES for PRE & POST RUNOFF VOLUMES — Page 1 of 3

DATE:	5-Oct-2012	ARMY INSTALLATION:	FORT MEADE				
PLANNER:	EEM						
PROJECT NAME:	AWG HEADQUARTERS COMPLEX						
PROJECT LOCATION:	ROCK AVE.						
PROJECT AREA (acres):	9.3	95% RAINFALL	1.6	SELECT THE SITE'S OVERALL SOIL TYPE:	Sandy-Loam	HSG =	B

PRE-PROJECT				POST-PROJECT		
LAND COVER	% of SITE	CN		LAND COVER	% of SITE	CN
WOODED (fair)	9.4%	60		WOODED (fair)		
MEADOW	82.0%	58		MEADOW		
BRUSH & WEEDS (fair)				BRUSH & WEEDS (fair)		
LAWN				LAWN	61.0%	69
ROADS & DRIVES (HSG/C&G)				ROADS & DRIVES (HSG/C&G)		
ROADS & DRIVES (W/C&G)				ROADS & DRIVES (W/C&G)		
PARKING, DRIVEWAYS & SIDEWALKS	4.6%	98		PARKING, DRIVEWAYS & SIDEWALKS	27.0%	98
BUILDING ROOF	4.0%	98		BUILDING ROOF	12.0%	98
			SELECTION OF OTHER LAND COVER TYPES			
TOTAL %	1			TOTAL %	1	
WEIGHTED AVERAGE CNn =		62		WEIGHTED AVERAGE CNd =		80

Figure 4-32. Pre-Project and Post-Project Curve Numbers

4.5.6.4 Calculate EISA Volume Requirement

At this point one is able to calculate the EISA Volume Requirement for the project, using the inputs of Pre-Project CN, Post-Project CN, Site Area, and 95th percentile storm depth. For this example, instead of calculating the 95th percentile rainfall depth as in previous examples, the 95th percentile depth for Baltimore, MD, given in Table 4-1 of this guide (also in Table 1 of EPA's *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act*) is used, **1.6 inches**.

The spreadsheet tool uses the SCS CN Method to compute the peak runoff volumes for both pre- and post-project conditions. The peak runoff volumes are computed to be 645 ft^3 and 11,672 ft^3, respectively. The difference between these volumes is the EISA Volume Requirement, which is the amount of runoff that needs to be retained on site using LID BMPs.

From this analysis, the Fort Meade project needs to manage **11,027 ft^3** of runoff, as shown in Figure 4-33.

<u>Input Parameters:</u>
Site Area (A) = 9.3 acres
95th Storm (P) = 1.6 inches
Existing CN = 62
Post CN = 80

<u>Output:</u>

$$S = \frac{1000}{CN} - 10$$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} x(A)$$

Q = Runoff Volume (ft^3)
Pre-Project Q = 645 ft^3
Post-Project Q = 11,672 ft^3
Difference in Q = 11,027 ft^3

SIMPLIFIED RUNOFF CURVE NUMBER METHOD

PRELIMINARY SELECTION AND SIZING OF STRUCTURAL LID PRACTICES

FOR COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, MODIFIED EPA OPTION 2

V 9.2 — PLANNING ESTIMATES for PRE & POST RUNOFF VOLUMES — Page 1 of 3

DATE:	5-Oct-2012	ARMY INSTALLATION:	FORT MEADE
PLANNER:	EEM		
PROJECT NAME:	AWG HEADQUARTERS COMPLEX		
PROJECT LOCATION:	ROCK AVE.		
PROJECT AREA (acres):	9.3	95% RAINFALL	1.6

SELECT THE SITE'S OVERALL SOIL TYPE: Sandy-Loam — HSG = B

PRE-PROJECT LAND COVER	% of SITE	CN	POST-PROJECT LAND COVER	% of SITE	CN
WOODED (fair)	9.4%	60	WOODED (fair)		
MEADOW	82.0%	58	MEADOW		
BRUSH & WEEDS (fair)			BRUSH & WEEDS (fair)		
LAWN			LAWN	61.0%	69
ROADS & DRIVES (WC/C&G)			ROADS & DRIVES (WC/C&G)		
ROADS & DRIVES (W/C&G)			ROADS & DRIVES (W/C&G)		
PARKING, DRIVEWAYS & SIDEWALKS	4.6%	98	PARKING, DRIVEWAYS & SIDEWALKS	27.0%	98
BUILDING ROOF	4.0%	98	BUILDING ROOF	12.0%	98
			SELECTION OF OTHER LAND COVER TYPES		
TOTAL %	1		TOTAL %	1	
WEIGHTED AVERAGE CNn =		62	WEIGHTED AVERAGE CNd =		80
RUNOFF VOLUME (95% RAIN) =	0.01	ACRE-FEET	RUNOFF VOLUME (95% RAIN) =	0.267949603	ACRE-FEET
645 CUBIC FEET	4828	GALLONS	11672 CUBIC FEET	87306	GALLONS

MINIMUM RUNOFF RETENTION VOLUME TO COMPLY WITH EISA 438 VOLUME CONTROL REQUIREMENT

0.25 ACRE-FEET — 11027 CUBIC FEET — 82478 GALLONS

Figure 4-33. Runoff Computations

4.5.6.5 Select LID BMPs to Manage EISA Volume

The LID practices chosen for this project to retain runoff is bioretention areas, concrete permeable pavers, and infiltration trenches (dry well). Figure 4-34 shows these proposed practices. Inputing the proposed surface area of each LID BMP in the spreadsheet, the volume of runoff retained is calculated, as shown in Figure 4-35. Summing these retention volumes (15947 ft^3 + 214 ft^3 + 1773 ft^3 + 1640 ft^3) gives a Total Volume Retained for the site, **19,574 ft^3**.

Since the Total Runoff Volume Retained (19,574 ft^3) exceeds the EISA Volume Requirement (11,027 ft^3), this project fulfills EISA Section 438 with the selected LID BMPs.

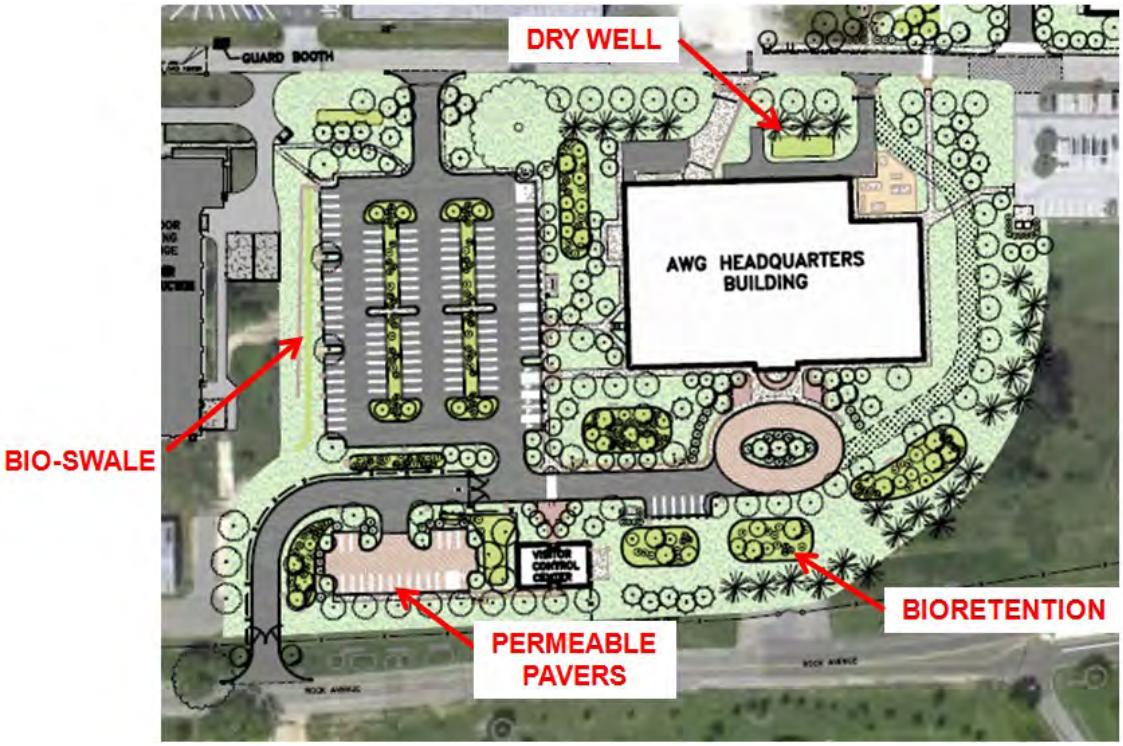


Figure 4-34. Proposed LID BMPs Implemented

SIMPLIFIED RUNOFF CURVE NUMBER METHOD

FOR PRELIMINARY SELECTION AND SIZING OF LID PRACTICES

IN COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, EPA OPTION 1

V 9.2 — PLANNING ESTIMATES for LID BEST MANAGEMENT PRACTICES — Page 2 of 3

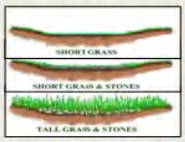
1.1.1.BIO-RETENTION

(*) Based on an INFILTRATION RATE of 9.743 (Inches/Day) for soils in Hydrologoic Soil Group B

PROPOSED BIO-RETENTION INFILTRATION AREA (square feet) =	23500
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	**15947**

1.1.2. SWALE

(*) Based on an INFILTRATION RATE of 9.743 (Inches/Day) for soils in Hydrologoic Soil Group B



SELECT SWALE TYPE =	TRAPEZOIDAL	SWALE TOP WIDTH (ft) =	16
SELECT GRADIENT (%) =	0.01	SWALE BOTTOM WIDTH (ft) =	4
SELECT SWALE SURFACE TYPE =	Short Grass, Few Weeds	MANNING'S n VALUE =	0.027
EST. FLOW AREA (sf) =	4995	EST. SURFACE STORAGE VOLUME (cubic feet) =	52
		ESTIMATED RUNOFF INFILTRATION VOLUME (cubic feet) =	162
		ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	**214**

1.1.3. VEGETATIVE FILTER STRIP

THE REDUCTION IN POST PROJECT RUNOFF FOR THIS LID PRACTICE IS ACCOUNTED FOR BY SELECTING IN AS ONE OF THE VARIOUS POST PROJECT "LAND COVERS" AND ENTERING THE PERCENTAGE OF THE SITE AREA PROPOSED FOR THIS USE.

1.1.4.PERMEABLE PAVING

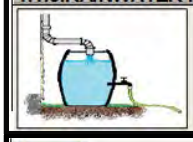
(*) Based on an INFILTRATION RATE of 9.743 (Inches/Day) for soils in Hydrologoic Soil Group B

ASSUMPTION IS THAT ONLY THE RAIN FALLING ON THE PAVEMENT IS BEING RETAINED

PERMEABLE PAVING AREA (sqft) =	13300
STONE SUB-BASE VOID RATIO =	0.4
MINUMUM STONE STORAGE DEPTH (inches) =	6.00
INFILTRATION TIME from STONE SUB-BASE (days) =	0
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	**1773**

[Estimate limited by the 95% RAINFALL. The available Retention Volume exceeds the required 95% RAINFALL]

1.1.5.RAINWATER HARVESTING



CATCHMENT (*ROOF*) AREA DRAINING INTO BMP (square feet) =	
ESTIMATED AVERAGE DAILY USAGE (gallons per day) =	
DESIRED NUMBER OF SERVICE DAYS (3 - 7 days) =	STORAGE CAPACITY (gallons) =
	ESTIMATED RUNOFF VOLUME (95% rain) (gallons) =
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	**0**

[Estimate limited by USAGE RATE]

SIMPLIFIED RUNOFF CURVE NUMBER METHOD

FOR PRELIMINARY SELECTION AND SIZING OF LID PRACTICES

IN COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, EPA OPTION 1

V 9.2 — PLANNING ESTIMATES for LID BEST MANAGEMENT PRACTICES — Page 3 of 3

1.1.6.GREEN ROOF

MAXIMUM RETENTION DEPTH BEFORE DISCHARGE STARTS (inches) =	
VEGETATIVE ROOF AREA (sqft) =	
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) =	**0**

1.1.7.INFILTRATION PRACTICE

(*) Based on an INFILTRATION RATE of 9.743 (Inches/Day) for soils in Hydrologoic Soil Group B

INFILTRATION BED AREA (sqft) =	2020	INFLITRATION BED DEPTH (ft) = 5	STONE VOLUME (cf) = 10100
STONE SUB-BASE VOID RATIO =	0.4		INFILTRATION RATE FOR HSG B (inches/day) = 9.743
EST. RUNOFF STORAGE VOLUME (cf) =	4040		POTENTIAL INFILTRATION VOLUME (cf) = 1640
		EST. INFILTRATION VOLUME (cubic feet) =	**1640**

Figure 4-35. LID BMP Computations

4.5.7 Fort Meade Case Study #2: Vehicle Maintenance Facility

4.5.7.1 Background

Please see Section 4.5.6.1 for Fort Meade background information. It is referenced instead of copied here to minimize redundancy.

4.5.7.2 Pre-Project Conditions

This re-development project includes a proposed Vehicle Maintenace Facility and associated pavement for vehicle and supply storage.

The existing 3.0 acre site, as shown in Figure 4-36 is developed and mostly impervious, with an existing building and associated pavement. These will be demolished as part of this prior to constructing the Vehicle Maintenance Facility. The site area is surrounded by mature woods. The site drains to the northwest to an ephemeral stream. Groundwater is not an issue; soil borings show the water table to be at least 15 feet below the grouned surface. Based on a review of the USDA soils database, the predominant hydrologic soil group for the project site is Hydrologic Soil Group A, "Sandy".

By inputting the percent site area of each land use (Building Roof, Parking/Driveway/Sidewalk, Grass) to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average pre-project CN is computed to be **87** (Figure 4-38).

Figure 4-36. Pre-Project Landuse Conditions

4.5.7.3 Post-Project Conditions

The proposed includes a 14,000 square foot Vehicle Maintenace building with surrounding pavement for vehicle and supply storage. There is no POV parking requirement for this project; the existing parking lot south of the site will be used.

The post-project land use, Figure 4-37, consists of Grass, Building Roof, and Parking/Driveway/Sidewalks. By inputting the percent of site area of each land use to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average post-project CN is computed to be **90** (Figure 4-38).

Figure 4-37. Post-Project Landuse Conditions

SIMPLIFIED RUNOFF CURVE NUMBER METHOD

PRELIMINARY SELECTION AND SIZING OF STRUCTURAL LID PRACTICES

FOR COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, MODIFIED EPA OPTION 2

V 9.2 — PLANNING ESTIMATES for PRE & POST RUNOFF VOLUMES — Page 1 of 3

DATE:	5-Oct-2012	ARMY INSTALLATION:	FORT MEADE
PLANNER:	EEM		
PROJECT NAME:	VEHICLE MAINTENANCE FACILITYY (VMF)		
PROJECT LOCATION:	MORRISON STREET		
PROJECT AREA (acres):	3.0	95% RAINFALL	1.6

SELECT THE SITE'S OVERALL SOIL TYPE: Sandy — HSG = A

PRE-PROJECT LAND COVER	% of SITE	CN	POST-PROJECT LAND COVER	% of SITE	CN
WOODED (fair)			WOODED (fair)		
MEADOW			MEADOW		
BRUSH & WEEDS (fair)			BRUSH & WEEDS (fair)		
LAWN	23.0%	49	LAWN	16.0%	49
ROADS & DRIVES (IMC/C&G)			ROADS & DRIVES (IMC/C&G)		
ROADS & DRIVES (IM/C&G)			ROADS & DRIVES (IM/C&G)		
PARKING, DRIVEWAYS & SIDEWALKS	59.0%	98	PARKING, DRIVEWAYS & SIDEWALKS	74.0%	98
BUILDING ROOF	18.0%	98	BUILDING ROOF	10.0%	98
			SELECTION OF OTHER LAND COVER TYPES		
TOTAL %	1		TOTAL %	1	
WEIGHTED AVERAGE CNn =		87	WEIGHTED AVERAGE CNd =		90

Figure 4-38. Pre-Project and Post-Project Curve Numbers

4.5.7.4 Calculate EISA Volume Requirement

At this point one is able to calculate the EISA Volume Requirement for the project, using the inputs of Pre-Project CN, Post-Project CN, Site Area, and 95th percentile storm depth. For this example, instead of calculating the 95th percentile rainfall depth as in previous examples, the 95th percentile depth for Baltimore, MD, given in Table 4-1 of this guide (also in Table 1 of EPA's *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act*) is used, **1.6 inches**.

The spreadsheet tool uses the SCS CN Method to compute the peak runoff volumes for both pre- and post-project conditions. The peak runoff volumes are computed to be 6,457 ft^3 and 8,407 ft^3, respectively. The difference between these volumes is the EISA Volume Requirement, which is the amount of runoff that needs to be retained on site using LID BMPs.

From this analysis, the Fort Meade project needs to manage **1,950 ft^3** of water, as shown in Figure 4-39.

Input Parameters:
Site Area (A) = 3.0 acres
95th Storm (P) = 1.6 inches
Existing CN = 87
Post CN = 90

Output:

$$S = \frac{1000}{CN} - 10$$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} x(A)$$

Q = Runoff Volume (ft^3)
Pre-Project Q = 6,457 ft^3
Post-Project Q = 8,407 ft^3
Difference in Q = 1,950 ft^3

SIMPLIFIED RUNOFF CURVE NUMBER METHOD
PRELIMINARY SELECTION AND SIZING OF STRUCTURAL LID PRACTICES
FOR COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, MODIFIED EPA OPTION 2

V 9.2 | PLANNING ESTIMATES for PRE & POST RUNOFF VOLUMES | Page 1 of 3

DATE:	5-Oct-2012	ARMY INSTALLATION:	FORT MEADE		
PLANNER:	EEM				
PROJECT NAME:	VEHICLE MAINTENANCE FACILITYY (VMF)				
PROJECT LOCATION:	MORRISON STREET				
PROJECT AREA (acres):	3.0	95% RAINFALL	1.6	SELECT THE SITE'S OVERALL SOIL TYPE: Sandy	HSG = A

PRE-PROJECT LAND COVER	% of SITE	CN	POST-PROJECT LAND COVER	% of SITE	CN
WOODED (fair)			WOODED (fair)		
MEADOW			MEADOW		
BRUSH & WEEDS (fair)			BRUSH & WEEDS (fair)		
LAWN	23.0%	49	LAWN	16.0%	49
ROADS & DRIVES (INC/C&G)			ROADS & DRIVES (INC/C&G)		
ROADS & DRIVES (IN/C&G)			ROADS & DRIVES (IN/C&G)		
PARKING, DRIVEWAYS & SIDEWALKS	59.0%	98	PARKING, DRIVEWAYS & SIDEWALKS	74.0%	98
BUILDING ROOF	18.0%	98	BUILDING ROOF	10.0%	98
			SELECTION OF OTHER LAND COVER TYPES		
TOTAL %	1		TOTAL %	1	
WEIGHTED AVERAGE CNn =	87		WEIGHTED AVERAGE CNd =	90	
RUNOFF VOLUME (95% RAIN) =	0.15	ACRE-FEET	RUNOFF VOLUME (95% RAIN) =	0.192990864	ACRE-FEET
6457 CUBIC FEET	48297	GALLONS	8407 CUBIC FEET	62882	GALLONS

MINIMUM RUNOFF RETENTION VOLUME TO COMPLY WITH EISA 438 VOLUME CONTROL REQUIREMENT

0.04 ACRE-FEET | 1950 CUBIC FEET | 14585 GALLONS

Figure 4-39. Runoff Computations

4.5.7.5 Select LID BMPs to Manage EISA Volume

The LID practices chosen for this project to retain runoff is bioretention areas, bio-swale, grass swale, and landscape infiltration. Figure 4-40 shows these proposed practices. Inputing the proposed surface area of each LID BMP in the spreadsheet, the volume of runoff retained is calculated, as shown in Figure 4-41. Summing these retention volumes (2719 ft^3 + 85 ft^3 + 741 ft^3) gives a Total Volume Retained for the site, **3545 ft^3**.

Since the Total Runoff Volume Retained (3545 ft^3) exceeds the EISA Volume Requirement (1950 ft^3), this project fulfills EISA Section 438 with the selected LID BMPs.

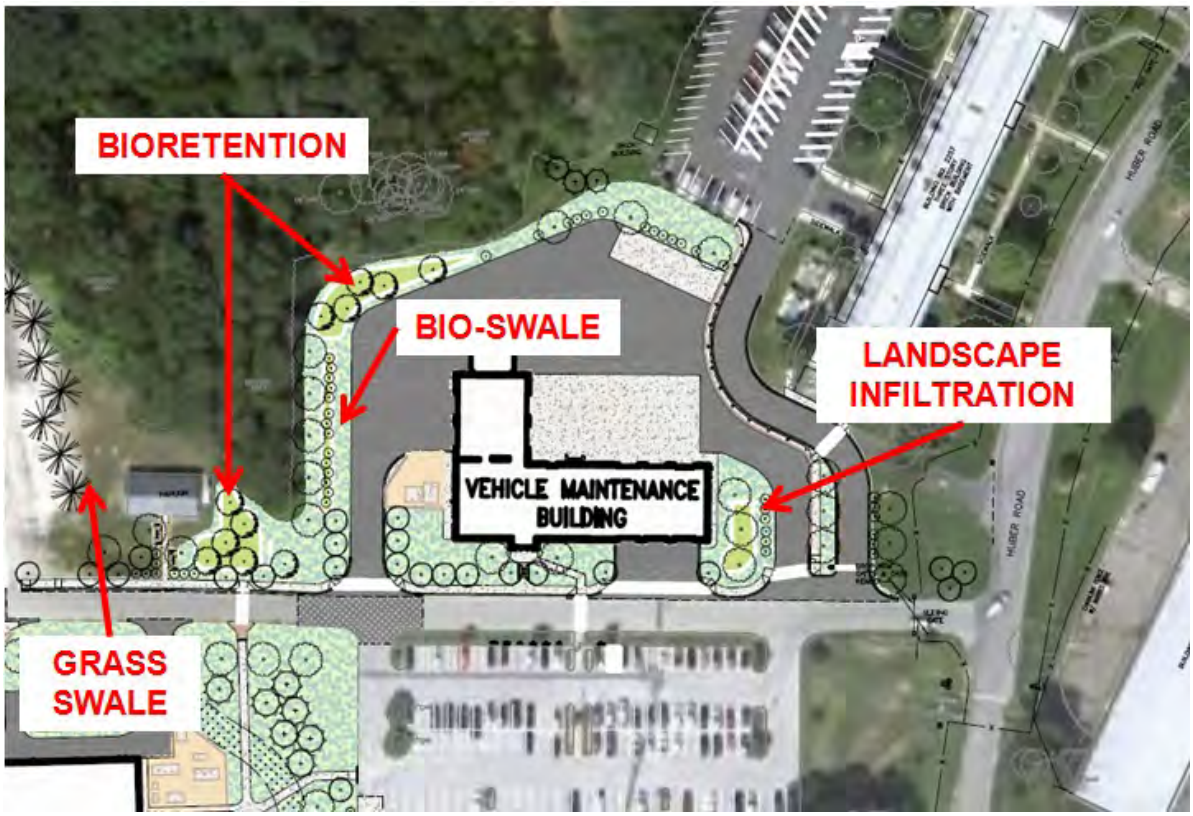
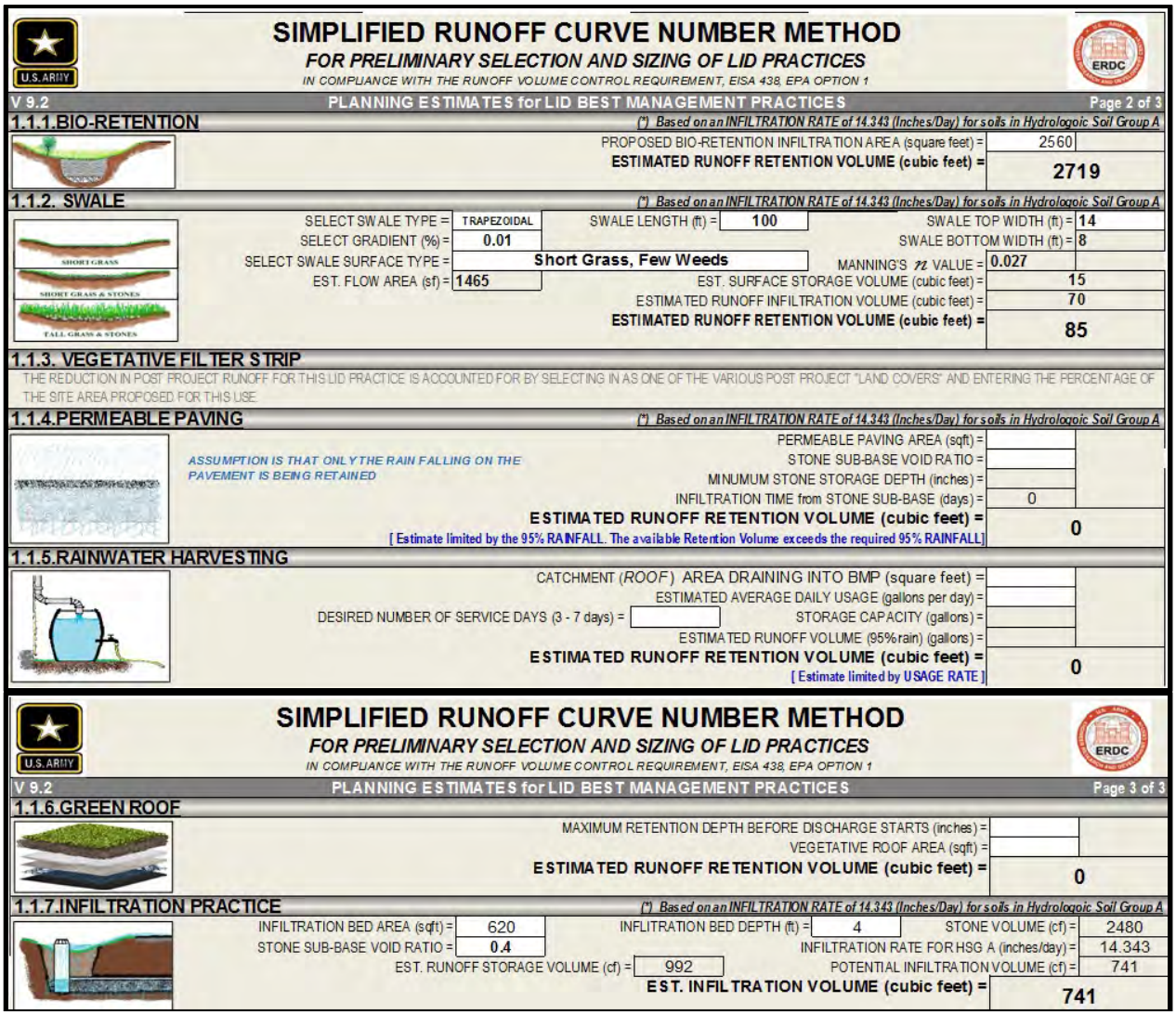


Figure 4-40. Proposed LID BMPs Implemented



SIMPLIFIED RUNOFF CURVE NUMBER METHOD
FOR PRELIMINARY SELECTION AND SIZING OF LID PRACTICES
IN COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, EPA OPTION 1

V 9.2 PLANNING ESTIMATES for LID BEST MANAGEMENT PRACTICES Page 2 of 3

1.1.1.BIO-RETENTION (*) Based on an INFILTRATION RATE of 14.343 (Inches/Day) for soils in Hydrologoic Soil Group A

PROPOSED BIO-RETENTION INFILTRATION AREA (square feet) = 2560
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 2719

1.1.2. SWALE (*) Based on an INFILTRATION RATE of 14.343 (Inches/Day) for soils in Hydrologoic Soil Group A

SELECT SWALE TYPE = TRAPEZOIDAL
SELECT GRADIENT (%) = 0.01
SELECT SWALE SURFACE TYPE = Short Grass, Few Weeds
EST. FLOW AREA (sf) = 1465
SWALE LENGTH (ft) = 100
SWALE TOP WIDTH (ft) = 14
SWALE BOTTOM WIDTH (ft) = 8
MANNING'S n VALUE = 0.027
EST. SURFACE STORAGE VOLUME (cubic feet) = 15
ESTIMATED RUNOFF INFILTRATION VOLUME (cubic feet) = 70
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 85

1.1.3. VEGETATIVE FILTER STRIP

THE REDUCTION IN POST PROJECT RUNOFF FOR THIS LID PRACTICE IS ACCOUNTED FOR BY SELECTING IN AS ONE OF THE VARIOUS POST PROJECT "LAND COVERS" AND ENTERING THE PERCENTAGE OF THE SITE AREA PROPOSED FOR THIS USE

1.1.4.PERMEABLE PAVING (*) Based on an INFILTRATION RATE of 14.343 (Inches/Day) for soils in Hydrologoic Soil Group A

ASSUMPTION IS THAT ONLY THE RAIN FALLING ON THE PAVEMENT IS BEING RETAINED

PERMEABLE PAVING AREA (sqft) =
STONE SUB-BASE VOID RATIO =
MINUMUM STONE STORAGE DEPTH (inches) =
INFILTRATION TIME from STONE SUB-BASE (days) = 0
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 0
[Estimate limited by the 95% RAINFALL. The available Retention Volume exceeds the required 95% RAINFALL]

1.1.5.RAINWATER HARVESTING

CATCHMENT (ROOF) AREA DRAINING INTO BMP (square feet) =
ESTIMATED AVERAGE DAILY USAGE (gallons per day) =
DESIRED NUMBER OF SERVICE DAYS (3 - 7 days) =
STORAGE CAPACITY (gallons) =
ESTIMATED RUNOFF VOLUME (95% rain) (gallons) =
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 0
[Estimate limited by USAGE RATE]

SIMPLIFIED RUNOFF CURVE NUMBER METHOD
FOR PRELIMINARY SELECTION AND SIZING OF LID PRACTICES
IN COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, EPA OPTION 1

V 9.2 PLANNING ESTIMATES for LID BEST MANAGEMENT PRACTICES Page 3 of 3

1.1.6.GREEN ROOF

MAXIMUM RETENTION DEPTH BEFORE DISCHARGE STARTS (inches) =
VEGETATIVE ROOF AREA (sqft) =
ESTIMATED RUNOFF RETENTION VOLUME (cubic feet) = 0

1.1.7.INFILTRATION PRACTICE (*) Based on an INFILTRATION RATE of 14.343 (Inches/Day) for soils in Hydrologoic Soil Group A

INFILTRATION BED AREA (sqft) = 620
STONE SUB-BASE VOID RATIO = 0.4
EST. RUNOFF STORAGE VOLUME (cf) = 992
INFLITRATION BED DEPTH (ft) = 4
STONE VOLUME (cf) = 2480
INFILTRATION RATE FOR HSG A (inches/day) = 14.343
POTENTIAL INFILTRATION VOLUME (cf) = 741
EST. INFILTRATION VOLUME (cubic feet) = 741

Figure 4-41. LID BMP Computations

Hydrologic modeling and simulation to meet the requirements of EISA Section 438 can be complemented by models and simulations that meet other regulatory requirements. As mentioned throughout the LID Technical User Guide, LID can be used to meet other regulatory requirements, such as state and local jurisdictions. Appendix E illustrates how LID and complementary modeling can be used to maximize compliance with regulations.

4.5.8 Fort Meade Case Study #3: DPW Building

4.5.8.1 Background

Please see Section 4.5.6.1 for Fort Meade background information. It is referenced instead of copied here to minimize redundancy.

4.5.8.2 Pre-Project Conditions

This re-development project includes a proposed Department of Public Works (DPW) Building with associated parking for POV and organizational vehicles and outdoor storage area.

The existing 3.30-acre site, as shown in Figure 4-42 is developed and mostly impervious, with a few grass islands that break up the pavement. An intermittent stream surrounded by woods divides the site in half. The site drains towards the stream which leaves the site through a culvert under 1st St. Groundwater is highly variable; a few feet below the ground in some places. Based on a review of the USDA soils database, the predominant hydrologic soil group for the project site is Hydrologic Soil Group C, "Silty Loam".

By inputting the percent site area of each land use (Parking/Driveway/Sidewalk, Lawn, Woods) to the spreadsheet tool, the estimated SCS curve number, CN, for each land use type is populated. Then the area weighted average pre-project CN is computed to be **91** (Figure 4-44).

Figure 4-42. Pre-Project Landuse Conditions

4.5.8.3 Post-Project Conditions

The proposed includes a 15,000 square foot DPW Building with associated pavement for parking and outdoor storage.

The post-project land use, Figure 4-43, consists of Lawn, Building Roof, Woods, and Parking/Driveway/Sidewalks. By inputting the percent of site area of each land use to the spreadsheet tool, the estimated the SCS curve number, CN, for each land use type is populated. Then the area weighted average post-project CN is computed to be **89** (Figure 4-44).

Note that the post-project CN (89) is less than the pre-project CN (91). This makes sense because the project reduced the total impervious area of the site from pre-project conditions.

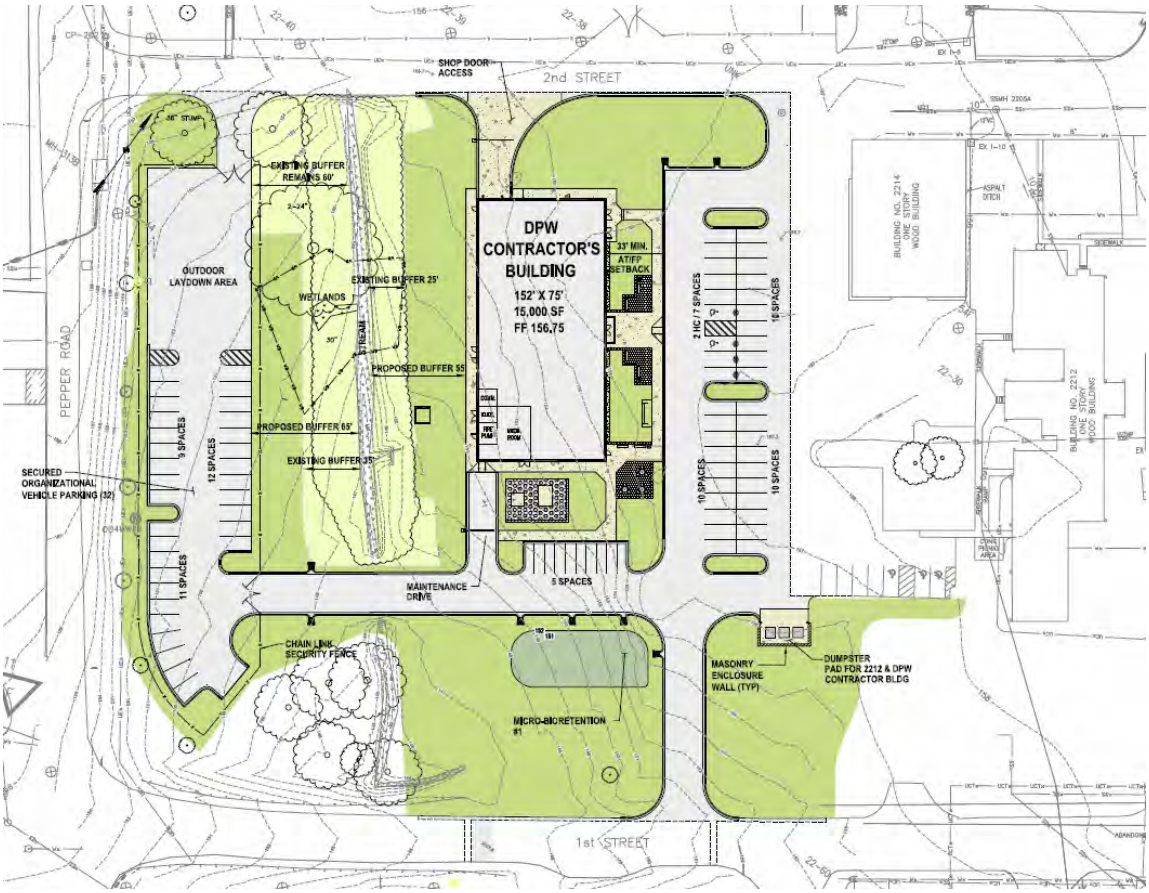


Figure 4-43. Post-Project Landuse Conditions

SIMPLIFIED RUNOFF CURVE NUMBER METHOD

PRELIMINARY SELECTION AND SIZING OF STRUCTURAL LID PRACTICES

FOR COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, MODIFIED EPA OPTION 2

V 9.2 — PLANNING ESTIMATES for PRE & POST RUNOFF VOLUMES — Page 1 of 3

DATE:	5-Oct-2012	ARMY INSTALLATION:	FORT MEADE
PLANNER:	EEM		
PROJECT NAME:	DPW CONTRACTOR'S BUILDING		
PROJECT LOCATION:	CHISHOLM AVE		
PROJECT AREA (acres):	3.3	95% RAINFALL	1.6

SELECT THE SITE'S OVERALL SOIL TYPE: Silty-Loam — HSG = C

PRE-PROJECT LAND COVER	% of SITE	CN	POST-PROJECT LAND COVER	% of SITE	CN
WOODED (fair)	10.0%	73	WOODED (fair)	10.0%	73
MEADOW			MEADOW		
BRUSH & WEEDS (fair)			BRUSH & WEEDS (fair)		
LAWN	23.0%	79	LAWN	35.0%	79
ROADS & DRIVES (^{IMC}/C&G)			ROADS & DRIVES (^{IMC}/C&G)		
ROADS & DRIVES (^{IM}/C&G)			ROADS & DRIVES (^{IM}/C&G)		
PARKING, DRIVEWAYS & SIDEWALKS	67.0%	98	PARKING, DRIVEWAYS & SIDEWALKS	47.0%	98
BUILDING ROOF			BUILDING ROOF	8.0%	98
			SELECTION OF OTHER LAND COVER TYPES		
TOTAL %	1		TOTAL %	1	
WEIGHTED AVERAGE CNn =		91	WEIGHTED AVERAGE CNd =		89

Figure 4-44. Pre-Project and Post-Project Curve Numbers

4.5.8.4 Calculate EISA Volume Requirement

At this point one is able to calculate the EISA Volume Requirement for the project, using the inputs of Pre-Project CN, Post-Project CN, Site Area, and 95th percentile storm depth. For this example, instead of calculating the 95th percentile rainfall depth as in previous examples, the 95th percentile depth for Baltimore, MD, given in Table 4-1 of this guide (also in Table 1 of EPA's *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act*) is used, **1.6 inches**.

The spreadsheet tool uses the SCS CN Method to compute the peak runoff volumes for both pre- and post-project conditions. The peak runoff volumes are computed to be 9,946 ft^3 and 8,372 ft^3, respectively. The difference between these volumes is the EISA Volume Requirement, which is the amount of runoff that needs to be retained on site using LID BMPs.

Since the post-project CN is less than pre-project CN, the post-project runoff volume is also reduced from the pre-project volume, resulting in a negative value as the EISA Volume Requirement, **-1,574 ft^3**, as shown in Figure 4-45.

Input Parameters:
Site Area (A) = 3.3 acres
95th Storm (P) = 1.6 inches
Existing CN = 91
Post CN = 89

Output:

$$S = \frac{1000}{CN} - 10$$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} x(A)$$

Q = Runoff Volume (ft^3)
Pre-Project Q = 9,946 ft^3
Post-Project Q = 8,372 ft^3
Difference in Q = -1,574 ft^3

Since DoD defines the "pre-development" condition as "pre-project" (UFC 3-210-10), this redevelopment project results in an improved hydrologic condition (decrease in runoff volume), and no additional retention is need to comply with EISA.

SIMPLIFIED RUNOFF CURVE NUMBER METHOD

PRELIMINARY SELECTION AND SIZING OF STRUCTURAL LID PRACTICES

FOR COMPLIANCE WITH THE RUNOFF VOLUME CONTROL REQUIREMENT, EISA 438, MODIFIED EPA OPTION 2

V 9.2 — PLANNING ESTIMATES for PRE & POST RUNOFF VOLUMES — Page 1 of 3

DATE:	5-Oct-2012	ARMY INSTALLATION:	FORT MEADE
PLANNER:	EEM		
PROJECT NAME:	DPW CONTRACTOR'S BUILDING		
PROJECT LOCATION:	CHISHOLM AVE		
PROJECT AREA (acres):	3.3	95% RAINFALL	1.6

SELECT THE SITE'S OVERALL SOIL TYPE: Silty-Loam — HSG = C

PRE-PROJECT LAND COVER	% of SITE	CN	POST-PROJECT LAND COVER	% of SITE	CN
WOODED (fair)	10.0%	73	WOODED (fair)	10.0%	73
MEADOW			MEADOW		
BRUSH & WEEDS (fair)			BRUSH & WEEDS (fair)		
LAWN	23.0%	79	LAWN	35.0%	79
ROADS & DRIVES (WC/C&G)			ROADS & DRIVES (WC/C&G)		
ROADS & DRIVES (W/C&G)			ROADS & DRIVES (W/C&G)		
PARKING, DRIVEWAYS & SIDEWALKS	67.0%	98	PARKING, DRIVEWAYS & SIDEWALKS	47.0%	98
BUILDING ROOF			BUILDING ROOF	8.0%	98
TOTAL %	1		TOTAL %	1	
WEIGHTED AVERAGE CNn =		91	WEIGHTED AVERAGE CNd =		89
RUNOFF VOLUME (95% RAIN) =	0.23	ACRE-FEET	RUNOFF VOLUME (95% RAIN) =	0.1921921	ACRE-FEET
9946 CUBIC FEET	74396	GALLONS	8372 CUBIC FEET	62622	GALLONS

SELECTION OF OTHER LAND COVER TYPES

MINIMUM RUNOFF RETENTION VOLUME TO COMPLY WITH EISA 438 VOLUME CONTROL REQUIREMENT

-0.04 ACRE-FEET — -1574 CUBIC FEET — -11774 GALLONS

Figure 4-45. Runoff Computations

4.5.8.5 Select LID BMPs to Manage EISA Volume

Although EISA Section 438 is satisified, the project still had to comply with State of Maryland stormwater management requirements. The project used the following LID BMPs to fulfill State requirements:

Non-Structural LID BMPs: Protect Sensitive Areas, Reduce Impervious Surfaces, Riparian Buffer Restoration, and Reforestation.

Structural LID BMPs: Bioretention, Grass Swale, Vegetated Filter Strip.

Page Intentionally Left Blank

5 DESIGN AND CONSTRUCTION CONSIDERATIONS FOR COMMON STRUCTURAL LID BMPS

5.1 INTRODUCTION

This chapter provides technical guidance on design and construction specifications for commonly used structural LID BMPs, as introduced in Chapter 2. Detailed descriptions, planning considerations, design considerations, components and materials, construction considerations and maintenance requirements are outlined for:

- Bioretention
- Vegetated Swales
- Vegetated Filter Strips
- Permeable Pavements
- Rainwater Harvesting
- Green Roofs

This chapter is intended to be used primarily by professionals engaged in master planning, designing, constructing, and maintaining stormwater projects at military facilities. Others who can benefit from the information in this chapter include: Department of Public Works (DPW), public officials, engineers, architects, landscape architects, and site design planners responsible for land use planning and decision making in watershed management.

The technical contents of this chapter are based on, and derived from, materials almost entirely in the public domain, published by federal or state agencies or public educational institutions. It must be noted that this chapter provides general technical guidance on LID BMP design and construction specifications. Since every site is unique - locally, geographically, and regionally, the soil type and topographic characteristics may differ even from site to site at the same installation. As such, the chapter is developed primarily to educate Army installation personnel (especially those responsible for policy making and engaged in stormwater management) in areas such as: (1) Role and significance of LID in addressing watershed stormwater management, and (2) Providing technically-sound knowledge and background information on design, construction and maintenance for their use in making intelligent policy and management decisions in planning, budgeting, project management, field implementation, and the monitoring of LID practices and procedures.

Therefore, the materials presented in this chapter are not intended to substitute formal project design and construction drawings which must be prepared and obtained from licensed industry

professionals. It is recommended that the following guidance should be used while developing formal design and construction drawings and specifications for LID projects.

- Use the information presented in this chapter primarily for planning and initial design and construction purposes.

- Adapt the information provided in the chapter to specific conditions at your site.

- Prior to construction of any practice described in this chapter, all permits must be obtained, including approval of erosion and sediment control plans and stormwater management plans from local permitting authority.

- It is extremely important to obtain professional services and have a licensed surveyor site stake to locate underground utilities. If in doubt, the identification and location of underground utilities must be performed early on during planning and design processes to avoid "work stop orders" and added costs later encountered during construction.

- Consult the local USDA NRCS Extension Service Office on your project development, especially regarding site-specific soil types and establishing and maintaining vegetation. Use boring logs and geotech report information as available.

- Final "Design and Construction Drawings" must be prepared by licensed engineering professionals in accordance with existing land use conditions and current site surveys.

5.2 BIORETENTION

5.2.1 Description

Bioretention is a stormwater infiltration and/or filtration practice used to reduce site stormwater runoff volume and pollutant loading. Bioretention systems are flexible in design and can be used to help fulfill the landscape requirements of a site. Bioretention systems are commonly located in or adjacent to parking lots or within small pockets in residential neighborhoods or commercial developments and have wide applicability.

Bioretention systems are flat-bottomed, shallow landscaped depressions used to collect and hold stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground or to an underdrain. Stormwater runoff from the contributing drainage area (e.g., parking lot) enters as sheet or concentrated flow into the bioretention system, where it temporarily ponds within the shallow depression and subsequently filters down through the various layers in the bioretention area: plants, mulch or ground cover, engineered soil media, a gravel base layer with a possible underdrain, until it infiltrates into the underlying soils. Runoff from larger storms is generally diverted through or around the bioretention system to the storm drain system via a yard inlet or overland relief via a spillway. Bioretention systems often provide complete on-site infiltration for small storm events (the "first flush"). Bioretention systems can be sized to infiltrate large storms in areas where soils are sandy, highly permeable, and drain well or bypass

to an approved discharge point. Bioretention systems reduce peak runoff rates and increase stormwater infiltration for volume reduction when designed to a larger capacity.

The bioretention system components make use of the chemical, biological and physical properties of soil, water, and plants to remove pollutants from stormwater runoff. Processes that take place within the soil-plant media of a bioretention system include sedimentation, adsorption, evapo-transpiration, physical filtration, infiltration, decomposition, phyto-remediation, bioremediation, storage, and pollutant uptake by plants. Bioretention systems remove a wide range of pollutants, such as suspended solids, nutrients, heavy metals, hydrocarbons, and bacteria from stormwater runoff. Bioretention systems encourage biologic, microbial and physical processes to occur and to self-perpetuate. This self-perpetuation represents a significant difference between bioretention and other stormwater treatment strategies. The components are intended to blend over time with soil, water, plant and root growth to produce organic decomposition and the development of a macro and microorganism community for removal of runoff pollutants. This microbial community in turn helps develop a natural soil horizon and structure that lengthens the bioretention systems' life span and reduces the need for maintenance.

5.2.2 Types of Bioretention

There are three main types of bioretention systems based on their scale and size of constructed area: bioretention, micro-bioretention, or rain gardens.

5.2.2.1 Bioretention Cell

Bioretention cells are systems that generally treat larger areas such as parking lots, commercial rooftops and areas in commercial, institutional or industrial settings (Photo 5-1). When constructed in residential areas, they may be distributed throughout the subdivision, but mostly they are located in common areas or within the drainage easements to treat a combination of roadway or parking lot runoff.

Contributing drainage areas to a bioretention cell should not exceed 5 acres. Pretreatment is often required to avoid sediment and debris clogging the filter bed. Forms of pretreatment include a forebay, stone diaphragm or vegetative filter strip.

Photo 5-1. Bioretention Cell
(Source: Low Impact Development Center, Inc., XXXX)

5.2.2.2 Micro-Bioretention Cell

Micro-bioretention cells are structurally and functionally the same as the bioretention cells described above. The only difference between the two is merely the size, wherein micro-bioretention cells are smaller than traditional bioretention cells. Since these practices are smaller, they do not require the same pretreatment techniques as traditional bioretention cells. Micro-bioretention cells have contributing drainage areas between approximately 10,000 square feet and 1/2 acre. Pretreatment is not usually required, except where concentrated flows, such as roof drain outfalls, are entering the filter bed.

5.2.2.3 Rain Gardens

Rain gardens have contributing drainage areas less than 10,000 square feet. Contrary to the common use of bioretention cells and micro-bioretention cells in commercial, industrial, and institutional applications, rain gardens are essentially small, distributed practices designed to treat runoff from small areas. Rain gardens are typically used to treat runoff from individual rooftops, driveways, and other on-lot features mostly in single family detached residential developments, as shown in Photo 5-2. Because of their small size and location, rain gardens often do not require an underdrain system or overflow inlet.

Table 5-1. Bioretention Types

Bioretention Type	Contributing Drainage Area	Infiltration or Underdrain?
Bioretention	1/2 to 5 acres	Could have one or both
Micro-Bioretention	10,000 sf to 1/2 acre	Could have one or both
Rain Garden	Less than 10,000 sf	Infiltration, no underdrain

Photo 5-2. Rain Garden

5.2.3 Planning Considerations

Bioretention systems are suitable for many types and sizes of new construction and redevelopment projects, including single-family residential as well as commercial, industrial, and institutional settings.

5.2.3.1 Applications

Bioretention systems can be used to filter the runoff from both residential and nonresidential developments. They are most effective when they receive runoff as close to its source as possible. They can vary in size and can receive and treat runoff from a variety of drainage areas within a land development site. They can be installed in lawns, median strips, parking lot islands, unused lot areas, and certain easements. They are intended to receive and filter storm runoff from both pervious and impervious areas.

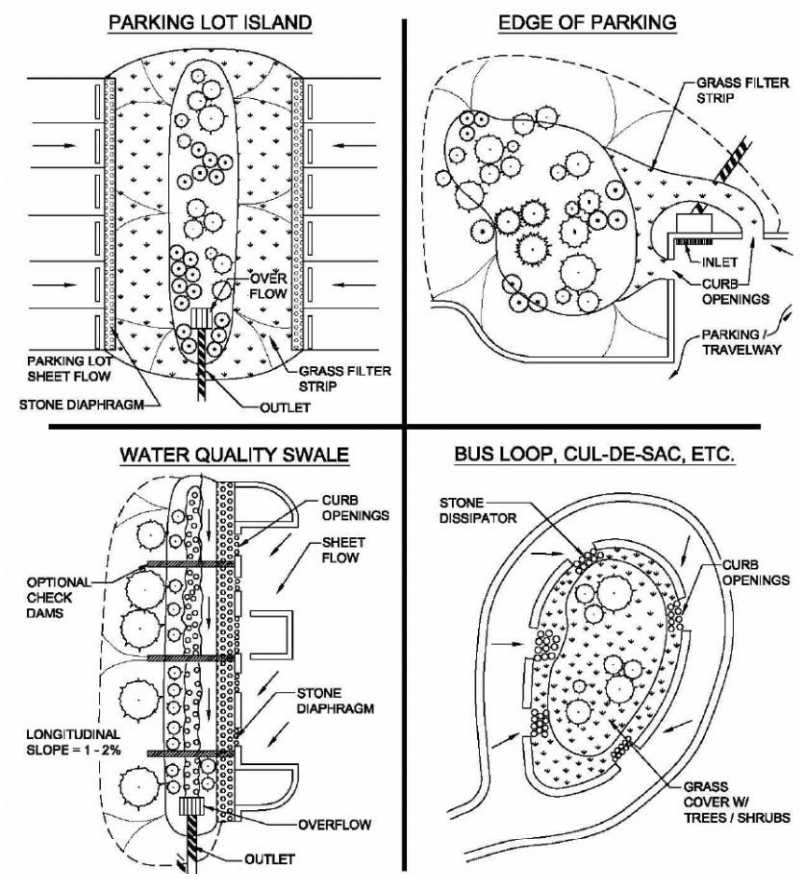


Figure 5-1. Typical Bioretention Applications

Typical residential, commercial and industrial applications for bioretention systems are shown in Figure 5-1, and are described below:

- Parking lots, parking lot edge, road medians, roundabouts, interchanges, cul-de-sacs, public right-of-way, commercial setbacks, courtyards, individual residential lots, etc. are the prime areas where bioretention can be successfully applied to enhance stormwater quality and aesthetics.

- Commercial/Industrial: Bioretention can be designed to treat runoff commercial parking lots, roads, rooftops, pervious areas, and/or pervious areas such as managed lawns.

- Institutional (*e.g.*, schools, government buildings, and parks): Bioretention features can be incorporated into bus loops, parking lot islands, roof downspout areas and access road shoulders, etc.

- Residential: Bioretention applications are most appropriate for residential settings. In this regard, they should be designed as distributed practices within areas designated as open space and covered by drainage easements. For example, roof or driveway runoff can be directed to rain gardens located at the front, side, or rear of a home. In

residential applications, bioretention features increase property values and enhance aesthetics.

- Retrofitting: Numerous options are available to retrofit an existing stormwater system or impervious area with bioretention applications in urban landscape.

5.2.3.2 Constraints

One of the most advantageous qualities of bioretention systems is that they can be installed independent of soil conditions (sandy, clayey, or in between) because stormwater infiltration and filtration is made artificially possible using engineered soil percolation media where soil conditions are not favorable. Nevertheless, there are several site constraints that must be considered in the designing and construction of bioretention facilities and practices.

<u>Drainage Area</u>
Ideally, the bioretention systems are used on small drainage areas, *i.e.*, less than 5 acres.

<u>Site Location and Topography</u>
The practice is best applied in areas with relatively gradual slopes, of the order of less than 5 percent but greater than 1 percent. Bioretention should not be constructed in areas where mature trees would have to be removed or within a floodplain.

<u>Available Hydraulic Head</u>
Hydraulic head is the difference in elevation between the runoff inflow point and the outflow point at the underdrain outlet where it meets the storm sewer system or overflows to downstream swale or a stream. The bioretention system is fundamentally and functionally constrained by the invert of the existing outlet to which the practice discharges (i.e., the bottom elevation needed to tie the underdrain from the bioretention system into the storm drain/sewer system or the downstream open channel). In general, a minimum of 4 to 5 feet of elevation above this invert is needed to create a hydraulic head needed to overcome friction losses through the proposed filter and gravel bed. For the bioretention facility to function properly and adequately, it must be capable of emptying the percolating runoff at a considerably faster rate than that of the infiltration rate of soil media above.

<u>Groundwater Table</u>
In order to avoid possible groundwater contamination, a minimum separation distance of 2 feet is required between the bottom of the excavated bioretention section and the seasonally high groundwater table.

<u>Soils</u>
As stated above, the soil conditions do not constrain the use of bioretention, although they do determine whether an underdrain or impermeable liner is needed. Clay soils, with low infiltration rates, often necessitate an underdrain pipe, which may not be required in loamy sand soils where infiltration is higher. If the site has karst (limestone) topography and is susceptible to sinkholes, the geotechnical engineer may require an impermeable liner to prevent any infiltration into the underlying soils that could cause instability or groundwater contamination.

Hotspot Land Uses

Hotspot land uses (gas stations, auto repair shops, motor pools, etc.) generate high concentrations of petroleum-base hydrocarbons and chemical contaminant loads. These areas should not be treated using infiltration bioretention systems but instead with bioretention systems that drain to an underdrain that is directed to the stormwater infrastructure. In addition to an underdrain, an impermeable bottom liner must be employed where bioretention is to receive and treat hotspot runoff to prevent aquifer contamination.

Root Barrier

The use of a vegetation root barrier should be considered when there are susceptible services or utilities nearby, such as water or sewer lines that are likely to be at risk from root penetration. The root barrier should be placed adjacent to the utilities which require protection.

Tail Water

The hydraulic design of the underdrain and overflow systems, as well as any stormwater quantity control outlets, must consider any significant tail water effects of downstream waterways, conveyance systems, or other stormwater management facilities. This includes instances where the lowest invert in the outlet or overflow structure is below the flooding or tide elevation in a downstream waterway or storm sewer system.

5.2.4 Design Criteria & Specifications

The major design goal for a bioretention is to maximize volume reduction and removal of stormwater suspended solids and other pollutants/contaminants. The basic design parameters of a bioretention systems is its storage volume, the thickness, character, and permeability or infiltration rate of its planting soil bed, and either the hydraulic capacity of its underdrain or the permeability of its subsoil (whichever is applicable). The system must have sufficient storage volume, if possible, above the surface of the soil bed to contain the design storm runoff volume without overflow. The thickness and character of the soil bed itself must provide adequate pollutant removal, while the soil bed permeability must be sufficient to drain the stored runoff. In addition, depending upon the type of bioretention system (i.e., infiltration or non-infiltration), either the capacity of the underdrain or the infiltration rate of the existing subsoil must also be sufficient to allow the system to drain preferably within 48 hours. Details of these and other design parameters and system components are presented in the following sections.

5.2.4.1 General

An important design factor to consider when designing a bioretention system is the size and scale of the practice at which it will be applied, as well as the existing site (i.e., soil texture) conditions where the bioretention facility will be constructed. The location and scale will determine the physical characteristics of the facility and whether it will require pretreatment measures. The soil characteristics of the site will further determine if the system can achieve full or partial on-site infiltration or if it will require an underdrain system connected to a conventional storm drain system.

Since the geology and soil conditions vary with the site location, bioretention design specifications will vary accordingly. The source of contributing drainage area and the resulting pollutant loading and its characteristics generated from within the drainage area will be another important factor in the design of a bioretention system. If the source is a high traffic area that generates large pollutant loads, such as a parking lot, the depth of filter bed or soil bed media will have to be greater than if the contributing drainage area is a residential lot producing relatively low pollutant loads.

5.2.4.2 Infiltration versus Underdrain

Bioretention systems can be designed to fully infiltrate the required volume, or can have an underdrain to convey treated stormwater to a storm drain system, or a combination of the two.

Non-Infiltration with Underdrain

Bioretention systems accept runoff from the contributing area (such as parking lot), filter runoff to remove and treat pollutants in the soil media, and then temporarily store runoff in a gravel storage layer. If the system includes an underdrain, the treated runoff is returned to the traditional storm drain system or daylights to the surface downstream. The underdrain consists of a perforated pipe buried within the gravel layer. A bioretention facility with an underdrain system is commonly referred to as an off-line bioretention practice. Typical details of an offline practice, with limited infiltration capability, are shown in Figure 5-2.

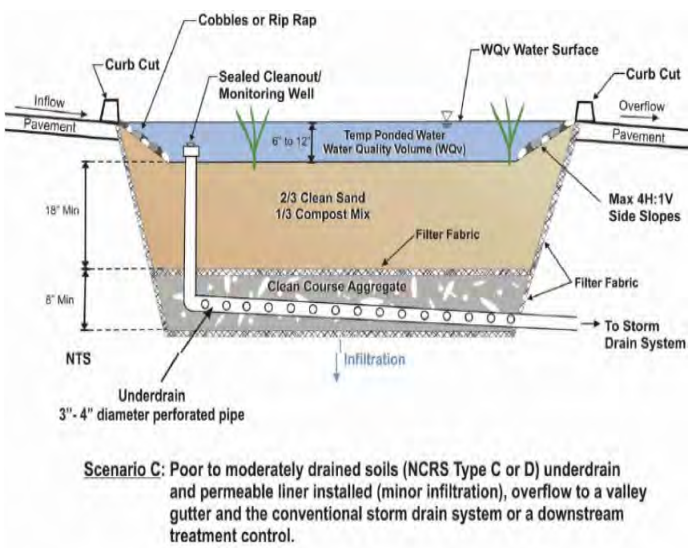


Figure 5-2. Design Components of an "Offline" Bioretention with Limited Infiltration

Infiltration without Underdrain

A bioretention system without an underdrain will allow the treated runoff to infiltrate directly into the native soils underneath. Infiltration (also called “online”) bioretention systems require permeable, sandy loam or loamy sand underlying soils (USDA Hydrologic Soil Group A or B) to function properly; these soils have infiltration rates in excess of 1 to 2 inch per hour. Typical details of an online practice are shown in Figure 5-3. Infiltration bioretention systems are

designed for sites where soils are highly permeable, groundwater table is low, and there is no risk for groundwater contamination.

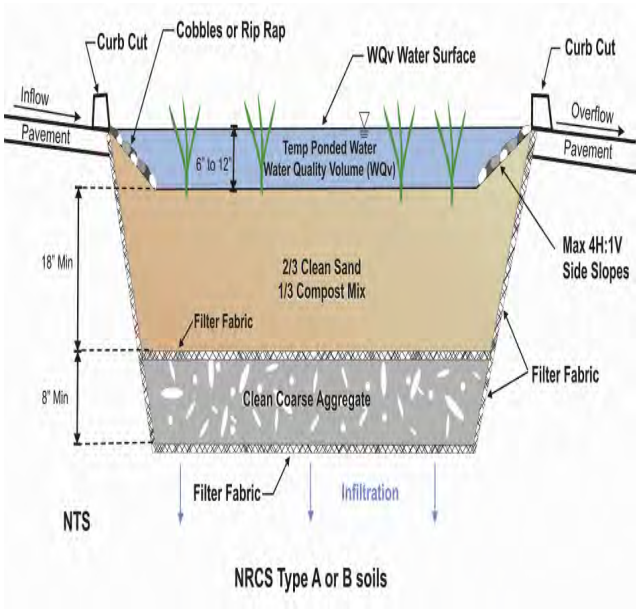


Figure 5-3. Design Componenets of an "Online" Infiltration Bioretention

<u>Combination Infiltration and Underdrain</u>

A combination of offline and online systems can be used where the underdrain is installed near the top of the gravel storage layer with a few inches of gravel over the top of the pipe, leaving a gravel “sump” that temporarily stores water for infiltration (Figure 5-4). This type of system will infiltrate runoff until the gravel layer fills up to the underdrain elevation, and then the underdrain will convey runoff to the storm drain system before it saturates the soil media layer.

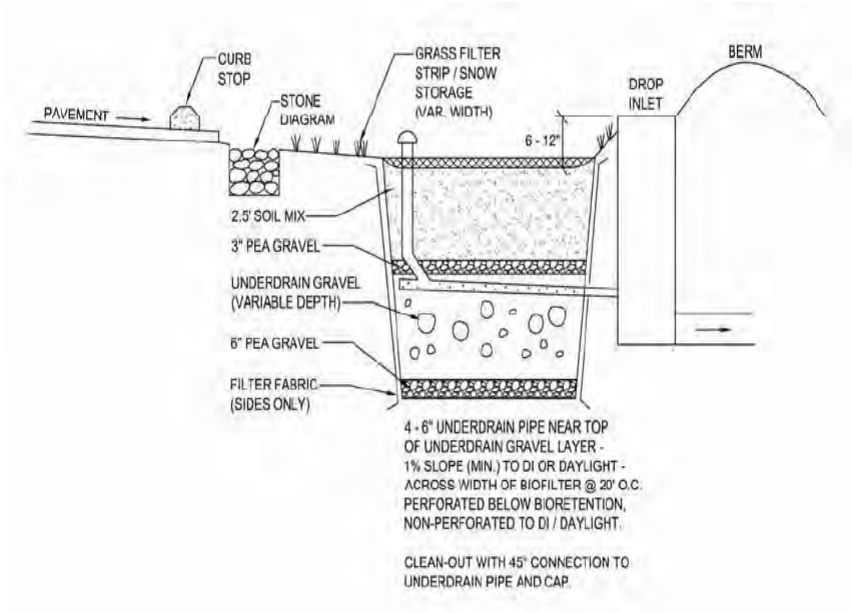


Figure 5-4. Combination Infiltration and Underdrain Bioretention System

5.2.4.3 Storage Volume, Depth, and Duration

Bioretention systems shall be designed to manage the volume of stormwater runoff required by EISA Section 438 through the EPA Technical Guidance Manual for the project site. Techniques to compute the stormwater runoff volume to be managed are discussed in Chapter 4, Hydrologic Modeling and Simulation; these techniques should be used as a guideline to determine the maximum water depth for managing the required runoff volume for the design storm. For more detailed information about sizing criteria, see the local permitting authority's stormwater design manual.

5.2.4.4 Contributing Drainage Area

Generally, the bioretention systems are constructed on sites that are disconnected by impervious area and consist of small contributing areas (i.e., two acres or less for impervious and less than 5 acres where the contributing drainage area is pervious). The cell size is designed to treat the first flush of runoff generated from approximately 1 inch of rainfall. The bioretention filter bed surface area may range between 3 percent to 12 percent of the contributing area depending on the imperviousness and desired bioretention type (bioretention cell, micro-bioretention cell, or rain garden).

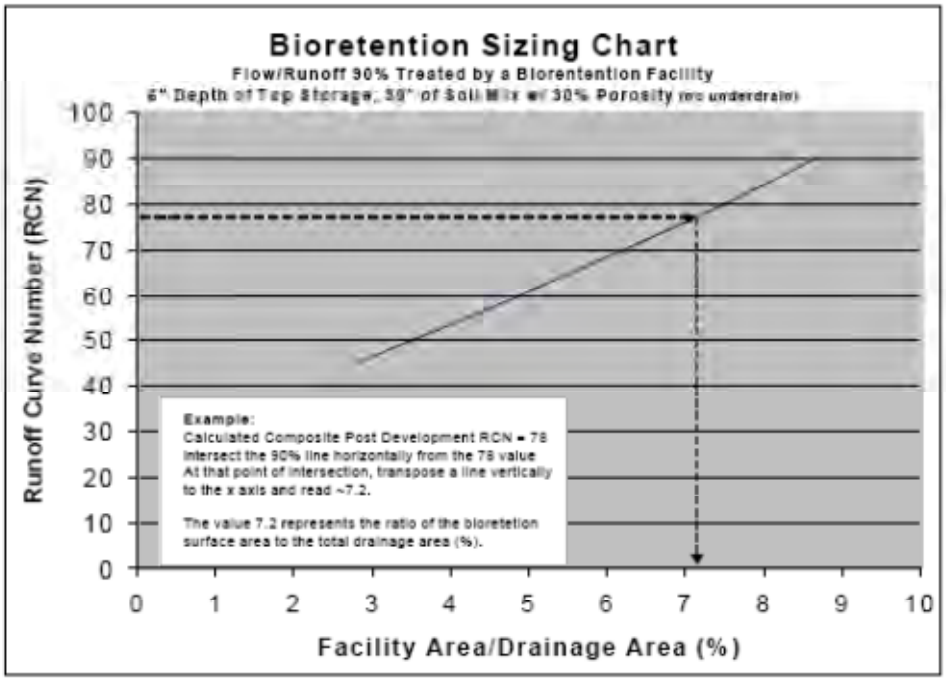


Figure 5-5. Bioretention Sizing Chart

Prince George's County, Maryland has developed a simplified criteria for sizing bioretention surface area (Figure 5-5) based on design drainage area and the post development curve number (that can be estimated using methods presented in Chapter 4, Hydrologic Modeling and Simulation). The graph presented in Figure 5-5 is applicable only for "online" infiltration-specific applications, and assumes surface ponding depth of 6 inches and soil storage capacity of 2.5 feet depth with 30 percent soil porosity.

5.2.4.5 Components of a Typical Bioretention

Bioretention is flexible in design and can be designed either as an infiltration or non-infiltration practice. The key elements of a bioretention are:

- Inflow Entrance
- Pretreatment
- Surface Ponding
- Mulch Layer
- Vegetation
- Soil Media
- Pea Gravel Choking Layer
- Gravel Storage Layer
- Underdrain
- Filter Fabric
- Liner
- Overflow or Drop Inlet

The system components of a bioretention are illustrated in Figure 5-6, and briefly described below.

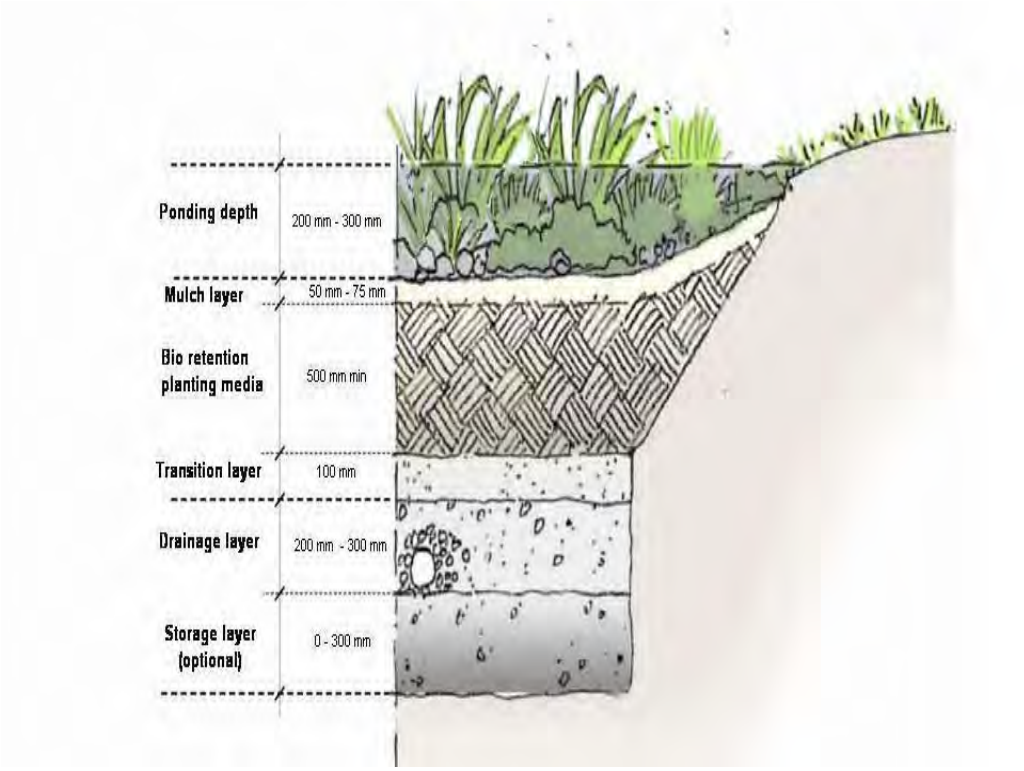


Figure 5-6. Typical Components of a Bioretention System

Inflow Entrance

The inflow entrance of a bioretention system is an important component as this is where the stormwater runoff will enter the system. The best method of capturing and treating runoff is to allow the water from contributing drainage area to sheet flow into the bioretention over grassed areas. This is not always possible, especially where site constraints or space limitations impede such an approach. A remedy to this problem is to provide flow entrances that can reduce the velocity of the water, such as riprap channels. In the case of parking lot landscape islands, curb cuts protected with energy dissipaters (such as landscape or surge stone or riprap) can be used. The curb cuts for the inflow entrance can be designed as a weir or flume, to regulate and allow defined flow volume directly from a contributing area into the bioretention. The design engineer will determine how many curb cuts are necessary (i.e., one curb cut every 20 linear feet of curb). Photos 5-3 and 5-4 show examples of curb cut inflow entrances with riprap and stone channels.

It is important to note that entrances of this type may become obstructed with sediment and trash that settles out at lower velocities. The accumulated sediment and debris should be removed from the inflow entrance area regularly.

Photo 5-3. Inflow Entrance - Curb Cut with Riprap

Photo 5-4. Inflow Entrance – Stone Channel

Pretreatment

To prevent premature clogging and possible failure of bioretention cells, incorporation of a pretreatment system is strongly recommended, and often required by the local stormwater management permitting authority. Pretreatment is a fundamental component of any bioretention in order to reduce incoming velocities and capture suspended sediment particles before runoff enters the bioretention facility. Pretreatment also extends the life of the bioretention. Sediments deposited in the pretreatment device must be periodically removed to maintain the system performance and functionality.

Several pretreatement options are listed below:

- Forebay, an excavated depression that collects runoff prior to the bioretention cell
- Grass filter strip between impervious area and bioretention cell
- Pea gravel diaphragm
- Riprap channel
- Level spreader

The most commonly used form of pretreatment is achieved through the use of a simple grass strip, which filters out most of the suspended sediment in the first 10 to 15 feet of the strip. Which pretreatment method to use depends on on the scale of the bioretention practice and whether it receives sheet flow, shallow concentrated flow or deep concentrated flows. For example, grass filter strips are appropriate for sheet flow whereas a gravel or stone diaphragm is recommended both for sheet flow and concentrated flow.

Surface Ponding Area

The surface storage ponding area is the area above the mulch layer that provides temporary storage for stormwater runoff and an environment for the settlement of suspended sediment and fine particles before infiltration, filtration, evaporation, and uptake processes can occur within the bioretention system. Ponding time provides water quality benefits by allowing larger debris and sediment to settle out from the runoff. The bioretention area should have a design depth of approximately one foot above the mulch layer, but may vary between 6-18 inches. Ponding time should not exceed 48 hours.

A convenient way to determine design ponding depth is simply to multiply the desired ponding time with infiltration rate of the planting soil. Conversely, the design ponding time (in hours) can be determined simply dividing ponding depth (in inches) by soil infiltrate rate (inches/hour).

Vegetation

Vegetation is an important component of a bioretention system. Plants uptake water and release it into the atmosphere through evapotranspiration and also uptake pollutants and nutrients; this contributes to the management of the stormwater runoff volume and quality. Plant roots enhance the infiltration capacity of the soil, creating pathways for percolation and infiltration of runoff through the soil. The plants species selected for bioretention planting should be native and designed to survive stresses such as frequent periods of inundation, ponding fluctuations and drought.

Root growth provides a media that fosters bacteriologic growth, which in turn develops a healthy soil structure. A variable plant community structure is preferred to avoid monoculture susceptibility to insect and disease infestation and to create a microclimate, which ameliorates

urban environmental stresses including heat and drying winds. Bioretention systems in parking lot islands are particularly susceptible to extended dry conditions because of urban heat effects. A layered planting scheme will help discourage weeds as well as creating suitable microclimates. There are many potential side benefits to the use of planting systems other than water quality and quantity treatment. Planting systems, if designed properly, can improve the property value of the site, provide shade and wind breaks, improve aesthetics, support wildlife, and absorb noise.

Native plants are preferable. Planting soil, mulch and plants selected will be appropriate for the local climatic conditions. The use of wetland plants is not recommended for bioretention planting, as these plants are not well suited to free draining soils or dry conditions. Plant materials should conform to the American Standard Nursery Stock as well as meet local requirements.

Organic Layer or Mulch

The mulch layer plays a vitally important role in the overall bioretention design and has several functions:

- Protects the soil bed from erosion
- Retains soil moisture to the benefit of plants
- Provides a medium for biological growth and decomposition
- Prevents evaporation, thus protects the soil surface from excessive drying
- Enhances plant survival
- Suppresses weed groth
- Provides runoff pretreatment by filtering sediment and fines before they enter the soil media

The mulch layer may consist of either a standard landscape shredded hardwood or hardwood chips (Figure 5-5). Other mulch materials include: organic materials such as compost, bark mulch, leaves, as well as small river gravel, pumice, or other inert materials. The mulch should be uniformly applied at approximately 3 to 4 inches in depth and replenished as necessary. If aged mulch is used, select the shredded type over the chip variety to minimize floatation and washouts. Mulch should be free of weed seeds, soil, roots, or any other substance not consisting of either branch wood or bark. Stone or gravel are not recommended in parking lot applications, since they increase soil temperature and have little or no water holding capacity.

As an alternative, if a dense herbaceous cover or 70 to 80 percent of tree canopy is established, a mulch layer is no longer necessary. While mulching provides an important function in the bioretention process, the establishment of an herbaceous layer or groundcover may be preferred over mulching for several reasons. First, the mulch material has the ability to float up-and-out during heavy rain events. Second, the herbaceous layer provides more opportunities to capture

and hold water through interception and evapotranspiration. Finally, providing thick, lush groundcover increases the aesthetic appeal and adds to the landscape character. A combination of groundcover and mulch is an equally preferable option.

Photo 5-5. Mulch Layer in Bioretention

Planting Soil Media

The planting soil media (also called soil media, filter media, planting growth media, soil mix, etc.) is the crucial component, and may be considered the "heart", of the bioretention providing several important functions, including:

- Provides media for infiltration and runoff volume reduction
- Support plant growth
- Provides home for soil microbial activity
- Provides environment for removal of pollutants
- Acts as a storage reservoir for moisture for plants

The planting soil is the region that provides water and nutrients for the plants to sustain growth. The upper soil zones are designed to enhance biological activity and encourage root growth. The macro-fauna breaks up organic matter into smaller parts, preparing it for the next stage of decomposition. In addition, as these microbes move through the soil, they provide aeration and redistribute soil components. This change in soil texture also allows more infiltration. The microbes (i.e., bacteria and fungi) break down complex organic compounds and transform nutrients into forms usable to plants. Symbiotic microbes living within plant roots enhance nutrient uptake and water retention. Clay particles also can adsorb heavy metals, nutrients, hydrocarbons, and other pollutants. The soil particles can also absorb some additional pollutants

through chemical processes, and the pore space (porosity) within soil particles can temporarily store a portion of runoff volume and dampen downstream peak flow from increased time of concentration.

The soil media composition will vary depending on design goals, available media (native soil or manufactured), targeted pollutants and the type of vegetation selected for the design bioretention practice. The soil media composition usually consists of sand and organic materials. The soil media should have a small amount of fines (silt and clay) to support plant growth and remove and treat pollutants and heavy metals. The soil media also must be permeable enough to allow water to pass at rates greater than 2 inches per hour. This balance is best achieved by using sandy loam or loamy sand soil, provided additional leaf compost or similar organic matter is added to increase soil pore space and, thus, the permeability. Leaf compost is essentially composed of aged leaf mulch and provides added organic matter to improve the health of the soil and ensure adequate soil structure. The soil must be a uniform mix, free of stones, stumps, roots, or other similar objects larger than two inches. No other materials or substances should be mixed or dumped within the bioretention that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations. The planting soil must be free of plant or seed material of non-native, invasive species, or noxious weeds.

Use of the native soil if it belongs to the USDA Hydrologic Soil Group A category (sandy loam) is acceptable to save costs and resources. The approach should simply consist of excavating the bioretention site to the design depth, save the excavated soil, and mix into it a 4 to 6 inch of well-aged organic matter, such as composted leaf mulch, double shredded mulch or pine fines, and planted with vegetation.

If soil conditions necessitate the use of manufactured media, make sure its characteristics conform to or exceed sandy loam soil characteristics in terms of structure, permeability, water holding capacity, the capability to support plant growth as well as water quality treatment characteristics such as the capability to remove suspended sediment and pollutants carried by runoff.

Soil bed depth will vary from site to site and depend on the type and function of bioretention.
The types of vegetation expected to grow in the bioretention cell also affect the depth of media selected. Grasses do not need more than 15 to 18 inches to survive, while certain small trees require a minimum of 4 to 5 feet soil depth. Most bioretention shrubs can survive and even flourish with a minimum of 24 inches, whereas bulbs may only need 12 inches to 18 inches. Most stormwater permitting authorities required a minimum 24 inches of soil media.

<u>Pea Gravel Choking Layer</u>
A pea gravel (No. 7, 8, or 89 stone) layer serves as a transition layer between the soil media and the underdrain gravel storage layer. This layer prevents fines from the soil media layer from migrating into open-graded gravel storage layer below.

<u>Sand Layer</u>
Sometimes the local permitting authority prefers a sand layer to serve as a transition between the planting soil bed and the gravel/underdrain layer in lieu of pea gravel. It must have a minimum

thickness of 9 to 12 inches and consist of pure washed sand or that of clean medium aggregate concrete sand. To ensure proper system operation, the sand layer must have a permeability rate at least twice as fast as the design permeability rate of the planting soil bed. The infiltration rate of sand is greater than 4 inches per hour compared with 1 to 2 inches per hour design permeability of soil media above.

Gravel "Sump" Storage Layer

The gravel layer is the bedding material and conveyance medium for the underdrain pipes. Thickness of the gravel layer will depend on the size of the perforated drain pipe and should be no less than 12 inches and consist of of clean, double washed No. 57 stone or equivalent. The design rule for gravel layer is that it must have sufficient thickness to provide a minimum of 3 inches or more of gravel above the underdrain pipe.

Depending on the placement of the underdrain, the gravel layer can provide some or no infiltration to the underlying soils. If the bioretention system does not require an underdrain, the gravel provides temporary storage for runoff before it infiltrates into the underlying soils. If some infiltration is desired, the underdrain can be placed within the gravel layer so there is additional gravel below the underdrain invert. The depth of the storage layer will depend on the target treatment and storage volume needed to meet EISA Section 438 and other stormwater volume and water quality or channel protection criteria, and should be a minimum of 12 inches deep. If no infiltration is desired, the underdrain should be placed at the bottom of the gravel layer. The bottom of the gravel layer must be at least 2 feet above the seasonally high water table to prevent the potential for groundwater contamination.

Underdrain

An underdrain is a perforated pipe (typically 4 to 6 inch diameter) installed within the gravel storage layer that conveys filtered runoff to the storm drain system (or daylights to a suitable, non-erosive outfall on the downstream slope). Bioretention systems may or may not incorporate an underdrain in their design depending on treatment goals and site conditions.

The role of an underdrain in the bioretention facility is to ensure proper drainage for the vegetation and to keep the soil at an adequate aerobic state, allowing plants to thrive and flourish. Underdrains are configured in many different ways and typically include a gravel/stone "blanket" encompassing a horizontal, perforated discharge pipe (Figure 5-7). The underdrain piping must connect to a downstream storm sewer manhole, catch basin, channel, swale, or ground surface at a location that is not subject to blockage by debris or sediment and is readily accessible for inspection and maintenance.

Underdrains are sometimes not necessary for in-situ soils with high infiltration rates (e.g. greater than 1 to 2 inches per hour) and where seasonally high water table depths are known to be greater than 2 feet below the proposed invert of the bioretention facility.

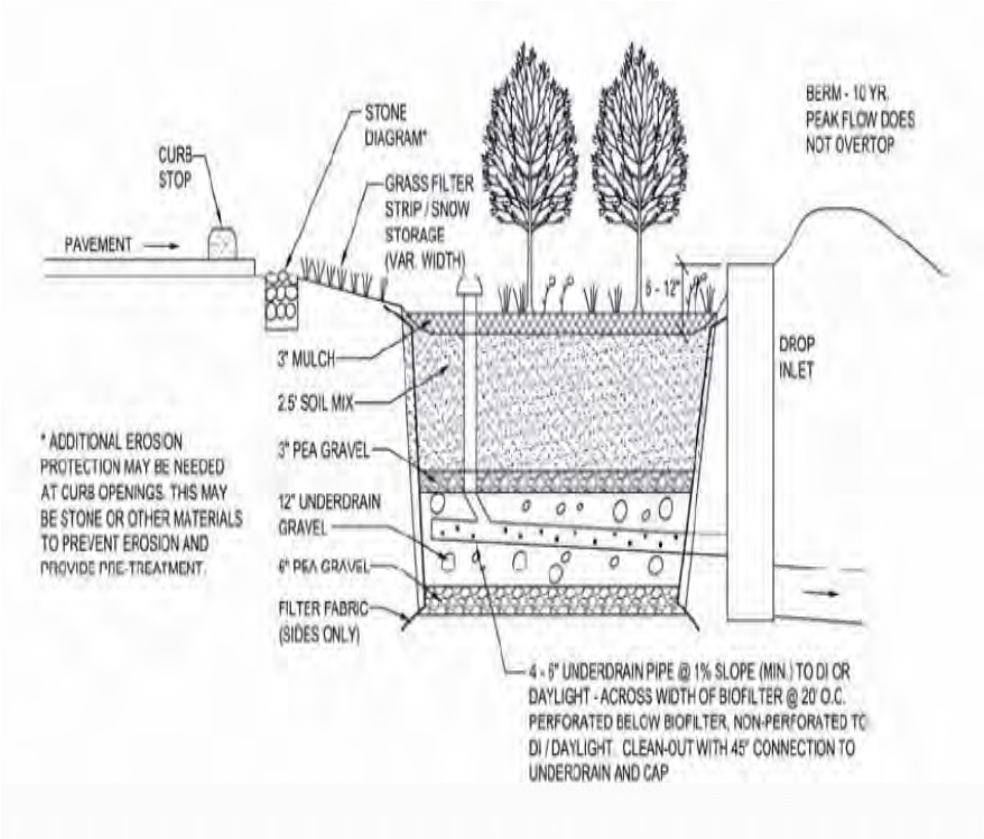


Figure 5-7. Use of Underdrain for Bioretention with Little or No Infiltration

Filter Fabric – Geotextile

The filter fabric is used to control silt and sediment migration and to control the direction of flow. There is a debate whether to use a permeable filter fabric between the gravel layer and the overlying soil growth media – this is on the premise that filter fabric does not adequately prevent the migration of finer soil as intended for bioretention applications. Preferably, in lieu of permeable fabric, pure sand and/or choking stone may be used as a separation layer between the underdrain gravel and the soil above.

Filter fabric should be placed along the sidewalls of the bioretention facility to help direct the water flow downward and to reduce lateral flows.

Liner – Impermeable Layer

In applications where bioretention is used for areas that require groundwater protection (karst topography, hotspot land uses, or source water protection), an appropriate impervious liner should be specified, provided, and installed. Clay liner should be of an appropriate impervious material, whereas synthetic liners, such as HDPE or PVC of appropriate thickness (at least 30 millimeters) can also be used. Any underdrain system shall be placed above the liner with a provision to cap the underdrain discharge pipe to confine drainage if needed. Care during placement of the liner is necessary to avoid puncture. To avoid compaction, soil medium placed over the liner should be placed by hand shovel rather than construction equipment.

Overflow/Outlet

As in the case of any impoundment, overflow of storm events that exceed the storage capacity of the facility should be addressed appropriately. An evaluation of overflow risks should always be performed when designing a stormwater facility.

In a residential setting where a rain garden is used, overflow may not present a problem if the system is located within a grassy area that provides a safe, non-erosive surface for any overflow conditions that may arise. Even in these cases, downstream conveyance must also be considered and designed appropriately.

For bioretention cells and micro-bioretention cells, it is important to design an overflow system to safely convey heavier, less frequent storms either through or around the bioretention facility. In commercial and industrial settings, a spillway or overflow yard inlet is often installed within the bioretention cell, as shown in Photo 5-6. The top of the outlet or overflow box is set at the desired maximum ponding depth. The overflow can outfall to the storm drain system or may "daylight" to a suitable, non-erosive outfall such as a swale or downslope area.

Photo 5-6. An Overflow within Bioretention

One common approach is to create an alternate flow path at the inflow point into the structure such that when the maximum ponding depth is reached, the incoming flow is bypassed or diverted past the bioretention facility to the storm drain system. In this case, the higher flows do not enter the bioretention area, and low flows are able to enter as the ponding water filtrates through the soil media.

Observation Well/Cleanout

An observation/cleanout standpipe should be installed in every bioretention facility that has a depth greater than 2 feet and/or an underdrain system. The standpipe will indicate how quickly

the bioretention facility dewaters following a storm, provides a maintenance cleanout port, and it will be connected to the underdrain system to facilitate cleanout. It should be located in the center of the structure and be capped flush with the ground elevation of the facility. The top of the well should be capped with a screw, or flange type cover.

5.2.5 Materials

Table 5-2 provides a summary of the typical material requirements for the bioretention components described in previous pages. Designers should follow their local stormwater management requirements when specifying materials.

Table 5-2. Typical Bioretention Material Specifications

Material	Specification	Notes
Surface Ponding	6 to 12 inches	Not to exceed 18 inches
Plantings	Natives trees, shrubs, or grasses: Plant 1 tree per 250 sq. ft. Plant shrubs that are a minimum of 30 inch high at 10-ft on-center. Plant ground cover plugs at 12 to 18 inch on-center. Plant container grown plants at 18 to 24 inch on-center; depending on the initial plant height and how large it will grow	Plants are site-specific. Establish plant material as specified in the local landscaping plan and recommended plant list. In general, plant species must be native and spacing must be sufficient to ensure the plant material achieve 80% cover in the proposed planting areas within a 3-year period. If seed mix is used, they should be free of weed and from an approved supplier' should be appropriate for stormwater basin applications.
Mulch Surface Layer	Shredded hardwood mulch 3 to 4 inch thick	Spread layer on the surface of soil filter bed. Alternative is native groundcover, such as seedums, in which case topsoil would replace mulch layer
Soil Filter Media	2 to 4 feet, to consist of: Sand = 85% to 88% Soil Fines = 8% to 12% Organic Matter = 3% to 5% ASTM C33	Use soil filter media 10% extra than computed value to account for settling or compaction. pH to range from 5.5 to 7.0. USDA soil types loamy sand or sandy loam with infiltration rate of 1 to 2 inches/ hour Soil media layer thickness depends on vegetation type: shrubs and trees require thicker layer than grasses and flowers
Pea Gravel Choking Layer	Minimum 4 inches No. 7, No. 8, or No. 9 washed stone	Transition between soil media and underdrain gravel.
Underdrain Gravel/ Storage Layer	Minimum 12 inches No. 57 or No. 6, double washed stone (3/8 to 3/4 inch) AASHTO M-43	Can exceed 12 inches for additional storage

Material	Specification	Notes
Underdrain Pipe, Cleanouts, and Observation Wells	4 to 6 inch rigid schedule 40 PVC or equivalent. 3/8 inch perforations at 6 inches on center on underdrain (non-perforated on cleanout) Minimum 3 inches gravel over pipe Wrap pipe with 1/4 inch galvanized hardware cloth Space 20 feet on-center.	Lay the perforated pipe under the length of the bioretention cell; and install non-perforated pipe as needed to connect with storm drain or daylight to ground surface Install T's and Y's as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface with vented caps. Not required for Rain Garden application.
Stone Diaphragm or Curtain Drain	River washed cobbles 2 to 5 inch	Depends on inlet flow velocity; engineer will design
Sand (if required)	AASHTO M6 or ASTM C-33	Clean, concrete sand, free of deleterious materials, grain size range 0.02 to 0.04 inch
Geotextile	ASTM D751 (puncture strength 125 lb), ASTM D 1117 (Mullen burst 400 PSI), and ASTM D 1682 (Tensile strength – 300 lb) PE Type 1 Non-woven	Fabric should have 0.08 inch thick, and maintain 120gal/ft^2 flow rate
Overflow Conveyance	Overflow yard inlet or Spillway	Not required for Rain Garden application

5.2.6 Construction Considerations

5.2.6.1 General

The construction phase of a bioretention is critical and must be phased to avoid soil media compaction or inflow of sediment laden runoff from disturbed areas during construction. All contributing drainage areas must be stabilized before the bioretention section is constructed. In this case, stabilization means having all pervious areas either fully landscaped (with mulch installed) or having well established grass or other stabilizing ground cover. If this is not possible, sediment laden runoff should be diverted around the bioretention and treated with erosion and sediment control practices. If sediment from disturbed areas is introduced to the bioretention cell during construction, the Contractor must remove the section and reconstruct it with new materials.

5.2.6.2 Excavation

The bioretention facility should be excavated to the dimensions, side slopes, and elevations indicated on the design plans. The method of excavation should minimize the compaction of the soils on the bottom of the bioretention facility. Excavators and backhoes, operating on the ground adjacent to the bioretention facility, should be used to excavate the facility if possible. Low ground-contact pressure equipment may also be used for excavation. Use of equipment with narrow tracks or narrow tires, rubber tires with large lugs, or high pressure tires will cause excessive compaction resulting in reduced infiltration rates and storage volumes, which should be avoided. Compaction of the base and the side walls of the bioretention area should be minimized. Excavation should not occur during wet or saturated conditions.

The bottom of the bioretention area should be tilled at least to an additional depth of 12 inch to promote infiltration for basins that allow for limited or full infiltration.

5.2.6.3 Soil Media Placement

The bioretention area should be prepared for soil media placement by scarifying the invert area of the bioretention facility in lifts of 12 to 18 inches. The preparation of the area should include light to minimal compaction to allow for adequate filtration; minimal compaction effort can be applied to the soil by tamping with a bucket from a dozer or backhoe. Excessive compaction will result in reduced infiltration rates, which reduces storage volumes and contributes to design failure.

The soil media should be placed and graded using excavators and/or backhoes operating on the ground adjacent to the bioretention facility or spread by hand, in order to avoid compaction and maintain the porosity of the media. If equipment must operate within the filter area itself, it must be light equipment that will not compact the soil to any appreciable degree (e.g., small loader with wide tracks or marsh tracks). No heavy equipment and/or equipment with narrow tracks, narrow tires, rubber tires, or high pressure tires should be used within the immediate filter area during or after the placement of the soil mix. The media should be overfilled above the proposed surface elevation, as needed, to allow for natural settling. After the final lift is placed, the soil media should be raked (to level it), saturated and allowed to settle for at least one week prior to installation of plant materials.

5.2.6.4 Watering

Once plant materials are planted, the bioretention area must be watered frequently to ensure establishment of the plants. Watering the plants is critical during establishment, especially during dry periods. Regular and frequent watering will reduce plant loss and provide the new plant materials with a chance to establish root growth.

5.2.6.5 Construction Sequence

The following is a typical construction sequence to properly install a bioretention facility. These steps may be modified to reflect different bioretention applications or site conditions:

1. The owner and the contractor should have a pre-construction conference and check the boundaries of the contributing drainage area and the actual inlet elevations to ensure they conform to original design. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the plan review/inspection authority.

2. Construction of the bioretention area may only begin after the entire contributing drainage area has been stabilized with vegetation. It may be necessary to block certain curbs or other inlets while the bioretention area is being constructed.

3. Temporary erosion and sediment controls are needed during construction of the bioretention area to divert stormwater away from the bioretention area until it is completed. Special protection measures, such as erosion control fabrics, may be needed

to protect vulnerable side slopes from erosion during the construction process. Construction runoff should be directed away from the proposed bioretention location using erosion and seiment control protection. Proposed bioretention areas may only be used as sediment traps during construction if at least two feet of soil are removed and replaced.

4. Excavate bioretention area to proposed invert depth and manually scarify the existing soil surfaces. Do not compact in-situ soils. It may be necessary to scarify the bottom soils to a depth of 6 to 12 inches to promote greater infiltration.

5. Place geotextile fabric on the sides of the bioretention area as per manufacturer specifications. If a stone storage layer will be used, place the appropriate depth of gravel on the bottom, install the perforated underdrain pipe, and place gravel to a minimum of 3 inches above the underdrain pipe.

6. Place choker stone/pea gravel as a transition between gravel layer and the soil media.

7. Place soil media in 12-inch lifts until the desired top elevation of the bioretention area is achieved. Wait a few days to check for settlement, and add additional media, as needed, to achieve the design elevation.

8. Prepare planting holes for any trees and shrubs, install the vegetation, and water accordingly. Install any temporary irrigation.

9. Place the surface cover in both cells (mulch, river stone or groundcover), depending on the design. If coir or jute matting will be used in lieu of mulch, the matting will need to be installed prior to planting, and holes or slits will have to be cut in the matting to install the plants.

10. Seed and plant vegetation as indicated on the plans and specifications.

11. Place mulch and hand grade to final elevations.

12. Water vegetation regularly during first year to ensure successful establishment.

5.2.7 Maintenance

5.2.7.1 General

Maintenance for bioretention systems is similar to the routine maintenance for any landscaped area. Routine repair and maintenance tasks specific for bioretention systems are presented in Table 5-3. Repair and maintenance inside the cell should not be conducted if its soil surface is wet or saturated to prevent compaction. Perform maintenance tasks when the soil is dry.

All bioretention system components expected to receive and/or trap debris and sediment must be inspected for clogging and excessive debris build up and sediment accumulation at least once

after each storm event exceeding one inch rain. Besides the surface ponding area above the facility, such components may include trash racks, low flow channels, outlet structures, riprap or gabion aprons, and cleanouts.

Sediment removal should take place when the basin is thoroughly dry. Disposal of debris, trash, sediment, and other waste material should be done at suitable disposal/recycling sites and in compliance with all applicable local, state, and federal waste regulations.

5.2.7.2 Vegetative Maintenance

Mowing and/or trimming of vegetation must be performed on a regular schedule based on specific site conditions. Grass outside of the bioretention system should be mowed at least once a month during the growing season. Vegetation within the bioretention system must be carefully maintained so as not to compact the soil, and by using hand-held tools, such as a hand held line trimmer. Vegetated areas must be inspected at least annually for erosion and scour. Vegetated areas should also be inspected at least annually for unwanted growth, which should be removed with minimum disruption to the planting soil bed and remaining vegetation.

When establishing or restoring vegetation, biweekly inspections of vegetation health should be performed during the first growing season or until the vegetation is established. Once established, inspections of vegetation health, density, and diversity should be performed at least twice annually during both the growing and non-growing seasons. All use of fertilizers, mechanical treatments, pesticides and other means to assure optimum vegetation health should not compromise the intended purpose of the bioretention system. All vegetation deficiencies should be addressed without the use of fertilizers and pesticides whenever possible.

5.2.7.3 Watering Requirements

Water is needed once a week during the first 2 months of planting, and then as needed during the entire growing period (April – October). Watering the vegetation on an “as needed basis” helps ensure a healthy condition and pleasing appearance. During dry periods the underdrain may cause the planting soil to dry out, resulting in plant stress.

5.2.7.4 Removal of Debris and Dead Plants

Experience has shown that up to 10 percent of the plants may die off in the first year. The construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction. The typical thresholds below which replacement is required are 85 to 90 percent survival of plants and 100 percent survival for trees.

5.2.7.5 Inspection

It is highly recommended that a spring maintenance inspection and cleanup plan be in place and conducted for each bioretention area. The following is a list of some of key maintenance problems to look for and take care of them accordingly.

- Check to see if 75 to 90 percent cover of mulch and vegetation has been achieved in the soil bed

- Check the bioretention bed for evidence of mulch floatation, excessive ponding, dead plants or concentrated flows

- Check for accumulated sediment and trash at filter strips, curb cuts, gravel diaphragms, pavement edges that may prevent flow from entering the bed, and check for other signs of stormwater bypassing.

- Check for clogged or slow-draining soil media or a crust formed on the top of soil bed layer

The most common non-routine maintenance problem involves standing water inside the basin. If water remains on the surface for more than 72 hours after a storm, it is an alarm that the soil bed and/or the underdrain perforated pipe is not functioning properly and may have become clogged. This is a serious problem and a precursor to practice failure and, thus, be addressed promptly. Open the underdrain observation well or cleanout and pour in water to verify that the underdrains are functioning and not clogged or otherwise in need of repair. The purpose of this check is to see if there is standing water all the way down through the soil. If there is standing water on top, but not in the underdrain, then there is a clogged soil layer. If the underdrain and stand pipe indicates standing water, then the underdrain must be clogged and will need to be snaked.

5.2.8 Benefits

The use of bioretention not only has the potential for quantity control and water quality, it also improves aesthetics and can increase property value.

- Can be very effective for removing fine sediment, trace metals, nutrients, bacteria, and organic
- Layout of bioretention facilities can be very flexible, and selection of plant species can provide a wide variety of landscape designs
- Can be applied in many different climates and geologic environments, with some minor design modifications
- Ideally suited for many highly impervious areas, such as parking lots, commercial roofs, and within public right of way
- Reduces the size and cost of downstream stormwater control facility and/or storm drain systems by runoff reductions *via* infiltration and evapotranspiration in upland areas.
- Reduces downstream flooding and protects streambank integrity by dampening flow peaks.
- Can be applied as stormwater retrofit, by modifying existing landscaped areas

Table 5-3. Suggested Maintenance Activities for Bioretention

	Task	Frequency	Maintenance Notes
1	Mowing of grass filter strips and bioretention turf cover	As needed	At least three times a year
2	Spot weeding, erosion repair, sediment, trash and debris removal, and mulch raking	Twice each year	
3	Replant vegetation to maintain desired planting density, remove invasive plants, stabilize the contributing area to prevent concentrated flow and erosion	As needed	Vegetative cover should be maintained at 75 to 90%. When vegetation falls below 50%, replant area in accordance with original specifications.
4	Spring inspection and clean up	Annually	
5	Remove sediment in pre-treatment cells and inflow/outflow points	Annually	
6	Pruning of Plants	1 to 2 times/yr	Nutrients cause vegetation to flourish and thus need pruning
7	Mulching	Biannually	Use hard wood to suppress weeds and retain moisture
8	Watering	As needed	Initially more frequently
9	Inspect inflow/overflow	After each storm	Check for clogging, rubbish, and debris

5.3 VEGETATED SWALES

5.3.1 Description

Vegetative swales are stormwater runoff conveyance systems that provide surface flow as an alternative to underground storm sewer systems. Vegetated swales are shallow in depth and configured as linear channels, with parabolic or trapezoidal cross sections (Photo 5-7 and Photo 5-8). Vegetated swales are densely planted with a variety of trees, shrubs, grasses, and other herbaceous plants. They can infiltrate entire stormwater runoff from low flows or carry runoff from heavy rains to storm drains or directly to surface waters.

Vegetative swales provide reduction in peak flow by increasing time of concentration and reducing runoff volume through infiltration and evapotranspiration. Vegetated swales provide improved water quality through settling, filtering, infiltration and plant uptake of pollutants from stormwater runoff. Swales can also provide pre-treatment for other stormwater treatment practices.

Vegetated swales are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system, where development density, topography and soils permit. Contrary to a concrete or riprap lined drainage channel or ditch, vegetated swales are aesthetically pleasing and can be landscaped similar to bioretention. Vegetated swales are generally less expensive to construct and maintain than concrete/riprap lined channels.

Photo 5-7. Vegetated Swale Adjacent to Impervious Parking Lot

Photo 5-8. Vegetated Swale in a Commercial Setting

5.3.2 Types of Vegetated Swales

There are three types of grass swales: grass swale, wet swale, and bio-swale. Brief descriptions of each are provided below.

5.3.2.1 Grass Swale

Grass swale (also known as grass channel) is quite similar to a conventional drainage ditch, with the major differences being flatter side slopes and longitudinal slopes, and a slower design

velocity for water quality treatment of small storm events (Figure 5-9). Grass swales are the least expensive option because they are constructed in native soils without the use of manufactured soil media. A common application of a grass swale is as a pretreatment to other structural stormwater treatment practices, such as bioretention (as described in Section 5.1).

The length of the swale is generally equivalent to the contributing impervious area. The runoff enters the grass swale as lateral sheet flow and the total contributing drainage area cumulatively increases along the length of the swale. The treatment component of the swale can extend to a greater length for additional storage.

Grass swales can provide a modest amount of runoff filtering and volume attenuation within the stormwater conveyance system. The performance of grass swales will vary depending on the underlying soil permeability. Grass swales, however, are not capable of providing the same stormwater functions as bio-swales as they lack the storage volume associated with the bio-swale's cross section (engineered soil media and gravel layers). Their runoff reduction performance can be boosted when compost amendments are added to the bottom of the swale. Grass swales can also be used to treat runoff from the managed turf areas of turf-intensive land uses, such as sports fields and golf courses, and drainage areas with combined impervious and turf cover (e.g., roads and yards).

Photo 5-9. Grass Swale

5.3.2.2 Wet Swale

Wet swales are similar to grass swales but intersect the groundwater table, and behave almost like a linear wetland cell. This design variation incorporates a shallow permanent pool and wetland vegetation to provide stormwater treatment.

These linear wetland cells often intercept shallow groundwater to maintain a wetland plant community. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. The cells are formed within the

channel to create saturated soil or shallow standing water conditions (typically less than 6 inches deep).

5.3.2.3 Bio-Swale

A bio-swale is a linear adaptation of a bioretention system that lines the edge of a contributing impervious area such as a roadway or parking lot (Figure 5-10). The cross section of a bio-swale is similar in design to traditional bioretention areas (see Section 5.1, *Bioretention*). The design incorporates a manufactured/engineered soil media and gravel layer under the channel. The gravel layer may or may not have an underdrain system (perforated pipe along the length of the swale).

The bio-swale is a soil bio-filtering system that filters and temporarily stores the stormwater runoff. If the underlying soils are very permeable, runoff infiltrates and the system functions exactly like a bioretention system without an underdrain. If the bio-swale has an underdrain, the runoff treated by the soil media flows into the underdrain, which conveys treated runoff back to the storm drain system further downstream (or daylights to surface flow), functioning like an off-line bioretention. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale beneath the filter media.

Photo 5-10. Typical Bio-Swale

5.3.3 Planning Considerations

5.3.3.1 Applications

The linear nature of vegetative swales makes them well-suited to treat roadway, low- and medium-density residential roadway runoff, or commercial applications where there is real estate to grade a swale. Typical applications of vegetative swales include the following:

- Within a roadway right-of-way, along roads and highways
- At roof downspout discharge points
- Along edges of paved areas (roads, parking lots), parking lot islands, intermediary common areas, open spaces, or adjacent to buildings.
- Within residential developments and commercial properties
- Pre-treatment for other LID practices
- Alternative to conventional curb/gutter and storm sewer

5.3.3.2 Constraints

Vegetated swales have some limitations, including:

- Individual grass swales cannot treat a very large drainage area
- Wet swales may become a nuisance due to mosquito breeding
- A thick vegetative cover must be maintained for proper function
- Vegetated swales are not recommended when residential density exceeds more than 4 dwelling units per acre, due to a lack of available land and the frequency of driveway crossings along the channel
- Runoff from hotspot land uses, such as gas stations and auto repair shops, should not be treated with infiltrating dry swales – an impermeable liner should be used when hotspot runoff is filtered

5.3.4 Design Criteria and Specifications

Vegetated swales can be designed to be simple, such as a grass swale, or more complex, such as the bio-swales, but all types require space and the appropriate topography or grading to convey water. The key to designing a vegetated swale is to ensure the conveyance of stormwater runoff from the impervious surface to either a receiving waterbody, a stormwater system, or to infiltrate

to groundwater while slowing the velocity of the runoff and increasing the time of concentration. Design criteria and specifications are discussed below and presented in Table 5-4 for all three types of vegetated swales.

5.3.4.1 Available Space

Vegetative swale footprints can fit into relatively narrow corridors between utilities, roads, parking areas, or other site constraints. Dry swales should be approximately 3 to 10 percent of the size of the contributing drainage area, depending on the amount of impervious cover.

5.3.4.2 Site Topography

Vegetative swales should have longitudinal slopes of less than 4 percent, but preferably less than 2 percent. The gradual slope helps to reduce the velocity of flow in the channel.

5.3.4.3 Contributing Drainage Area

The maximum contributing drainage area to a bio-swale should be 5 acres, but preferably not more than two acres. When bio-swales or vegetated swales treat larger drainage areas, the velocity of flow through the surface channel often becomes too great to treat runoff or prevent erosion in the channel. Similarly, the longitudinal flow of runoff through the soil, stone, and underdrain may cause hydraulic overloading at the downstream sections of the swale. An alternative is to provide a series of inlets or diversions that convey the treated water to an outlet location.

5.3.4.4 Soils

Soil conditions do not constrain the use of vegetated swales, although they normally determine whether an underdrain is needed. Low-permeability soils with an infiltration rate of less than 1/2 inch per hour, such as those classified in Hydrologic Soil Groups (HSG) C and D, will require an underdrain.

5.3.4.5 Depth to Water Table

Restrictions on the depth to groundwater depend on the type of swale used. The bottom of a grass swale or bio-swale should be at least 2 feet above the seasonally high groundwater table, to ensure that groundwater does not intersect the swale bottom, since this could lead to groundwater contamination or practice failure. In a wet swale it is permissive to intersect the groundwater table since treatment is enhanced by the saturated conditions.

5.3.4.6 Hydraulic Capacity and Swale Size

Vegetated swales are usually sized to temporarily store and infiltrate the “first flush” (one inch) storm event. In addition to treating runoff for water quality, grass swales need to convey larger storms safely. Typical designs allow the runoff from the 2-year storm (i.e., the storm that occurs, on average, once every two years) to flow through the swale without causing erosion. Swales

should also have the capacity to pass larger storms (typically a 10-year storm) safely**.** This means the swale should contain the 10-year design flow within its banks, so the swale's surface dimensions are more often determined by the need to pass the 10-year storm events, which can be a constraint in the siting of vegetated swales within existing rights-of-way (e.g., constrained by sidewalks or roads). The maximum ponding time is 48 hours, though 24 hours is more desirable. Studies have shown that the maximum amount of swale filtering occurs for water depths below 6 inches.

A major difference between vegetated swales and other stormwater treatment practices is the method used to size the practice. Most stormwater treatment practices are sized by volume of runoff. That is, the practice captures and treats a defined water quality volume, or the volume of water. The grass swale, on the other hand, is based on flow rate (i.e., a peak flow from the water quality storm; this varies from region to region but a typical value is the one inch storm), grass swales should be designed to ensure that runoff takes an average of ten minutes to flow from the top to the bottom of the channel. Bio-swales use a combination of this sizing method but also incorporate storage in the soil media and gravel layers.

5.3.4.7 Available Hydraulic Head

A minimum amount of hydraulic head is needed for effective bio-swales, measured as the elevation difference in elevation between the inflow point and the downstream underdrain invert. Bio-swales typically require 3 to 5 feet of hydraulic head since they have both a filter bed and an underdrain layer.

5.3.4.8 Vegetation

The dense vegetation helps reduce flow velocities, protect the swale from erosion, and acts as a filter to treat stormwater runoff. During construction, it is important to stabilize the channel of the swale before the turf has been established, either with a temporary grass cover, or the use of natural or synthetic erosion control products.

5.3.4.9 Channel Geometry

Although there are different design variations of the vegetated swales *(*e.g., grass, wet, and bio-swale), several design considerations are common to all. For example, the cross-sectional geometry of all three options is similar. Channels should generally have a trapezoidal or parabolic cross section with relatively flat side slopes (generally 3:1 or flatter). Designing the channel with flat side slopes also maximizes the wetted perimeter. The wetted perimeter is the length along the edge of the channel cross section where runoff flowing through the channel is in contact with the vegetated sides and bottom of the swale. Increasing the wetted perimeter slows runoff velocities and provides more contact with vegetation to encourage filtering and infiltration. Another advantage of flat side slopes is that runoff entering the grassed swale from the side receives some pretreatment along the side slope. The flat channel for each type of vegetated swale should be between two and eight feet wide. The minimum width ensures filtration for water quality treatment, and the maximum width prevents braiding, the formation of small channels within the swale bottom.

Table 5-4 summarizes design guidance for vegetated swales.

Table 5-4. Vegetated Swale Design Guidance

Design Criteria	Grass Swale	Wet Swale	Bio-Swale
Bottom Width	4 to 8 feet	4 to 8 feet	4 to 8 feet
Side Slope	3H:1V or flatter	3H:1V or flatter	3H:1V or flatter
Longitudinal Slope	2 to 4%	2 to 4%	2 to 4%
Water Quality Treatment	Sized for 1 inch (first flush)	Sized for 1 inch (first flush)	Sized for 1 inch (first flush)
Maximum Contributing Drainage Area	5 acres	5 acres	5 acres
Flow Capacity: 2-year storm	Convey at non-erosive velocity	Convey at non-erosive velocity	Convey at non-erosive velocity
Flow Capacity: 10-year storm	Convey within banks at minimum 6 inches freeboard	Convey within banks at minimum 6 inches freeboard	Convey within banks at minimum 6 inches freeboard
Vegetation	Grass	Wetlands plants	Native vegetation that can handle ponding or drought
Depth from Channel Bottom to Water Table	Minimum 2 feet	Water table intersects channel	Minimum 2 feet
Gravel Layer/Underdrain	No	No	Yes
Engineered Filter Media	No	No	Yes

5.3.5 Components of a Vegetated Swale

The design components of vegetated swales vary between the grass swale, wet swale and bio-swale. The key elements of a vegetated swale are:

- Pretreatment
- Conveyance and Overflow
- Landscaping and Planting Plan
- Soil Media (for bio-swale sonly)
- Underdrain and Gravel Storage Layer (for bio-swales only)

5.3.5.1 Pretreatment

No matter which swale type is chosen, pre-treatment is recommended to allow for removal of sediments from the stormwater runoff. Pre-treatment could be in the form of a small forebay upstream of the channel to trap incoming sediments. A pea gravel diaphragm (a small trench filled with river run gravel) can also be used to pretreat runoff that enters the sides of the channel. In addition, a grass filter strip (minimum 10 feet wide) along the length of the contributing impervious drainage area, such as parking lot, could be used.

5.3.5.2 Conveyance and Overflow

The bottom width and slope of a vegetative swale should be designed such that the velocity of flow from a 1-inch rainfall will not exceed 3 feet per second. Gravel check dams may be used to achieve the needed runoff reduction volume and flow velocity. Check dams should be spaced based on channel slope and ponding requirements. Use non-erosive material such as wood, gabions, riprap, or concrete. All check dams should be underlain with filter fabric, and include weep holes. Wood used for check dams should consist of pressure-treated logs or timbers, or water-resistant tree species such as cedar, hemlock, swamp oak or locust.

5.3.5.3 Landscaping and Planting Plan

Designers should choose grasses, herbaceous plants, or trees that can withstand both wet and dry periods and relatively high velocity flows for planting within the channel. Salt tolerant grass species should be chosen for vegetative swales located along roads. Taller and denser grasses are preferable, although the species is less important than good stabilization and dense vegetative cover. Grass species should have the following characteristics: a deep root system to resist scouring, high stem density with well-branched top growth, water-tolerance, resistance to being flattened by runoff, and an ability to recover growth following inundation. Photo 5-11 illustrates the thick vegetation of a dry swale. To find a list of plant species suitable for your area, consult the local USDA NRCS office.

Photo 5-11. Dry Swale

5.3.5.4 Soil Media (for bio-swales only)

Bio-swales require replacement of native soils with an engineered soil media. The soil media provides adequate drainage, supports plant growth, and facilitates pollutant removal within the swale. The soil media for bio-swales is identical to that used for bioretention systems. The soil media should be obtained from an approved vendor to create a consistent, homogeneous fill media.

5.3.5.5 Underdrain and Gravel Storage Layer (for bio-swales only)

Where the underlying soil infiltration rates meet applicable requirements, bio-swale design would not need an underdrain. In case of impermeable soils (infiltration rates less than 0.50 inches per hour), a gravel storage layer will surround a perforated underdrain pipe to ensure proper drainage after storms. The underdrain should be encased within a gravel bed. The depth of the gravel storage layer will depend on the target treatment and storage volumes needed to meet water quality, channel protection, and/or flood protection criteria. Typical construction details of a bio-swale with an underdrain and gravel storage layer are given in Figure 5-8.

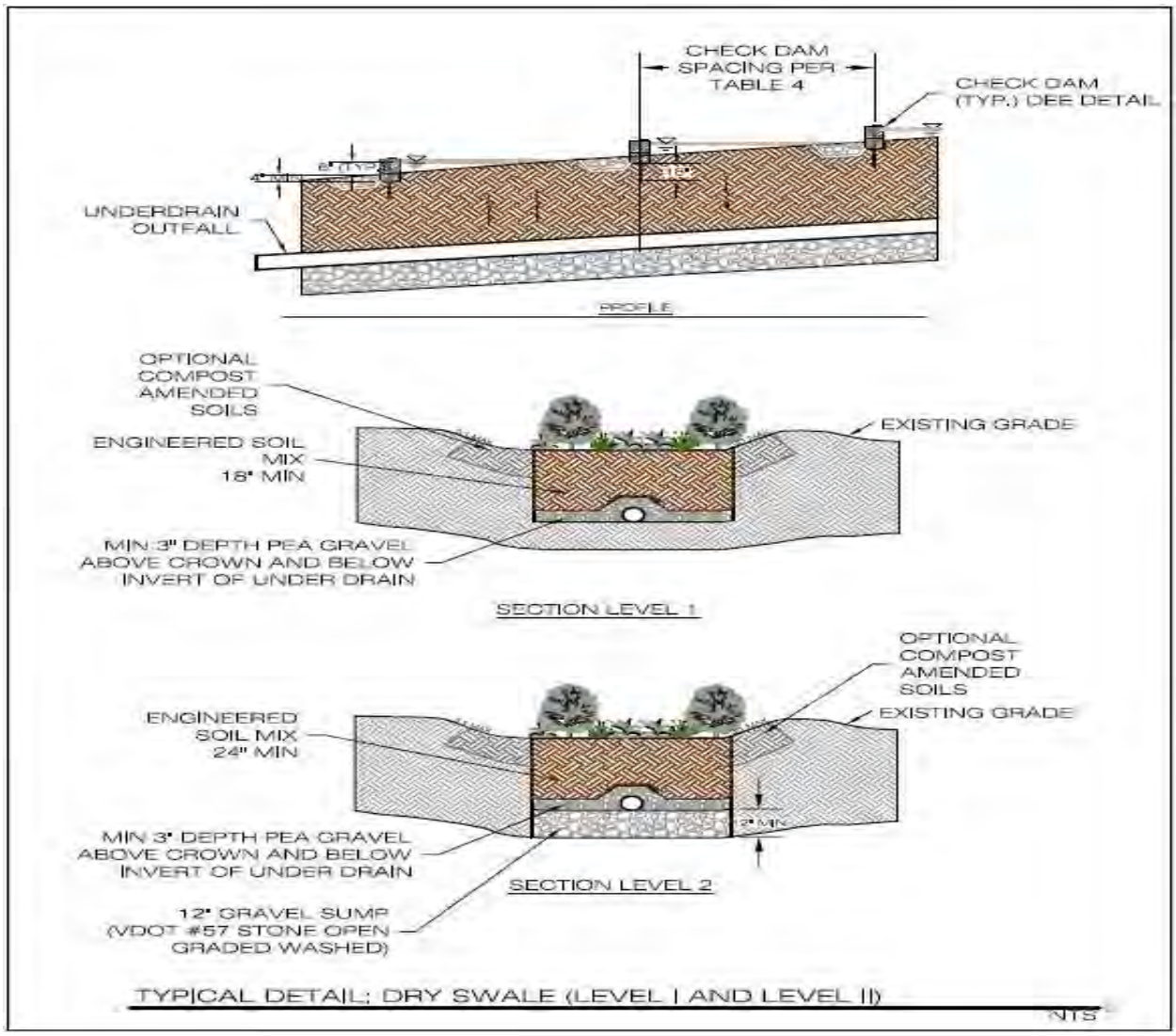


Figure 5-8. Typical Design Details of a Bio-Swale

5.3.6 Materials

Bio-swales are the only swale type that involves manufactured materials. See the materials specifications in Table 5-2 in Section 5.2.5 for bioretention materials. Designers should follow their local stormwater management requirements when specifying materials.

5.3.7 Construction Considerations

5.3.7.1 General

Construction of the vegetated swale should begin when the up-gradient site has been sufficiently stabilized and state-approved temporary erosion and sediment control measures are in place. Use light equipment and avoid excessive compaction and/or land disturbance during construction of the vegetated swale. Excavating equipment should operate from the sides of the swale and never on the bottom. If excavation leads to substantial compaction of the subgrade, excavate 18 inches

and replace with a blend of topsoil and sand to promote infiltration and biological growth. Vegetative swales should be fully protected by silt fence or construction fencing, particularly if they will provide an infiltration function (i.e., have no underdrains) during construction within the immediate area.

Vegetative swales should remain outside the limit of disturbance during construction to prevent soil compaction by heavy equipment. However, this is seldom practical given that swales are a key part of the drainage system at most sites. In these cases, temporary erosion and sediment controls such as dikes, silt fences and other similar measures should be integrated into the swale design throughout the construction sequence. Specifically, barriers should be installed at key check dam locations, erosion control fabric should be used to protect the channel, and excavation should be no deeper than 2 feet above the proposed invert of the bottom of the planned underdrain. Vegetative swales without an underdrain that provide for infiltration must be fully protected by silt fence or construction fencing to prevent compaction by heavy equipment during construction within the immediate area.

5.3.7.2 Construction Sequence

The following is a typical construction sequence to properly install a vegetated swale, although the steps may be modified to adapt to different site conditions.

1. Installation may only begin after the entire contributing drainage area has been stabilized.

2. Excavators or backhoes should work from the sides to excavate the vegetative swale area to the appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the project area.

3. The bottom of the swale should be ripped, roto-tilled or otherwise scarified to promote greater infiltration.

4. Rough grade the swale. For bio-swale, continue to Step 5. For grass and wet swale, skip to Step 7.

5. Place filter fabric on the excavated sides of the vegetated swale with a minimum overlap as specificed by manufacturer. Place the stone needed for storage layer. Lay the perforated underdrain pipe. Add the remaining stone jacket, ensuring a minimum 3 inches of gravel above the top of the underdrain, and then add pea gravel choker layer.

6. Place the engineered soil media in 12-inch lifts until the desired top elevation of the swale is achieved. Wait a few days to check for settlement, and add additional media as needed.

7. Install check dams, driveway culverts and internal pre-treatment features, as specified in the plan.

8. Fine grade the swale.

9. Prepare planting holes for specified trees and shrubs, install erosion control fabric where needed, spread seed or lay sod, and install any temporary irrigation.

10. Plant landscaping materials as shown in the landscaping plan, and water them weekly during the first 2 months. The construction contract should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.

5.3.7.3 Final Inspection

A final construction inspection should be conducted and a punch list developed for facility acceptance. Items to inspect are as follows:

- Check elevations such as the invert of the underdrain, inverts for the inflow and outflow points, and the ponding depth provided between the surface of the filter bed and the overflow structure.

- Check the filter media to confirm that it meets specifications and is installed to the correct depth.

- Ensure that caps are placed on the upstream (but not the downstream) ends of the underdrains.

- Make sure the desired coverage of turf or erosion control fabric has been achieved following construction, both on the filter beds and their contributing side-slopes.

- Inspect check dams and pre-treatment structures to make sure they are properly installed and working effectively.

- Check that outfall protection/energy dissipation measures at concentrated inflow and outflow points are stable.

The real test of a vegetative swale occurs after its first big storm. The post-storm inspection should focus on whether the desired sheet flow, shallow concentrated flows or fully concentrated flows assumed in the plan actually occur in the field. Also, inspectors should check that the swale drains completely within the minimum 6-hour drawdown period. Minor adjustments are normally needed as a result of this post-storm inspection (e.g., spot reseeding, gully repair, added armoring at inlets or outfalls, and check dam realignment).

5.3.8 Maintenance

Once established, vegetated swales have minimal maintenance needs outside of the spring cleanup, regular mowing, and pruning and management of trees and shrubs. Additional effort

may be needed to repair check dams, stabilize inlet points, and remove deposited sediment from pre-treatment cells.

In a bio-swale, the surface of the filter bed can become clogged with fine sediment over time, but this can be alleviated through core aeration or deep tilling of the filter bed. Additional effort may be needed to repair check dams, stabilize inlet points, and remove deposited sediment from pre-treatment cells. Maintenance activities are similar to that of bioretention; refer to Section 5.1.7 for bioretention maintenance.

Table 5-5 is a schedule of inspection and maintenance activities recommended for vegetated swales.

Table 5-5. Suggested Maintenance Activities for Vegetated Swales

	Task	Frequency	Maintenance Notes
1	Re-mulch /re-plant void areas	As needed	
2	Replace diseased trees, shrubs, vegetation	As needed	
3	Clean Overflow	Monthly	Clear leaves and debris
4	Inspect soil and repair eroded areas	Monthly	
5	Remove litter and debris from swale	Monthly	
6	Inspect for sediment buildup, vegetative condtions, etc.	Annually	
7	Inspect all trees and shrubs to evaluate helath	Biannually	

5.3.9 Benefits

Vegetative swales provide reduction in peak flow by increasing time of concentration and runoff volume reduction by infiltration and evapotranspiration. Vegetated swales also provide improved water quality via filtering polluted runoff. They are more aesthetically pleasing than concrete/riprap lined drainage ditch. Vegetated swales are generally less expensive to construct and maintain than lined channels. Vegetated swales protect local and regional water quality by reducing sediment and nutrients; and increase community character and aesthetics. Some benefits are summarized below.

- Can be used in residential and commercial settings
- Inexpensive
- Combines water quality treatment with runoff conveyance
- Reduces runoff velocities
- Low maintenance

5.4 VEGETATED FILTER STRIP

5.4.1 Description

A vegetated filter strip is a densely vegetated strip of land designed to receive stormwater runoff from an impervious area, such as a road or parking lot. These systems function by slowing stormwater runoff and filtering out sediment and other pollutants as the stormwater runoff passes through the filter strip or infiltrates to groundwater. Stormwater runoff is absorbed by the soils and is taken up by plants and transpired or may infiltrate into the ground if the soil is well drained. A properly designed and operating filter strip reduces overland flow velocity and provides water quality treatment by reducing the amount of sediment, organic matter, nutrients, and metals carried in stormwater runoff.

The main purpose of a VFS is to reduce the velocity of the stormwater runoff through the surface roughness of the vegetation and to encourage filtration, sediment deposition, infiltration, absorption, and plant uptake of nutrients from the stormwater runoff. Usually, a vegetated filter strip is used as a pretreatment component in conjunction with a primary stormwater BMP (such as bioretention, vegetated swale, etc.) for slowing runoff velocity and reducing sediment and particulate pollutant load that could otherwise reach the primary BMP and impact its effectiveness.

Vegetated filter strips have historically been used and proven effective on agricultural lands, usually downslope along field crops (Grimser, 2006). In urban settings, vegetated filter strips are most effective in treating runoff from isolated impervious areas such as rooftops, parking lots, and small impervious areas. Sheet flow access from upslope paved areas to the filter strip is a mandatory requirement for its proper function and effectiveness. One challenge associated with filter strips, therefore, is that it is difficult to maintain sheet flow over longer flow paths, so the practice may be "short circuited" by concentrated flows, receiving little or no treatment.

5.4.2 Planning Considerations

5.4.2.1 Applications

The vegetated filter strips are suitable for many types of development projects in residential, commercial and industrial settings. They are usually recommended for use as a pretreatment component for other stormwater BMPs as they slow runoff velocities and can direct stormwater runoff to another BMP, though they do not provide adequate pollutant removal benefits while acting as a standalone practice. As stated above, vegetated filter strips are generally not recommended as “stand alone” features, but as pretreatment systems for other BMPs, such as infiltration trenches, vegetated swales, or bioretention areas. They are generally a poor stormwater retrofit option because they consume a relatively large amount of space and cannot treat large drainage areas (PA DEP, 2006).

Vegetated filter strips rely on their relatively flat cross slope, mild downslope, and dense vegetation to slow and remove stormwater runoff pollutants. These design features ensure that runoff remains as sheet flow while passing through the strip. The Virginia Departement of Conservation and Recreation (2011) recommends that vegetated filter strip systems are effective only where the runoff enters the filter strip, from above the contributing drainage area, as sheet flow and remains in sheet flow condition while flowing through the strip. This requirement limits flow length over impervious surfaces not to exceed 75 feet (Claytor and Schueler, 1996).

The proper planning and construction of a filter strip should consider factors such as: soil characteristics (texture, soil type, hydrologic soil group, infiltration rate, and permeability); the slope, shape, length, and size of the contributing area; and the designed quantity of pollutant removal from runoff (sediment, nutrient, organic matter, metals and hydrocarbons, etc.). The type of vegetation applicable to local climatic conditions, and time of the year to properly establish that vegetation (by seed or sod) are also important considerations. Although, the type of vegetation used can be very broad, the best performance is associated with native plant species having deep, fibrous roots and dense ground patterns such as turf-forming grasses.

5.4.2.2 Constraints

Vegetated filter strips require runoff to enter as sheet flow to work effectively, therefore, they should not receive large volumes of runoff since such flows tend to concentrate and form channels. Channels within a filter strip allow runoff to short-circuit the BMP, rendering it ineffective.

Vegetated filter strips have several other limitations related to their performance and space consumption such as:

- VFSs are not intended to treat concentrated flow and are only effective when runoff flows as sheet flow
- Not recommended for soils with high clay content because VFSs require some infiltration for proper treatment
- Very poor soils that cannot sustain a grass cover are also a limiting factor
- Filter strips require a large amount of space, making them often infeasible in urban environments where land space is limited
- Vegetated filter strips should not receive “hot spot” runoff for potential aquifer contamination, because the practice encourages infiltration
- Sheet flow is the mandatory requirement for proper functioning of the BMP which is difficult to achieve and maintain, especially for longer flow reaches

5.4.3 Design Criteria & Specifications

Vegetated filter strips require minimal design as they essentially a grassed landscape with a gentle to flat slope. Thus, the design and construction criteria are not much different than seeding/sodding a residential lawn. However, some design features are critical to ensure that a vegetated filter strip properly slows stormwater runoff and provides intended water quality treatment. These features include its slope, length, width, and type of surface cover. To be effective, vegetated filter strips require the stormwater runoff to sheet flow across the entire strip.

Key vegetated filter strip design elements are described in several state Stormwater BMP Manuals, such as New Jersey BMP Manual (2003), PA DEP (2006), Virginia DCR (2011), etc., and are also discussed on the USEPA Website: EPA Menu of Stormwater BMPs (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm) under "Management Measures for Vegetated Treatment Systems. These elements are briefly described in the following sections.

5.4.3.1 General

The basic design parameters for a vegetative filter strip are its longitudinal slope and length (i.e., parallel to flow) and the type of vegetative cover. The vegetation in the filter strip will slow the stormwater runoff; the degree to which the vegetation slows the runoff is associated with the roughness of the vegetation. Different types of vegetation have different roughness coefficients called the Manning's roughness coefficient, n, which refers to the resistance of the bed of a channel to the flow of water. The vegetation is selected to have a certain roughness for slowing runoff velocity which, in combination with vegetated filter strip slope, is used to determine the required filter strip length parallel to flow through the strip. In addition, since runoff from upslope contributing drainage area must enter as sheet flow into the vegetated filter strip, the peak runoff rate originating from the contributing drainage area (such as from a parking lot) must be sufficiently low and uniformly distributed to ensure sheet flow conditions over the entire area. The sheet-flow length limitation, in turn, limits the size of the contributing drainage area to the filter strip and, consequently the peak runoff rate. Details of these and other design parameters are presented in the following sections. The components of a typical vegetated filter strip are shown in Figure 5-9.

5.4.3.2 *Contributing Drainage Area and Runoff Characteristics*

Typically, vegetated filter strips are used to treat very small drainage areas. The limiting design factor, however, is not the drainage area but the sheet flow requirement for the runoff to travel over the impervious area, which limits the length of flow not to exceed 75 feet over the paved area (CWP, 1996). As noted above, the maximum sheet flow travel length over an impervious, paved surface is 75 feet (CWP, 1996). Therefore, the maximum contributing drainage area to a VFS will be limited to an area 75 feet long measured perpendicular to the upslope edge of the filter strip. If the width of the drainage is equal to the width of the vegetated filter strip, then the contributing drainage area is essentially equal to length multiplied by width.

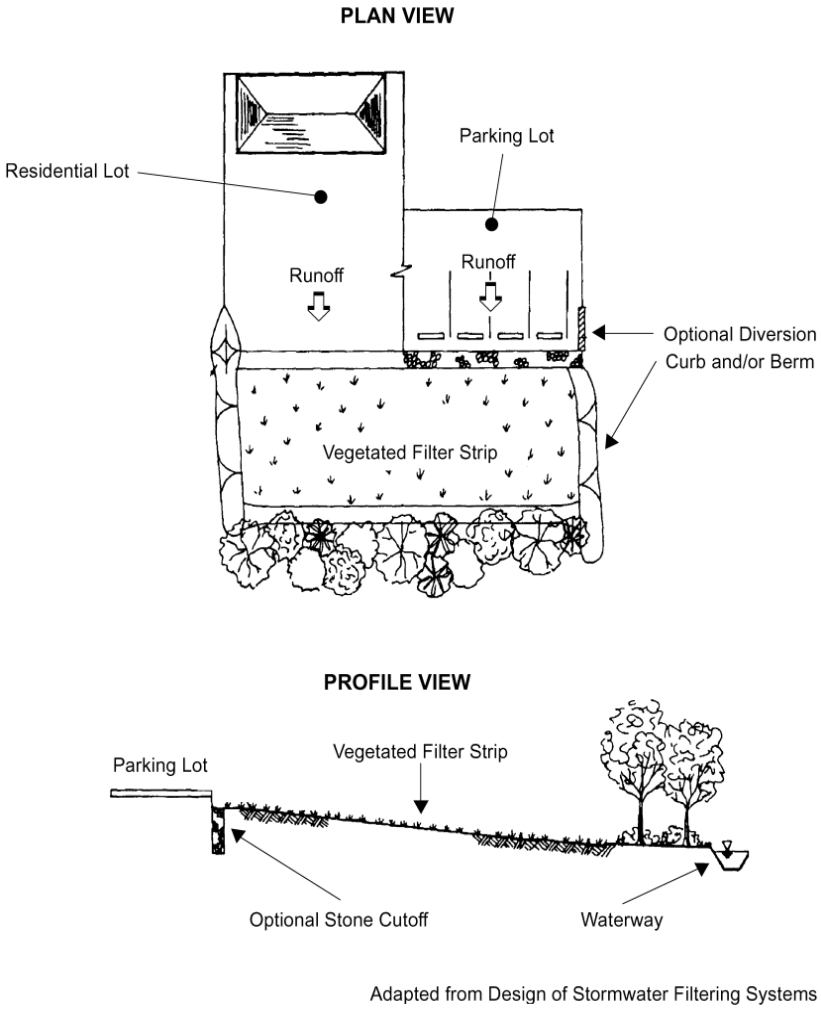


Figure 5-9. Vegetated Filter Strip Components
(Source: CWP, 1996)

5.4.3.3 *Vegetation Cover and Manning's Roughness Coefficient, n*

Vegetation for filter strips may be comprised of turf grasses, meadow grasses, shrubs, and native vegetation. Native vegetation helps to minimize erosion by stabilizing the soil with deep root structure common in native plants. A vegetated filter strip should be densely vegetated with a mix of erosion resistant species that have fibrous root system to effectively bind the soils. The selection of plants should be based on their compatibility with local climatic conditions, soils, topography; and their ability to tolerate urban thermal stress, variable soil moisture conditions, drought, and ponding conditions.

Table 5-6 below presents Manning's roughness coefficient, n, values for various surface covers. These Manning's "n" values, in combination with respective slopes may be used to determine maximum filter strip lengths for VFS systems (New Jersey BMP Manual, 2003).

Table 5-6. Manning's Roughness Coefficients (n)

Vegetation Cover in Filter Strip	Manning's N
Dense Grass	0.25
Sod	0.35
Meadow or Woods with Dense Vegetation	0.35
Natural Woods with Dense Vegetation	0.40

(Source: New Jersey BMP Manual, 2003)

5.4.3.4 Filter Strip Slope

The vegetated filter strips should, in general, be designed for slopes, parallel to flow length, between 2 and 6 percent. The maximum slope should not be more than 8 percent, whereas the minimum should be not less than 2 percent to promote positive drainage. Steeper slopes will increase flow velocity and lead to concentration of runoff and likelihood of erosion and gullying. In addition, as the slope increases, the treatment effectiveness decreases. Slopes flatter than 2 percent may be appropriate in some geographic regions, but are discouraged in residential areas due to the tendency for surface ponding that creates potential nuisance conditions. The recommended cross slope for a vegetated filter strip is 1 percent or flatter.

The maximum filter strip slopes for various vegetation covers and soil types for a vegetated filter strip are shown in Table 5-7. Except for coarse sandy soils, the recommended slopes for other soils types and hydrologic soil groups (HSG) are mostly in the range of 8 percent. County soil surveys can help determine the soil type and HSG within a vegetated filter strip, although site soil testing may be necessary for accurate design.

Table 5-7. Maimum Vegetated Filter Strip Slopes for Various Soil Types

Soil Type	HSG	Maximum Slope, %	Maximum Slope, %
		Dense Grass, Sod, and Bermuda Grass	Woods with Dense Underbrush
Sand	A	7	5
Sandy Loam	A	8	7
Loam, Silt Loam	B	8	8
Sandy Clay Loam	C	8	8
Clay Loam, Silty Clay, Clay	D	8	8

(Source: New Jersey Stormwater BMP Manual, 2003)

5.4.3.5 *Filter Strip Length*

In vegetated filter strip systems, the limiting design factor is the length of the flow both over the contributing drainage area, as well as, through the vegetated filter strip itself; sheetflow needs to be maintained across the contributing drainage area and the vegetated filter strip (PA DEP, 2006). Vegetated filter strip length (the dimension parallel to flow path) is a function of slope, vegetation type, soil type, and the desired amount of pretreatment. Figure 5-10 provides vegetated filter strip lengths as a function of various vegetation types (Manning's roughness, n, Table 5-6) and slopes, Table 5-7. It should be noted that that linear interpolation may be used for Manning's n values not specifically plotted in the figure. As shown in the figure, the minimum filter strip length is 20 feet regardless of slope or Manning's n value**.**

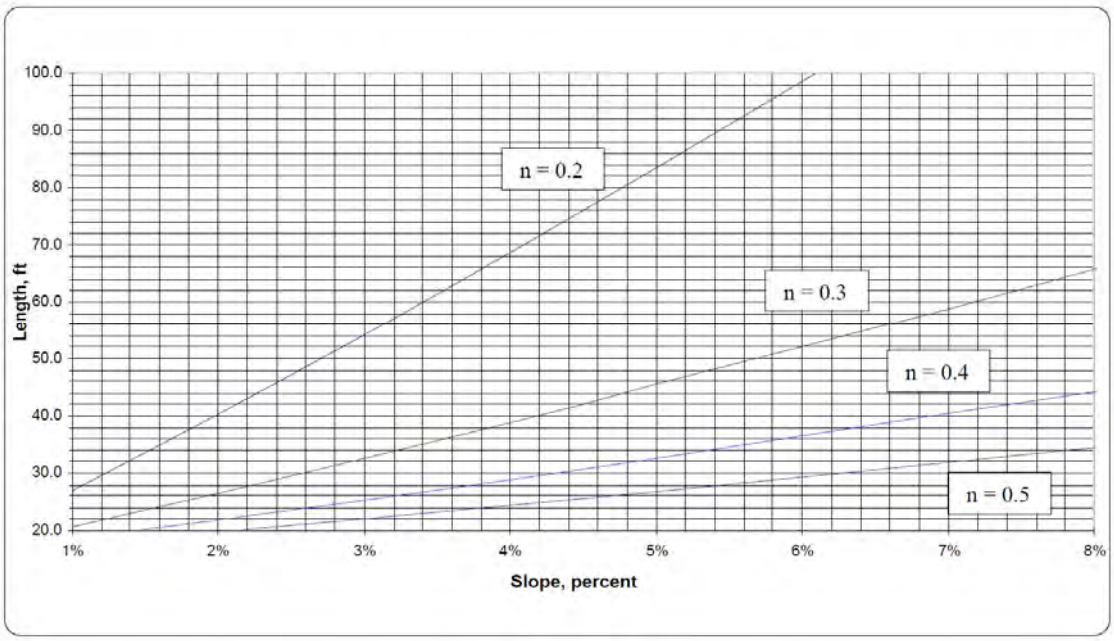


Figure 5-10. Vegetated Filter Strip Length Determination

(Source: New Jersey BMP Manual, 2003)

It is also important to note that the lengths shown in Figure 5-10 are applicable only for filter strips with coarse soils, such as sands. For filter strip areas with less coarse soils, such as silt and clays, the length shown in the Figure 5-10 must be multiplied by the factors shown in Table 5-8.

Table 5-8. Filter Strip Length Correction Factors

Soil Type	HSG	Correction Factor
Sand	A	1.0
Sandy Loam	A	1.1
Loam, Silt Loam	B	1.3
Sandy Clay Loam	C	1.5
Clay Loam, Silty Clay, Clay	D	1.8

(Source: New Jersey BMP Manual, 2003)

5.4.3.6 Filter Strip Width and Travel (Contact) Time

The vegetated filter strip should be designed to provide a 20-minute travel time (contact time) for runoff passing through the filter strip. The Iowa SUDAS (2000) recommends that this 20-minute level of contact time with vegetation would provide approximately 85 percent removal of total suspended solids.

The width of the VFS, perpendicular to flow length, should be sized according to Manning's equation to limit the flow depth to one half inch or less. As a general rule, the width should be equal to the width of the contributing drainage area above. When this is not possible, a pea gravel diaphragm or a level spreader should be provided to reduce the flow width to that of the filter strip. CWP (1996) and Virginia DCR (2011) guidelines suggest a minimum vegetated filter strip width of 25 feet at 1 percent or flatter cross slope.

5.4.3.7 Pea Gravel or Gravel Trench

A pea gravel diaphragm should be installed along the entire up-gradient edge of the strip. The pea gravel diaphragm serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader or energy dissipater for maintaining sheet flow as runoff flows over the filter strip. The pea gravel diaphragm is created by excavating a 2-foot wide and 1-foot deep trench that runs on the same contour as the top of the filter strip. A layer of geotextile filter fabric should be placed between gravel and underlying soil trench. When placed directly adjacent to an impervious surface (parking lot), a drop (between the paved edge and the trench) of 2-3 inches is recommended.

5.4.3.8 Permeable Berm

Filter strip effectiveness may be enhanced through the addition of a pervious berm at the toe of the slope for providing a temporary ponded area. The filter strip should be designed with a permeable berm of sand and pea gravel at toe of the vegetated filter strip. The runoff volume ponded behind the berm should be equal to the water quality volume. The water quality volume is the amount of runoff that will be treated for pollutant removal inside the filter strip. Typical water quality volume is the runoff from a 1-inch storm or ½-inch of runoff over the entire

contributing drainage area to the filter strip. The permeable berm should have the following design characteristics:

- A wide and shallow trench, 6-12 inches deep, should be excavated at the upstream toe of the berm
- Media for the berm should consist of 40 percent excavated soils, 40 percent coarse sand, and, and 20 percent pea gravel
- The berm, 6 to 12 inches high, should be located down gradient of the excavated trench and should have gentle side slopes to promote easy mowing
- Stone may be used to armor the top of the berm to handle runoff overtopping

A permeable berm is not needed when a VFS is used as a pretreatment to another stormwater practice.

5.4.4 Materials

Vegetation selected for filter strips should have dense growth to provide good, uniform soil cover, and a fibrous root system for stability. In addition, the type of vegetation selected should be adapted to local soil and climatic conditions, and have good regrowth characteristics following dormancy and mowing. Common materials used in filter strips are outlined in Table 5-9.

Table 5-9. Vegetated Filter Strip Material Specifications

Material	Specification
Gravel Diaphragm	Pea gravel ASTM D 448, size #6 or #8 (1/8-nch to 3/8-inch dia); DOT stone #57: Diaphragm should be 2 feet wide, 1 feet deep, and at least 3 inches below the edge of pavement
Permeable Berm	Not required when VFS is used as a pretreatment practice; otherwise use 40% topsoil, 40% sand, and 20% gravel
Geotextile	Non-woven, ASTM D4491
Compost	Compost shall be derived from plant material

(Source: Virginia DCR, 2011)

5.4.5 Construction Considerations

In general, the same considerations apply for the installation of a filter strip as for the establishment of lawns and other landscaped areas. Land grading and other soil surface preparation is necessary to ensure establishing vegetation and that the runoff will enter the strip in the form of sheet flow.

Begin vegetated filter strip construction only when the up-gradient site has been sufficiently stabilized and “state-approved” temporary erosion and sediment control measures are in place.

Construction should be initiated, if possible, at a time of the year when successful establishment without irrigation is most likely. However, irrigation may be needed in periods of little or no rain.

5.4.5.1 Construction Sequence

The following procedures should be followed during construction.

1. Rough grade the site using light equipment to avoid compaction.

2. If existing topsoil is stripped during grading, it should be stockpiled for later use.

3. Prepare a firm seedbed by plowing and cultivating to a depth of 6-12 inches.

4. Plant the seed shallow (1/4-inch) with a seed drill or by broadcast. Make sure the seed is on a firm seedbed to obtain good seed-to-soil contact.

5. Before seeding, apply soil amendments that would ordinarily be used for turf grasses including fertilizer, lime, compost or gypsum per soil tests.

6. Use native vegetation as recommended by your local USDA NRCS Extension Office.

7. Must use wheat straw or blanket mulch over seeded area to ensure germination and early plant establishment.

8. Irrigate after seeding. During periods of dry weather, germination of seed and plant establishment may require subsequent irrigations.

5.4.6 Maintenance

Vegetated filter strips require regular maintenance. Inspections are critical during the first few years to ensure that the VFS becomes adequately established. Once a VFS is established and is functioning, as intended, periodic maintenance such as watering, fertilizing and spot repair may still be necessary. Overseeing and replanting should be limited to those species which have exhibited the ability to thrive.

Maintenance for grassed filter strips may consist of the following simple steps and as summarized in Table 5-10.

Table 5-10. Suggested Maintenance Activities for Vegetated Filter Strips

Activity	Frequency
Inspect pea gravel diaphragm for clogging and remove build-up sediment	Annually
Inspect vegetation for rills and gullies and correct	Annually
Seed or sod bare areas	Annually
Ensure that grass has established. If not, replace with an alternate species	Annually
Mow during growing season	As needed
Remove weeds and invasive species	As needed

5.4.7 Benefits

Vegetated filter strips are agricultural BMPs and their effectiveness in urban settings, especially as a pretreatment practice, has not been widely investigated and established (Yu et al., 1992). However, some significant benefits and limitations of vegetated filter strip systems include:

- Water quality treatment via filtering of suspended sediments and NPS pollutant control
- Provides pretreatment control to capture coarse sediments before they reach main stormwater BMP such as a bioretention or vegetated swale
- Can be used to treat runoff along residential streets, stream corridors, and parking lots
- Provides an aesthetically pleasing appearance

5.5 PERMEABLE PAVEMENTS

Pervious or permeable pavements consist of a permeable surface course underlain by a uniformly graded stone-bed laid on uncompacted soil. The surface course consists of porous asphalt, porous concrete, or various porous pavers. Stormwater drains through the permeable surface course to the stone bed, where it is temporarily stored to provide peak flow reduction and promote infiltration to the underlying soils. A layer of geotextile filter fabric separates the aggregate from the underlying soil, preventing the migration of fines into the bed. The application of permeable pavement allows stormwater runoff to infiltrate the surface more evenly, resulting in a reduction of runoff and minimizes concentrated flows. Permeable pavements and pavers provide water quantity and quality benefits by promoting infiltration, while still providing a stable load-bearing surface without increasing the project impervious area.

5.5.1 Types of Permeable Pavement

There are several types of permeable pavements and pavers. For the purposes of the Army LID Technical User Guide, the four main categories of permeable pavements and pavers will be discussed: porous asphalt, pervious concrete, permeable concrete pavers, reinforced turf.

5.5.1.1 Porous Asphalt

Porous asphalt is similar to conventional asphalt in structure and form, except that the fines (sand and finer material) from parent asphalt mix have been removed. The same mixing and application is used for porous or pervious asphalt as the impervious asphalty; only the formula for the asphalt is different.

Porous asphalt is appropriate for only pedestrian-use areas and for very low-volume, low-speed vehicular areas such as overflow parking areas, residential driveways, alleys, and parking stalls. Photo 5-12 shows porous asphalt use on a playground and basketball court.

Photo 5-12. Porous Asphalt in Playground

5.5.1.2 Pervious Concrete

Pervious concrete can be used in place of conventional concrete in most situations. Smaller amounts of fines, larger pea gravel, and a lower water-to-cement ratio are used to achieve a pebbled, open surface that is roller compacted. In northern and mid-Atlantic climates, such as Pennsylvania, pervious concrete should always be underlain by a stone subbase designed for stormwater management and should never be placed directly onto a soil subbase. Pervious concrete has a coarser appearance than its conventional counterpart, as seen in Photo 5-13. Care must be taken during placement to avoid working the surface and creating an impervious layer.

Photo 5-13. Standard and Porous Concrete

5.5.1.3 Permeable Concrete Pavers

Permeable pavers consist of interlocking units (often concrete or brick) that have pervious pea gravel, vegetation or mulch in the spaces between the units to form a grid system. The pervious spaces between the pavers allow for filtration of stormwater through layers of open-graded aggregated and infiltration into the underlying soils. Permeable pavers provide pervious surfaces throughout the otherwise impervious surface and also enhance the aesthetic appeal of the area. They are most often used for driveways, small parking areas, entryways, walkways, plazas, patios or terraces to achieve a more aesthetically pleasing appearance. Photo 5-14 illustrates the use of two colors of permeable pavers to outline parking spots within a larger parking lot.

Photo 5-14. Permeable Pavers at Multnomah Art Center
(Source: Portland Philadelphia Stormwater Manual)

5.5.1.4 Reinforced Turf

Reinforced turf and gravel are highly permeable as they have voids where, once installed, grass, flowers, or vegetation are planted inside and allowed to grow through the paver. The pavers themselves can be made from plastic, concrete, or gravel, and can be used in high traffic areas (Photo 5-15).

Reinforced turf consists of interlocking structural units that contain voids or areas for turf grass growth and are suitable for traffic loads and parking. The reinforce turf is underlain by a stone and/or sand layer to filter pollutants and temporarily store runoff. There are also products available that provide a fully permeable surface through the use of high strength plastic geogrids (often made from recycled materials) filled with gravel or grass. After heavy rains, the grids act as mini holding-ponds, and allow water to gradually absorb into the soil below.

Reinforced turf applications work well for fire access roads, overflow parking, and occasional use parking. Reinforced turf application allows for the reduction of the required standard pavement width for paths and driveways that must occasionally provide for emergency vehicle access.

The reinforced turf grides provide a support structure for heavy vehicles, and prevent erosion. While both plastic and concrete units perform well for stormwater management and traffic needs, plastic units tend to provide better turf establishment and longevity, largely because the plastic

will not absorb water and diminish soil moisture conditions. A number of products (e.g., Grasspave, Geoblock, GravelPave, Grassy Pave, Geoweb) are available and the designer is encouraged to evaluate and select a product suitable to the design in question.

Photo 5-15. Examples of Reinforced Turf

5.5.2 Planning Considerations

Permeable pavements can be used as a substitute for impervious pavements in most land use areas to reduce stormwater runoff. However, as there are many opportunities to employ permeable pavers, there are also many constraints. Permeable pavements work well in parking lots and some roads but the may be limited in supported the weight of heavy vehicles or heavy traffic. There are also human safety concerns, such as use in handicap parking areas, where pavers can be a hazard if the surface is uneven.

5.5.2.1 Applications

There are several opportunities to incorporate permeable pavements into many types of land uses. Such applications include:

- Ultra urban, commercial, industrial, retrofit, highway/roadway(limited use), and residential streets and driveways
- Public play grounds, tennis courts, parking lots, plazas, and similar uses
- Areas adjacent to tree islands in parking lots (Photo 5-16)
- Service drives and emergency vehicle access lanes and fire lanes
- Pedestrian sidewalks (Photo 5-17 and Photo 5-18)

Photo 5-16. Permeable Pavers in Parking Lots Adjacent Tree Island

Photo 5-17. Porous Asphalt Along Pedestrian Walkways

Photo 5-18. Pervious Concrete Along Roads and Streets

5.5.2.2 Constraints

Permeable pavements are not suitable in areas where the underlying soils do not drain well. Permeable pavements should be laid on uncompacted, level soil. Compacting the subgrade will prevent runoff from being able to infiltrate. If new fill is required, it should consist of additional stone and not compacted soil.

Permeable pavements/pavers are not recommended where:

- Excessive sediment could be deposited on the surface
- Steep erosion prone areas that are likely to deliver sediment and clog pavement
- Underlying soils are composed of fill material, which can become unstable when saturated
- Maintenance is unlikely to be performed at appropriate intervals
- Porous asphalt is not recommended for slopes exceeding 5%

- Pervious concrete is not recommended on slopes exceeding 6%

- Porous asphalt not ideal for high traffic/high speed areas because it has lower load-bearing capacity than conventional asphalt.

- Areas where requirements under the Americans with Disabilities Act apply, such as handicap parking spaces

- Permeable pavement should not be used on stormwater "hotspot land use" (such as gas stations) applications with high pollutant loads because the rain falling directly on the paved surface cannot be pretreated prior to filtering through the pavement section and infiltrating into the subgrade.

5.5.3 Design Criteria & Specifications

Permeable pavements can be used in place of conventional pavements, though additional factors must be considered in the placement and design as there are some structural differences. Design considerations include the permeability of underlying soils, risk of contaminating groundwater in hotspots, and the type of permeable pavement to be used.

5.5.3.1 Site Investigation

The overall site should be evaluated for potential pervious pavement/infiltration areas early in the design process. Pervious pavement and infiltration beds should not be placed on areas of recent fill or compacted fill. Any grading that requires fill should be done using the gravel subbase material.

5.5.4 Components of Permeable Pavement Section

A permeable pavement section consists of a pervious surface course (porous asphalt, pervious concrete, permeable concrete pavers or reinforced turf) underlain by layers uniformly graded and clean-washed coarse aggregate with a void space of at least 40 percent. The depth of the bed is a function of stormwater storage requirements, frost depth considerations, site grading, and anticipated loading. Stormwater drains through the surface, is temporarily held in the voids of the stone bed, and then slowly drains into the underlying, uncompacted soil mantle. The stone bed can be designed with an overflow control structure or subdrain so that during large storm events peak rates are controlled, and at no time does the water level rise to the surface course. A layer of geotextile filter fabric separates the aggregate from the underlying soil, preventing the migration of fines into the bed. Figure 5-11 shows an example of a permeable concrete paver section without an underdrain.

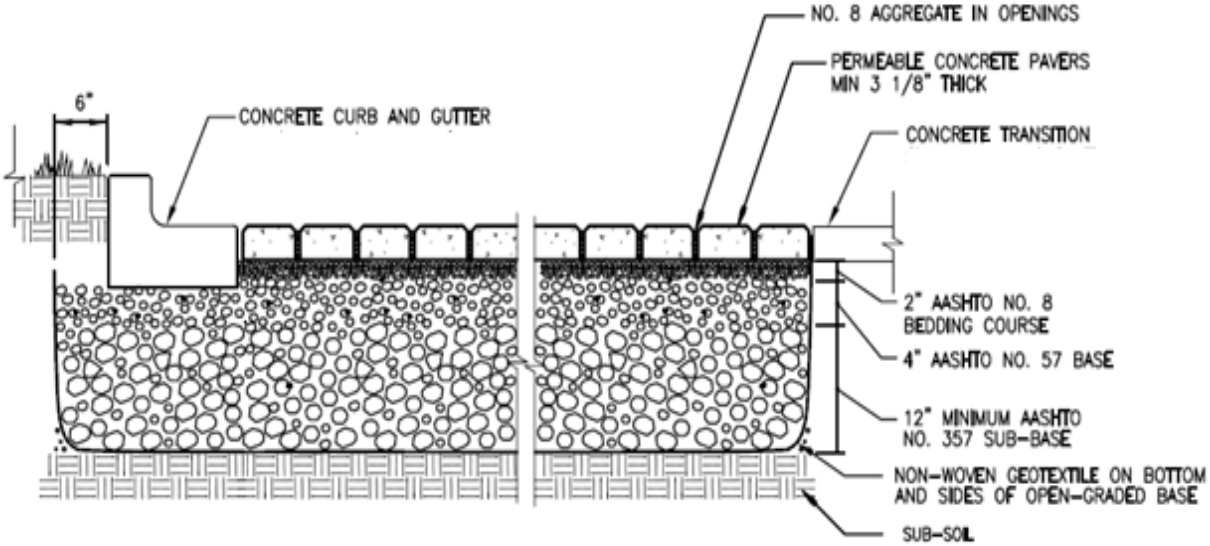


Figure 5-11. Cross Section of Permeable Concrete Paver
(Source: USACE, 2011)

5.5.4.1 Drainage/Overflow

All systems should be designed with an overflow system. Water within the subsurface stone bed should never rise to the level of the pavement surface.

While infiltration beds are typically sized to handle the increased volume from a storm, they should also be able to convey and mitigate the peak of the less-frequent, more intense storms (such as the 10 or 100-year). The subsurface bed and overflow may be designed and evaluated in the same manner as a detention basin to demonstrate the mitigation of peak flow rates. In this manner, the need for a detention basin may be eliminated or reduced in size. Control in the beds is usually provided in the form of an outlet control structure. A modified inlet box with an internal weir and low-flow orifice is a common type of control structure. The specific design of these structures may vary, depending on factors such as rate and storage requirements, but it always should include positive overflow from the system.

All pervious pavement installations should have a backup method for water to enter the stone storage bed in the event that the pavement fails or is altered. In uncurbed lots, this backup drainage may consist of an unpaved stone edge or curtain drain connected directly to the bed. In curbed lots, inlets with water quality devices may be required at low spots. Backup drainage elements will ensure the functionality of the infiltration system, if the pervious pavement is compromised.

In areas with poorly draining soils, infiltration beds below pervious pavement may be designed to slowly discharge to adjacent wetlands or bioretention areas. Only in extreme cases (i.e., industrial sites with contaminated soils or karst topography) will the aggregate bed need to be lined to prevent infiltration.

5.5.5 Materials

Table 5-11 provides a summary of the typical material requirements for the permeable pavement components described in previous pages. Designers should follow their local stormwater management requirements when specifying materials.

Table 5-11. Typical Permeable Pavement Material Specifications

Material	Specification	Notes
PERMEABLE PAVER		
Interlocking Concrete Paver	Min. 3-1/4 in. thick meeting ASTM C 396 or CSA A231.2	20% or more surface area open
Pea Gravel Bedding Course	2-inch layer 1/8 to 3/8 – inch aggregate (AASHTO No. 8 stone)	
Open Graded Base Course	4-inch layer AASHTO No. 57 stone	
Subbase Course	AASHTO No. 2 stone	40% voids Thickness varies, minimum 6 inches
Non-woven Geotextile	ASTM-D4632 ASTM-D3786 ASTM-D4491 ASTM D-4355 Nonwoven polypropylene fibers	
REINFORCED TURF		
Plastic Geogrid	Minimum 1-3/4 inch thick	
Subbase Course	AASHTO No. 2 stone	Minimum 30% voids Thickness varies, minimum 6 inches
POROUS ASPHALT AND PERVIOUS CONCRETE		
Cement	Portland Cement Type I or II conforming to ASTM C 150 Portland Cement Type IP or IS conforming to ASTM C 595	Cement content shall not be less than 600 lbs/cy for pavement subjected to vehicle loads
Air Entraining Agent	ASTM C 260	
Admixture	Type D Water Reducing – ASTM D 494	
Mixing Water	Potable	
Aggregate/Cement Ratio	4:1 to 4.5:1	
Water/Cement Ratio	0.34 to 0.40	
Asphalt and Concrete Mix Design	Consult pavement designer	Pavement shall have load capacity cable of supporting applicable traffic and vehicle loads

Material	Specification	Notes
Asphalt and Concrete	Minimum 15 percent air voids in the completed top lift. Concrete strength 2400 to 2500 psi after 28 days curing period.	
ALL PERMEABLE PAVEMENT TYPES		
Subgrade (Existing Subsoil)	Subgrade shall not be compacted	
Aggregate Layers	Aggregates shall be washed and free of fines	
Underdrain	Minimum 6-inch perforated pipe PVC Schedule 40 HDPE to meet AASHTO M252, Type S or AASHTO M294, Type S.	

5.5.6 Construction Considerations

5.5.6.1 General

Due to the nature of construction sites, permeable pavement and other infiltration measures should be installed toward the end of the construction period, when the surrounding areas are stabilized. If this is not possible, sediment laden runoff during construction shall be diverted around the permeable pavement. Sediment on the pervious surface or in the constructed gravel bed can clog the pores and lead to system malfunction.

During construction, the excavated bed may serve as a temporary sediment basin or trap. This will reduce overall site disturbance. The bed should be excavated to within one foot of the final bed bottom elevation for use as a sediment trap or basin. Following construction and site stabilization, sediment should be removed and final grades established.

5.5.6.2 Construction Sequence

Installation techniques vary for the type of permeable material chosen, but the sequence is in general similar. The installation and construction of permeable pavement should be done in accordance with designer of record specifications and standards. However the following construction sequence should be followed.

1. Bed bottoms should be level. Sloping bed bottoms will lead to areas of ponding and reduced distribution.

2. Excavate the project area to the depth of the entire pavement section.

3. Cover the uncompacted subsoil with geotextile fabric to reduct migration of fines into the gravel reservoir. Place geotextile in accordance with manufacturer's specifications.

4. Install clean, washed gravel subbase (and perforated underdrain if required). Place gravel in lifts and lightly compact according to specifications.

5. Install gravel base course (to transition bedding course to subbase).

6. Install the bedding course (pea gravel or sand depending on permeable pavement type).

7. Lay the surface course (set in place concrete pavers or open grid units, plastic geogrid, or cast in place asphalt/concrete).

8. If using permeable concrete pavers fill the voids between pavers with pea gravel. For reinforced turf, fill spaces or voids with planting soil, sand or gravel. Follow manufacturer's specifications.

9. Seed, fertilize, and mulch the entire surface for grass applications.

10. Water immediately and then every couple of days until the grass is established.

5.5.7 Maintenance

5.5.7.1 General

The primary goal of permeable pavement maintenance is to prevent the pavement surface and/or the underlying infiltration-bed from being clogged with fine sediments. To keep the system clean throughout the year and its lifespan, the pavement surface should be swept with a street sweeper and vacuumed once every two years with a commercial vacuum unit. Use of conventional pavement washing and/or compressed systems is not recommended.

Planted areas adjacent to pervious pavement should be well maintained to prevent soil washout onto the pavement surface. If any washout does occur it should be cleaned off the pavement immediately to prevent future clogging of the pores. Furthermore, if any bare spots or eroded areas are observed within the planted areas, they should be replanted or reseeded to stabilize the area. All trash and other litter that is observed during routine inspections should be removed. Soil particles that become ground from repeatedly traffic use leads to clogging. Therefore, trucks or other heavy vehicles should be prevented from tracking and spilling sediment onto the permeable pavement.

Maintenance agreements should clearly specify how to conduct maintenance activities. See Table 5-12 for suggested maintenance activities and frequency.

5.5.7.2 Winter Maintenance

Winter maintenance for a permeable pavement parking lot may be necessary but is usually less intensive than that required for a standard impervious surface. By its very nature, a permeable pavement system with subsurface aggregate has superior snow melting characteristics compared to standard pavements. The underlying stone bed tends to absorb and retain heat so that freezing

rain and snow melt faster on pervious surfaces. However, snow will accumulate during heavier snowstorms. Snow plow blades should be set slightly higher than usual by approximately one inch. Salt is acceptable for use as a deicer on the pervious surface; though nontoxic, organic deicers, applied either as blended, magnesium chloride-based liquid products or as pre-treated salt, are preferable. Sand should never be used.

5.5.7.3 Repairs

Potholes in porous asphalt and pervious concrete are unlikely; though settling might occur if a soft spot in the subgrade is not removed during construction. Small damaged area can be patched by any suitable means. Under no circumstances should the pavement surface ever be seal coated.

Table 5-12. Suggested Maintenace Activities for Permeable Pavement

	Task	Frequency	Maintenance Notes
1	Sweep and Vacuum Pavement	2 to 3 times / yr	Commercial sweeper/vacuum unit
2	Clean Inlets, Drainage Pipe, Stone Edge Drains, etc.	2 times /yr	Remove sediment and debris
3	Water Reinforced Turf and Grass-filled Open Grid Pavement	Regularly	
4	Clean Up Soil Deposited on Pavement	Immediately	
5	Maintain Planted Areas adjacent to Permable Pavement	Regularly	Prevent mulch and soil washout onto pavement surface
6	Snow Removal	As Needed	Raise plow blade 1 inch higher Do not use sand

5.5.8 Benefits

There are numerous advantages to permeable pavement systems, including:

- Reduces drainage infrastructure costs
- Reduces stormwater runoff by infiltration
- Contributes to good water quality
- Volume and Peak flow reduction
- Landscaping for aesthetics
- Promote stormwater infiltration and groundwater recharge
- Improved water quality through pollutant reduction by processes such as filtration/infiltration
- Minimizes “urban heat island” effects

5.6 RAINWATER HARVESTING

5.6.1 Description

Rainwater harvesting is the process of collecting water from roof surfaces and impervious surfaces, such as parking lots, during rain events and storing it in tanks, barrels, or cisterns for non-potable use. Potential uses include indoor non-potable applications (*i.e.*, toilet flushing, laundry) and outdoor applications such as landscape irrigation.

Rainwater harvesting follows ecologically sound principles as it promotes water conservation, reduces peak flows and runoff volumes, and provides irrigation water for landscaping during dry periods. Runoff collected from rooftops is sodium and chlorine free, low in salt content, and high in nitrogen, and relatively clean that can be used for irrigation and for flushing toilets and urinals. Capturing and using rainwater runoff also reduces site discharge and erosion, and the potential for stormwater pollutants.

5.6.2 Types of Rainwater Harvesting Systems

Rain barrels and cisterns are the most common water storage tanks for capturing and storing rooftop rainwater or runoff from other impervious surfaces.

5.6.2.1 Rain Barrels

Rain barrels are 50-150 gallon covered plastic tanks with a hole at the top for downspout discharge, an overflow outlet, and a valve and hose adapter at the bottom. They are used almost exclusively on residential properties. Since rain barrels rely on gravity flow, they should be placed near, and slightly higher than, the point of use (whether a garden, flower bed, or lawn.) A hose is attached to a faucet at the bottom of the barrel and water is distributed by gravity pressure. The overflow outlet should be routed to a dry well, bioretention area, or rain garden. It is important for property owners to use the water in rain barrels on a regular basis, or else they fill up and no additional roof runoff can be stored. It is recommended that each house have at least two rain barrels; a one inch storm produces over 500 gallons of water on a 1000 square foot roof.

For residential applications, a typical rain barrel design will include a hole at the top to allow for flow from a downspout, a sealed lid, an overflow pipe (to divert excess water once the barrel is full), and a spigot at or near the bottom of the barrel (Photo 5-19). A screen is often included to control mosquitoes and other insects. The water can then be used for lawn and garden watering or other uses such as supplemental domestic water supply. Rain barrels can be connected in a series to provide larger volumes of storage

Some commercially available rain barrels are manufactured with upper and lower ports linking the primary barrel to a second barrel (and potentially others) linked together in series. Screening at any orifice or entry point to the tank discourages vectors such as mosquitoes. A food grade plastic barrel used for bulk liquid storage in restaurants and grocery stores can be fitted with a

bulkhead fitting and spigot for garden watering. However those that are not opaque must be screened from sunlight. Standard tanks must be installed above ground.

Photo 5-19. Residential Rain Barrel

5.6.2.2 Cisterns

Surface tanks and cisterns may be larger than rain barrels but serve the same function. They can be integrated into sites where a significant water need exists or rain harvesting and reuse is desired. They may drain by gravity or be pumped. Unlike rain barrels, cisterns and tanks typically need design professional assistance for more complex water collection and delivery system design. Also, they typically need to be installed to local code by a certified and bonded plumbing or construction contractor.

Cistern capacities range from 250 to over 30,000 gallons (Virginia Department of Conservation and Recreation Stormwater Design Specification No. 6, 2011). Multiple tanks can be placed adjacent to each other and connected with pipes to balance water levels and increase overall storage as needed.

Cisterns are partially or fully buried tanks with a secure cover and a discharge pump; they provide considerably more storage than barrels as well as pressurized distribution. Cisterns can collect water from multiple downspouts or even multiple roofs, and then distribute this water wherever it needs to go through an electric pump. Property owners may use one large tank or multiple tanks in series. Either way, the overflow for the systems should be a drywell or other infiltration mechanism, so that if the cistern is full, excess roof runoff is infiltrated, and not discharged to the stormwater system. Some cisterns are designed to continuously discharge water

at a very slow rate into the infiltration mechanism, so that the tank slowly empties after a storm event.

5.6.3 Planning Considerations

Rainwater harvesting and reuse is a direct way to reduce stormwater runoff volume. The harvesting barrels, tanks or cisterns should be sized for the climate and ranges of rainfall events, and relate to the amount of impervious area, reuse applications and consideration of the downstream effects. There are opportunities to collect rainwater in all land use situation with minimal constraints. Rain barrels and cisterns can be retro-fitted to existing buildings or integrated into new building design. Rainwater harvesting systems can range from a simple 55-gallon rain barrel to a complex multimillion-gallon cistern with electronic pumps and controls. It is important to evaluate existing site conditions of the project to ensure compliance with state and local requirements during the planning phase. Identify opportunities and areas where water can be reused for irrigation, released to an infiltration area, or meet indoor use needs. Estimate the rate at which water can be reused.

5.6.3.1 Applications

Rainwater harvesting systems can be as simple as a rain barrel for garden irrigation at the end of a downspout, or as complex as a domestic potable water supply system or a multiple end-use system at a larger scale. The rainwater harvesting systems may be above or below ground, and they may drain by gravity or be pumped. Stored water may be slowly released to a pervious, grass area, used for landscape irrigation, or used indoors for non-potable purposes such as toilet flushing.

Rain barrel design and construction is simple where the rain barrels are available commercially in almost “ready to install” configurations. The only consideration is that there must be enough room near the downspout for the installation of rain barrels. Also, a rain barrel will need a flat, stable surface to sit upon. On the contrary, cisterns are large and require careful planning in terms of site topography, water table, and soil conditions. However, they do not need to be located adjacent to the building since piping and pumps will convey the rainwater.

Underground utilities, high water tables or shallow bedrock may limit the sites available for tank planned for underground installation. Locate utilities, and investigate groundwater and geological restrictions during the planning phase. Buoyant forces can act on an empty underground and cause it to float out of ground. Careful consideration should be given to manufacturer’s installation guides and instructions in order to correctly site and protect tanks against negative impacts of soils with a high water table.

General planning considerations include:

- Existing topography will influence storage locations, site layout, rainwater harvesting design and layout, and types of rainwater harvesting features.

- Capture as much runoff as possible without depriving adjacent or downstream vegetation of water, and without violating downstream water rights (applicable in the western United States). If all runoff cannot be permanently captured, then slow the flow of the remaining volume to increase percolation and on-site infiltration.

- Design for overflow from large rainfall events with erosion controls and overflow conveyance to useful and safe discharge locations.

- Above-ground tanks maintain head pressure to allow some gravity flow. Below-ground tanks take less space above-ground but usually require pumps. The higher on the site above-ground tanks are located, the more gravity-feed pressure will be available. Water can be distributed by gravity flow or by a booster pump via hoses, irrigation systems, channels, or perforated pipes.

- For all tanks, install a tank overflow and route it to a logical location in the landscape where it will be put to beneficial use. The overflow capacity must be equal to or greater than the inflow capacity.

- Screen inflow from roof to tank to keep debris out. Screen tank outflow before it enters the irrigation system to prevent clogging.

- Select roofing surface based on planned uses of tank water (metal or tile roofing provides high quality runoff water).

- Evaluate the potential to use tank water in site cooling towers or for wash water uses; design location and piping accordingly.

- Carefully plan roof slopes to direct water to specific downspouts based on tank capacity.

5.6.3.2 Constraints

The stormwater volume/peak discharge rate benefits of cisterns and rain barrels depend on the amount of storage available at the beginning of each storm. One rain barrel may provide a useful amount of water for garden irrigation, but it will have little effect on overall runoff volumes, especially if the entire tank is not drained in between storms. Greater effectiveness can be achieved by having more storage volume and by designing the system with a continuous discharge to an infiltration mechanism, so that there is always available volume for retention.

When selecting a location for cistern installation, note that roofs constructed with tar, gravel, treated cedar shakes, or old asbestos shingle roofs may produce too much contamination for rainwater harvesting. Similarly, rainwater should not be harvested if it is conveyed via gutters with lead soldering or lead-based paints. Roofs exposed to air borne particles originating from cement kilns, gravel quarries, crop dusting, or concentrated automobile emissions will create runoff that could adversely affect the rainwater quality.

One concern that must be considered is mosquitoes. In some situations, poorly designed rainwater systems can create habitat suitable for mosquito breeding and reproduction. Designers should provide screens on above- and below-ground tanks to prevent mosquitoes and other vector insects from entering the tanks and vicinity if water is intended for landscaping use.

The water collected is for non-potable uses only and its use for potable (drinking) purpose is not cost-effective.

Storage tank and cisterns may have permit requirements.

5.6.4 Design Criteria & Specification

5.6.4.1 Sizing Criteria

For the purposes of meeting the requirements of EISA Section 438, rainwater harvesting systems should be sized with respect to the stormwater runoff volumes required to be managed onsite (refer to Chapter 4), and also considering the possible use of other BMPs. As a general rule of thumb, one square foot rooftop area will yield approximately 0.62 gallons of water per one inch of rainfall can be collected during a rain event. The volume of water that can be collected from a given rain event can be calculated as:

$$V_{collect} = 0.62 * A_{roof} * \text{Rainfall}$$

Where:

$V_{collect}$ = Volume of rainwater collected, gallons
A_{roof} = Roof surface area, ft^2
Rainfall = Design rainfall, inch (such as 95th percentile or 2-year, 24 hour)

The basic rule for sizing any rainwater harvesting system is that the volume of water that can be captured and stored (the supply) must equal or exceed the volume of water used (the demand). Storage capacity needs to be sufficient to store water collected during heavy rain events to last through dry periods. Some residences might be constrained by the size of the collection surfaces and/or the volume of storage capacity that can be installed due to space or costs. The following section describe ways to determine the amount of rainfall, the estimated demand, and how much storage capacity is needed to provide enough rainwater to meet the demand. A much more in-depth analysis of how to calculate potential harvested rainwater is available through the American Rainwater Catchment Systems Associated website (http://www.arcsa.org) in their guidelines publication.

Cisterns can vary in size and may consist of several thousand gallons of storage capacity. It is important to gauge what size and storage capacity is right for the site and facility. Low storage capacities will limit rainwater harvesting so that the system may not be able to provide water in a low rainfall period, and increased storage capacities add to construction and operating costs. A factor that will assist in determining the size of the cistern is the volume of water available for capture. An analysis of precipitation records should be performed to determine the amount,

frequency, and seasonal variation of rainfall for the area. Including several years of data is recommended in order to account for dry and wet years. The anticipated daily or monthly demand for the harvested rainwater should also be determined. This will first require determining what the end use of the collected water will be, and then predicting the amount needed. Toilet and urinal flushing impart a consistent daily demand on a water system while outdoor irrigation may be somewhat more episodic. The total surface area of the roof is another factor in determining cistern size.

5.6.4.2 Components of Rainwater Harvesting

Cistern tanks should have three openings where pipes will be placed: an inlet, outlet/outflow (or faucet), and overflow. Overflows should be directed away from structures and toward pervious areas to allow for infiltration.

Generally all rainwater tank/cistern designs should include the components below. More information on some of the components is provided in this section.

- A solid secure cover
- A leaf / mosquito screen at cistern entrance
- A coarse inlet filter with clean-out valve
- An overflow pipe
- A manhole, sump, and drain to facilitate cleaning
- An extraction system that does not contaminate the water (e.g. a tap or pump)
- A soak-away to prevent spilled water from forming puddles near the tank

Additional features might include:

- A device to indicate the amount of water in the tank
- A sediment trap, tipping bucket, or other "foul flush" mechanism
- A lock on the tap

<u>Screen</u>
A screen keeps leaves and other debris from entering and clogging the rain barrel/cistern. A screen also prevents mosquitoes from breeding in the storage element. A screen is typically placed at the end of the roof leader, before flow enters the rain barrel or cistern. A leaf strainer may also be placed where the gutter connects to the roof leader.

Storage Element

The storage element is the barrel, cistern, or tank itself (Photo 5-20). Rain barrels are typically made of plastic. Underground cisterns may be poured concrete or prefabricated plastic tanks similar to septic tanks. Proprietary products that store water in a variety of structures are also available. Tanks larger than rain barrels may be used above or below ground.

The selection of tank is based on three main criteria: size, location, and material.

All systems consist of the same basic components: a collection surface (roof top – only roof surfaces are addressed in this practice), a conveyance system, pre-tank treatment, water storage, and distribution.

Photo 5-20. Rainwater Harvesting Storage Element

Slow Release Mechanism or Pump

For the storage element to serve its stormwater control function, it must be partially or completely drained between most wet weather events. Rain barrels are typically drained in one of two ways: manually by means of a spigot similar to ordinary outside water faucets; and, the continual, slow release using a soaker hose to a garden or infiltration area. Larger surface tanks may drain by gravity or may be pumped. Subsurface systems and systems where stormwater is reused for needs other than irrigation (toilet flushing, car wash) are typically pumped.

Overflow Mechanism

The storage capacity of rain barrels, cisterns, and other tanks may be exceeded in large storms. In rain barrels, a flexible hose is provided at an elevation near the top of the barrel. The diameter of the hose is at least equal in size to the roof leader to allow runoff to flow unimpeded during large events. The overflow from cisterns and larger tanks can occur through a weir, pipe, or other mechanism.

A design consideration involving the overflow pipe is to connect it to the inlet of a second cistern tank (Figure 5-12 and Photo 5-21). This would be appropriate for areas with heavy rainfall or large facilities with a high demand for non-potable water.

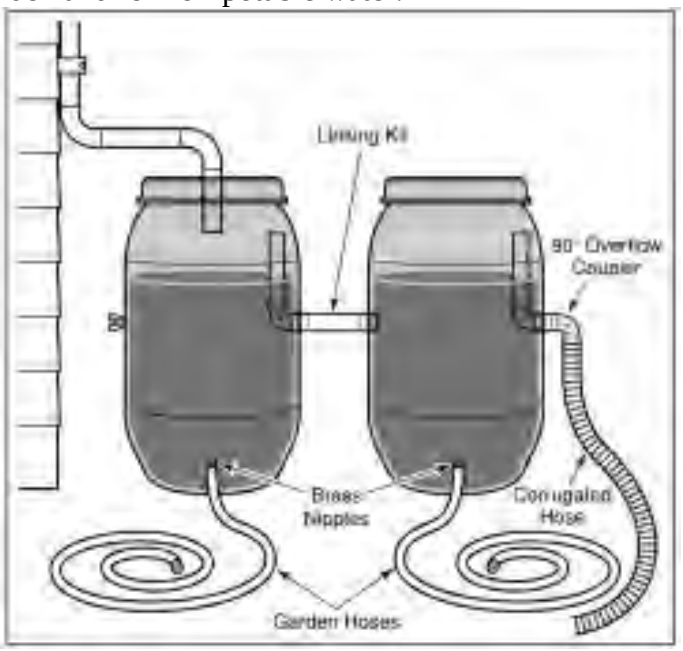


Figure 5-12. Linked Rainwater Harvesting Cisterns

Photo 5-21. Linked Rainwater Harvesting Cisterns

First Flush Diverter

A diverter at the cistern inlet can redirect the "first flush" of runoff which is more likely to have particulates, leaves, and air-deposited contaminants washed off the roof. Direct the first flush to an infiltration trench, bioretention area, or grassed swale sized to infiltrate the required volume.

Make-Up Water

When make-up water is required to be provided to the cistern from the municipal system, steps must be taken to prevent cross-contamination. Pipes connected to the outflow (or any part of the harvesting system) should never connect to potable water piping. The make-up supply to the cistern is the point of greatest risk for cross-contamination of the potable supply. A backflow prevention assembly on the potable water supply line, an air gap, or both must be provided to prevent collected rainwater from entering the potable supply. Dedicated piping should be color-coded and labeled as harvested rainwater, not for consumption. Faucets supplied with non-potable rainwater should also contain signage identifying the water source as non-potable and not for consumption. The designated dual piping system is also part of the cross-contamination prevention measures. Specific requirements can be obtained by local water system authorities.

Vent

All tanks (aboveground and belowground) must have a vent to expel air as rainwater enters the tank and draw air in as rainwater is pumped out of the tank. If the tank overflow does not have a water trap, air can be displaced through the overflow as rainwater enters the tank. In these cases, the vent only needs to be as big in diameter as the water supply line leaving the tank. If air cannot leave the tank through the overflow, the vent diameter should be 1.5 times the diameter of the inlet pipe.

5.6.4.3 Design Considerations

Cistern design should be conducted by a licensed professional engineer experienced in rainwater harvesting design. Licensed plumbers are required by law to install any plumbing systems. Only licensed contractors should install any rainwater harvesting system, but special rainwater harvesting installers are not required.

The following list includes basic guidelines that should be followed when designing and installing rain barrels and cisterns.

- Only rooftop rainwater should be collected.
- The roof materials should be selected carefully.
- Systems must be equipped with overflow pipes that direct water to another tank, stormwater pipes, pervious, grass surface.
- Storage tanks should be accessible for maintenance and cleaning. Underground systems should have a standard size manhole or equivalent opening to allow access for cleaning,

inspection, and maintenance. This access point should be secured/locked to prevent unwanted access.

- Storage tank openings must be covered and screened.
- Gutters and roof drains should be designed in accordance with local code.
- Above ground storage tanks should be UV resistant or otherwise protected from direct sunlight to inhibit algae growth and should be screened to prevent mosquito breeding and reproduction.
- Underground storage tanks must be designed to support the overlying soil burden and any other anticipated loads (e.g., vehicles, pedestrian traffic, etc.).
- All rainwater harvesting systems should be sealed using a water-safe, non-toxic substance.
- For gravity-fed systems, a minimum of 6 inches of dead storage should be provided for sedimentation.
- Tanks should be sized to adequately capture runoff based on local precipitation patterns, roof area, and anticipated demand.
- Water should be drained between rainfall events (for irrigation) to maximize effectiveness.
- Rain barrels are most effective when they are designed to help meet demands for non-potable water, such as irrigation.

Tank size is always dependent on the roof area and the anticipated use of the water. However, size decisions may also be based on availability of space on the site, stormwater or LEED requirements, and the availability of a back-up water supply. Tank size selection will affect possible tank locations and location and size will then help in the selection of tank materials.
American Rainwater Catchment System Association has published guidelines for rainwater harvesting systems, and the Association has developed national standards for the rainwater harvesting industry which are available on their web site (www.arcsa.org). Currently Rainwater Catchment Design and Installation Standards are being developed by a joint effort of ARCSA and the American Society of Plumbing Engineers (ASPE). The purpose of these standards is to assist engineers, designers, plumbers, builders, developers, local government, and end users in successfully implementing rainwater catchment systems.

Residential Design

Residential rainwater harvesting systems in residential settings primarily collect rainwater from the rooftops and downspouts. They can be designed for reuse for non-potable needs such as toilet flushing, laundry washing, and landscape irrigation. These non-potable uses account for 78 percent of total household water use, with outdoor use alone accounting for 59 percent of

household use (VA Rainwater Harvesting Manual, 2009) Because outdoor use is more than half of residential use, bringing harvested rainwater indoors for potable or non-potable uses is often not cost-effective, particularly in retrofit situations.

Commercial, Industrial, Institutional

Rainwater harvesting systems in commercial, industrial and institutional settings can vary from rooftop collection to collection from large impervious surfaces in underground cisterns. Collected rainwater can serve non-potable needs in these settings. For example, 87 percent of water use in an office building is for restrooms alone (Huston, et al., 2004). Huston (2004) reported that 34 percent of all water use in the United States for landscape irrigation.

Roof Considerations

Roof materials should be non-porous and smooth. Copper roofs and roofs with lead components (for example, flashing or solder) should not be used in any application with a potential for human ingestion (for example, vegetable gardens). Aluminum and rubber membrane are recommended roof materials for rainwater harvesting. Green roofs should be used with caution in rainwater harvesting and rainwater harvested from green roofs with soil bases should only be used for irrigation.

Roof Drains

While rain barrels and cisterns can be integrated with any roof drain system, siphonic roof drains (Photo 5-22) present a number of advantages. When siphonic roof drains are used, the downpipes can be located near the cistern. When conventional roof drains are used instead of siphonic, pipes often have to be brought longer distances (often either around or under the building).

Photo 5-22: Roof Drain

5.6.5 Materials

5.6.5.1 Roofs

Metal roofs, with the exception of copper and lead components, are recommended for rainwater harvesting. Because of a low runoff coefficient and many of the products used to treat wood, wood shingles are not recommended for rainwater harvesting as well. Membrane roofs create an ideal surface for rainwater harvesting. These roofs have a high runoff coefficient and have not been shown to add harmful contaminants to the harvested water.

5.6.5.2 Material Specifications

Cisterns can be constructed of nearly any impervious, water retaining material. However, it is generally advisable to select a material that is rated for potable water use by the National Sanitation Foundation to prevent the introduction of any additional contaminants into the harvested rainwater. Commercially available systems are typically constructed of high density plastics. They can also be made of metal or concrete and can be cast-in-place. Outdoor tanks should be constructed of opaque materials or otherwise shaded or buried to prevent damage from sunlight. They should also contain adequate screening at each opening to prevent insects from entering the tank.

Other materials utilized for the construction of cisterns can include redwood, polyethylene, fiberglass, metal, concrete, plaster (on walls), ferro-cement and impervious rock such as slate and granite.

The basic specifications for rain water harvesting systems are presented in Table 5-13. Designers should consult with experienced irrigation installers on the choice of recommended manufacturers of fabricated tanks and other system components.

Table 5-13. Rain Water Harvesting System Material Specifications

Material	Specification
Gutters and Downspout	• Materials commonly used for gutters and downspouts include polyvinylchloride (PVC), pipe, vinyl, aluminum and galvanized steel. Lead should not be used as gutter and downspout solder, since rainwater can dissolve the lead and contaminate the water supply. • The length of gutters and downspouts is determined by the size and layout of the catchment and the location of the storage tanks. • Be sure to include needed bends and tees
Pre-Treatment	• Provide pretreatment by installing screens to remove debris for all collected rainwater
Storage Tanks	• Materials used to construct storage tanks should be structurally sound • Tanks should be constructed in areas of the site where native soils can support the load associated with design stored water • Tanks should be water tight and sealed using a water-safe, non-toxic substance • Tanks should be opaque to prevent the growth of algae • Underground tanks should be installed below local frost line • Rain barrels commonly plastic, wood or steel • Cisterns commonly fiberglass, concrete, plastic, brick or other materials

(Source: Virginia DCR Stormwater Design Specification No. 6, 2011)

Table 5-14 compares the advantages and disadvantages of different cistern materials.

Table 5-14. Advantages and Disadvantages of Various Cistern Materials

Tank Material	Advantages	Disadvantages
Fiberglass	Commercially available; durable; light weight; integral fitting; no leaks	Must be installed on smooth, solid, level footing; expensive in small sizes
Polyethylene	Commercially available; alterable; affordable; available in wide range of sizes; can install above or below ground; little maintenance; broad application	Can be UV-degradable; must be painted or tinted for above ground installations
Modular Storage	Can modify to topography; can alter foot-print and create various shapes to fit site; relatively inexpensive	Longevity may be less than other materials; higher risk of puncturing of water tight membrane during construction
Plastic	Commercially available; inexpensive	Low storage capacity (20-50 gals.; limited application
Galvanized steel	Commercially available, available in range of sizes; film develops inside to prevent corrosion	Possible external corrosion and rust; must be lined for potable use; can only install above ground; soil pH may limit underground applications
Steel	Commercially available	Small storage capacity; prone to corrosion and rust can lead to leaching of metals; water and soil pH my also limit applications
Ferro Concrete	Durable and immoveable; suitable for above or below ground installations; neutralizes acid rain	Potential to crack and leak
Cast in Place Concrete	Durable; immoveable; suitable for above or below ground installations; neutralizes acid rain	Potential to crack and leak; permanent; will need to provide adequate platform and design for placement in clay soils
Stone or concrete block	Durable and immoveable; keeps water cool in summer months	Difficult to maintain, expensive to build

(Source: Cabell Brand, 2009)

5.6.6 Construction Considerations

5.6.6.1 General

Prefabricated rainwater harvesting cisterns or rain barrels can be purchased and installed professionally. The interior of tanks should be accessible for periodic inspection and maintenance. Position outlet pipes several inches above the bottom of the tank to allow sediment to settle in the bottom. All tanks need an overflow pipe of equal or greater capacity than the fill pipe. Overflow pipes should be able to operate passively (i.e. not dependent on a pump). Water in aboveground tanks can be delivered by gravity flow alone to low-pressure uses nearby. Below-ground tanks save land area, but require substantially more construction. A booster pump can be added to hook tanks into an irrigation system. Tank water should be filtered as it enters irrigation lines to keep debris from plugging the irrigation system. The tank should be installed somewhat angled upward to protect settled sediment and inlet installed above tank bottom to provide for sediment sedimentation. The tank should have an overflow of at least the same diameter as the inlet pipe to prevent backup in gutters and downspouts. This overflow should be directed to a pervious area such as nearby landscape grass area.

5.6.6.2 Construction Sequence

Commercially available aboveground and belowground tanks should always be installed in compliance with manufacturers' recommendations. Depending on the type and purpose of the system, the installation can be involved. Cisterns must be installed by licensed professional contractor. When constructing underground cisterns, local utility companies should be contacted in order to locate any underground pipes or cables that may be in the installation site.

It is advisable to have a single contractor install the rainwater harvesting system, outdoor irrigation system and secondary runoff reduction practices. The contractor should be familiar with rainwater harvesting system sizing, installation, and placement. A licensed plumber is required to install the rainwater harvesting system components to the plumbing system.

A standard construction sequence for proper rainwater harvesting system installation is provided below. This can be modified to reflect different rainwater harvesting system applications or expected site conditions.

1. Check with local jurisdiction if a permit is required to install a rain barrel and/or cistern for non-potable water use.

2. Excavate the hole to the required dimensions (for underground) or prepare platform for above ground system. Ensure smooth stable surface for cistern or rain barrel.

3. Install the pre-fabricated cistern or rain barrel as per manufacturer's specifications.

4. Seal the inside of the cistern.

5. Install the pump (if needed) and piping to end-uses (indoor re-use, outdoor irrigation, or tank dewatering release)

6. Install the lid, screens and hatches.

7. Route all downspouts or roof drains to pre-screening devices and first flush diverters. Stormwater should not be diverted to the rainwater harvesting system until the overflow filter.

5.6.6.3 Final Inspection

Inspections during construction are needed to ensure that the cistern is built in accordance with manufacturer's specifications. The following items should be inspected prior to final sign-off and acceptance of a rainwater harvesting system.

- Rooftop area matches design plans
- Diversion system is properly sized and installed
- Pretreatment system is installed
- Screens and seals are installed on all openings
- Overflow device is directed as shown on design plans
- Tank foundation or platform is constructed as shown on plans
- Catchment area and overflow area are stabilized

5.6.7 Maintenance

Maintenance requirements for rainwater harvesting systems vary according to use. Systems that are used to provide supplemental irrigation water have relatively low maintenance requirements, while systems designed for indoor uses have much higher maintenance requirements (Table 5-15).

Rainwater harvesting systems, including all their components and accessories, should undergo regular inspection at least twice a year. An example maintenance inspection checklist for Rainwater Harvesting can be accessed in Appendix C of Chapter 9 of the *Virginia Stormwater Management Handbook* (2010). Replacement or repair of the unit as a whole, and any of its constituent parts and accessories should subsequently be undertaken if needed. Tanks must be "winterized" or drained prior to winter to prevent damage if freezing conditions prevail.

Table 5-15: Suggested Maintenance Tasks for Rainwater Harvesting Systems

Activity	Frequency
Clean gutters and downspouts of leaves and other debris and check for leaks.	Twice a year
Inspect overflow that it is draining in non-erosive manner	Twice a year
Inspect and clean pre-screening devices and first flush diverters.	Four times per year
Inspect and clean storage tank lids, paying special attention to vents and screens on inflow and outflow spigots. Check mosquito screens and patch holes or gaps immediately.	Once per year
Inspect condition of overflow pipes, overflow filter path and/or secondary runoff reduction practices.	Once per year
Inspect tank for sediment buildup and seal leaks.	Every third year
Clear overhanging vegetation and trees over roof surface.	Every third year
Inspect structural integrity of tank, pump, pipe, over flow preventer and electrical system. Replace damaged or defective system components.	Every third year
If mosquitoes become a problem, mosquito dunks (floating donut-shaped briquettes containing the biological insecticide) can be used.	As needed

(Source: Virginia DCR Stormwater Design Specification No. 6, 2011)

5.6.8 Benefits

When properly installed, cisterns reduce the peak discharge rate and runoff volume through detention. However, when compared to other stormwater BMP options, the peak discharge is minimally impacted by the use of rain barrels or cisterns. However, if many rainwater barrels or large capacity tanks are installed, then benefits may be seen in terms of reduced peak flows and volumes entering sewers and streams.

- Reduces stormwater runoff volume and flow rates
- Reduces erosion in urban environments
- Reduce on-site flooding
- Water conservation and supplemental water supply
- Increase water availability for non-potable uses
- Meet LEED Credit

5.7 GREEN ROOFS

5.7.1 Description

Green roofs (also known as vegetative roofs, living roofs, bio-roofs, or eco-roofs) are thin layers of living vegetation installed on top of conventional roofs (Photo 5-23). Green roofs typically consist of waterproofing and drainage materials and an engineered growing media that is designed to support plant growth.

The purpose of green roofs is to maximize nutrient and pollutant removal and runoff volume reduction. A portion of the captured stormwater evaporates or is taken up by plants and transpired, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites.

Photo 5-23. Green Roof – Washington, DC
(Source: Healthy Roofs for Healthy Cities (Photo by US DOT))

Green roofs filter particulate matter from the air, retain and cleanse stormwater and provide new opportunities for biodiversity preservation and habitat creation. They generate aesthetic benefits and help to reduce the urban heat island effect (the over-heating of cities in summer from dark roof surfaces, which contributes to air pollution and increased energy consumption).

5.7.2 Types of Green Roofs

There are two types of green roof systems: extensive and intensive green roofs. The variation in each type is the depth of growing media, which relates to the volume of stormwater that can be absorbed by the vegetation and soils.

5.7.2.1 Extensive Green Roof

Extensive roofs typically have much shallower growing media (3 to 8 inches) that is planted with carefully selected drought tolerant vegetation (Photo 5-24 and Photo 5-25). With shallower growing media, this type of green roof is lightweight and relatively easy to construct and maintain. Extensive roofs can be easily applied to Army construction.

The most common vegetated roof cover in temperate climates at Army facilities may in the future be a single un-irrigated 4 to 6 inch layer of lightweight soil growth media planted with succulent plants and herbs. In Germany, this simple design has demonstrated the highest benefit-to-cost ratio (Virginia Department of Conservation and Recreation, Stormwater Design Specification No. 5, 2011).

Photo 5-24. Green Roof – Washington, DC
(Source: Healthy Roofs for Healthy Cities (Photo by US DOT))

Photo 5-25. Hamilton Building Green Roof
(Source: Portland Stormwater Management Manual)

5.7.2.2 Intensive Green Roof

Intensive green roofs have a deeper growing media layer that ranges from 6 inches to 4 feet thick. These deep layer roofs are planted with a wider variety of aesthetically pleasing plants, including shrubs and shallow-rooted trees. The thick growing media and dense vegetation makes these green roofs heavy, which can put strain on the roof and building structure. Design must consider building structure, possibility of roof leaks, weight of the green roof, and high maintenance requirements. Intensive green roofs may not always be applicable on Army facilities nor cost effective for the volume of stormwater they may manage, thus, only the details for extensive green roofs are provided below. The extensive green roofs are much lighter and less expensive than intensive green roofs and are recommended on most development and redevelopment sites.

5.7.3 Planning Considerations

5.7.3.1 Applications

Green roofs are ideal for use on commercial, industrial, institutional, municipal and multi-family residential buildings. They are particularly well suited for use on ultra-urban development and redevelopment sites to reduce/prevent "urban heat island" effects.

5.7.3.2 Constraints

Green Roofs have several limitations, including:

- Structural Capacity – Consider structural capacity to support live and dead weight, including additional (15 to 30 psf) weight of stormwater for an extensive green roof.

- Roof Access – adequate access to the roof must be provided to deliver construction materials and perform routine repair and maintenance.

- Roof Type – can be applied to most conventional surfaces, although concrete roof decks are preferred.

- Setbacks – Green roofs should not be located near rooftop electrical and HVAC systems.

- Local Building Codes – Building codes often differ in each municipality and local planning and zoning authorities should be consulted to obtain proper permits.

- Leaky Roofs – Research on green roofs has demonstrated that a well designed and installed green roof would have fewer problems with roof leaks than that of with a traditional roof. A waterproof liner is recommended to prevent leaks.

5.7.4 Design Criteria & Specifications

In the United States, green roof designs are generally regulated using existing standards for ballasted roofs. In general, the municipalities follow "The International Code Council (ICC), formerly the BOCA, construction code that requires that "wet weight" of the green roof be treated as an additional dead load.

Specific design considerations may include energy efficiency, green building or LEED points, architectural considerations, visual amenities and landscaping features for human enjoyment.

5.7.4.1 General

All well-designed green roof focus on three main design criteria:

Drainage
Provision for drainage from the rooftop must be provided for stormwater not absorbed by the green roof. The drainage layer may include filter fabric, gravel, or it can be the growing (soil) media itself. An approved discharge location must be identified for every green roof and drain(s) provided. Design must both maintain optimum growing conditions in the plant soil growth media and manage heavy rainfall without sustaining damage due to erosion or ponding of water.

Plant Nourishment and Support
The engineered or manufactured soil growth media must meet requirements for void (porosity or open) ratio, moisture retention, and plant material containing adequate nutrients for sustainable plant establishment and continued growth. Plant species are selected so that the roof does not need supplemental irrigation or fertilization after vegetation is initially established.

Protection of Underlying Water Proofing Systems
The green roof design must provide protection measures for the underlying waterproofing system from human activities (including impacts of maintenance) and biological, weather, climatic and

other environmental impacts to prevent leaks from the roof into the building that could compromise the building.

5.7.4.2 Sizing Requirements

Green roofs should be sized to capture a portion of the stormwater runoff volume from the project site as required to be treated for compliance with EISA Section 438, called the treatment volume. The Treatment Volume (Tv) is estimated as below:

$$Tv = (RA * D * P)$$

Where:

- Tv = Required storage volume capacity, ft^3
- RA = Vegetated roof surface area, ft^2
- D = Soil media depth, ft
- P = Soil media porosity (usually 0.30, but may be higher, consult manufacturer)

Details are provided in Chapter 4, Hydrologic Modeling and Simulation, regarding estimating of water quantity runoff volumes to comply with EISA Section 438. The methods described in this section may be used to determine water quality requirements for use in designing of green roofs.

5.7.4.3 Structural Capacity

Green roofs can be limited by additional weight of the fully saturated soil and plants, in terms of physical/structural capacity to bear additional (15 to 30 lbs/sft) structural loads, a condition that may preclude retrofit applications.

5.7.5 Components of Green Roofs

As shown in the Figure 5-13, a green roof is composed of several different systems or layers. The generic cut-away shows common types of green roofs that utilize a lower granular drainage layer in combination with an upper growth medium or substrate.

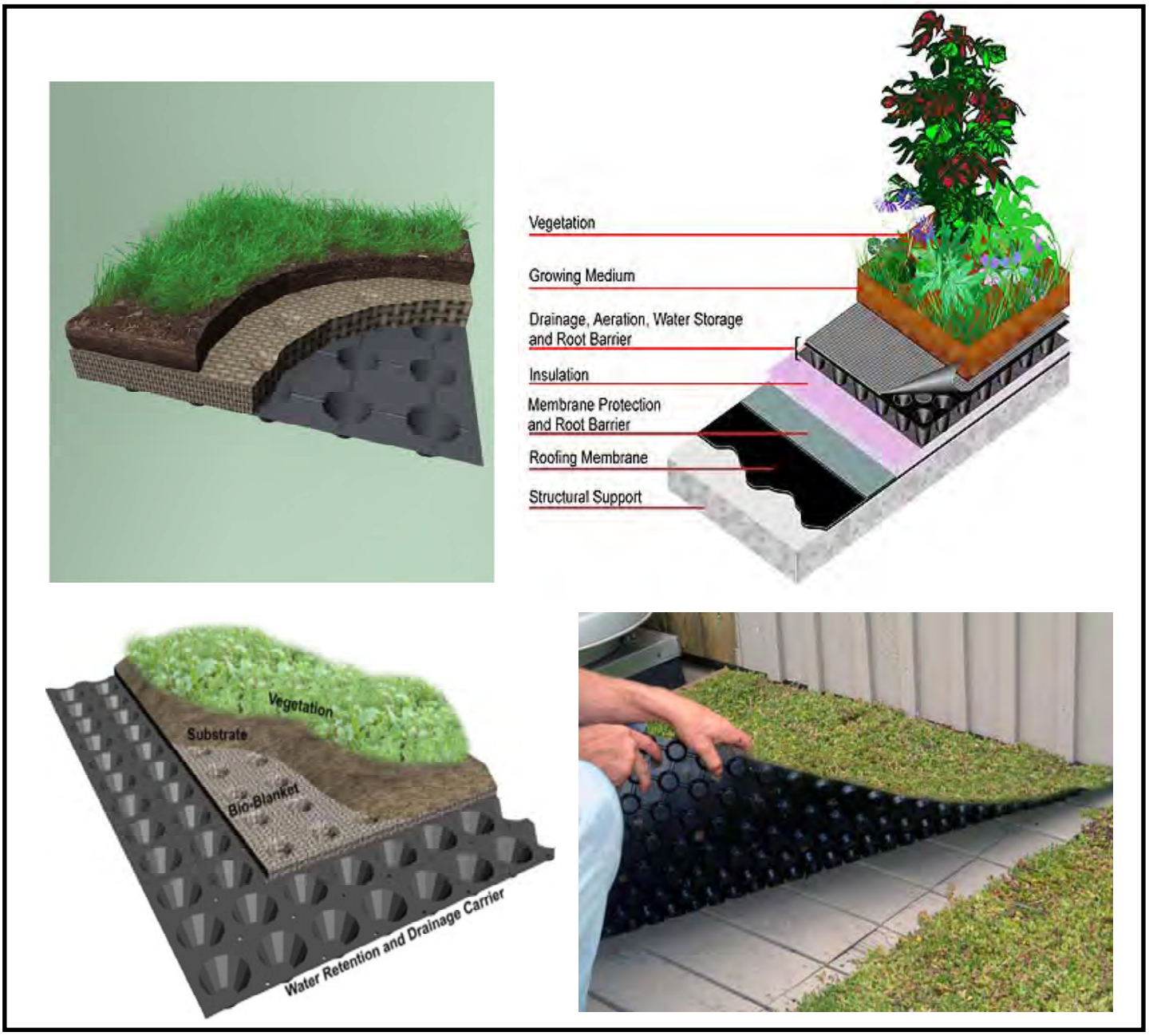


Figure 5-13. Various Layers of a Green Roof

Typical components of a green roof, as illustrated in Figure 5-14, include:

- Plant – Perennials and shrubs
- Erosion control blanket
- Plant Growth Media – 3” to 6” for Extensive and 6” to 4 feet for Intensive roofs
- Filter Fabric
- Drain: 4” to 6”
- Filter Fabric
- Aluminum Curbing
- Gravel (Optional)
- Vegetation-free strip gravel

- Thermal Insulation
- Leak Detection System
- Protection Layer
- Root Barrier
- Water Proof Membrane
- Root Deck with vapor Barrier and Root Structure
- Perforated aluminum Curb w/Drainage Fabric
- Roof Drain w/parapet well
- Emergency Overflow

Sizing

Green roofs replace impervious area at a 1:1 ratio. They are not allowed to receive runoff from other impervious areas.

Slope

Maximum roof slope shall be 25 percent, unless the designer provides documentation of runoff control on steeper slopes.

Waterproofing and Roofing Membrane

A good-quality waterproofing material, such as modified asphalt, synthetic rubber, or reinforced thermal plastics, shall be used on the roof surface. Some waterproofing materials also act as a root barrier. A roofing membrane covers the natural roof to protect the structural supports of the roof. The membrane protection and root barrier protects the roof membrane and prevents roots from penetrating the roof. Insulation helps insulate the building, keeping it cooler during the summer and warmer in the winter. The drainage section to insure the proper range of water content in the growing medium, aeration section is essential to promote optimal vegetation growth; the water storage section will provide more successful growth of vegetation.

Protection Boards or Materials (optional)

These materials protect the waterproof membrane from damage during construction and over the life of the system and are usually made of soft fibrous materials. They often are not needed, depending on the membrane selected.

Ballast (optional)

Gravel ballast is sometimes placed along the perimeter of the roof and at air vents or other vertical elements. The need for ballast depends on operational and structural design issues. It is sometimes used to provide maintenance access, especially to vertical elements that require regular, periodic maintenance. In many cases, very little, if any, ballast is needed.

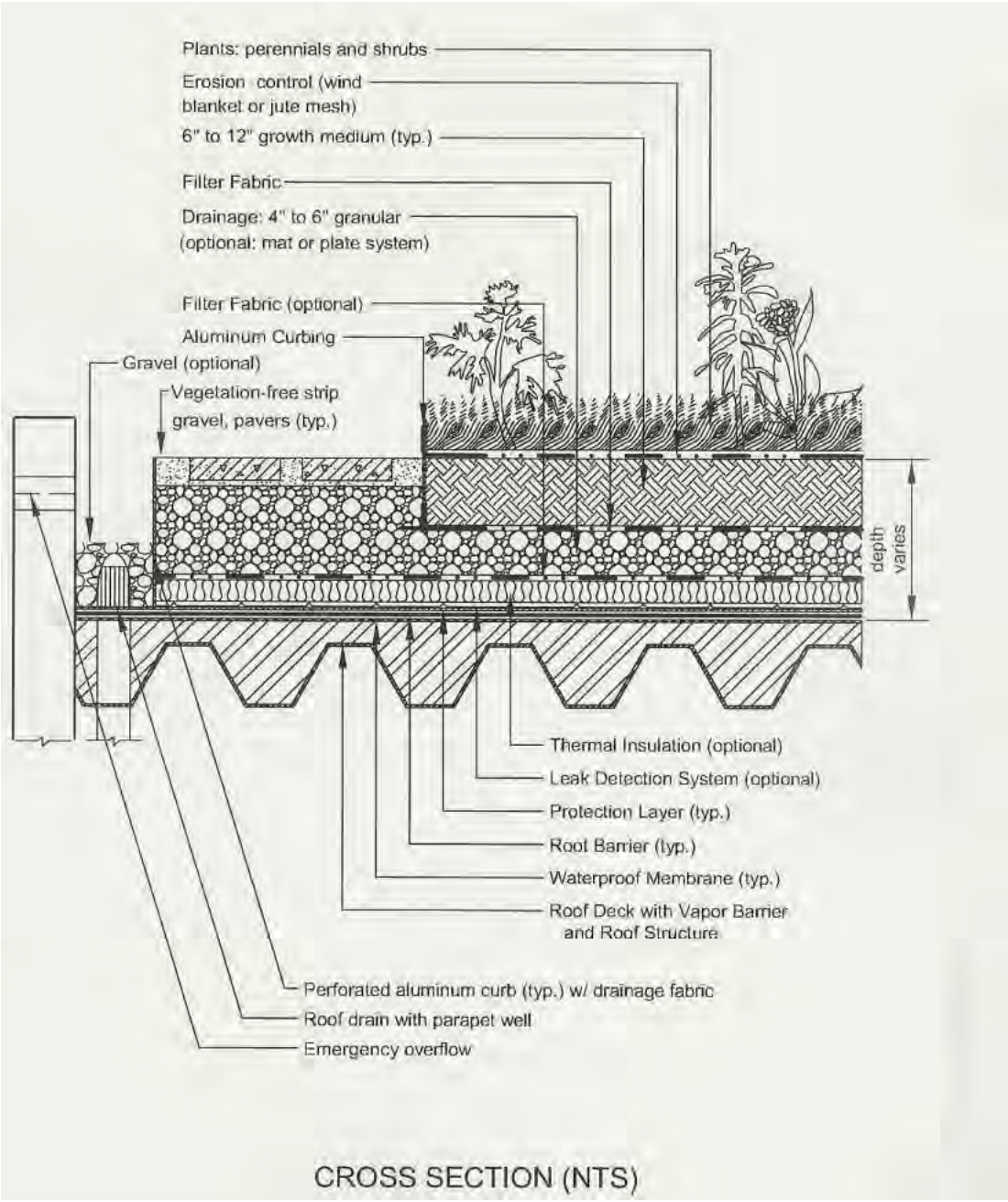


Figure 5-14. Cross Section of an Intensive Green Roof
(Source: Northern Virginia Regional Commission)

Header/Separation board (optional)

In some situations, a header or separation board may be placed between gravel ballast and adjacent elements (such as soil or drains), but pressure-treated lumber is prohibited. In many cases, a header is not needed, and designers are encouraged to use one only when necessary.

Root Barrier

A root barrier is sometimes required in addition to waterproofing material, depending on the type used and the types of vegetation proposed. Root barriers impregnated with pesticides, metals, or

other chemicals that may leach into stormwater are not permitted, unless the applicant can provide documentation that leaching would not occur. If a root barrier is used, it must extend under any gravel ballast and the growing medium and up the side of any vertical elements.

5.7.6 Materials

Table 5-16 provides guidelines for typical material specifications used for extensive green roofs. Always follow manufacturer's specifications.

Table 5-16. Extensive Green Roof Material Specification

Material	Specification	Notes
Roof	-Structural Capacity should conform to ASTM E-2397-05, Practice for Determination of Live Loads and Dead Loads Associated with Green Roof Systems. -ASTM E2398-05 for Water Capture and Media Retention of Geo-composite Drain Layers for Green Roof Systems -ASTM E 2399-05 for Maximum Media Density for Dead Load Analysis.	Architect, structural engineer, and civil engineer must coordinate design criteria
Vegetation	-Drought tolerant plants must achieve 90% coverage within 2 years. -Minimum 50% green roof must be composed of evergreen species -Maximum 10% green roof area may be non-vegetated (gravel ballast, pavers for maintenance access, etc.)	-Vegetation must be recommended by professional landscape architect, horticulturist, or the local USDA Natural Resources office -Succulent, herbaceous plants and perennial grasses that are shallow-rooted, self-sustaining, and tolerant of direct sunlight, drought, wind, and frost. See ASTM E2400-06, *Guide for Selection, Installation and Maintenance of Plants for Green (Vegetated) Roof Systems*.
Waterproof Membrane	In accordance with local county ordinances and laws	
Root Barrier	In accordance with local county ordinances and laws	
Drainage Layer	1 to 2 inch layer of clean washed granular material, such as ASTM D 448 size No. 8 stone.	Roof drains and emergency overflow should be designed in accordance with local county ordinances and laws.

Material	Specification	Notes
Filter Fabric	Needled, non-woven, polypropylene geotextile. -Density (ASTM D3776) > 16 oz./sq. yd., or approved equivalent. -Puncture resistance (ASTM D4833) > 220 lbs., or approved equivalent.	
Growth Media	-80% lightweight inorganic materials and 20% organic matter (well-aged compost). -Determine acceptable saturated water permeability using ASTM E2396-05.	Inorganic materials include expanded slates, shales or clays, pumic, scoria or similar.

5.7.7 Construction Considerations

5.7.7.1 Construction Sequence

Given the wide diversity of green roof designs, there is no typical step-by-step construction sequence for green roof installation that would cover all situations. The green roof manufacturer's instructions should always be followed. The following is a general construction sequence:

1. Construct the roof deck with the appropriate slope and material.

2. Install the waterproofing method, according to manufacturer's specifications.

3. Conduct a flood test to ensure the system is water tight by placing at least 2 inches of water over the membrane for 48 hours to confirm the integrity of the waterproofing system.

4. Add additional system components (*e.g.*, insulation, root barrier, drainage layer, interior drainage system, and filter fabric, etc.), taking care not to damage the waterproofing. Drain collars and protective flashing should be installed to ensure free flow of excess stormwater.

5. The growing media should be mixed prior to delivery to the site. Media should be spread evenly over the filter fabric surface. The growing media should be covered until planting to prevent weeds from growing. Sheets of exterior grade plywood can also be laid over the growing media to accommodate foot or wheelbarrow traffic. Foot traffic and equipment traffic should be limited over the growing media to reduce compaction.

6. The growing media should be moistened prior to planting, and then planted with the ground cover and other plant materials, per the planting plan, or in accordance with

ASTM E2400. Plants should be watered immediately after installation and routinely so during initial establishment

7. Generally it takes 12 to 18 months for the vegetation to establish fully on the roof. An initial fertilization using slow release fertilizer (e.g., 14-14-14) with adequate minerals is often needed to support and promote plant growth and dense establishment. Temporary watering may also be needed during the first summer, if drought conditions persist. Hand weeding is also critical in the first two years.

8. All construction contracts should contain a "Care and Replacement Warranty" from the contractor that specifies a 75 percent minimum survival after the first growing season of species planted and a minimum effective vegetative ground cover of 75 percent for flat roofs and 90 percent for pitched roofs.

5.7.7.2 Inspections

Inspections during construction are needed to ensure that the vegetated roof is built in accordance with the designer of record specifications. Also, an experienced installer should be retained to construct the vegetated roof system. The vegetated roof should be constructed in sections for easier inspection and maintenance access to the membrane and roof drains. Careful construction supervision is needed during several steps of vegetated roof installation, as follows:

- During placement of the waterproofing layer, to ensure that it is properly installed and watertight
- During placement of the drainage layer and drainage system
- During placement of the growing media, to confirm that it meets the specifications and is applied to the correct depth
- Upon installation of plants, to ensure they conform to the planting plan
- Before issuing use and occupancy approvals; and
- At the end of the first or second growing season, to ensure desired surface cover specified in the Care and Replacement Warranty has been achieved.

5.7.8 Maintenance

Vegetated roofs are designed to have minimal maintenance requirements. Plant species are selected so that the roof does not need supplemental irrigation or fertilization after vegetation is initially established. Table 5-17 lists suggested maintenance activities for extensive green roofs.

A vegetated roof should be inspected twice a year during the growing season to assess vegetative cover, and to look for leaks, drainage problems and any rooftop structural concerns. In addition, the vegetated roof should be hand-weeded to remove invasive or volunteer plants, and soil media

should be added to repair bare areas (refer to ASTM E2400). Many practitioners also recommend an annual application of slow release fertilizer in the first five years after the vegetated roof is installed.

If a roof leak is suspected, it is advisable to perform an electric leak survey (*i.e.,* Electrical Field Vector Mapping) to pinpoint the exact location, make localized repairs, and then reestablish system components and ground cover.

The use of herbicides, insecticides, and fungicides should be avoided, since their presence could hasten degradation of the waterproof membrane. Only non-chemical fertilizers may be used. Also, power-washing and other exterior maintenance operations should be avoided so that cleaning agents and other chemicals do not harm the vegetated roof plant communities.

Green roof maintenance may include watering, fertilizing and weeding, and is typically greatest in the first two years as plants become established. Maintenance largely depends on the type of green roof system installed and the type of vegetation planted. The use of native vegetation cannot be overemphasized in planting vegetation on roofs and is highly recommended in order to reduce plant maintenance in both extensive and intensive systems.

A green roof should be monitored after completion for plant establishment, leaks and other functional or structural concerns. Vegetation should be monitored for establishment and viability, particularly in the first two years.

Table 5-17. Suggested Maintenance Activities for Extensive Green Roofs

	Task	Frequency	Maintenance Notes
1	Inspect Vegetation	Twice during growing season	
2	Inspect for Leaks, Drainage Problems, Structural Concerns and Repair	Inspect Biannually Repair As Needed	
3	Remove Weeds and Replant Bare Areas	Regularly	
4	Watering for plant establishment	Regularly	In first two years

5.7.9 Benefits

Benefits of green roofs include:

- Controlling stormwater runoff peak flow and volume. Vegetative roofs are particularly effective at controlling runoff on large roofs typical of commercial and institutional buildings.

- Improving stormwater quality by mechanisms of bio-filtration and plant uptake.

- Mitigating unban heat-island effects and energy conservation (see Figure below).

- Green roofs may reduce cooling energy demands in summer and heating bills in winter because of up-roof insulation; they be less important in multi-story buildings.

- Prolonging the service life of roofing materials. Studies have shown that a roof assembly that is covered with a green roof is expected to outlast a comparable roof without a green roof by a factor of at least two, and often three.

- In urban areas, up to 30 percent of nitrogen and phosphorous released into receiving streams originates from dust that accumulated on rooftops. Acting on natural bio-filtration devices, green roofs reduce this nutrient contamination carried by roof-top runoff.

Figure 5-15 exhibits the stormwater runoff reduction benefits of a green roof.

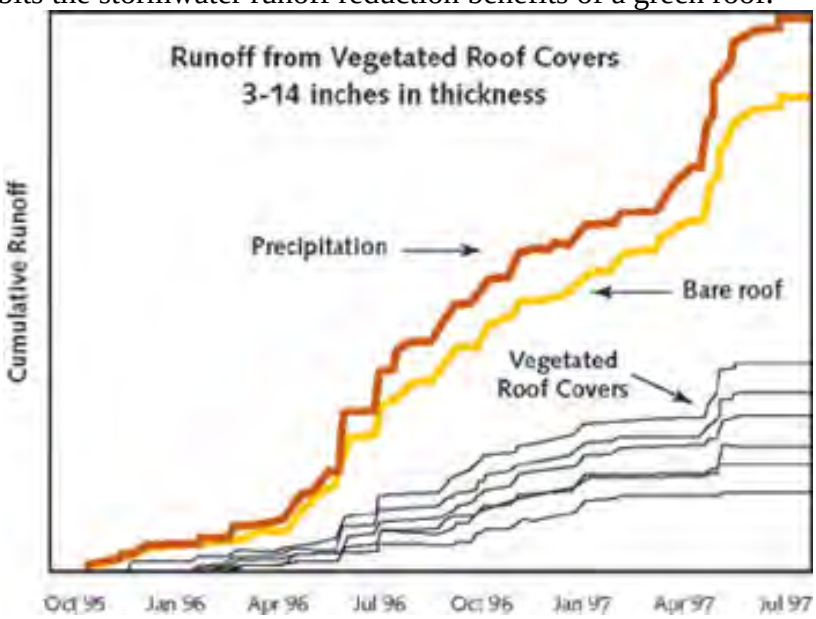


Figure 5-15. Runoff Reduction Benefits from Green Roods

6 REFERENCES

American Planning Association. 2006. Planning and Urban Design Standards. John Wiley & Sons, Inc. Hoboken, New Jersey.

Bicknell, Brian R., Imhoff, John C., Kittle Jr., John L., Jobes, Thomas H., Donigian Jr., Anthony S. 2005. "HSPF Version 12.2 User's Manual", Aqua Verra Consultants, Mountain View, CA. 94043.

Booth, Derek Direct Testimony. 2008. Pollution Control Hearings Board for the State of Washington, Puget Soundkeeper Alliance and People for Puget Sound; Pierce County Public Works and Utilities Department; City of Tacoma; The Port of Seattle; Snohomish County; Clark County; and Pacificorp and Puget Sound Energy, Appellants, vs. Department of Ecology, Respondent, and King County; City of Seattle; Port of Tacoma, and Washington State Department of Transportation, Intervenors, August 2008.

Galli, John. 1991. Thermal Impacts Associated with Urbanization and Stormwater Best Management Practices in Maryland, Anacostia Restoration Team for the Maryland Department of the Environment, Washington, DC.

Bureau of Environmental Services, City of Portland OR. 1999. Stormwater Management Manual. Chapter 2: Stormwater Management Facility Design. Retrieved from http://www.portlandonline.com/bes/index.cfm?a=55791&c=35122.

CAPT Robin Brake. 2008. Photo of Green Roof at the Pentagon Remote Delivery Facility. Office Deputy Assistant Secretary of the Navy, Environment Director Marine Science, 10 June 2008 Retrieved from http://www.fedcenter.gov/_kd/go.cfm?destination=ShowItem&Item_ID =10244.

Chino, Mike. 2008. The New Green California Academy of Sciences Unveiled! Retrieved from http://inhabitat.com/california-academy-of-sciences-unveiled/.

City of Saugatuck, MI. Photo of subsurface infiltration bed. Permission obtained via personal communication October 2011. Retrieved fromhttp://library.semcog.org/InmagicGenie/Document Folder/LIDManualWeb.pdf.

Claytor, R., and T. Schueler. 1996. Design of Stormwater Filtering Systems. The Center for Watershed Protection. Silverspring, Maryland. P 6–1, 6–14.

Coffman, Larry S. 2008. Photos of Bioretention. Permission obtained through personal communication. September 2011. Retrieved from http://www.water.rutgers.edu/Rain_Gardens/ RainGardenSymp/1_coffman.pdf and http://www.texaslid.org/pdfs/AP_Coffman%20 Bioretention.pdf.

Dunne, T. and L. B. Leopold. 1978. Water in Environmental Planning. W. H. Freeman: New York, pp.1-818.

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. Stream Corridor Restoration: Principles, Processes, and Practices. GPOJ Item No. 0120-A; SuDocs No. A 57.6/2 EN3/PT.653. ISVN-0-934213-59-3.

Federal Legislation. (2007). Energy Independence and Security Act (EISA). Retrieved from http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid= f%3Ah6enr.txt.pdf.

Garner, Birtice A. IV, The University of Georgia College of Environment and Design. Photo of Watershed Inventory of Natural Features. Permission obtained via personal communication September 2011. Retrieved from http://birtice.com/site-inventory-and-analysis.html.

Hawkins Partners, Inc. 2009. EPA to Test Porous Pavement and Raingarden Benefits. Permission obtained from Will Mark on September 2011. Retrieved from http://hpigreen.com/2009/11/.

Horton, R.E. 1933. The Role of Infiltration in the Hydrologic Cycle. Trans. AGU, 14th Ann. Mtg., p. 446–460.

InSite Design Studio. Photo of a Schematic of a Typical Level Spreader. Permission obtained via personal communication October 2011. Retrieved from http://library.semcog.org/ InmagicGenie/DocumentFolder/LIDManualWeb.pdf.

International Code Council, Inc. (ICC). 2009. ICC International Energy Conservation Code® (IECC). ICC, Country Club Hills, IL.

Interlocking Concrete Pavement Institute. 2010. Permeable Pavers: What is Permeable Interlocking Pavement? Retrieved from http://www.icpi.org/node/553

Kohler, M.A., T.J. Nordenson, and D.R. Baker. 1959. Evaporation maps for the United States. U.S. Weather Bureau Technical Paper 37.

Kosmowski, Christine. Environmental Programs Coordinator, City of Battle Creek, MI. Photo of a Level Spreader Used in Storm Drain Project. Permission obtained via personal communication September 2011. Retrieved from Retrieved from http://library.semcog.org/InmagicGenie/ DocumentFolder/LIDManualWeb.pdf.

Lemoine, Randel. 2011. "A Hydrology Model for Mimicking Pre and Post Development Runoff Volumes", Proceedings of the 2011 Georgia Water Resources Conference, Athens GA.

Low Impact Development Center, Inc. 2011. "Volume Based Stormwater Management Guidance", Beltsville, MD.

Low Impact Design Studio. 2010. Low Impact Development Technologies. Retrieved from http://www.wbdg.org/resources/lidtech.php#lidt.

Marywood Campus, Dominican Sisters, Grand Rapids, MI. Photo of native Prairie Vegetation in Natural Flow Pathway Permission obtained through communication with Karen Bidwell. September, 2011.

Low Impact Development Center, Inc. 2011. "Volume Based Stormwater Management Guidance", Beltsville, MD (under construction).

National Research Council. 2008. Urban Stormwater Management in the United States. The National Academies Press, Washington, DC. 20250.

New York State Department of Environmental Conservation (DEC). Latham Business Park Wet Swale. Retrieved from http://www.dec.ny.gov/lands/59310.html.

Parker, Tony. 2007. Classic Landscapes. Revisit a Project. Retrieved from http://www.classiclandscapesnc.com/project-revisit.asp

Pennsylvania Department of Environmental Protection (PA DEP), Bureau of Watershed Management. 2006. Pennsylvania Stormwater Best Management Practices Manual. Retrieved from http://www.elibrary.dep.state.pa.us/dsweb/View/Collection-8305.

Philadelphia Water Department. Photo of a Pervious Pavement Basketball Court. Permission and photograph obtained through personal communication with Stephanie Chiorean September 2011.

Pokagon Band of Potawatomi Indians. Photo of Permeable Concrete Pave Street in Dowagiac, MI. Permission obtained from Wade Hawes via personal communication October 2011. Retrieved from http://library.semcog.org/InmagicGenie/DocumentFolder/LIDManualWeb.pdf

Ponce, Victor Miguel. 1989. "Engineering Hydrology – Principles and Practices", Prentice Hall, Englewood Cliffs, New Jersey.

Prince George's County, MD. 1999. Low-Impact Development Design Strategies: An Integrated Design Approach. Retrieved from http://www.epa.gov/owow/NPS/lidnatl.pdf.

Prince George's County, MD. 1993. *Design Manual for Use of Bioretention in Stormwater Management.* Prince George's County, MD Department of Environmental Protection. Watershed Protection Branch, Landover, MD.

Prince George's County, MD Department of Environmental Resources. Photo of Downspout Disconnection into aVegetated Area. Permission obtained through personal communication September 2011. Retrieved from http://www.werf.org/livablecommunities/toolbox/downspout.htm.

Pudget Sound Action Team and Washington State University Pierce County Extention. 2005. Low Impact Development Technical Guidance Manual for Pudget Sound. Retrieved from www.psp.wa.gov/downloads/LID/LID_manual2005.pdf.

Rossman, Lewis A. 2010. "Storm Water Management Model User's Manual Version 5.0", EPA/600/R-05/040, U.S. Environmental Protection Agency (EPA), Cincinnati OH. 45268.

Schueler, T. and M. Helfrich. 1988. "Design of Wet Extended Detention Pond Systems," *Design of Urban Runoff Controls*, L. Roesner and B. Urbonas eds., American Society of Civil Engineers, New York, NY.

SEMCOG, the Southeast Michigan Council of Governments.2008. Low Impact Development Manual for Michigan. Permission for photos obtained through personal communication with Glenda Marks, September 2011. Retrieved from http://library.semcog.org/InmagicGenie/DocumentFolder/LIDManualWeb.pdf.

Shaver, E., R. Horner, J. Skupien, C. May, and G. Ridley. 2007. Fundamentals of Urban Runoff Management: Technical and Institutional Issues – 2nd Edition, North American Lake Management Society, Madison, WI.

Skabelund, Lee. 2006. Kansas State University. Photo of a Level Spreader Dispersing into a Wetland Area. Permission obtained through personal communication September 2011. Retrieved from http://www.asla.org/ppn/article.aspx?id=1374

Southwestern Illinois Resource Conservation and Development, Inc. 2006. Conservation Subdivision Design Handbook. Retrieved from http://www.swircd.org/pdf/conservation%20subdivision%20design%20handbook.pdf.

Thibaudeau, Steve. 2010. U.S. Corps of Engineers.The Importance of LID at USACE. Retrieved from http://posts.same.org/kentuckiana/Presentation%201%20--%20USACE.pdf

US Army. 2010. Assistant Secretary of Army (Installations, Energy & Environment) Policy Memo, Sustainable Design and Development Policy Update (Environmental and Energy Policy), 27 Oct 2010 (para5f). Retrieved from https://eko.usace.army.mil/_temp/6744A846-188B-313F-1B4C818188BC6FBA/Sustainable_Design_and_Dev_Policy_Update.pdf

US Army. 1988. Army Regulation 200-2. Environmental Quality: Environmental Effects of Army Actions. Retrieved from http://www.sustainability.army.mil/resources/libdocs_regulatory/army_regulations/AR%20200_2%2023%20Dec%201988.pdf.

US Army Corps of Engineers (USCOE). 2008. Public Works Technical Bulletin 200-1-62. Low Impact Development for Sustainable Installations: Stormwater Design and Planning Guidance for Development Within Army Training Areas. Retrieved from http://www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_200_1_62.pdf.

US Department of Agriculture (USDA), National Resources Conservation Service. No Date. Success Stories: Buffer Bonus from Bear Creek. Retrieved from http://www.ia.nrcs.usda.gov/news/successstories/successstories.html.

US Department of Agriculture (USDA). 2009. "Small Watershed Hydrology – WinTR-55 User's Guide", Natural Resources Conservation Service (NRCS), Conservation Engineering Division, Washington DC.

US Department of Defense (DoD). 2010. Unified Facilities Criteria (UFC): Low Impact Development. UFC 3-210-10. Retrieved from http://www.wbdg.org/ccb/DOD/UFC/ufc_3_210_10.pdf.

DoD. 2012. Unified Facilities Criteria (UFC): Installation Master Planning. UFC 2-100-01. Retrieved from http://www.wbdg.org/ccb/DOD/UFC/ufc_2_100_01.pdf.

DoD. 2004. Unified Facilities Criteria (UFC): Area Planning, Site Planning, and Design. UFC 3-210-01A. http://www.wbdg.org/ccb/DOD/UFC/ufc_3_210_01a.pdf

US Environmental Protection Agency (USEPA). 2011. Stormwater Management Techniques in Use at EPA Headquarters. Retrieved from http://www.epa.gov/oaintrnt/stormwater/hq_stormwater_techniques.htm.

US EPA 2010. Stormwater Management at EPA Headquarters. Retrieved from http://www.epa.gov/owow/NPS/lid/stormwater_hq/.

US EPA. 2009. Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act. Retrieved from http://www.epa.gov/oaintrnt/documents/epa_swm_guidance.pdf.

US EPA 2007a. National Pollutant Discharge Elimination System (NPDES), Stormwater Program. Retrieved from http://cfpub.epa.gov/npdes/home.cfm?program_id=6.

US EPA 2006. Reducing Stormwater Costs through LID Strategies and Practices. Retrieved from http://www.epa.gov/owow/NPS/lid/costs07/

US EPA. 2003a. Washington, D.C. "Protecting Water Quality from Urban Runoff." Document No. EPA 841-F-03-003. Retrieved from http://www.epa.gov/npdes/pubs/nps_urban-facts_final.pdf.

US EPA, 2003b. National Pollutant Discharge Elimination System: State Program Status. Retrieved from http://cfpub.epa.gov/npdes/statestats.cfm.

US Green Building Council (USGBC), 2011. About USGBC. Retrieved from www.usgbc.org/about.

US Geological Survey (USGS) 2011. USGS Real-Time Water Data for the Nation. Created from http://waterdata.usgs.gov/nwis/rt.

USGS. 1986. Average Runoff, 1951-1980. Retrieved from http://www.unl.edu/nac/atlas/Map_Html/Clean_Water/National/Average_Annual_Runoff/Average_Annual_Runoff.htm

U.S. Office of the President. 2009. Federal Leadership in Environmental, Energy, and Economic Performance. Executive Order 13514. Federal Register, vol 74, No. 194, http://edocket.access.gpo.gov/2009/pdf/E9-24518.pdf.

U.S. Office of the President. 2007. Strengthening Federal Environmental, Energy, and Transportation Management. Executive Order 13423. Federal Register, vol 72, No. 17, http://edocket.access.gpo.gov/2007/pdf/07-374.pdf.

Wayne County, MI Department of Public Works, Water Quality Management Division. Photos of a Two Chambered Sand Filter and a Vegetated Filter Strip. Permission obtained from Kelly Cave, September 2011. Retrieved from the SEMCOG LID Manual http://www.semcog.org/uploadedfiles/Programs_and_Projects/Water/Stormwater/LID/lid_manual_intro.pdf.

Western Michigan University. Photo of Protection of Existing Native Woodlands and Wetlands. Permission obtained via personal contact November 2011 from David Dakin. Retrieved from http://www.semcog.org/Data/lid.report.cfm?lid=141.

7 GLOSSARY

AASHTO – American Association of State and Highway Transportation Officials.

Adsorption – The process by which a solute is attracted to a solid surface. Adsorption is the process utilized in stormwater management BMPs to enhance the removal of soluble pollutants.

Alkalinity – A measure of the capacity of water to neutralize acids because of the presence of one or more of the following bases in the water: carbonates, bicarbonates, hydroxides, borates, silicates, or phosphates.

Ammonia Nitrogen (NH_4-N) – A reduced form of nitrogen produced as a by-product of organic matter decomposition and synthesized from oxidized nitrogen by biological and physical processes.

Anti-Seep Collar – A device constructed around a pipe or other conduit and placed into a dam, levee, or dike for the purpose of reducing seepage losses and piping failures along the conduit it surrounds.

Anti-Vortex Device – A device placed at the entrance to a pipe conduit structure to help prevent swirling action and cavitation from reducing the flow capacity of the conduit system.

Aquatic Bench – A 10- to 15-foot wide bench around the inside perimeter of a permanent pool that ranges in depth from 0 to 12 inches. Vegetated with emergent plants, the bench augments pollutant removal, provides habitats, protects the shoreline from the effects of water level fluctuations, and enhances safety.

Aquifer – A porous, water bearing geologic formation generally restricted to materials capable of yielding an appreciable supply of water.

As-Built (drawing) – A drawing or certification of conditions as they were actually constructed.

Aspect Ratio – Ratio of wetland cell length to width.

Atmospheric Deposition – The process by which atmospheric pollutants reach the land surface either as dry deposition or as dissolved or particulate matter contained in precipitation.

Attenuation – Reduction in magnitude, as in the lowering of peak runoff discharge rates, in the case of dry ponds; or the reduction of contaminant concentrations, as in the action of biodegradation in wetlands or bioretention facilities.

Baffle – Guides, grids, grating or similar devices placed in a pond to deflect or regulate flow and create a longer flow path from the inlet to the outlet structure.

Bankfull Flow – Condition where flow fills a stream channel to the top of bank to the point where the water begins to overflow onto a floodplain.

Barrel – A closed conduit used to convey water under or through an embankment; part of the principal spillway.

Base Flow – Normally refers to the stream levels associated primarily with groundwater or subsurface contributions, as opposed to storm flow which corresponds to stream levels associated with recent precipitation and surface runoff.

Basin – A facility designed to impound stormwater runoff.

Bedrock – Layer of consolidated rock over which lies an overburden of soil (regolith), including unconsolidated rock.

Benthic – Pertaining to occurrence on or in the bottom sediment of wetland and aquatic ecosystems, including wetlands.

Best Management Practices (BMP) – Activities, facilities, measures, or procedures used to manage the volume, rate, and water quality of stormwater runoff.

Biodiversity – The number of species of plants and animals in a defined area. Biodiversity is measured by a variety of indices that consider the number of species and, in some cases, the distribution of individuals among species.

Biological Processes – A pollutant removal pathway in which microbes break down organic pollutants and transform nutrients.

Biomass – The total mass of living tissues (plant and animal).

Biochemical Oxygen Demand (BOD) – A measure of the concentration of aerobically degradable compounds in water. Measured as the oxygen consumed during degradation of organic and inorganic materials in water.

Bioretention Basin – A water quality BMP engineered to filter the water quality volume through an engineered planting bed consisting of a vegetated surface layer (vegetation, mulch, ground cover), planting soil, and sand bed (optional), and subsequently into the in-situ material. Also called rain gardens.

Bioretention Filter – A bioretention basin with the addition of a sand layer and collector pipe system beneath the planting bed.

BMP Fingerprinting – A series of techniques for locating BMPs (particularly ponds) within a development site so as to minimize their impacts to wetlands, forest, and sensitive stream reaches.

BOD_5 – Five-day biochemical oxygen demand.

Buffer – A vegetated strip immediately adjacent to a waterbody. The primary function of buffers is to protect the receiving water from sediment and pollutants derived from upstream areas. Ancillary benefits may include infiltration of rainfall and habitat enhancement. A buffer is a special case of a filter strip. Forested riparian buffers are one example of a best management practice related to the use of buffers.

Catch Basin – An inlet chamber usually built at the curb line of a street or low area, for collection of surface runoff and admission into a sewer or subdrain. These structures commonly have a sediment sump at its base, below the sewer or subdrain discharge elevation, designed to retain solids below the point of overflow.

Channel – A natural or man-made waterway.

Channel Stabilization – The introduction of natural or man-made materials placed within a channel so as to prevent or minimize the erosion of the channel bed and/or banks.

Channelization – The creation of a channel or channels resulting in faster water flow, a reduction in hydraulic residence time, and less contact between water and solid surfaces in the waterbody.

Check Dam – A small dam constructed in a channel for the purpose of decreasing the flow velocity, minimizing channel scour, and promoting deposition of sediment. Check dams are a component of grassed swale BMPs.

Chemical Oxygen Demand (COD) – A measure of the concentration of substances which can be oxidized in water. Expressed as the oxygen equivalent consumed when an aqueous sample is reacted of the organic matter in water, based on reaction with a strong chemical oxidant.

Choker Course – A filter layer of finer material, usually crushed stone, that is installed over a coarse road base material. The purpose of the choker course is to provide a stable foundation for the construction of pavement.

Chute – A high velocity, open channel for conveying water to a lower level without erosion.

Clay (SOILS) – 1. A mineral soil separate consisting of particles less than 0.002 millimeter in equivalent diameter. 2. A soil texture class. 3. (Engineering) A fine grained soil (more than 50% passing the No. 200 sieve) that has a high plasticity index in relation to the liquid limit (Unified Soil Classification System).

Coconut Rolls – Also known as coir rolls, these are rolls of natural coconut fiber designed to be used for streambank stabilization.

COE – The United States Army Corps of Engineers.

Compaction (Soils) – Any process by which the soil grains are rearranged to decrease void space and bring them in closer contact with one another, thereby increasing the weight of solid material per unit of volume, increasing the shear and bearing strength and reducing permeability.

Conduit – Any channel intended for the conveyance of water, whether open or closed.

Constructed Stormwater Wetlands – Areas intentionally designed and created to emulate the water quality improvement function of wetlands for the primary purpose of removing pollutants from stormwater.

Contour – A line representing a specific elevation on the land surface or a map.

Core Trench – A trench filled with relatively impervious material intended to reduce seepage of water through porous strata.

Cradle – A structure usually made of concrete shaped to fit around the bottom and sides of a conduit to support the conduit, increase its strength, and, in dams, to fill all voids between the underside of the conduit and soil.

Crest – The top of a dam, dike, spillway or weir, frequently restricted to the overflow portion.

Critical Depth – The depth of flow at which the specific energy is a minimum for a given discharge rate. Flow is critical when the Froude number is equal to one: where V is the velocity of the flow, g is the gravitational constant, and D is the hydraulic depth of the flow.

Crushed Stone – Aggregate consisting of angular particles produced by mechanically crushing rock.

Curve Number (CN) – A numerical representation of a given area's hydrologic soil group, plant cover, impervious cover, interception, and surface storage derived in accordance with Natural Resource Conservation Service methods. This number is used to convert rainfall depth into runoff volume. Sometimes referred to as Runoff Curve Number.

Cut – A reference to an area or material that has been excavated in the process of a grading operation.

Cut-And-Fill – The process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

Cutoff – A wall or other structure, such as a trench, filled with relatively impervious material intended to reduce seepage of water through porous strata.

CZARA – Acronym used for the Coastal Zone Act Reauthorization Amendments of 1990. These amendments sought to address nonpoint source pollution issues by requiring states to develop Coastal Nonpoint Pollution Control Programs in order to receive federal funds.

Dam – A barrier constructed for the purpose of confining or impounding water.

Denitrification – The removal of nitrate ions from soil or water, anaerobic microbial reduction of oxidized nitrate nitrogen to nitrogen gas.

Dense Graded Material – Granular mixture characterized by a large range in particle sizes. Dense graded materials have superior structural properties to open graded materials. However, they are less permeable.

Design Storm – A selected rainfall hyetograph of specified amount, intensity, duration, and frequency that is used as a basis for design.

Detention – The temporary impoundment or holding of stormwater runoff.

Detention Basin – A stormwater management facility which temporarily impounds runoff and discharges it through a hydraulic outlet structure to a downstream conveyance system. While a certain amount of outflow may also occur via infiltration through the surrounding soil, such amounts are negligible when compared to the outlet structure discharge rates and, therefore, are not considered in the facility's design. Since an extended detention basin impounds runoff only temporarily, it is normally dry during nonrainfall periods.

Detention Structure – A structure constructed for the purpose of temporary storage of stream flow or surface runoff and gradual release of stored water at controlled rates.

Detritus – Dead plant material that is in the process of microbial decomposition.

Dike – An embankment, usually linear, to confine or direct water.

Discharge – Flow of water across the land surface or within the confines of a natural or man-made channel, or stream.

Dissolved Oxygen – A form of oxygen found in water that is essential to the life of aquatic species.

Distributed Runoff Control (DRC) – A stream channel protection criteria which utilizes a non-uniform distribution of the storage stage-discharge relationship within a SMP to minimize the change in channel erosion potential from pre-developed to developed conditions.

Disturbed Area – An area in which the natural vegetative soil cover or existing surface treatment has been removed or altered and, is therefore susceptible to erosion.

Diurnal – Occurring daily or during the daylight.

Diversion – A channel or dike constructed to direct water to areas where it can be used, treated, or disposed of safely.

Drainage – 1. The removal of excess surface water or groundwater from land by means of surface or subsurface drains. 2. Soils characteristics that affect natural drainage.

Drainage Area (Watershed) – All land and water area from which runoff may run to a common (design) point.

Drainage Basin – An area of land that contributes stormwater runoff to a designated point. Also called a drainage area or, on a larger scale, a watershed.

Drop Structure – A man-made device constructed to transition water to a lower elevation.

Dry Swale – An open drainage channel explicitly designed to detain and promote the filtration of stormwater runoff through an underlying fabricated soil media.

Duration – The length of time over which precipitation occurs.

Ecosystem – All organisms and the non-living environmental factors with which they interact.

Ecotone – The boundary between adjacent ecosystem types. An ecotone can include environmental conditions that are common to both neighboring ecosystems and can have higher species diversity.

Eh – A measure of the reduction-oxidation (redox) potential of soil according to a hydrogen scale.

Emergent Plant – A rooted, vascular plant that grows in periodically or permanently flooded areas and has parts of the plant (stems and leaves) extending through and above the water plane.

EPA – The United States Environmental Protection Agency.

Embankment – A man-made deposit of soil, rock, or other material used to form an impoundment.

Emergency Spillway – A channel, usually an open channel constructed adjacent to an embankment, which conveys flows in excess of the design capacity of the principal spillway.

Energy Dissipator – A device used to reduce the velocity or turbulence of flowing water.

Erosion – The wearing away of the land surface by running water, wind, ice, or other geological agents.

Accelerated Erosion – Erosion in excess of what is presumed or estimated to be naturally occurring levels and which is a direct result of human activities.

Gully Erosion – Erosion process whereby water accumulates in narrow channels and removes the soil to depths ranging from a few inches to 1 or 2 feet to as much as 75 to 100 feet.

Rill Erosion – Erosion process in which numerous small channels only several inches deep are formed.

Sheet Erosion – The spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may subsequently be removed by surface runoff.

Erosive Velocities – Velocities of water that are high enough to wear away the land surface. Exposed soil will generally erode faster than stabilized soils. Erosive velocities will vary according to the soil type, slope, structural, or vegetative stabilization used to protect the soil.

Eutrophic – Water containing an excess of plant-growth nutrients that typically result in algae blooms and extreme (high and low) dissolved-oxygen concentrations.

Eutrophication – The process of over-enrichment of waterbodies by nutrients often typified by the presence of algal blooms.

Evapotranspiration – The combined processes of evaporation from the water or soil surface and transpiration of water by plants.

Exceedence Probability – The probability that an event having a specified volume and duration will be exceeded in one time period, usually assumed to be one year. If a storm has a one percent chance of occurring in any given year, than it has an exceedence probability of 0.01.

Excessively Rapid Drainage – For purposes of this manual, corresponds to infiltration rates of soils in excess of 6 inches per hour. (Normally 6 inches is considered rapid drainage but the manual indicates that special precautions need to be taken with an infiltration rate of 6 inches per hour or more)

Exfiltrate – The leaking of water to surrounding ground through openings in structures.

Exfiltration – The downward movement of runoff through the bottom of a stormwater facility and into the soil.

Exotic Species – A plant or animal species that has been intentionally or accidentally introduced and that does not naturally occur in a region.

Extended Detention – A function provided by BMPs which incorporate a water quality storage. BMPs with extended detention intercept runoff and then release it over an extended period of time.

Extended Detention Basin – A stormwater management facility which temporarily impounds runoff and discharges it through a hydraulic outlet structure over a specified period of time to a downstream conveyance system for the purpose of water quality enhancement or stream channel erosion control. While a certain amount of outflow may also occur via infiltration through the surrounding soil, such amounts are negligible when compared to the outlet structure discharge rates and, therefore, are not considered in the facility's design. Since an extended detention basin impounds runoff only temporarily, it is normally dry during non-rainfall periods.

Extended Detention Basin-Enhanced – An extended detention basin modified to increase pollutant removal by providing a shallow marsh in the lower stage of the basin.

Extended Detention (ED) Pond – Temporarily detains part of stormwater runoff for up to 24 hours after a storm by using a fixed orifice. ED ponds normally are "dry" between storm events and do not have permanent standing water. An enhanced ED pond is designed to prevent clogging and re-suspension. It provides flexibility in achieving target detention times. It may be equipped with plunge pools near the inlet, a micropool at the outlet, and may have an adjustable reverse-sloped pipe at the ED control device.

Extended Detention Control Device – A pipe or series of pipes that extend from the riser of the stormwater pond that are used to gradually release stormwater from the pond over a 12- to 48-hour interval.

Extreme Flood (Q_f) – The storage volume required to control those infrequent but large storm events in which overbank flows approach the floodplain boundaries of the 100-year flood.

Fascine – Bundled willow cuttings used to stabilize stream banks. Bundling allows otherwise weak green twigs to reinforce each other and resist the forces of stream currents.

Field Capacity – The quantity of water which will not freely drain from the root zone of shallow soil layers. Usually measured as the moisture content (by volume) in soil at a capillary tension of .33 bars.

Fill – A reference to an area or material that has been placed by mechanical equipment in the process of a grading operation.

Filter Bed – The section of a constructed filtration device that houses the filtering media.

Filter Fence – A geotextile fabric designed to trap sediment and filter runoff.

Filter Media – The sand, soil, or other organic material in a filtration device used to provide a permeable surface for pollutant and sediment removal.

Filter Strip – A vegetated boundary characterized by uniform mild slopes. Filter strips may be provided down-gradient of developed tracts to trap sediment and sediment-borne pollutants and to reduce imperviousness. Filter strips may be forested or vegetated turf. Filter strips located adjacent to waterbodies are called buffers.

Fines (Soil) – Generally refers to the silt and clay size particles in soil.

First Flush – The first portion of runoff, usually defined as a depth in inches, considered to contain the highest pollutant concentration resulting from a rainfall event.

Flash Boards – Removable boards used in a weir to control water levels.

Floating Aquatic Plant – A rooted or non-rooted vascular plant that is adapted to have some plant organs (generally the chlorophyll-bearing leaves) floating on the surface of the water in wetlands, lakes, and rivers.

Flood Fringe – The flood fringe occupies the distal parts of the floodplain, outside of the floodway. Complete obstruction of the flood fringe will not significantly increase flood levels. The flood fringe boundary is typically based on an increase in flood level of one foot during the 100-year return frequency flooding event.

Flooding – When the volume or rate flow exceeds the capacity of the natural or man-made conveyance system and overflows onto adjacent lands, causing or threatening damage.

Floodplain – Lands adjoining a river or stream that have been or may be expected to be inundated by flood waters in a 100-year frequency flood.

Floodway – The channel of the watercourse and portions of the adjoining floodplains which are reasonably required to carry and discharge the 100-year frequency flood. Unless otherwise specified, the boundary of the floodway is as indicated on maps and flood insurance studies provided by FEMA. In an area where no FEMA maps or studies have defined the boundary of the 100-year frequency floodway, it is assumed, absent evidence to the contrary, that the floodway extends from the stream to 50 feet from the top of the bank of the stream.

Flow Splitter – An engineered hydraulic structure designed to divert a portion of storm flow to a BMP located out of the primary channel, or to direct stormwater to a parallel pipe system, or to bypass a portion of baseflow around a BMP.

Forebay – A stormwater design feature that uses a small basin to settle out incoming sediment before it is delivered to a stormwater BMP.

Fourth Order Stream – Designation of stream size where many water quantity requirements may not be needed. A first order stream is identified by "blue lines" on USGS quad sheets. A second order stream is the confluence of two first order streams, and so on.

Freeboard – The vertical distance between water surface elevation experienced during the design flood and the crest elevation of a dam, levee, floodwall, or other embankment.

French Drain – A type of drain consisting of an excavated trench filled with pervious material such as coarse sand, gravel or crushed stone. Water percolates through the voids in the material and exfiltrates into the soil.

Frequency (design storm frequency) – The recurrence interval of storm events having the same duration and volume. The frequency of a specified design storm can be expressed either in terms of exceedence probability or return period.

Fresh Water – Water with a total dissolved solids content less than 500 mg/L (0.5 parts per thousand salts).

Gabion – A wire cage used to contain rip rap and stone. Gabions are used to increase the resistance of rip rap to movement caused by flowing water.

Gabion Mattress – A thin gabion, usually six or nine inches thick, used to line channels for erosion control.

Geotextile – A fabric manufactured from synthetic fiber that is designed to achieve specific engineering objectives, including seepage control, media separation (e.g., between sand and soil), filtration, or the protection of other construction elements such as geomembranes.

GIS – Geographic Information System. A method of overlaying spatial land and land use data of different kinds. The data are referenced to a set of geographical coordinates and encoded in a computer software system. GIS is used by many localities to map utilities and sewer lines and to delineate zoning areas.

Grade – The slope of a specific surface of interest such as a road, channel bed or bank, top of embankment, bottom of excavation, or natural ground. Grade is commonly measured in percent (unit of measurement per one hundred units) or a ratio of horizontal to vertical distance.

Grass Channel – An open vegetated channel used to convey runoff and to provide treatment by filtering out pollutants and sediments.

Grassed Swale – An earthen conveyance system which is broad and shallow with check dams and vegetated with erosion resistant and flood tolerant grasses, engineered to remove pollutants from stormwater runoff by filtration through grass and infiltration into the soil.

Gravel – 1. Aggregate consisting of mixed sizes of ¼ inch to 3 inch particles which normally occur in or near old streambeds and have been worn smooth by the action of water. 2. A soil having particle sizes, according to the Unified Soil Classification System, ranging from the No. 4 sieve size angular in shape as produced by mechanical crushing.

Gravel Diaphram – A stone trench filled with small, river-run gravel used as pretreatment and inflow regulation in stormwater filtering systems.

Gravel Filter – Washed and graded sand and gravel aggregate placed around a drain or well screen to prevent the movement of fine materials from the aquifer into the drain or well.

Gravel Trench – A shallow excavated channel backfilled with gravel and designed to provide temporary storage and permit percolation of runoff into the soil substrate.

Green Alleys – A network of bioretention basins, infiltration trenches, or bioretention filters that provide both redundant water quality management and stormwater conveyance.

Greenway – A strip or belt of vegetated land that typically includes both upland and riparian areas. Greenways are often used for recreation, as a land use buffer, or to provide a corridor and habitat for wildlife.

Ground Cover – Plants that are low-growing and provide a thick growth which protects the soil as well as providing some beautification of the area occupied.

Gully – A channel or miniature valley cut by concentrated runoff through which water commonly flows only during and immediately after heavy rains or during the melting of snow. The distinction between gully and rill is one of depth. A gully is sufficiently deep and would not be obliterated by normal tillage operations, whereas a rill is of lessor depth and would be smoothed by ordinary farm tillage.

Habitat – The environment occupied by individuals of a particular species, population, or community.

Head (Hydraulics) – 1. The height of water above any plane of reference. 2. The energy, either kinetic or potential, possessed by each unit weight of a liquid expressed as the vertical height through which a unit weight would have to fall to release the average energy possessed. Used in various terms such as pressure head, velocity head, and head loss.

Headwall – A wall of stone, metal, concrete, or wood at the end of a culvert or drain to protect fill from scour or undermining, increase hydraulic efficiency of conduit, divert flow, retard disjointing of short sectional pipe, or serve as a retaining wall.

Heavy Metals – Metallic elements having atomic weights above 21 on the periodic table.

Head – The height of water above any plane or object of reference; also used to express the energy, either kinetic or potential, measured in feet, possessed by each unit weight of a liquid.

HEC-1 – Hydraulic Engineering Circular - 1; a rainfall-runoff event simulation computer model sponsored by the U.S. Corps of Engineers.

Herbaceous – Plant parts that contain chlorophyll and are non-woody.

Hi Marsh – A pondscaping zone within a stormwater wetland which exists from the surface of the normal pool to a six inch depth and typically contains the greatest density and diversity of emergent wetland plants.

Hi Marsh Wedges – Slices of shallow wetland (less than or equal to 6 inches) dividing a stormwater wetland.

Hot Spot – Area where land use or activities generate highly contaminated runoff, with concentrations of pollutants in excess of those typically found in stormwater.

Hydraulic Conductivity (K) – An expression of the readiness with which a liquid such as water flows through a soil in response to a given potential gradient. Hydraulic conductivity is a constant physical property of soil or rock, one of several components responsible for the dynamic phenomenon of flow.

Hydraulic Gradient – The slope of the hydraulic grade line. The slope of the free surface of water flowing in an open channel.

Hydraulic loading rate (HLR) – The ratio of the surface area of a hydraulic device and the average rate at which water is delivered to a land area with units of volume per area per time or simply reduced to depth per time (for example, $m^3/(m^2/d)$ or cm/d).

Hydraulic Residence Time (HRT) – A measure of the average time that water occupies a given volume with units of time. The theoretical HRT is calculated as the volume divided by the flow (for example, $m^3/(m^2/d)$). The actual HRT is estimated on the basis of tracer studies that used conservative tracers such as lithium or dyes.

Hydraulics – The physical science and technology of the static and dynamic behavior of fluids.

Hydric Soil – A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions. Hydric soil that is in areas having indicators of hydrophytic vegetation and wetland hydrology is wetland soil.

Hydrodynamic Structure – An engineered flow through structure which uses gravitational settling to separate sediments and oils from stormwater runoff.

Hydrologic Cycle – A continuous process by which water is cycled from the oceans to the atmosphere to the land and back to the oceans.

Hydrograph – A record of the change in flow rate with time.

Hydrologic Soil Group – A designation developed by the NRCS which describes the infiltration capacity of soil. Soil associations are categorized in decreasing infiltration capacity from A to D.

Hydrology – Science dealing with the distribution and movement of water.

Hydroperiod – The period of wetland soil saturation or flooding. Hydroperiod is often expressed as a number of days or a percentage of time flooded during an annual period (for example, 25 days or 7%).

Hydroseed – Seed or other material applied to areas in order to revegetate after a disturbance.

Hyetograph – A graph of the time distribution of rainfall over a watershed.

Hypoxia – Lack of oxygen in a waterbody resulting from eutrophication.

Impervious cover – A surface composed of any material that significantly impedes or prevents natural infiltration of water into soil. Impervious surfaces include, but are not limited to, roofs, buildings, streets, parking areas, and any concrete, asphalt, or compacted gravel surface.

Impoundment – An artificial collection or storage of water, as a reservoir, pit, dugout, sump, etc.

Industrial Stormwater Permit – NPDES permit issued to a commercial industry for regulating the pollutant levels associated with industrial stormwater discharges. The permit may specify on-site pollution control strategies.

Infiltration – The entrance of surface water into the soil, usually at the soil/air interface.

Infiltration Facility – A stormwater management facility which temporarily impounds runoff and discharges it via infiltration through the surrounding soil. While an infiltration facility may also be equipped with an outlet structure to discharge impounded runoff, such discharge is normally reserved for overflow and other emergency conditions. Since an infiltration facility impounds runoff only temporarily, it is normally dry during non-rainfall periods. Infiltration basin, infiltration trench, infiltration dry well, and porous pavement are considered infiltration facilities.

Infiltration Rate (Fc) – The rate at which stormwater percolates into the subsoil, measured in inches per hour.

Infiltration Testing – Specific tests designed to measure the saturated movement of water into the soil in a single direction downward through a two dimensional soil surface.

Inflow Protection – A water handling device used to protect the transition area between any water conveyance (dike, swale, or swale dike) and a sediment trapping device.

Initial Abstraction – The maximum amount of rainfall that can be absorbed under specific conditions without producing runoff. Also called initial losses.

Intensity – The depth of rainfall divided by duration.

Invert – The lowest flow line elevation in any component of a conveyance system, including storm sewers, channels, weirs, etc.

Karst Topography – Regions that are characterized by formations underlain by carbonate rock and typified by the presence of limestone caverns and sinkholes.

Kjeldahl Nitrogen (TKN) – A measure of the ammonia and organic nitrogen present in a water sample.

Lag Time – The interval between the center of mass of the storm precipitation and the peak flow of the resultant runoff.

Land Development – A man-made change to, or construction on, the land surface that changes its runoff characteristics.

Landscaping – The placement of vegetation in and around stormwater management BMP's.

Level Spreader – A device for distributing stormwater uniformly over the ground surface as sheet flow to prevent concentrated, erosive flows and promote infiltration.

Limnetic – Relating to or inhabiting the open water part of a freshwater body with a depth that light penetrates. The area of a wetland without emergent vegetation.

Linear Development Project – A land development project that is linear in nature such as, but not limited to, (i) the construction of electric and telephone utility lines, and natural gas pipelines; (ii)construction of tracks, rights-of-way, bridges, communication facilities and other related structures of a railroad company; and (iii) highway construction projects.

Littoral Zone – The shoreward zone of a lake or wetland. The area where water is shallow enough for emergent vegetation to dominate.

Locality – A county, city, or town.

Low Impact Development (LID) – Hydrologically functional site design with pollution prevention measures to reduce impacts and compensate for development impacts on hydrology and water quality.

Macrophyte – Macroscopic (visible to the unassisted eye) vascular plants.

Manning's Equation – A formula for calculating the anticipated uniform flow in an open-channel flow, published by Manning in 1890.

Manning's Formula – An equation used to predict the velocity of water flow in an open channel or pipeline.

Marsh – A wetland dominated by herbaceous emergent plants.

Micronutrient – A chemical substance that is required for biological growth in relatively low quantities and in small proportion to the major growth nutrients. Some typical micronutrients include molybdenum, copper, boron, cobalt, iron, and iodine.

Micropool – A smaller permanent pool which is incorporated into the design of larger stormwater ponds to avoid resuspension of particles, provide varying depth zones, and minimize impacts to adjacent natural features.

Microtopography – The complex contours along the bottom of a shallow marsh system, providing greater depth variation which increases the wetland plant diversity and increases the surface area to volume ratio of a stormwater wetland.

Mitigation – The replacement of functional values lost when an ecosystem is altered. Mitigation can include replacement, restoration, and enhancement of functional values.

Modified Rational Method – A variation of the rational method used to calculate the critical storage volume whereby the storm duration can vary and does not necessarily equal the time of concentration.

Mulch – Any material such as straw, sawdust, leaves, plastic film, loose soil, wood chips, etc. that is spread or formed upon the surface of the soil to protect the soil and/or plant roots from the effects of raindrops, soil crusting, freezing, evaporation, etc.

Municipal Stormwater Permit – NPDES permit issued to municipalities to regulate discharges from municipal separate storm sewers for compliance with EPA regulations and to specify stormwater control strategies.

Nitrification – Biological transformation (oxidation) of ammonia nitrogen to nitrite and nitrate forms.

Nitrogen Fixation – A microbial process in which atmospheric nitrogen gas is incorporated into the synthesis of organic nitrogen.

Nitrogen-Fixing (Bacteria) – Bacteria having the ability to fix atmospheric nitrogen, making it available for use by plants. Inoculation of legume seeds is one way to insure a source of these bacteria for specified legumes.

National Pollutant Discharge Elimination System (NPDES) – The national program for issuing, modifying, monitoring, and enforcing permits under Sections 307, 402, 318, and 405 of the Clean Water Act.

Nonpoint Source Pollution – Contaminants such as sediment, nitrogen and phosphorous, hydrocarbons, heavy metals, and toxins whose sources cannot be pinpointed but rather are washed from the land surface in a diffuse manner by stormwater runoff.

Normal Depth – The depth of flow in an open conduit during uniform flow for the given conditions.

Off-line – A stormwater management system designed to manage a portion of the stormwater which has been diverted from a stream or storm drain. A flow splitter is typically used to divert the desired portion of the flow.

On-line – A stormwater management system designed to manage stormwater in its original stream or drainage channel.

One Year Storm (Q_P 1) – A stormwater event which occurs on average once every year or statistically has a 100% chance on average of occurring in a given year.

One Hundred Year Storm (Q_P 100) – An extreme flood event which occurs on average once every 100 years or statistically has a 1% chance on average of occurring in a given year.

Open Channels – Also known as swales, grass channels, and biofilters. These systems are used for the conveyance, retention, infiltration, and filtration of stormwater runoff.

Open Graded Material – Uniform granular mixture with a narrow distribution of grain sizes. Open graded material has higher permeability than dense graded material.

Organic Nitrogen (Org-N) – Nitrogen that is bound in organic compounds.

Outfall – Place where effluent is discharged into receiving waters.

Outlet – The point at which water discharges from such things as a stream, river, lake, tidal basin, pipe, channel, or drainage area.

Outlet Channel – A waterway constructed or altered primarily to carry water from man-made structures such as terraces, subsurface drains, diversions, and impoundments.

Palustrine Wetland – All nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens; and all such tidal wetlands in areas where salinity from ocean-derived salts is below 0.5 parts per thousand.

Peak Attenuation Storage – The volume set aside within a BMP for the purpose of attenuating the inflow runoff peak rate.

Peak Discharge – The maximum rate of flow associated with a given rainfall event or channel.

Peak Discharge Rate – The maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.

Percolation – The downward movement under the influence of gravity of water under hydrostatic pressure through the interstices of the rock or soil.

Percolation Rate – The velocity at which water moves through saturated, granular material.

Perennial – Persisting for more than one year. Perennial plant species persist as woody vegetation from year to year or resprout from their rootstock annually.

Periphyton – The community of microscopic plants and animals that grows on the surface of emergent and submergent plants in waterbodies.

Permanent Seeding – Results in establishing perennial vegetation which may remain on the area for many years.

Permeability – The ability of rock, soil or other material to transmit a gas or liquid.

Permissible Velocity (Hydraulics) – The highest average velocity at which water may be carried safely in a channel or other conduit. The highest velocity that can exist through a substantial length of a conduit and not cause scour of the channel. A safe, non-eroding or allowable velocity.

Permittivity (cross-plane flow capacity) – The rate that water will flow freely through a thin layer, such as a geotextile. Equal to the hydraulic conductivity divided by the thickness of the layer. Permittivity is measured in units of inverse time (e.g., sec^{-1}).

pH – An expression of the intensity of the basic or acidic condition of a liquid. Natural waters usually have a pH range between 6.5 and 8.5. A pH of 7.0 denotes neutrality, higher values indicate alkalinity, and lower values indicate acidity.

Phosphorus – An element found in fertilizers and sediment runoff which can contribute to the eutrophication of waterbodies.

Photic Zone – The area of a waterbody receiving sunlight.

Piezometric Surface – The surface defined by elevation to which groundwater will rise in a well.

Piping – The removal of soil material through subsurface flow channels or pipes, developed by seepage water.

Planning Area – A designated portion of the parcel on which a land development project is located. Planning areas must be established by delineation on a master plan. Once established, planning areas must be applied consistently for all future projects.

Plant Community – All of the plant species and individuals occurring in a shared habitat or environment.

Plug Flow – Linear flow along the length of a wetland cell. Ideal plug flow does not involve the dispersion or diffusion of constituents. The flow can be perceived as a series of independent "packets" of water that do not interact with each other.

Plugs – Pieces of turf or sod, usually cut with a round tube, which can be used to propagate the turf or sod by vegetative means.

Plunge Pool – A small permanent pool at either the inlet to a BMP or at the outfall from a BMP. The primary purpose of the pool is to dissipate the velocity of stormwater runoff.

Pocket Pond – A stormwater pond designed for treatment of small drainage area (< 5 acres) runoff and which has little or no baseflow available to maintain water elevations and relies on groundwater to maintain a permanent pool.

Pocket Wetland – A stormwater wetland design adapted for the treatment of runoff from small drainage areas (< 5 acres) and which has little or no baseflow available to maintain water elevations and relies on groundwater to maintain a permanent pool.

Pollutant Removal – Removing pollutants by decomposing them or eliminating them from an area or system (e.g. volitize), or rendering them non-harmful or unavailable in a soil or medium by means of adsorption, chelation, and similar binding mechanisms.

Point Source – The discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, container, concentrated animal feeding operation, or landfill leachate collection system from which pollutants may be discharged. This term does not include return flows from irrigated agriculture or agricultural stormwater runoff.

Pond Buffer – The area immediately surrounding a pond which acts as a filter to remove pollutants and provide infiltration of stormwater prior to reaching the pond. Provides a separation barrier to adjacent development.

Pond Drain – A pipe or other structure used to drain a permanent pool within a specified time period.

Pondscaping – Landscaping around stormwater ponds which emphasizes native vegetative species to meet specific design intentions. Species are selected for up to six zones in the pond and its surrounding buffer, based on their ability to tolerate inundation and/ or soil saturation.

Pore Space – Open space in rock or granular material; also known as interstices.

Porosity – The ratio of pore or open space volume to total solids volume.

Post Development – Refers to conditions that reasonably may be expected or anticipated to exist after completion of the land development activity on a specific site or tract of land.

Precipitation – A deposit on the earth of hail, mist, sleet, rain or snow.

Pre-development – Refers to the conditions that exist at the time that plans for the land development of a tract of land are approved by the plan approval authority. Where phased development or plan approval occurs (preliminary grading, roads and utilities, etc.), the existing conditions at the time prior to the first item being approved or permitted establishes the pre-development conditions.

Pretreatment – The techniques employed in a stormwater management plan to provide storage or filtering to help trap coarse materials before they enter the stormwater BMP. Pretreatment is required on some BMPs to help avoid costly maintenance.

Principal Spillway - The primary spillway or conduit for the discharge of water from an impoundment facility; generally constructed of permanent material and designed to regulate the rate of discharge.

Protozoa – Small, one-celled animals including amoebae, ciliates, and flagellates.

Rational Method – Means of computing peak storm drainage flow rates based on average percent imperviousness of the site, mean rainfall intensity, and drainage area.

Receiving Water – A waterbody into which wastewater or treated effluent is discharged.

Recharge – Replenishment of groundwater reservoirs by infiltration through permeable soils.

Redevelopment – New development activities on previously developed land.

Retention – The amount of precipitation on a drainage area that does not escape as runoff. It is the difference between total precipitation and total runoff.

Retention Basin – A stormwater management facility which includes a permanent impoundment or normal pool of water for the purpose of enhancing water quality and, therefore, is normally wet, even during nonrainfall periods. Storm runoff inflows may be temporarily

stored above this permanent impoundment for the purpose of reducing flooding or stream channel erosion.

Return Period (storm event) – The average period of time between the occurrence of storms of equal or greater magnitude. The probability that such a storm will occur in any given year is equal to the reciprocal of the return period (e.g. there is a 50% chance that a 2-year storm event will occur in any given year, but only a 10% chance that a 10-year storm event will occur).

Reverse-Slope Pipe – A pipe which draws from below a permanent pool extending in a reverse angle up to the riser and which determines the water elevation of the permanent pool.

Rhizosphere – The chemical sphere of influence of plant roots growing in flooded soils. Depending on the overall oxygen balance (availability and consumption), the rhizosphere can be oxidized, resulting in the presence of aerobic soil properties in an otherwise anaerobic soil environment.

Right-Of-Way – Rite of passage, as over another's property. A route that is lawful to use. A strip of land acquired for transport or utility construction.

Riparian – Pertaining to a stream or river. Also, plant communities occurring in association with any spring, lake, river, stream, or creek through which waters flow at least periodically.

Riparian Corridor – Narrow strip of land centered on a stream that includes the floodplain as well as related riparian habitats adjacent to the floodplain.

Rip-Rap – Broken rock, cobbles, or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream, for protection against the action of water (waves); also applies to brush or pole mattresses, or brush and stone, or similar materials used for soil erosion control.

Riverine Wetlands – Wetlands associated with rivers.

Riser – A vertical pipe or structure extending from the bottom of a pond SMP and houses the control devices (weirs/orifices) to achieve the discharge rates for specified designs.

Roughness Coefficient (Hydraulics) – A factor in velocity and discharge formulas representing the effect of channel roughness on energy losses in flowing water. Manning's 'n' is a commonly used roughness coefficient.

Routing – A method of measuring the inflow and outflow from an impoundment structure while considering the change in storage volume over time.

Runoff (Hydraulics) – The portion of the precipitation on a drainage area that is discharged from the area in the stream channels. Types include surface runoff, groundwater runoff, or seepage.

Runoff Coefficient (R_V) – A value derived from a site impervious cover value that is applied to a given rainfall volume to yield a corresponding runoff volume.

Runoff Capture Design Storm – A benchmark rainfall event used to develop criteria for designing the groundwater recharge function of BMPs. The runoff capture design storm is the largest rainfall event from which no appreciable runoff is expected to occur. Complete specification of the storm includes the rainfall depth in inches, return frequency, and storm duration.

Runoff Capture Storage – The combined storage volume provided by BMPs on a site for the retention and eventual infiltration of rainfall.

Runoff Capture Volume – The minimum volume of rainfall that should be retained and completely infiltrated on-site during every storm. It is also equal to the rainfall quantity associated with the runoff capture design storm. The runoff capture volume is conveniently stated as a rainfall volume, in inches, over the area of the site.

Runoff Curve Number (CN) – A parameter developed by the NRCS which is an indicator of runoff potential. Curve number is related to hydrologic soil group and land use type. The larger the runoff curve number, the greater the percentage of rainfall that will appear as runoff.

Runoff Peak Attenuation Design Storm – A benchmark rainfall event used to develop criteria for the design of runoff peak attenuation BMPs. The design criteria generally requires that the predicted post development peak runoff rate for the selected runoff peak attenuation design storm will not exceed the peak associated with redeveloped condition. Complete specification of the storm includes rainfall depth in inches, return frequency, and storm duration.

SCS – Soil Conservation Service (now called Natural Resource Conservation Service, NRCS), a branch of the U.S. Department of Agriculture.

Safety Bench – A flat area above the permanent pool and surrounding a stormwater pond designed to provide a separation to adjacent slopes.

Sand – 1. (Agronomy) A soil particle between 0.05 and 2.0 millimeters in diameter. 2. A soil textural class. 3. (Engineering) According to the Unified Soil Classification System, a soil particle larger than the No. 200 sieve (0.074mm) and passing the No. 4 sieve (approximately ¼ inch).

Sand Filter – A contained bed of sand which acts to filter the first flush of runoff. The runoff is then collected beneath the sand bed and conveyed to an adequate discharge point or infiltrated into the in-situ soils.

Saturated Soil – Soil in which the pore space is completely filled with water.

Seasonally High Water Table – Shallow water tables associated with periods of recent high levels of precipitation and/or low levels of evapotranspiration. Frequently determined in the spring.

Sediment – Solid material, both mineral and organic, that is in suspension, being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

Sediment Forebay – A settling basin or plunge pool constructed at the incoming discharge points of a stormwater facility.

Sedimentation (or settling) – A pollutant removal method to treat stormwater runoff in which gravity is utilized to remove particulate pollutants. Pollutants are removed from the stormwater as sediment settles or falls out of the water column. An example of a BMP utilizing sedimentation is a detention basin.

Seed Bank – The accumulation of viable plant seeds occurring in soil and available for germination under favorable environmental conditions.

Seepage – 1. Water escaping through or emerging from the ground. 2. The process by which water percolates through the soil.

Seepage Length – In sediment basins or ponds, the length along the pipe and around the anti-seep collars that is within the seepage zone through an embankment.

Setback – A distance from the edge of a waterbody within which intensive development is restricted. Setbacks are established by local regulation for the purpose of maintaining open space next to streams, lakes, and other waterbodies. The area within setbacks is frequently used for flood control, recreation, preservation of drinking water supply, and wildlife habitat enhancement.

Shallow Marsh – A zone within a stormwater extended detention basin that exists from the surface of the normal pool to a depth of 6 to 18 inches and has a large surface area, therefore requiring a reliable source of baseflow, groundwater supply, or a sizeable drainage area to maintain the desired water surface elevations to support emergent vegetation.

Sheet Flow – Water flow with a relatively thin and uniform depth.

Short-Circuit – A faster, channelized water flow route that results in a lower actual hydraulic residence time than the theoretical hydraulic residence time. This may reduce the effectiveness of a BMP.

Side Slopes (Engineering) – The slope of the sides of a channel, dam, or embankment. It is customary to name the horizontal distance first, as 1.5 to 1, or frequently, 1 ½: 1, meaning a horizontal distance of 1.5 feet to 1 foot vertical.

Silt – 1. (Agronomy) A soil separate consisting of particles between 0.05 and 0.002 millimeter in equivalent diameter. 2. A soil textural class. 3. (Engineering) According to the Unified Soil Classification System a fine grained soil (more than 50% passing the No. 200 sieve) that has a low plasticity index in relation to the liquid limit.

Silviculture – A branch of forestry dealing with the development and care of forests.

Site – The parcel of land being developed, or a designated planning area in which a land development project is located.

Soil Science – Science dealing with soils as a natural resource on the surface of the earth including soil formation, classification, mapping; physical, chemical, biological, and fertility properties of soils per se; and these properties in relation to the use and management of soils.

Soil Test – Chemical analysis of soil to determine needs for fertilizers or amendments for species of plant being grown.

Soil Texture – Relative proportion of the physical components of any given soil. For instance, clay is defined as soil having > 40% clay, < 45% sand and < 40% silt.

Spillway – An open or closed channel, or both, used to convey excess water from a reservoir. It may contain gates, either manually or automatically controlled to regulate the discharge of excess water.

Spillway Design Flood (SDF) – A benchmark rainfall event used to develop criteria for the design of BMPs that incorporate emergency spillways or overflows. Complete specification of the storm includes rainfall depth in inches, return frequency, and storm duration.

Stabilization – Providing adequate measures, vegetative and/or structural, that will prevent erosion from occurring.

Stage – Water surface elevation above any chosen datum.

Stage-Area Curve – A line graph showing the relationship between the depth of water and the surface area of a pond, wetland, or lake.

Stage-Discharge Curve – A line graph showing the relationship between water depth and outflow from a body of water.

Stage (Hydraulics) – The variable water surface or the water surface elevation above any chosen datum.

State Project – Any land development project which is undertaken by any state agency, board, commission, authority or any branch of state government, including state supported institutions of higher learning.

Stilling Basin – An open structure or excavation at the foot of an outfall, conduit, chute, drop, or spillway to reduce the energy of the descending stream of water.

Storm Sewer – A system of pipes, separate from sanitary sewers, that only carries runoff from buildings and land surfaces.

Stormwater Filtering – Stormwater treatment methods which utilize an artificial media to filter out pollutants entrained in urban runoff.

Stormwater Hot Spot – An area where the land use or activities are considered to generate runoff with concentrations of pollutants in excess of those typically found in stormwater.

Stormwater Management Facility – A device that controls stormwater runoff and changes the characteristics of that runoff including, but not limited to, the quantity and quality, the period of release, or the velocity of flow.

Stormwater Management Plan – A document containing material for describing how existing runoff characteristics will be affected by a land development project and methods for complying with the requirements of the local program or this chapter.

Stormwater Ponds – A land depression or impoundment created for the detention or retention of stormwater runoff.

Stormwater Wetlands – Shallow, constructed pools that capture stormwater and allow for the growth of characteristic wetland vegetation.

Stream Buffers – Zones of variable width which are located along both sides of a stream and are designed to provide a protective natural area along a stream corridor.

Stream Channel Protection (C_pV) – A design criteria which requires 24 hour detention of the one year post developed, 24 hour storm event for the control of stream channel erosion.

Structural SMPs – Devices which are constructed to provide temporary storage and treatment of stormwater runoff.

Subcritical Flow – The state of flow when the depth is greater than the critical depth.

Subgrade – Soil that is prepared and compacted to support a structure or a pavement system.

Substrate – Substances used by organisms for growth in a liquid medium. Surface area of solids or soils used by organisms to attach.

Succession – The temporal changes of plant and animal populations and species in an area that has been disturbed.

Super Critical Flow – The state of flow when the depth is less than the critical depth. Transitions between supercritical and sub-critical flow may result in turbulence associated with a hydraulic jump.

Surcharge – A flow condition occurring in closed conduits when the hydraulic grade line is above the crown of the sewer. This condition usually results localized flooding or stormwater flowing out the top of inlet structures and manholes.

Surface Infiltration Rate – The rate at which water enters the soil or other porous surface. The measurement of surface infiltration rates requires that the underlying soil be completely saturated and that infiltration occurs by gravity under a unit hydraulic gradient.

SWMM (Storm Water Management Model) – Rainfall-runoff event simulation model sponsored by the U.S. Environmental Protection Agency.

Tailwater – Water, in a river or channel, immediately downstream from a structure.

Tailwater Condition – minimum and maximum - The depth of water in the receiving water.

Technical Release No. 20 (TR-20) - A Soil Conservation Service (now NRCS) watershed hydrology computer model that is used to compute runoff volumes and route storm events through a stream valley and/or ponds.

Technical Release No. 55 (TR-55) – A watershed hydrology model developed by the Soil Conservation Service (now NRCS) used to calculate runoff volumes and provide a simplified routing for storm events through ponds.

Temporary Seeding – A seeding which is made to provide temporary cover for the soil while waiting for further construction or other activity to take place.

Ten Year Storm (QP 10) – The peak discharge rate associated with a 24 hour storm event that occurs on average once every ten years (or has a likelihood of occurrence of 1/10 in a given year).

Terrestrial – Living or growing on land that is not normally flooded or saturated.

Time of Concentration – The time required for water to flow from the most remote point of a watershed, in a hydraulic sense, to the outlet.

Toe (Of Slope) – Where the slope stops or levels out. Bottom of the slope.

Toe Wall – The downstream wall of a structure, usually to prevent flowing water from eroding under the structure.

Topsoil – Fertile or desirable soil material used to top dress roadbanks, subsoils, parent material, etc.

Total Nitrogen (TN) – A measure of all organic and inorganic nitrogen forms in a water sample. Functionally, TN is equal to the sum of TKN and NO_3 + NO_2-N.

Total Organic Carbon (TOC) – A measure of the total reduced carbon in a water sample.

Total Phosphorus (TP) – A measure of the total phosphorus in a water sample, including organic and inorganic phosphorus in particulate and soluble forms.

Total Suspended Solids (TSS) – A measure of the filterable matter in a water sample.

Tractive Force – The total cross-sectional force experienced by a rigid channel or conduit as a result of channel flow (expressed in units of force per length). This force tends to displace soil particles, rocks and channel liners in the downstream direction and must be resisted by friction or by structural anchors. The tractive force is equal to the unit tractive force multiplied by the wetted perimeter of the conduit.

Transition Zone – The area between habitats or ecosystems (see ecotones). Frequently, transition zone is used to refer to the area between uplands and wetlands. In other cases, wetlands are referred to as transitional areas between uplands and aquatic ecosystems.

Transmissivity (in-plane flow capacity) – Rate that water can be made to flow through the cross section of a thin layer or conduit under the influence of a unit hydraulic gradient. Measured as a volumetric rate per unit width (e.g., square feet meters per minute, or gallons per minute per foot). Equal to the hydraulic conductivity times the thickness of the layer or conduit.

Transpiration – The transport of water vapor from the soil to the atmosphere through growing plants.

Trash Rack – Grill, grate, or other device at the intake of a channel, pipe, drain, or spillway for the purpose of preventing oversized debris from entering the structure.

Travel Time – The time required for water to flow from the outlet of a drainage sub-basin to the outlet of the entire drainage basin being analyzed. Travel time is normally concentrated flow through an open or closed channel.

Trout Waters – Waters classified as (T) or (TS) by the New York State DEC.

Turbidity – Cloudiness of a liquid, caused by suspended solids; a measure of the suspended solids in a liquid.

Two Year Storm (Q_P 2) – The peak discharge rate associated with a 24 hour storm event that occurs on average once every two years (or has a likelihood of occurrence of 1/2 in a given year).

Type II Rainfall Distribution – One of the standard NRCS 24-hour rainfall distributions. The distribution allocates rainfall as a percentage of total rainfall over discrete time intervals.

Uniformity Coefficient – A measure of the range in particle sizes associated with a granular mixture. Materials with the lowest uniformity coefficients are most uniform. Uniform materials are also called open graded materials. If the uniformity coefficient is less than 4 or 5, the material is considered uniform in particle size. The uniformity coefficient is computed as follows: $C_u = (D_{60} / D_{10})$

D_{60} is the sieve opening size through which 60% of the layer material will pass. D_{10} is the sieve opening size through which 10% of the layer material will pass.

Ultimate Condition – Full watershed build-out based on existing zoning.

Urban Runoff – Stormwater from city streets and adjacent domestic or commercial properties that carries nonpoint source pollutants of various kinds into the sewer systems and receiving waters.

Ultra-Urban – Densely developed urban areas in which little pervious surface exists.

Unit Tractive Force (or tractive stress) – The stress (expressed in units of force per area) induced by open channel flow on the bottom and sides of its conduit or channel. This stress is responsible for sediment erosion and the downstream transport of streambed materials. The average unit force acting on a channel cross-section is equal to the product of the unit weight of water, the slope of the channel, and the hydraulic radius of the flow.

Upland – An area that is not an aquatic, wetland, or riparian habitat. An area that does not have the hydrologic regime necessary to support hydrophytic vegetation.

Velocity Head – Head due to the velocity of a moving fluid, equal to the square of the mean velocity divided by twice the acceleration due to gravity (32.16 feet per second per second).

Volumetric Runoff Coefficient (Rv) – The value that is applied to a given rainfall volume to yield a corresponding runoff volume based on the percent impervious cover in a drainage basin.

Water Quality Design Storm – A benchmark rainfall event used to develop criteria for the design of water quality BMPs. Water quality design storms are used to size BMPs that are intended to achieve specific quality treatment objectives. Criteria based on water quality storms generally require that the design treatment efficiency be achieved during the water

quality design storm and all smaller events. Complete specification of the storm includes rainfall depth in inches, return frequency, and storm duration.

Water Quality Standards – State-adopted and EPA-approved ambient standards for waterbodies. The standards prescribe the use of the waterbody and establish the water quality criteria that must be met to protect designated uses.

Water Quality Storage – The volume set aside within a BMP to detain storm runoff. The detained water is released over an extended period of time. The water quality storage is frequently expressed as a multiple of the water quality volume.

Water Quality Velocity – The maximum flow velocity encountered in a water quality BMP during the course of the water quality design storm.

Water Quality Volume – The total volume of runoff which is delivered to the inlet of a water quality BMP during the course of the water quality design storm.

Watershed – A defined land area drained by a river, stream, or drainage way, or system of connecting rivers, streams, or drainage ways such that all surface water within the area flows through a single outlet.

Water Surface Profile – Longitudinal profile assumed by the surface of a stream flowing in an open channel; hydraulic grade line.

Water Table – The upper surface of the free groundwater in a zone of saturation.

Wattles – A fence or barrier constructed of interwoven twigs and branches used to stabilize soil from erosive forces.

Wedges – A design feature in stormwater wetlands which increases flow path length to provide for extended detention and treatment of runoff.

Weir – A device used to control and measure water flow.

Weir Gate – Water-control device used to adjust water levels and measure flows simultaneously.

Wetland – An area that is inundated or saturated by surface water or groundwater at a frequency, duration, and depth sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs, and similar areas.

Wet Swale – An open drainage channel or depression, explicitly designed to retain or intercept water.

Wet Weather Flow – A combination of dry weather flows and stormwater runoff groundwater for water quality treatment.

Wetted Perimeter – The length of the line of intersection of the plane or the hydraulic cross-section with the wetted surface of the channel.

Wilting Point – The quantity of water which will not be removed from soil under normal conditions of evaporation and plant transpiration. Usually measured as the moisture content (by volume) in soil with a capillary tension of 15 bars.

Wing Wall – The side wall extensions of a structure used to prevent sloughing of banks or channels and to direct and confine overfall.

Zonation – The development of a visible progression of plant or animal communities in response to a gradient of water depth or some other environmental factor.

Glossary References

New York State Stormwater Management Design Manual, Department of Environmental Conservation, October 2001.

Pennsylvania Stormwater Best Management Practices Manual, Department Of Environmental Protection, December 30, 2006.

Virginia Stormwater Management Handbook, Volume II, Virginia Department of Conservation and Recreation, 1999.

Page Intentionally Left Blank

APPENDIX A

LID REFERENCES

This page intentionally left blank.

APPENDIX A
1 LID REFERENCES

1.1 ARMY AND DOD RESOURCES

1.1.1 Unified Facilities Criteria (UFC) System

The Unified Facilities Criteria (UFC) system provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities. UFC are used for all DoD projects and work for other customers where appropriate. They are living documents and are periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Center for Engineering and the Environment (AFCEE) are responsible for administration of the UFC system. UFC are effective upon issuance and are distributed only in electronic media from the following source: Whole Building Design Guide web site http://dod.wbdg.org/.

1.1.2 Public Works Technical Bulletins (PWTB)

Public Works Technical Bulletins are published by the U.S. Army Corps of Engineers, 441 G Street NW, Washington, DC 20314-1000. They are intended to provide information on specific topics in areas of Facilities Engineering and Public Works. They are not intended to establish new DA policy. All PWTBs are available electronically at the National Institute of Building Sciences' Whole Building Design Guide web page, http://www.wbdg.org.

PUBLICATION	SUMMARY
PTWB 200-1-62 1 OCTOBER 2008 Low Impact Development For Sustainable Installations: Stormwater Design And Planning Guidance For Development Within Army Training Areas	This Public Works Technical Bulletin (PWTB) provides information on techniques and technologies that can be applied in Army training area development and addresses stormwater management and nonpoint source (NPS) pollution control through small, cost-effective landscape features known as Integrated Management Practices (IMPs). The intent of this PWTB is to provide appropriate guidance for the planning and application of Low Impact Development (LID) technologies and practices specifically for Military Range and Training Area Development. This document is intended to be a practical field guide to LID Technologies and Practices for Army installations and to provide field personnel with operational information to mitigate the negative environmental impacts of training activities. This PWTB is a field guide to practices that addresses both NPDES and other Natural Resource regulatory issues http://www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_200_1_62.pdf

PUBLICATION	SUMMARY
PTWB 200-1-36 30 SEPTEMBER 2005 Sustainable Stormwater Storage Alternatives For Army Installations	This Public Works Technical Bulletin (PWTB) transmits current information on a variety of alternative methods to store stormwater and applicability of these methods to Army installations. This report summarizes the variety of storage alternatives available other than traditional detention ponds. The focus is on alternatives for smaller sites, addressing plastic, metal, and concrete-type structures with an emphasis on underground storage so that surface areas may be used for other purposes. Alternatives discussed include pipe networks of various materials (corrugated steel, plastic and concrete); interlocking plastic block structures; French drains; and concrete vaults. Appendix A: Stormwater Management Methods reviews LID and other potential options. Appendix B contains commercially available stormwater management systems and other alternatives for storage. Appendix C provides cost information for alternative stormwater systems. Appendix D provides a summary of stormwater management methods and costs. http://www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_200_1_36.pdf
UFC 3-210-10 15 NOVEMBER 2010 Low Impact Development	This UFC provides technical criteria, technical requirements, and references for the planning and design of applicable projects to comply with stormwater requirements under Section 438 of the Energy Independence and Security Act (EISA) enacted in December 2007. The criteria and design standards in this UFC are required for all Department of Defense construction in the United States and United States Territories. This document discusses Policy and General Requirements, Planning and Design considerations, and provides a list of LID Best Practices. http://www.wbdg.org/ccb/DOD/UFC/ufc_3_210_10.pdf

PUBLICATION	SUMMARY
UFC 4-030-01 21 December 2007 Sustainable Development	This UFC provides instruction, requirements and references for customers, DoD facility professionals—including planners, programmers, designers, and maintenance personnel—and architect/engineer and construction contractors to apply sustainable development principles and strategies consistently in DoD facilities throughout their life cycle: from planning to programming and securing of funds, to site selection, design and construction, to documentation and operations and maintenance, and to reuse, or deconstruction and removal. This document also provides the sustainable policies of the Military Departments to satisfy the Office of Management and Budget (OMB) Energy Management Scorecard requirement to demonstrate comprehensive implementation of a sustainability program for green. This UFC contains discussion on LEED requirements to Control Erosion, Sedimentation, and Water Quality, Manage Stormwater Runoff, and LID practices. http://www.wbdg.org/ccb/DOD/UFC/ufc_4_030_01.pdf
DoD Guidance on Minimizing TMDL Related Impacts to DoD: Understanding and Participating in the TMDL Development Process August 2005	The purpose of this document is to assist DoD installations in minimizing impacts from the establishment of Total Maximum Daily Loads (TMDLs), including associated compliance costs. Specifically, this document provides information on the TMDL process and the operational effects of TMDLs. It then identifies opportunities for DoD personnel participation in the TMDL development process to ensure that regulators will accurately analyze an installation's pollutant contribution(s), if any, to an impaired waterbody. DoD personnel who may benefit from this document include command and installation water program managers. This document answers the following frequently asked questions: A. What is a TMDL and what are the current regulatory requirements? B. Why should DoD installations care about TMDLs? C. How can an installation determine if it may be impacted by a TMDL? D. What can DoD personnel do to address potential TMDL impacts? This document was prepared by the DoD Clean Water Act Services Steering Committee (CWASSC), which is comprised of representatives from the Military Services and other DoD Components. http://www.usma.edu/dhpw/rci/documents/7.20.pdf

PUBLICATION	SUMMARY
ASHRAE Standard 189.1 High Performance Green Buildings	The purpose of this standard is to provide minimum requirements for the siting, design, construction, and plan for operations of high-performance green buildings to: a. balance environmental responsibility, resource efficiency, occupant comfort and well-being, and community sensitivity, and b. support the goal of development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act, EPA 841-B-09-001	The purpose of this document is to provide technical guidance and background information to assist federal agencies in implementing EISA Section 438. Each agency or department is responsible for ensuring compliance with EISA Section 438. The document contains guidance on how compliance with Section 438 can be achieved, measured and evaluated. In addition, information detailing the rationale for the stormwater management approach contained herein has been included. http://www.wbdg.org/ccb/EPA/epa_841b09001.pdf
USACE Army LEED Implementation Guide January 15, 2008	This implementation guidance is to assist USACE Project Delivery Teams (PDTs) meet the Army's Sustainable Design and Development policy.
Questions and Answers Re. Section 438 Guidance December 2009	This document provides a series of questions and answers regarding the definition and implementation of EISA Section 438. http://www.epa.gov/owow/NPS/lid/section438/pdf/final_sec438_qa.pdf
Installation Design Guide For A Sustainable Fort Bragg, U.S. Army Corps Of Engineers Savannah District September 2003	The Installation Design Guide for a Sustainable Fort Bragg (IDG) provides a guide for design and development decisions that will enhance the physical environment and sustainability of the installation. The IDG includes methodology that promotes spatial and visual order, consistent architectural character, and development sustainability. It consists of three parts: Chapter I, Fort Bragg Design and Development Principles; Chapter II, Implementation of Fort Bragg Principles; and Chapter III, Fort Bragg Guide Specifications and Fort Bragg Specific MILCON Transformation RFP (TRFP) Requirements. https://pwbc.bragg.army.mil/pwbc/idg/html/chapter1/1-1_intro.htm

PUBLICATION	SUMMARY
LEED 2009 For Neighborhood Development U.S. Green Building Council February 2011	The LEED Reference Guide for Green Neighborhood Development, 2009 Edition, is a user's manual that guides a LEED-ND project from registration to certification. This guide is specifically designed to provide the tools necessary for sustainable choices to be made by developers, planners, architects and others involved in the vertical and horizontal development of a neighborhood development project. The Reference Guide includes detailed information on the process for achieving LEED-ND certification, detailed credit and prerequisite information, resources, and standards for the LEED 2009 for Neighborhood Development Rating System. For each credit or prerequisite, the guide provides: intent, requirements, point values, environmental, economic and social issues, related credits, summary of referenced standards, credit implementation discussion, timeline, and team recommendations, calculation methods and formulas, documentation guidance, examples, exemplary performance options, regional variations, resources, and definitions. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148

1.2 OVERVIEW OF STANDARDS AND SPECIFICATIONS

1.2.1 ASTM

ASTM International, formerly known as the American Society for Testing and Materials (ASTM), is a globally recognized leader in the development and delivery of international voluntary consensus standards. ASTM International standards are developed in accordance with the guiding principles of the World Trade Organization for the development of international standards: coherence, consensus, development dimension, effectiveness, impartiality, openness, relevance, and transparency.

These standards are used in many different fields and are very common in the construction industry and for test methods for various construction materials. Some ASTM International standards are jointly published and duplicates of AASHTO (American Association of State Highway and Transportation Officials) standards.

1.2.2 ANSI

American National Standards Institute (ANSI) oversees the creation, promulgation, and use of thousands of norms and guidelines that directly impact businesses in nearly every sector from acoustical devices to construction equipment, from dairy and livestock production to energy distribution, and many more.

1.2.3 ASHRAE

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) develops standards for its members and others professionally concerned with refrigeration processes and the design and maintenance of indoor environments. ASHRAE writes standards for the purpose of establishing consensus for: 1) methods of test for use in commerce and 2) performance criteria for use as facilitators with which to guide the industry. ASHRAE publishes the following three types of voluntary consensus standards: Method of Measurement or Test, Standard Design, and Standard Practice. ASHRAE does not write rating standards unless a suitable rating standard will not otherwise be available.

Consensus standards are developed and published to define minimum values of acceptable performance, whereas other documents, such as design guides, may be developed and published to encourage enhanced performance.

1.2.4 IBC

The International Building Code (IBC) is a model building code developed by the International Code Council (ICC). A model building code has no legal status until it is adopted or adapted by government regulation. The IBC provides minimum standards to insure the public safety, health, and welfare insofar as they are affected by building construction and to secure safety to life and property from all hazards incident to the occupancy of buildings, structures, or premises.
It incorporates all aspects of building construction. It is made up of thirty-five (35) chapters and several appendices. Each chapter is broken down into sections and each section into sub-sections. Each section describes performance criteria to be met or references other sections of the IBC or other standards such as ANSI, ASTM, etc.

1.3 LEED AND LID

The following LEED credits can be achieved by employed LID BMPs in the project. Please refer to the US Green Build Council for further information.

1.3.1 Credit 5.1 – Site Development, Protect of Restore Habitat (1 point)

The intent is to conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity. The ability to earn this credit depends greatly on the size of the project site and land within the site boundary (but outside development footprint) that is made available for habitat.

OPTION 1
On greenfield sites, limit all site disturbance to 40 feet beyond the building perimeter; 10 feet beyond surface walkways, patios, surface parking, and utilities less than 12 inches in diameter; 15 feet beyond primary roadway curbs and main utility branch trenches; and 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities, and playing fields) that require additional staging areas in order to limit compaction in the constructed area.

OR

OPTION 2
On previously developed or graded sites, restore or protect a minimum of 50% of the site area (excluding the building footprint) with native or adapted vegetation. Native/adapted plants are plants indigenous to a locality or cultivars of native plants that are adapted to the local climate and are not considered invasive species or noxious weeds. Projects earning Sustainable Site Credit 2 and using vegetated roof surfaces may apply the vegetated roof surface to this calculation if the plants meet the definition of native/adapted.

1.3.2 Credit 5.2 – Site Development, Maximize Open Space (1 point)

The intent of this credit is to provide a high ratio of open space to development footprint to promote biodiversity.

1.3.3 Credit 6.1 – Stormwater Design, Quantity Control (1 point)

The intent of this credit is to limit disruption of natural water hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff, and eliminating contaminants. Because the reduction of stormwater runoff reduces the amount of contaminants flowing into the soil, ecosystem health is promoted.

CASE 1: Sites with Existing Imperviousness 50% or Less

OPTION 1
Implement a stormwater management plan that prevents the post development peak discharge rate and quantity from exceeding the pre-development peak discharge rate and quantity for the 1- and 2-year 24-hour design storms.

OPTION 2
Implement a stormwater management plan that protects receiving stream channels from excessive erosion. The stormwater management plan must include stream channel protection and quantity control strategies.

CASE 2: Sites with Existing Imperviousness Greater Than 50%
Implement a stormwater management plan that results in a 25% decrease in the volume of stormwater runoff from the 2-year 24-hour design storm.

1.3.4 Credit 6.2 – Stormwater Design, Quality Control (1 point)

The intent is to limit disruption and pollution of natural water flows by managing stormwater runoff. Specifically, the goal is to reduce the runoff of total suspended solids and nutrients from the building site.

Implement a stormwater management plan that reduces impervious cover, promotes infiltration, and captures and treats the stormwater runoff from 90% of the average annual rainfall using acceptable best management practices (BMPs).

BMPs used to treat runoff must be capable of removing 80% of the average annual post development total suspended solids (TSS) load based on existing monitoring reports. BMPs are considered to meet these criteria if (1) they are designed in accordance with standards and specifications from a state or local program that has adopted these performance standards, or (2) there exists in-field performance monitoring data demonstrating compliance with the criteria. Data must conform to accepted protocol (e.g., Technology Acceptance Reciprocity Partnership [TARP], Washington State Department of Ecology) for BMP monitoring.

1.3.5 Credit 7.1 – Heat Island Effect, Non-Roof (1 point)

The intent is to reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.

OPTION 1
Provide any combination of the following strategies for 50% of the site hardscape (including roads, sidewalks, courtyards and parking lots):

- Shade (within 5 years of occupancy)
- Paving materials with a Solar Reflectance Index (SRI) of at least 29
- Open grid pavement system

OR

OPTION 2
Place a minimum of 50% of parking spaces under cover (defined as underground, under deck, under roof, or under a building). Any roof used to shade or cover parking must have an SRI of at least 29.

1.3.6 Credit 7.2 – Heat Island Effect, Roof (1 point)

The intent is to reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.

OPTION 1
Use roofing materials having a Solar Reflectance Index (SRI) equal to or greater than the values in the table below for a minimum of 75% of the roof surface.

OR

OPTION 2
Install a vegetated roof for at least 50% of the roof area.

OR

OPTION 3

Install high albedo and vegetated roof surfaces that, in combination, meet the following criteria:

(Area of SRI Roof / 0.75) + (Area of vegetated roof / 0.5) ≥ Total Roof Area

This page intentionally left blank.

APPENDIX B

CURRENT STATE NPDES AND REGULATORY PROGRAMS

Source: U.S. Environmental Protection Agency
Office of Water Office of Wastewater Management Water Permits Division
June 2011

http://www.epa.gov/npdes/pubs/sw_state_summary_standards.pdf

This page intentionally left blank.

EPA Region	Program	Date	Where required?	Size Threshold	Volume Control Requirement			Redevelopment Standard
					Retention	Treatment	Exception	
1	Connecticut	2009	MS4s	1 acre disturbed area		Capture and treat 1" (non-regulatory – only described in the manual)		Same as new development
1	Maine	2008	MS4s	1 acre disturbed area		Treat 1" times impervious area plus 0.4 times pervious area		No increase in current stormwater runoff
1	Massachusetts	2009	Wetland areas	1 acre disturbed area	Recharge (post development volume to predevelopment volume)	Treat 0.5" (1" in critical and other areas)		Post to pre, minimize recharge loss, follow Stormwater Management Standards
1	New Hampshire	2003	MS4s	1 acre disturbed area / 100,000 sf outside MS4s	Infiltrate, evapotranspire, or capture first 1"			Same as new development
1	Rhode Island	2011	State-wide	1 acre disturbed area		Capture and treat WQv equivalent to 1.2" rainfall runoff	WQv requirement may be waived or reduced by applying disconnection-based LID practices	Same as new development if < 40% IC; >40% IC then reduce IC by 50% or water quality and recharge for 50% of area
1	Vermont	2003 (Draft 2010)	State-wide	1 acre development, redevelopment and/or increase IC	Capture 90% annual storms		WQv may be reduced where non-structural practices are employed.	Reduce IC by 20% or treat 20% of WQv
2	New Jersey	2009	State-wide	1 acre disturbed area or increase IC by ≥ 0.25 acres	Maintain groundwater recharge volume or infiltrate runoff for 2-year storm (post development volume to predevelopment volume)			50% TSS reduction or equivalent to existing BMP; 80% TSS removal to new IC
2	New York	2010	State-wide	1 acre disturbed area	RR for post-development volume (0.8" – 1.2") to replicate pre-development hydrology	Remaining WQv not retained must be treated	Single family homes less than 5 acre disturbance	Same as new development but if not possible IC reduced by 25%, and/or 25% WQv treated
3	Delaware	2010 (Draft)	State-wide	5,000 sf disturbed area	RR for 1-year event (post-development runoff volume to predevelopment volume) or 0% effective IC		RR practices should be employed to the MEP.	RR to reduce runoff by 20% from existing conditions[2]
3	Maryland	2009 (2000)	State-wide	5,000 sf disturbed area	Manage 0.9" / 1" of rainfall			Same as new development if <40% IC, For >40% IC, volume control required for 50% of existing imperviousness, no channel protection for existing imperviousness

EPA Region	Program	Date	Where required?	Size Threshold	Volume Control Requirement			Redevelopment Standard
					Retention	Treatment	Exception	
3	Pennsylvania	2006	MS4s	1 acre disturbed area	For sites < 1 acre; Remove 1" of runoff from IC. All sites: No post development runoff volume increase for the 2-year storm	Sites <1 acre: Capture 2" of runoff from contributing IC.		Same as new development; modeling guidance for pre-development IC
3	District of Columbia	2004	State-wide	5,000 sq ft of land disturbance	Narrative standard			
3	Virginia	2008	MS4s	1 acre disturbed area	Narrative standard			20% (sites > 1ac) 10% (sites ≤1ac)P reduction from existing condition
3	West Virginia	2009	MS4s	1 acre disturbed area	Keep and manage on site 1" rainfall from 24-hour storm preceded by 48 hours of no rain			0.2" reduction of 1" on site retention standard and additional 0.2" reductions exist
4	Alabama	2009	MS4s	1 acre disturbed area	Narrative standard			
4	Florida	1995 - present	State-wide	4,000 sq ft imperv area	Must meet predevelopment volume in closed basins only	Varies by WMD – From first ½ inch runoff to 1.25 times percent imperviousness plus an additional one half inch of runoff for online retention systems.		Same as new development
4	Georgia	2007	MS4s	1 acre disturbed area		Treat runoff from 85% of storms (1.2" rainfall)		Same as new development
4	Kentucky	2010	MS4s	1 acre disturbed area		Manage 80th percentile precipitation event runoff (0.75")[2]		Same as new development
4	Mississippi	2009	MS4s	1 acre disturbed area	Narrative standard			
4	North Carolina	2006	In 20 coastal counties; Water supply watersheds, nutrient sensitive waters, ONRWs	1 acre disturbed area; Coastal-Non residential: 10,000 sf IC; Residential w/in ½ mile shellfish waters: 10,000 sf IC		Non-coastal: 1" rainfall; Coastal: 1.5" rainfall		Same as new development
4	South Carolina	2006	MS4s	1 acre disturbed area	1,000 ft from shellfish waters, retain 1.5" of rainfall	Volume control varies by practice		Same as new development
4	Tennessee	2010	MS4s	1 acre disturbed area	Infiltrate, evapotranspire, harvest, or use first 1" of rainfall		If retention standard cannot be met, 80% TSS removal standard applied to remaining volume	Same as new development

EPA Region	Program	Date	Where required?	Size Threshold	Volume Control Requirement			Redevelopment Standard
					Retention	Treatment	Exception	
5	Illinois	2009	MS4s	1 acre disturbed area	Narrative standard			Same as new development
5	Indiana	2003	MS4s	1 acre disturbed area		Phase I only: Treat runoff from first 1" of precipitation		Same as new development
5	Michigan	MS4 permit withdrawn in November 2010						
5	Minnesota	2006	State-wide	1 acre disturbed area		Treat ½ inch runoff from new imp. surfaces > 1 acre		Reduce IC and/or implement stormwater management practices
5	Ohio	2009	State-wide	1 acre disturbed area		Treat WQv equivalent to 0.75" rainfall runoff volume		20% WQv treatment and/or 20% IC reduction
5	Wisconsin	2010	State-wide	1 acre disturbed area	Infiltrate runoff to achieve 60% -90% of predevelopment volume based on IC level		Size of infiltration area is limited to 1%-2% of site area.	40% TSS reduction from parking areas and roads or MEP
6	Arkansas	2009	MS4s	1 acre disturbed area	Narrative standard			
6	Louisiana	2007	MS4s	1 acre disturbed area	Narrative standard			
6	New Mexico	2007	MS4s	1 acre disturbed area	Narrative standard			
6	Oklahoma	2005	MS4s	1 acre disturbed area	Narrative standard			
6	Texas	2007	MS4s	1 acre disturbed area	Narrative standard			
7	Iowa	2009	MS4s	1 acre disturbed area		Treat 1.25 inch WQv	WQv depth can be adjusted locally based on historical data	Same as new development
7	Kansas	2004	MS4s	1 acre disturbed area	Narrative standard			
7	Missouri	2008	MS4s	1 acre disturbed area	Narrative standard			
7	Nebraska	2005	MS4s	1 acre disturbed area	Narrative standard			
8	Colorado	2001	MS4s	1 acre disturbed area	Narrative standard			
8	Montana	2010	MS4s	1 acre disturbed area	Infiltrate, evapotranspire, or capture for reuse runoff from first 0.5"			Same as new development
8	North Dakota	2009	MS4s	1 acre disturbed area		Treat 0.5" runoff from IC		Same as new development
8	South Dakota	2003	MS4s	1 acre disturbed area	Narrative standard			

EPA Region	Program	Date	Where required?	Size Threshold	Volume Control Requirement			Redevelopment Standard
					Retention	Treatment	Exception	
8	Utah	2010	MS4s	1 acre disturbed area	Narrative standard			
8	Wyoming	2010	MS4s	1 acre disturbed area	Narrative standard			
9	Arizona	2002	MS4s	1 acre disturbed area	Narrative standard			
9	California	2003	MS4s	1 acre of disturbed area	Retain volume from 85th percentile storm event		Biofiltration may be used if retention is infeasible	Local program defined
9	Hawaii	2007	MS4s	1 acre disturbed area	Narrative standard			
9	Nevada	2010	MS4s	1 acre disturbed area		80% annual runoff volume treatment	Treatment volume may be locally determined based on historical records	Same as new development
10	Alaska	2009	MS4s	1 acre disturbed area	Retain first 0.52 inches of rainfall from 24 hr event preceded by 48 hrs of no precip.			Same as new development
10	Idaho	2000	MS4s	1 acre disturbed area	Narrative standard			
10	Oregon	2007	MS4s	1 acre disturbed area	80% average annual runoff volume reduction (for Phase I)			Capture and treat 80% annual average runoff
10	Washington	2007	MS4s	2000 sf of new and/or replaced IC or 7000 sf disturbed area	Infiltrate, disperse, and retain onsite to MEP	Volume predicted from 6 month 24 hr storm OR 91st percentile 24 hr runoff volume indicated by continuous runoff model. Max flow rate where 91% of runoff volume (determined by model) will be treated		Same as new development when size threshold is met.

APPENDIX C

GREEN STREETS

This page intentionally left blank.

APPENDIX C: GREEN STREETS

Municipal streets are key determinants of neighborhood livability. They provide access to homes and neighborhood destinations for pedestrians, and a variety of vehicle types, from bicycles and passenger cars to moving vans and fire apparatus. Urban streets provide a place for human interaction: a place where children play, neighbors meet, and residents go for walks and bicycle rides. The design of residential streets, together with the amount and speed of traffic they carry, contributes significantly to a sense of community, neighborhood feeling, and perceptions of safety and comfort.

1.1 DEFINITION

Defined as "Parks not Pipes, the "green streets" are a LID solution to stormwater runoff providing direct infiltration and evaporation of stormwater runoff close to its source, that can provide sustainable, LID stormwater management to new development, redevelopment, and high density urban retrofits. A "green" street is a stormwater management approach that uses soil, water, and plants to filter, infiltrate, evaporate, and treat stormwater from urban roads and streets.

Photo 1-1: Rendering of a Green Street

According to the "*Green Streets – Innovative Solutions for Stormwater and Stream Crossings,*" eco-friendly "green" streets may be defined as having the functional characteristics designed to:

- Integrate a system of runoff pollutant treatment within its right of way (ROW)
- Reduce the quantity of water that is piped directly to streams and rivers through traditional storm drain systems
- Reduce combined sewer overflow (CSO) infrastructure
- Be a visible component of the system of "green infrastructure" that is incorporated into the aesthetics of the community
- Maximize the use of street tree canopy coverage for rainfall interception as well as temperature (urban heat island) mitigation

1.1.1 Purpose

Urban stormwater runoff that isn't properly managed can pollute rivers and streams and contribute to CSOs. Green streets reduce the negative impacts of stormwater runoff. They mimic natural conditions by using soil, water and vegetation to manage runoff on the surface, at its source where the rain falls.

The main purpose is to retain and treat stormwater runoff generated by urban streets through a contiguous network of bioretention systems, vegetated swales, permeable pavements, infiltration trenches (planters), street trees and sediment filtered strips, etc.

Green streets use bioretention and soil filtration to collect and treat runoff pollutants through layers of mulch, soil media, plant roots, and grave. Pollutants such as oil, grease, bacteria, are retained, broken down or absorbed. Because the system is open bottomed, treated water is then infiltrated into the ground, or can be directed into a traditional stormwater collection system, or diverted directly to streams.

While curb-gutter-pipe systems transport and concentrate runoff problems elsewhere, ecologically-based green street solutions use landscape to absorb and treat runoff on-site. Among many, eco-friendly "green" streets provide function such as:

- Provide safety for walkers, bikers, buses, and cars
- Create a greener, more sustainable environment
- Provide runoff reduction and reduce combined sewer overflow (CSO) infrastructure demands
- Reduce stormwater runoff pollutant transport into downstream water
- Help reduce heat island effect
- Improve air quality and aesthetics
- Provide "on-site" source control for stormwater
- Reduce and treat stormwater close to the source, and
- Increased urban open space

1.1.2 Conditions Where Practice Applies

New construction and retrofits in residential, commercial, institutional, and industrial settings. This is to address issues such as runoff flow and volume; pollution transport; CSO infrastructure demands; and urban heat island effects.

The figures in the following page best illustrate some typical sustainable green street applications in some major cities within the country and the world around.

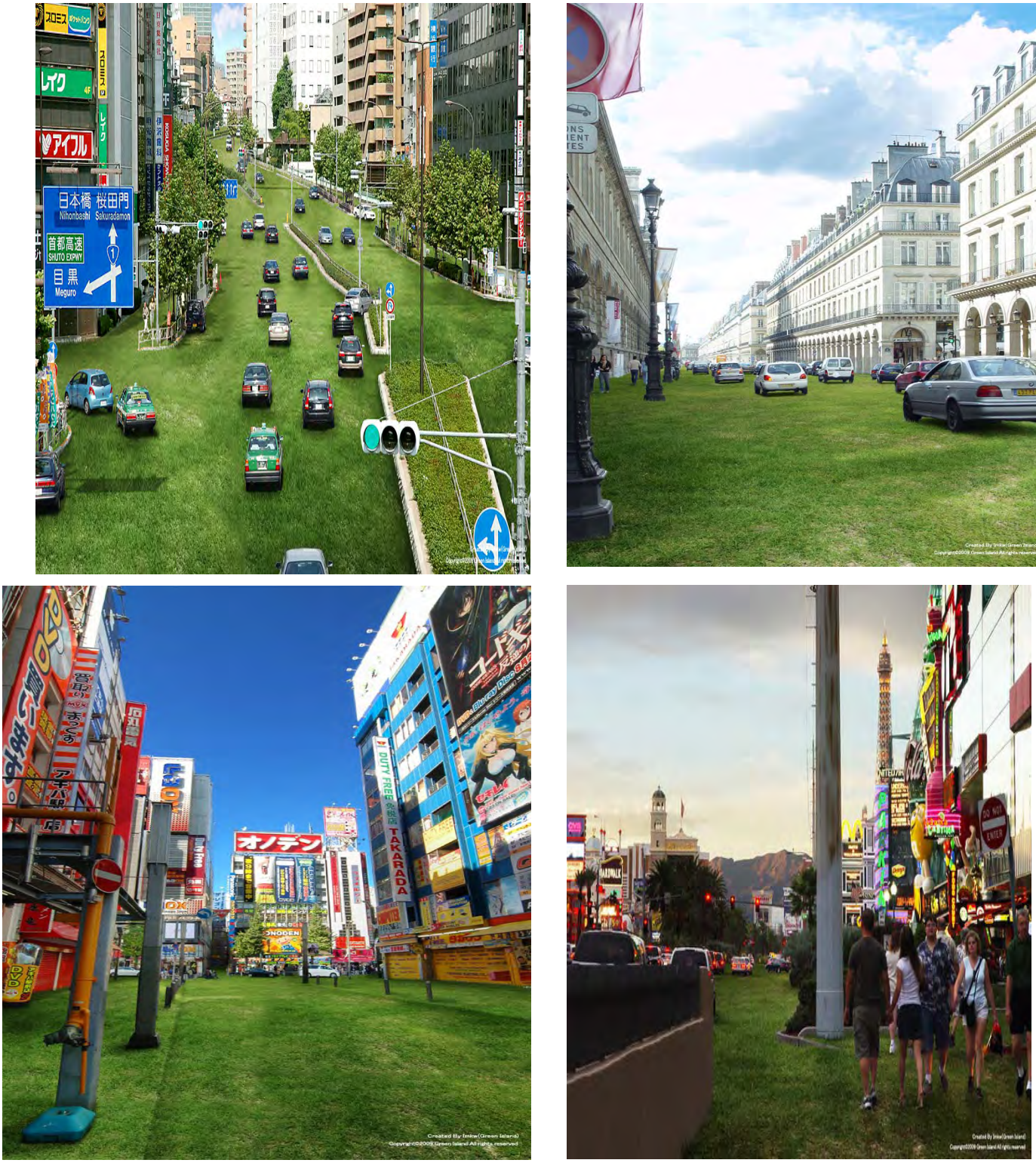


Photo 1-2: Typical Sustainable Green Street Applications in Major Cities

1.1.3 Planning Considerations

Urban roads and streets are the prime collection sites for myriad pollutants. The Federal Highway Administration estimates that more than 20 percent of U.S. roads are in urban areas. Urban roads, along with sidewalks and parking lots, are estimated to constitute almost two-thirds of the total urban impervious cover, and also contribute to a correspondingly similar ratio of polluted runoff generated from these municipal streets.

Urban roads and streets generate a significant amount of runoff that is transported to the municipal storm drain system through a huge and complicated network of curbs and gutters, drop inlets, buried pipes, and much more. Effective road drainage-disposal goal, which may be translated as moving stormwater runoff into the curb-gutter-pipe system as quickly as humanly possible, has been the usual design priority for cities while opportunities for "at-source" runoff control and enhanced environmental concerns have been overlooked, especially in the modern urbanized environment.

Compounding the deliberate rapid disposal of stormwater *via* curb-gutter-pipes, roads also have become the prime collection sites for urban pollutants. Since the roads are an integral component of total urbanscape, especially the stormwater runoff conveyance system, besides being a convenient carrier of runoff pollutants, they are also impacted by many pollutants such as trash (*e.g.*, cups, cans, and plastic bags), sediments, metals, organics associated with petroleum and widespread waste food products, etc. These pollutants result from many sources including: vehicle brake pads, vehicle tires, combustion byproducts, motor oil, vehicle emissions, brake linings, automotive fluids, gas stations, and atmospheric deposition, as well as myriad other waste products typical of metropolitan roads and streets. These are the concerns that must be addressed promptly and effectively by city officials for public safety and for providing clean, sustainable environment for the citizens.

Urban roads and streets present many opportunities for "green street" infrastructure applications to address such pollution and environmental problems, as stated above, cost-effectively and efficiently. Among many, following are the few guiding principles that may be considered for the planning and designing of eco-friendly "green" streets.

1. Modest, small, decentralized, distributed green infrastructure can have a cumulative effect.

2. Each distributed parcel must in some way contribute to the city green infrastructure.

3. Environmental impacts of developments must be mitigated at source .

4. Need to bring local zoning ordinances and codes in conformity with state and federal water quality and stormwater runoff control regulations such as Clean Water Act, 2002 (CWA) and subsequent 1987 Amendments to CWA, as well as recently passed Energy Independence & Security Act (EISA) of 2007.

New research conducted both at national and state levels points to opportunities for managing stormwater runoff and associated pollutants originating from roads and streets using "Green Street "practices, procedures, and approaches. Many of these practices use standard LID stormwater management BMPs, such as rain gardens, bio-retention basins, and vegetated swales, green roofs,

permeable pavements and pavers, grass strips, trees, shrubs, planters, etc. Others methods go far beyond by advocating measures such as: changing site-design elements to maximize existing infrastructure by focusing on reducing parking spaces; narrower streets; efficient "green" street lighting; eliminating cul-de-sacs and dead-end streets; reducing impervious areas; and that of the re-designing of road surfaces such that the surface runoff is directed towards the center (i.e., reversed crown) instead of the conventional roadway center-crown surface design.

1.1.4 Design Criteria & Specification

The determining goal for "green" street design is to maximize removal of pollutants and runoff reduction by processes such as infiltration through soil matrix and evaporation and nutrient uptake by vegetation, respectively. Following LID design principles, the green street design approach tries to blend the natural hydrological cycle within the "engineered" design urbanscape infrastructure.

Before considering design criteria, an understanding of the basic functional differences between traditional and "green" street design goals as well as the outstanding institutional barriers in adopting this approach is important and discussed in the following two sections.

1.1.4.1 Green Streets vs. Traditional Streets

Green streets provide complete integration of design functions from different disciplines for achieving water quality treatment and runoff volume reduction goals; while improving community image, enhancing neighborhood friendliness, promote walkability, and access and safety to pedestrian and bikers. Green streets approach can have considerable savings compared with traditional streets by reducing costs for CSO infrastructure requirements and those resulting from reduced sewage treatment volumes. Contrary to reduced impervious area and "at-source" runoff control by green streets, the traditional streets are designed on the premise to dispose of rainwater as quickly as possible by using curb-gutter-pipe infrastructure that results in extra burden on storm drain and CSOs, and added sewage treatment volumes.

Tree-lined eco-friendly green street approach, with landscaped vegetated strips alongside pedestrian walkways, may be another cost-effective alternative for retrofit and new construction over traditional street design. Though, they may not be able to filter all pollutants from the runoff effectively, the simple addition of trees and landscaped bioswales along streets does help in pleasing look, enhanced aesthetics, and improved environment in many ways including the following:

- Provide source control for stormwater by on-site stormwater harvesting using practices such as bioretention, bioswale, permeable paving, street trees and planters.
- Reduce impervious area by using narrower streets, redesigned roadside walkways, etc.
- Limit its transport and pollution conveyance to collection system
- Improve air and water quality
- Contribute towards enhanced aesthetics and improved environment

- Promote walkability and pedestrian friendliness
- Use the public right-of way for multiple purposes
- And much more

1.1.4.2 *Creating Institutional Framework for Success*

Technologies and engineering are no longer significant obstacles or barriers to successful implementation of the "Green Street" approach. Nevertheless, institutional issues can create the most daunting obstacles to broader acceptance and implementation of Green Street practices in new and existing urban developments. For example, narrower street design results in reduced impervious area (and thus less runoff and associated pollutants and problems) but Unified Fire Code (UFC) requirements and resistance by Fire Marshal and emergency access vehicles always overtakes the Green Street initiative. The concerns raised by opponents include that the standards for reducing street width would compromise access to larger vehicles of fire, police, ambulance, and garbage disposal, and similar service providers. There is a need to revisit UFC and local zoning codes to address and accommodate concerns raised by Fire Marshal and other service providers by providing alternative parking configurations, prohibiting parking near intersections, providing vehicle pullout space, and using smaller block lengths.

Urban roads and streets are generally in the public right of way. Therefore, their construction and implementation is the responsibility of the municipal public sector. Cooperation from transportation department, public works, police, and fire departments is essential and ideally they would play a leadership role, especially in new construction and for streets needing repair or retrofits. The city leaders and planning departments can also take the leadership to put implementation mechanisms in place such that encourage or require private developers to make "green" street concepts as in integral component of their developments.

1.1.4.3 Design Criteria

Alleys may be considered as the "low hanging fruit" of green street design. In many towns and cities, (*see* City of Chicago example below) alleys compromise a significant amount of impervious surface and are sometimes prone to flooding because they are often not connected to the storm drain system. Green street techniques like bioretention, swales, permeable paving, street planters, and curb extensions can effectively reduce and treat runoff, reduce and/or alleviate flooding, and are far less expensive than installing curb-gutter-pipe networks and connections to sewers.

As stated in the above paragraph, it is the responsibility of the cities and towns to design, construct, and maintain municipal roads and streets. Nonetheless, some or all of the following techniques should be considered and used when designing green streets.

<u>Stormwater Management</u>
Incorporating green streets as a feature of urban stormwater management requires matching road transportation functions with those of environmental performance. Enhancing roads with green

elements can improve their primary function as a transportation corridor, while simultaneously mitigating negative stormwater pollution and environmental impacts. Towns and cities are fast accepting and promoting bioretention (filtering & infiltration), bioswales, permeable paving, street tree, and other green-space programs along their urban transportation corridors; aiming to control runoff pollution and flow volumes as well as managing stormwater intelligently and efficiently.

Integrated Management Practices (IMPs)

The evolution from centralized stormwater management to greener, more sustainable BMPs necessitates a progression from installing small, distributed, individual practices to implementing broader water quality programs. Conventional end-of-pipe management practices are often installed myopically, focused primarily on collecting runoff from the drainage area and disposing it off as quickly as possible. The use of green streets allows stormwater integrated management practices (IMPs) to act in a broader environmental capacity than solely managing stormwater; wherein IMPs are defined as LID tools used for water quality treatment and flow control. For example, Chicago's Green Alley program, by using light-colored permeable and recycled concrete, addresses urban heat island effect and waste disposal issues simultaneously with stormwater management.

Green streets are an example of how individual stormwater IMPs are used as elements of a broader program aimed at mitigating a significant source of stormwater pollution. Urban roads, along with sidewalks and parking lots, are estimated to constitute almost two-thirds of the total impervious area in urban areas and contribute a similar ratio of runoff and urban stormwater pollution. Green streets use a combination of stormwater management features of bioretention, vegetated swales, and permeable pavers and pavements to enhance stormwater quality, runoff reduction, and improve the design and function of urban streets.

Reduction of Impervious Surfaces

Urbanization results in vast impervious landscapes which present challenges for the environmental sustainability of the nation’s towns and municipalities. Reducing the amount of impervious surface requirement in green street design would help in stormwater management and reduction in heat island effect and to realize many of the benefits as described later in Section 6.5.9 of this chapter.

Improved Water Quality

Urban stormwater runoff pollutes the natural water system flowing directly or through CSOs. The type of vegetative planting and biofiltration processes used in green street design help to treat and reduce runoff for improved water quality downstream.

Use of Public Right-of-Way (ROW)

The green street design approach recognizes and respects the finite limits between urban land use needs (such as efficient transportation requirements) and the protection of sustainable natural resources. By integrating stormwater infiltration/evaporation practices with other public utilities and opportunities for recreation, the design promotes shared uses within the public right of way.

Narrow Street Widths

The standards for the designing and construction of municipal streets, in particular the width of streets (for reducing stormwater pollution and “urban heat island” effect through reduced imperviousness), have been one of the most contentious issues in local jurisdictions across the country. The concerns

raised by opponents include that the standards for reducing street width would compromise access to larger vehicles of fire, police, ambulance, and garbage disposal, and similar service providers.

Reasonable safety can be achieved by providing street widths such as those recommended for low, medium, or high density developments in level, rolling, or hilly terrains. Preferably, a street should be "no wider than the minimum needed" to safely and accommodate usual vehicular mix that the street will serve.

One reason that streets constitute such a significant source of stormwater volume and pollution is the impervious area associated with them. Green streets first reduce stormwater impacts by eliminating unnecessary impervious area. Many urban and suburban streets are sized to meet code requirements for emergency service vehicles, on-street parking, and free flow of traffic. These code requirements often result in streets being oversized for their typical everyday functions. The Uniform Fire Code requires that streets have a minimum 20 feet of unobstructed width; a street with parking on both sides would require a width of at least 34 feet. In practice, many suburban and urban streets may be much wider than this as local design practices have increased street widths to 40 and 50 feet. There is often a large percentage of street impervious area that serves no practical purpose other than generating stormwater runoff. In addition to stormwater concerns, wide streets have many detrimental effects on neighborhood livability, traffic conditions, and pedestrian safety.

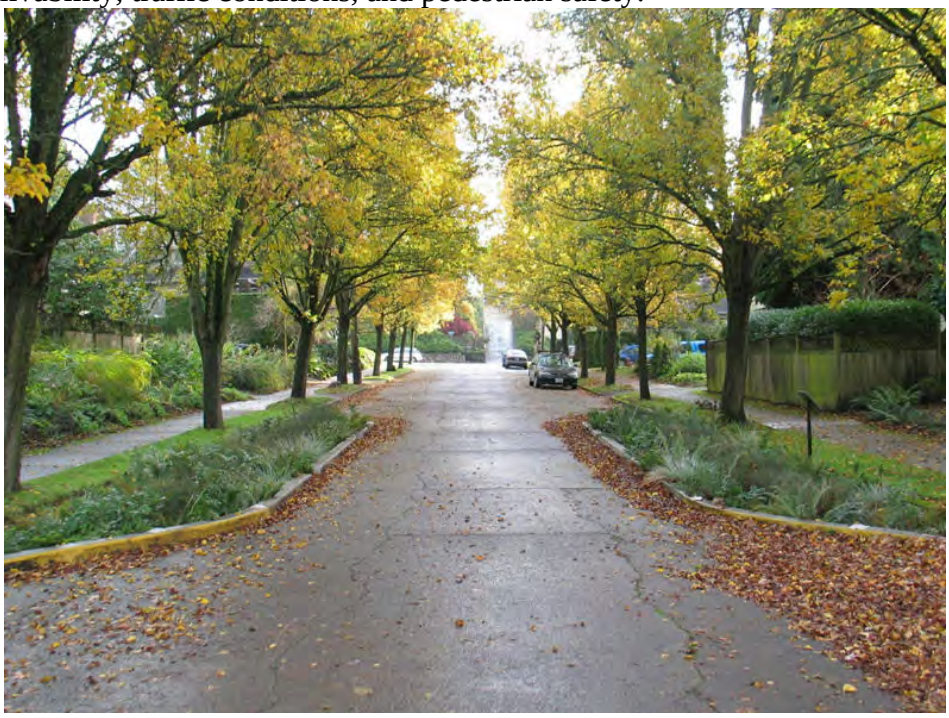


Photo 1-3: A Green Street

Many communities have adopted narrower street width standards while also accommodating emergency vehicles by developing alternative street parking configurations, prohibiting parking near intersections, providing vehicle pullout space, and using smaller block lengths. A key to identifying and successfully codifying narrow street widths is coordination amongst departments, including fire, transportation, and public works.

Why Narrow Streets?
The width of streets also affects other aspects of livability. Narrow streets are less costly to develop and maintain and they present less impervious surface, reducing runoff and water quality problems. The topic of automobile speeds on neighborhood streets probably tops the list of issues. Where streets are wide and traffic moves fast, cities often get requests from citizens to install traffic calming devices, such as speed humps. However, these can slow response times of emergency service vehicles creating the same, or worse, emergency response concerns than narrow streets.

Safe and Livable
There is growing appreciation for the relationship between street width, vehicle speed, the number of crashes, and resulting fatalities. Deaths and injuries to pedestrians increase significantly as the speed of motor vehicles goes up. In 1999, planner Peter Swift studied approximately 20,000 police accident reports in Longmont, Colorado to determine which of 13 physical characteristics at each accident location (e.g., width, curvature, sidewalk type, etc.) accounts for the crash. The results are not entirely surprising: the highest correlation was between collisions and the width of the street. A typical 36-foot wide residential street has 1.21 collisions/mile/year as opposed to 0.32 for a 24 foot wide street. The safest streets were narrow, slow, 24-footwide streets.

Green streets can incorporate a wide variety of design elements including street trees, permeable pavements, bioretention, and swales. Although the design and appearance of green streets will vary, the functional goals are the same. Green streets techniques will encourage the interaction of stormwater with soil and vegetation to promote infiltration and retention.

The use of green streets offers the capability of transforming a significant stormwater and pollutant source into an innovative treatment system. Green streets optimize the performance of public space easing maintenance concerns and allowing municipalities to coordinate the progression and implementation of stormwater control efforts. In addition, green streets optimize the performance of both the transportation and water infrastructure. Effectively incorporating green techniques into the transportation network

Green streets have different shapes and sizes, but they all have stormwater management benefits (Section 6.5.9 in this Chapter) that help protect watershed integrity and health. Green street features include: vegetated curb extensions; sidewalk planters; landscaped medians; bioretention cell and rain garden; vegetated swales; permeable paving; and streets. Here below are provided some examples of typical green street features and characteristics.

Photo 1-4: A Green Street

1.1.4.4 Design Elements

Green streets are generally in the public right of way (ROW), and, thus, their implementation will largely depend on the public sector. Cooperation transportation, emergency, fire and other departments is essential and ideally they would play a leadership role, especially in retrofit decision-making. The city leaders and planning departments can also take the leadership to put implementation mechanisms in place that encourage or require private developers to participate in developing and supporting "green" sustainable street design in their retrofit and new construction.

Photo 1-5: A Green Street in the ROW

Green street design and its integration with surrounding buildings and open spaces attempts to mimic pre-development hydrologic functions. The design describes stormwater management strategies that allow infiltration and limit stormwater runoff. The effort provides guidance for designing environmentally sustainable and sound streets that can help protects streams and wildlife habitat. The guidance also describes basic stormwater management strategies and illustrates street designs with features such as street trees, landscaped swale, rain gardens, tree boxes, and special paving materials that allow infiltration and limit runoff.

Green street design and its integration with surrounding buildings and open spaces attempt to integrate various solutions by blending natural hydrological functions within the designed urbanscape. Green streets can incorporate a wide variety of design elements including bioretention, bioswales, permeable paving, street trees, boxes, and planters. Although design and appearance will vary depending on region and locality, the functional goals are the same such as described in the following:

(1) Provide stormwater control at source

(2) Reduce runoff flow and volume

(3) Minimize the transport of pollutant conveyance to downstream water by providing pollutant removal strategies and practices

(4) Reduce or minimize CSO loads, and

(5) Provide aesthetically, soothing, and pleasing roads and streets.

Although typical green street elements, as stated above, have already been described extensively in Chapter 2 and Chapter 5, and elsewhere, a brief description of the same is again given in the following paragraphs.

Bioretention, Bioretention Curb Extension and Sidewalk Planters

Bioretention is a versatile green street strategy. Bioretention features have been described in Section 5.1, *Bioretention,* in detail. Structural and functional characteristics of bioretention equally apply to green street features, including features such as tree boxes, planters, and curb extensions. Many natural processes occurring bioretention such as infiltration, runoff reduction, water quality, removal of pollutants, biological and chemical reactions occurring in mulch and soil matrix, nutrient uptake by plants, etc., also occur in the green street environment as well.

Photo 1-6: Bioretention

Vegetated Swales

Vegetated swales are long, shallow, vegetated depressions, with a slight longitudinal 1 to 2 percent slope. As water flows through the swale, it is slowed by vegetation, allowing sediment and pollutants to settle out. Water soaks into the soil and it is taken up by plants, and may infiltrate into the ground if the soil is well drained.

Swales or grass channels are vegetated open channels designed to accept sheet flow runoff and convey it in broad non-erosive shallow flow. The intent of swales is to reduce stormwater volume through infiltration, improve water quality through plant uptake and filtration, and reduce flow velocity by increasing channel roughness. In the simple roadside form, they have been a common historical component of road design. Additional benefits in green street design can be attained through more complex construction such as those with amended soils, underdrain, gravel storage, and thick diverse vegetation (See Chapter 5, Section 2 for Details on Vegetated Swales).

Photo 1-7: Vegetative Swale

Permeable Pavement

Alleys are typically slow-speed, low-traffic streets and therefore highly suitable locations for using permeable paving. The entire street surface could be constructed using permeable pavers. If heavier vehicles are anticipated for loading and unloading or the alley is "reversed crown" (sloping towards the center line), then only the middle section needs to be permeable. Permeable paving on commercial streets can be incorporated into sidewalks and parking lanes.

Photo 1-8: Permeable Pavement

Permeable pavement and pavers are described in Section 5.3 and their description equally applies to green street applications. Permeable pavements and pavers come in several forms: porous asphalt, porous concrete, permeable interlocking concrete pavers, and grid pavers, etc. Permeable asphalt and concrete are similar to their counterparts but are open graded or have reduced fines and typically have a special binder added. Methods for pouring, setting, and curing these permeable pavements also differ from the impervious versions. The concrete grid pavers are modular systems. The concrete pavers are installed with gaps between them that allow water to pass through to the base. Grid pavers are typically a durable plastic matrix that can be filled with gavel or vegetation. All of the permeable pavement systems have an aggregate base in common which provides structural support, runoff storage, and pollutant removal.

Permeable paving (pavers, porous asphalt, and pervious concrete) in the parking lane converts impervious surfaces to allow stormwater to infiltrate into the ground, which results in runoff reduction without any loss of parking on the street. The aesthetics of permeable paving can also give the illusion of narrower street and therefore help slow down traffic.

Street Trees

Street trees provide multiple benefits to the urban landscape by reducing the urban heat island effect, reducing stormwater runoff, improving the urban aesthetics, and improving air and water quality. Street trees catch and absorb/evaporate rainwater, and are important to city's sustainable stormwater efforts.

Correspondingly, they are also a critical component of green streets. However, urban environments are often inhospitable for tree growth. Trees are often given little space to grow, the soil around street trees often becomes compacted during the construction of paved surfaces, and underground utilities encroach on root space.

Photo 1-9: Street Tree

If tree roots are surrounded by compacted soils or are deprived of air and water by impervious streets and sidewalks, their growth will be impaired, their health will decline, and their expected life span will be cut short. By providing adequate soil volume and a good engineered soil mixture, the benefits obtained from a street tree would definitely multiply. To obtain a healthy soil volume, install larger tree boxes or use structural soils, root paths, or "silva cells" used under sidewalks or other paved areas. These options allow tree roots the space they need to grow to full size.

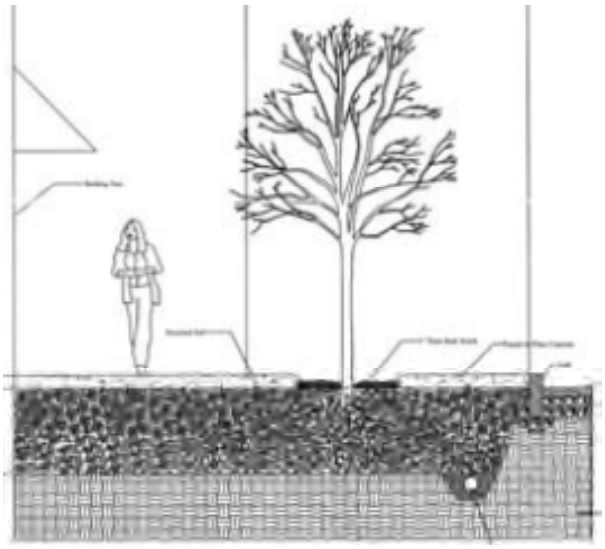


Photo 1-10: Street Tree Schematic

Street trees perform many functions and provide many benefits including calming traffic, improving air quality and conserving energy. Street trees perform a variety of functions that help reduce the amount and rate of stormwater runoff entering the piped stormwater system. Trees absorb water through their leaves, branches and roots. Trees planted in biofiltration swales slow down water flow even more by allowing water to infiltrate into the soil. While all street trees perform these functions, particular species may perform them better than others depending on characteristics such as the following:

- Foliage texture and spread characteristics
- Tree life span or longevity
- Growth rate and canopy density
- Drought tolerance and tolerance to saturated soils, compacted soils, poor soils
- Resistance to urban pollutants (air and water)

1.1.4.5 Sidewalk Tree, Tree Boxes, and Planters

Trees help reduce urban heat island effect, reduce stormwater by evaporation, and improve urban aesthetics and air quality. However, most often street trees are given very little space to grow in often inhospitable environments. The soil around street trees becomes compacted during the construction of paved surfaces and minimized as underground utilities encroach on root space. By providing adequate soil volume and a good soil mixture, the benefits obtained from a street tree multiply. To obtain a healthy soil volume, trees can simply be provided larger tree boxes, or manufactured soils, root paths, or “silva cells” can be used under sidewalk or other paved areas for roots to expand and grow. These allow tree roots expanded root zone and the space they need to grow to their full size.

1.1.5 Case Studies

Several townships and cities have started using “green” street approach to address their stormwater and related pollution problems and for realizing environmental benefits (*see* 6.5.9, *Benefits)* that green streets provide and are described in Section 6.5.9, *Benefits* of this Chapter. To illustrate the point further, successful stories from two cities, Portland and Chicago, are briefly narrated below.

1.1.5.1 *City of Portland, Oregon - - Green Streets Program*

City of Portland, Oregon, is the pioneer leader in using city-wide green street strategies that manage and treat stormwater runoff “Nature’s Way” by using soil-water-plant microbial processes (as extensively described in Section 6.1, 6.2, 6.3, and 6.4), for enhancing Portland community and neighborhood livability, and strengthening the local economy.

Portland has received a great deal of recognition for the success of their green street stormwater program that was facilitated by the Green Streets Team (hereinafter Team), a local interdisciplinary team. The Team envisioned, initiated, and developed a comprehensive policy on implementing “Green Street” program in their city. The Team recognized the fact that two-third of the City's total runoff, and a similar amount of runoff pollution, was generated form within the streets and right-of-ways. The Portland city also recognized the opportunity to accomplish following goals and objectives to address both runoff and transportation problems.

- Satisfying numerous City goals for neighborhood livability, sustainable development, increased green space, stormwater management, and groundwater protection
- Integrating infrastructure functions by creating "linear parks" along streets that would provide access and safety to pedestrians and bikers
- Avoiding the key impacts of unmanaged stormwater typical of conventional urban streets
- Managing stormwater with investments that citizens can support, participate in, and lead by example
- Managing stormwater as a resource rather than an unwanted waste
- Reducing curb-gutter-pipe requirements and burden of CSOs
- Reducing impervious area by using methods as advocated by LID strategies, and
- Providing increased neighborhood amenities and value.

Photo 1-11: City of Portland, OR Green Street

The Team assembled the players who had a stake in the design, management, and maintenance of the city streets and allowed them to work together to propose and identify approaches to meet stated goals and objectives. The team first identified challenges and issues that would confront the green streets program including challenges such as local zoning ordinances, codes and standards that would disallow or discourage green street strategies and initiatives. The team members then focused on developing the necessary outreach, technical guidance, infrastructure and maintenance plans, and funding sources to address these barriers. The results of these efforts were then synthesized into a citywide Green Streets Policy, which was adopted by the Portland City Council in March 2007, and since then is being practiced and implemented successfully city-wide.

Portland Greet Street program includes the collection and treatment of polluted stormwater through using LID practices such as green roofs, planted gutters, and stormwater planters on terraces. For example, at the first floor, glass awnings are provided to collect storm runoff and funnel it directly into street cisterns. At the street level, pervious pavements are used to provide car parking and crosswalks.

1.1.5.2 *Chicago's Green Alleys Program*

Chicago's green alleys program is another example of institutional planning that developed the framework for a successful multi-benefit environmental program. The City's 13,000 publicly owned alleys consist of 1,900 miles, or equivalent of 3,500 acres of impermeable surfaces. The alley system preceded sewer connections and was originally unpaved. As the alleys were paved over time, the lack of a stormwater drainage system often led to flooding in adjacent garages and basements. The City's approach to managing stormwater from the alleys took the position that the most sustainable approach was one that did not add additional stormwater to an already overburdened sewer system, rather reduce it by on-site stormwater harvesting.

Photo 1-12: Before and After Drainage Improvement

The Green Alley Program is important for two main reasons. First, it marries green infrastructure practices in the public right-of-way with those of green infrastructure efforts on private property. This is carried out by encouraging private residents to install stormwater BMPs on their property adjacent to the green alleys to increase the environmental benefits. Second, the City used the alley retrofit efforts as an opportunity to address pollution and other environmental problems by using LID practices (described previously in Sections 6.1, 6.1, 6.3, and 6.4) of the chapter, thus, making the program truly multi-dimensional and multi-beneficial.

The main objectives of the Green Alley Program are:

- Changing the grade of the alley to drain to connecting streets rather than ponding water in the alley or draining toward garages or private property
- Using light colored paving material (concrete or asphalt) that reflects sunlight rather than adsorbing it, reducing urban heat island effect
- Incorporating recycled materials into the pavement mix to reduce the need for virgin materials and reduce the amount of waste going into the landfill; and
- Using green dark sky dark sky-compliant light fixtures to direct lamp light downward and outward where it is useful rather than upward where it wastes energy and contributes to glare and light pollution

Green alleys incorporate a variety of characteristics by using the following approaches:

- Permeable pavements (asphalt, concrete or pavers) that allow stormwater to filter through the pavement and drain into the ground, instead of collecting on hard surfaces or draining into the sewer system. The pavement can be used on the full width of an alley, or simply in a center trench.

- Recycle construction materials can be incorporated in a variety of ways in green alleys. Recycled concrete aggregate can be used in the concrete mix and as a base beneath surface paving. Also, slag, a byproduct of steel production, can be used as a component of the concrete mix, reducing industrial waste. Ground tire rubber can be used in porous asphalt and in reclaimed nonporous pavements.

- Open bottom bioretention catch basins--installed in alleys to capture and infiltrate runoff.

- High-albedo pavement, a lighter-colored surface that reflects sunlight instead of absorbing it, helping reduce the urban heat island effect.

The Program incorporates design flexibility as alleys installed are tailored to local conditions. For instance, permeable pavement is used for the entire alley surface. In other situations where buildings come right up to the edge of pavement and infiltrated water could threaten foundations, or to save on construction costs, impermeable pavement strips are used on the outside with a permeable pavement strip down the middle of medians. In areas where soils do not provide much infiltration capacity, the alley is re-graded to drain properly by directing flow to streets.

The design provides that if an alley is crowned in such a way that water flows to the side (center crown), then stormwater runoff can be accommodated by simply planting edges of the alley with swales and planters for increased infiltration and evaporation. Alternately, the alley design features advocate that all alleys, whether permeable or not, should be properly graded and pitched towards the center to allow water to run towards the center of the alley and then flow directly into the street. This prevents the need for additional CSO infrastructure and prevents adjacent buildings from flooding.

Green Street Design Issues

Green street design elements may be applicable to both new construction as well as retrofits. Typically, designing green streets in new developments are less complicating than retrofitting in existing development. below describes some of these issues. Green street design solutions may be applicable to both new streets and existing streets. Typically, designing green streets in new development are less complicated than retrofitting in existing development. The Table below from "*Green Street – Innovative Solutions for Stormwater Crossings"* describes some of these issues.

Table 1-1: Green Street Design Issues for Retrofit and New Construction

	Issue	Retrofit	New Construction
1	Planning implications	Installation of appropriate designs are restricted to existing Right of Way and any easements onto private property need to be negotiated	Creation of new road system that incorporates designs can lay framework for new development. A "system" of treatment facilities can be designed from the outset to adhere to particular site conditions, and existing drainage systems (streams).
2	Right of way requirements	"Right of Way (ROW)" restricted by adjacent development. Must ensure that installation of designs does not come at expense of pedestrian and bicycle facilities.	Dedication of new ROW can incorporate designs. Pedestrian and bicycle accommodations can be incorporated from the outset of street design.
3	Edge of roadway condition	Substantial modification to edge of roadway may be met with public resistance.	Edge treatments can be designed in accordance with chosen stormwater design.
4	Street trees	Proposed system must adapt itself to existing street trees due to expected public resistance to tree removal. Provide opportunity for increased street planting but location and species choice should reflect available planting areas.	Tree placement and species can be fully incorporated into the system
5	Utilities	Installation of designs would generally have to work around existing utilities due to prohibitive expense in removing utilities	Utilities can be consolidated and localized to eliminate conflict with designs
6	Overflow contingencies	Existing storm drain system can serve as overflow	Overflow regime must be considered
7	Stream crossing	Replace culverts with clear-space bridges (or at minimum bottomless culverts). The abutments should be set back from the river bank and outside the active floodplain so that the edge remains undisturbed and flood risks are not increased.	Opportunity for clear-span bridges set back from the river bank and outside the active floodplain, preferably with an arch to increase span/depth ration and resulting in high aesthetic appeal.

8	Cost	Structural BMP retrofit of existing development is expensive requiring retrofit to existing storm drain facilities, to existing municipal open space (*i.e.*, detention ponds) or to other developed sites (*i.e., underground storage in downtown area). Retrofits are typically funded by a municipality.*	With exception of major streets, structural designs for new construction are typically funded by a private land developer.

1.1.6 Benefits

Green streets reduce peak stormwater flows, free capacity in the pipes to carry more wastewater to sewage treatment plant, and stop sewer backups in basements. They can reduce and/or eliminate the need to install or replace expensive underground collection, conveyance, and treatment systems.

Green streets offer many benefits that curb-gutter-sewer pipes can't. They replenish groundwater supplies, absorb carbon, improve air and water quality, and improve neighborhood livability and aesthetics, and provide green connection between parks and open space.

Photo 1-13: Green Streets Improve Bicycle Safety

Photo 1-14: Green Streets Improve Pedestrian Safety

The following is a brief summary of typical benefits that green streets provide:

- Enhance neighborhood livability
- Increase community and property values
- Enhance pedestrian access and safety
- Reduce impervious surface
- Reduce stormwater in sewer system and reduce demand on City's CSO infrastructure
- Improve air quality and reduce air temperature
- Improve urban heat island effect
- Add urban green space and wildlife habitat

This page intentionally left blank.

APPENDIX D
STANDARD HYDROLOGIC MODELING AND SIMULATION REFERENCE TABLES

This page intentionally left blank.

APPENDIX D: STANDARD HYDROLOGIC MODELING AND SIMULATION REFERENCE TABLES

Table D-1: Average Rational Method Runoff Coefficients for Urban Areas: 5-y and 10-y frequency based on Description of Area

DESCRIPTION OF AREA	RUNOFF COEFFICIENTS
Business Downtown areas Neighborhood areas	 0.70 to 0.95 0.50 to 0.70
Residential Single family areas Multiple units, detached Multiple units, attached Suburban Apartment dwelling areas	 0.30 to 0.50 0.40 to 0.60 0.60 to 0.75 0.25 to 0.40 0.50 to 0.70
Industrial Light areas Heavy areas	 0.50 to 0.80 0.60 to 0.90
Parks, Cemeteries	0.10 to 0.25
Playgrounds	0.10 to 0.25
Railroad yard areas	0.20 to 0.40
Unimproved areas	0.10 to 0.30

Source: (Ponce, 1989)

Table D-2: Average Rational Method Runoff Coefficients for Urban Areas: 5-y and 10-y frequency based on Character of Surface

CHARACTER OF SURFACE	RUNOFF COEFFICIENTS
Streets Asphaltic Concrete Brick	 0.70 to 0.95 0.80 to 0.95 0.70 to 0.85
Drives and Walks	0.70 to 0.85
Roofs	0.70 to 0.85
Lawns, sandy soil Flat (2 percent) Average (2 to 7 percent) Steep (7 percent)	 0.05 to 0.10 0.10 to 0.15 0.15 to 0.20
Lawns, heavy soil (clay soil) Flat (2 percent) Average (2 to 7 percent) Steep (7 percent)	 0.13 to 0.17 0.18 to 0.22 0.25 to 0.35

Source: (Ponce, 1989)

Table D-3: Average Rational Method Runoff Coefficient for Rural Areas

TOPOGRAPHIC AND VEGETATION	SOIL TEXTURE		
	OPEN SANDY LOAM	CLAY AND SILT LOAM	OPEN SANDY CLAY
Woodland			
Flat (0 to 5 percent)	0.10	0.30	0.40
Rolling (5 to 10 percent)	0.25	0.35	0.50
Hilly (10 to 30 percent)	0.30	0.50	0.60
Pasture			
Flat (0 to 5 percent)	0.10	0.30	0.40
Rolling (5 to 10 percent)	0.16	0.36	0.55
Hilly (10 to 30 percent)	0.22	0.42	0.60
Cultivated Land			
Flat (0 to 5 percent)	0.30	0.50	0.60
Rolling (5 to 10 percent)	0.40	0.60	0.70
Hilly (10 to 30 percent)	0.52	0.72	0.82

Source: (Ponce, 1989)

Table D-4: Seasonal Rainfall Limits for Three Levels of Antecedent Moisture Conditions (AMC) – SCS Method

AMC	TOTAL 5 DAY ANTECEDENT RAINFALL (cm)	
	DORMANT SEASON	GROWING SEASON
I	Less than 1.3	Less than 3.6
II	1.3 to 2.8	3.6 to 5.3
III	More than 2.8	More than 5.3
Note: This table was developed using data from the Midwestern U.S. Therefore, caution is recommended when using the values supplied in the table for AMC determination in other geographic or climatic regions.		

Source: Ponce, 1989

Table D-5: SCS Runoff Curve Numbers for Urban Areas (Ponce, 1989)

Cover Description		Curve Numbers for Hydrologic Soil Group:			
Cover Type and Hydrologic Condition	Average Percent Impervious Area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover less than 50%)		68	79	86	89
Fair condition (grass cover 50 to 75%)		49	69	79	84
Good condition (grass cover greater than 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curves and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-in. sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
$\frac{1}{8}$ ac. or less (town houses)	65	77	85	90	92
$\frac{1}{4}$ ac.	38	61	75	83	87
$\frac{1}{3}$ ac.	30	57	72	81	86
$\frac{1}{2}$ ac.	25	54	70	80	85
1 ac.	20	51	68	79	84
2 ac.	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (curve numbers (CNs) are determined using cover types similar to those in Table 5-2(c)).					

Notes:

[1]Average antecedent moisture condition and $I_a = 0.2S$.

[2]The average percent impervious area shown was used to develop the composite *CN*s. Other assumptions are as follows: Impervious areas are directly connected to the drainage system; impervious areas have a $CN = 98$; and pervious areas are considered equivalent to open space in good hydrologic condition. *CN*s for other combinations of conditions may be computed using Fig. 5-16 or 5-17.

[3]*CN*s shown are equivalent to those of pasture. Composite *CN*s may be computed for other combinations of open space cover type.

[4]Composite CN's for natural desert landscaping should be computed using Figs. 5-16 or 5-17 based on the impervious area percentage ($CN = 98$) and the pervious area *CN*. The pervious area *CN*s are assumed equivalent to desert shrub in poor hydrologic condition.

[5]Composite *CN*s to use for the design of temporary measures during grading and construction should be computed using Figs. 5-16 or 5-17, based on the degree of development (impervious area percentage) and the CNs for the newly graded pervious areas.

Table D-6: SCS Runoff Curve Numbers for Rural Areas (Ponce, 1989)

Cover Description		Curve Numbers for Hydrologic Soil Group:			
Cover Type	Hydrologic Condition	A	B	C	D
Pasture, grassland, or range-continuous forage for grazing[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay	—	30	58	71	78
Brush—brush-weed grass mixture with brush being the major element[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods—grass combination (orchard or tree farm)[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

Notes:

[1]Average antecedent moisture condition and $I_a = 0.2S$.

[2]*Poor:* less than 50% ground cover on heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: more than 75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* less than 50% ground cover.
Fair: 50 to 75% ground cover.
Good: more than 75% ground cover.

[4]Actual curve number is less than 30; use $CN = 30$ for runoff computations.

[5]*CN*s shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the *CN*s for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table D-7: SCS Runoff Curve Numbers for Arid and Semi-Arid Rangelands (Ponce, 1989)

Cover Description		Curve Numbers for Hydrologic Soil Group:			
Cover Type	Hydrologic Condition[2]	A[3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

Notes:

[1]Average antecedent moisture condition and $I_a = 0.2S$. For range in humid regions, use Table 5-2(c).

[2]*Poor:* less than 30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: more than 70% ground cover.

[3]Curve numbers for group A have been developed only for desert shrub.

This page intentionally left blank.

APPENDIX E
USING LID TO MEET TMDLS AND OTHER REGULATORY REQUIREMENTS

This page intentionally left blank.

APPENDIX E
1 USING LID TO MEET TMDLS AND OTHER REGULATORY REQUIREMENTS

1.1 USING LID FOR VOLUME CONTROL TO MEET TMDLS

Reducing runoff volume is one of the most powerful tools available for reducing pollutant loading to receiving waters (LID, 2011). Load reductions are straightforward to estimate, as they are based on the volume of runoff captured rather than the pollutant removal performance of a particular BMP. Capture of all storms smaller than a specified value, for example the 95th percentile storm, means that no runoff, and therefore no pollutant loading, occurs for storms smaller than the design storm. For storms exceeding the design storm, runoff from the early part of the storm, which often contains higher concentrations of pollutants, is captured, and only runoff from later in the storm, which is often less polluted, is discharged. There is some debate as to whether this concept of a "first flush" is accurate; that is, whether storms exhibit a characteristic pattern of high pollutant loads at the onset of runoff, and lower pollutant loading as the storm event continues, but even if runoff pollutant concentrations are assumed to be constant, capturing the majority of small storms greatly reduces pollutant loads.

For planning purposes, annual loads with and without 95th percentile capture can be estimated by (LID, 2011):

$$L = \frac{PC_p R_v C}{100} \qquad \text{(D.1)}$$

Where,

L = annual load (kg/ha-yr)

P = annual precipitation (mm/yr)

C_p = correction factor for events that do not produce runoff (0.9 for impervious areas)

R_v = runoff coefficient for drainage area

C = pollutant event mean concentrations (EMC, mg/L)

Whereas for design purposes a continuous model such as SWMM or HSPF may be more appropriate in order to assess pollutant loads across a variety of meteorological conditions. For estimating pollutant loads from urban areas with storm pipe networks the SWMM model will be most appropriate, whereas for areas with more natural land use types and no storm drains, the HSPF model will be most appropriate.

1.2 REGIONAL STORMWATER MANAGEMENT REQUIREMENTS

Stormwater management requirements may be established at the state or local level and vary throughout the country. Often specific design requirements or general guidelines are provided by state and local agencies. Common requirements are provided below.

1.2.1 Quantity control

Most stormwater management programs began at the local level and required developments to address peak flow attenuation. These ordinances typically require that post construction peak flow rates do not exceed pre-construction peak flow rates for a series of storm events. These events can include some or all of the following: 2-year, 5-year, 10-year, 25-year, 50-year and or 100-year storm events. This results in a requirement for detention (quantity control). The specific requirements may be established by cities, counties, regional or State agencies.

1.2.2 Extreme Flood Protection

The Extreme Flood Protection criterion specifies that all stormwater management facilities be designed to safely handle the runoff from a large (extreme) storm event, typically the 100-year, 24-hour return frequency storm event, denoted Q_f. This may be accomplished either by:

1. Controlling Q_f through on-site or regional structural stormwater controls to maintain the existing 100-year floodplain. This is done where residences or other structures have already been constructed within the 100-year floodplain fringe area; or

2. By sizing the on-site conveyance system to safely pass Q_f and allowing it to discharge into a receiving water whose protected full build out floodplain is sufficiently sized to account for extreme flow increases without causing damage.

The intent of the extreme flood protection is to prevent flood damage from infrequent but large storm events, maintain the boundaries of the mapped 100-year floodplain, and protect the physical integrity of the structural stormwater controls as well as downstream stormwater and flood control facilities.

It is recommended that Q_f be used in the routing of runoff through the drainage system and stormwater management facilities to determine the effects on the facilities, adjacent property, and downstream. Emergency spillways of structural stormwater controls should be designed appropriately to safely pass the resulting flows.

1.2.3 Water Quality

The Water Quality sizing criterion, denoted WQV, specifies a treatment volume required to remove a significant percentage of the total pollution load inherent in stormwater runoff by intercepting and treating between the 80th and 90th (typically the 85th) percentile storm event, which varies from approximately 0.5 inches in arid regions to 1.5 inches in humid regions. The Water Quality Volume is a runoff volume that is directly related to the amount of impervious cover at a site. This criterion is often specified by the local or state agency.

Hydrologic studies show that small-sized, frequently occurring storms account for the majority of rainfall events that generate stormwater runoff. Consequently, the runoff from these storms also accounts for a major portion of the annual pollutant loadings. Therefore, by treating these frequently occurring smaller rainfall events and a portion of the stormwater runoff from larger events, it is possible to effectively mitigate the water quality impacts from a developed area.
A water quality treatment volume (WQV) is specified to size structural control facilities to treat these small storms up to a maximum runoff depth and the "first flush" of all larger storm events. The 85th percentile volume has traditionally been considered the point of optimization between pollutant removal ability and cost-effectiveness. Capturing and treating a larger percentage of the annual stormwater runoff would provide only a small increase in additional pollutant removal, but would considerably increase the required size (and cost) of the structural stormwater controls.

The most common approach to determining this volume is to use the volumetric runoff coefficient (Rv) which was derived from a regression analysis performed on rainfall- runoff volume data from a number of cities nationwide and is a shortcut method considered adequate for runoff volume calculation for the type of small storms normally considered in stormwater quality calculations.

Some states allow a maximized stormwater quality capture volume for the area, based on historical rainfall records, determined using the formula and volume capture coefficients set forth in Urban Runoff Quality Management (WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, 1998, pages 175-178).

The Urban Runoff Quality Management approach is based on two regression equations. The first regression equation relates rainfall to runoff. The rainfall to runoff regression equation was developed using 2 years of data from more than 60 urban watersheds nationwide. The second regression equation relates mean annual runoff-producing rainfall depths to the "Maximized Water Quality Capture Volume" which corresponds to the "knee of the cumulative probability curve". This second regression was based on analysis of long-term rainfall data from seven rain gages representing climatic zones across the country. The Maximized Water Quality Capture Volume corresponds to approximately the 85th percentile runoff event, and ranges from 82 to 88%.

The two regression equations that form the Urban Runoff Quality Management approach are as follows:

$$C = 0.858i3 - 0.78i2 + 0.774i + 0.04 \quad (4.13)$$

$$P0 = (a \cdot C) \cdot P6 \quad (4.14)$$

Where,

C = runoff coefficient

i = watershed imperviousness ratio which is equal to the percent total imperviousness divided by 100

P_0 = Maximized Detention Volume, in watershed inches

A = regression constant, a=1.582 and a=1.963 for 24 and 48 hour draw down, respectively

P_6 = mean annual runoff producing rainfall depths, in watershed inches

The Urban Runoff Quality Management Approach is simple to apply and usually results in a smaller WQV. The following steps describe the use of the approach:

1. Identify the "BMP Drainage Area" that drains to the proposed BMP. This includes all areas that will contribute runoff to the proposed BMP, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the BMP.

2. Calculate the "Watershed Imperviousness Ratio" (i), which is equal to the percent of total impervious area in the "BMP Drainage Area" divided by 100.

3. Calculate the "Runoff Coefficient" (C) using the following equation:

$$C = 0.858i3 - 0.78i2 + 0.774i + 0.04$$

4. Determine the "Mean Annual Runoff" (P_6) for the "BMP Drainage Area".

5. Determine the "Regression Constant" (a) for the desired BMP drain down time.
   Use a = 1.582 for 24 hrs and a=1.963 for 48 hr draw down.

6. Calculate the "Maximized Detention Volume" (P_0) using the following equation:
   $$P_0 = (a \cdot C) \cdot P_6$$

7. Calculate the required capture volume of the BMP by multiplying the "BMP Drainage Area" from Step 1 by the "Maximized Detention Volume" from Step 6 to give the BMP volume. Due to the mixed units that result (e.g., ac-in., ac-ft) it is recommended that the resulting volume be converted to ft^3 for use during design.

1.2.4 Flow-Based BMP Design

Flow-based BMP design standards apply to BMPs whose primary mode of pollutant removal depends on the rate of flow of runoff through the BMP. Examples of BMPs in this category include swales, screening devices, and many proprietary products. Typically, a flow-based BMP design criteria calls for the capture and infiltration or treatment of the flow runoff produced by rain events of a specified magnitude.

The following are examples of flow-based BMP design standards from current municipal stormwater permits. The permits require that flow-based BMPs be designed to capture and then to infiltrate or treat stormwater runoff equal to one of the following:

- 10% of the 50-yr peak flow rate (Factored Flood Flow Approach)

- The flow of runoff produced by a rain event equal to at least two times the 85th percentile hourly rainfall intensity for the applicable area, based on historical records of hourly rainfall depths

- The flow of runoff resulting from a rain event equal to a pre-determined intensity (Uniform Intensity Approach)

1.2.5 Volume Control

The criteria for maintaining recharge is often based on the average annual recharge rate of the hydrologic soil group(s) (HSG) present at a site as determined from USDA, NRCS Soil Surveys, or from detailed site investigations. More specifically, each specific recharge factor is based on the USDA average annual recharge volume per soil type divided by the annual rainfall in a particular state and multiplied by 90%. This keeps the recharge calculation consistent with the WQV methodology. Thus, an annual recharge volume requirement is specified for a site as follows:

The intent of the recharge criteria is to maintain existing groundwater recharge rates at development sites. This helps to preserve existing water table elevations thereby maintaining the hydrology of streams and wetlands during dry weather. The volume of recharge that occurs on a site depends on slope, soil type, vegetative cover, precipitation and evapo-transpiration. Sites with natural ground cover, such as forest and meadow, have higher recharge rates, less runoff, and greater transpiration losses under most conditions. Because development increases impervious surfaces, a net decrease in recharge rates is inevitable.

1.2.6 Channel Protection (Stream Stability)

The Channel Protection sizing criterion often specifies that 24 hours of extended detention be provided for runoff generated by the 1-year, 24-hour rainfall event to protect downstream channels. The required volume needed for 1-year extended detention, denoted *CPv*, is roughly equivalent to the required volume needed for peak discharge control of the 5- to 10-year storm.

The increase in the frequency and duration of bankfull flow conditions in stream channels due to urban development is one of the primary causes of stream bank erosion and the widening and downcutting of stream channels. Therefore, it is believed that channel erosion downstream of a development site can be significantly reduced by storing and releasing stormwater runoff from the channel-forming runoff events in a gradual manner to ensure that critical erosive velocities and flow volumes are not exceeded.

This page intentionally left blank.

SECTION 6: Pollution Prevention / Good Housekeeping

This page intentionally left blank.

SECTION 6: Pollution Prevention / Good Housekeeping
DCBP APPENDIX

This page intentionally left blank.

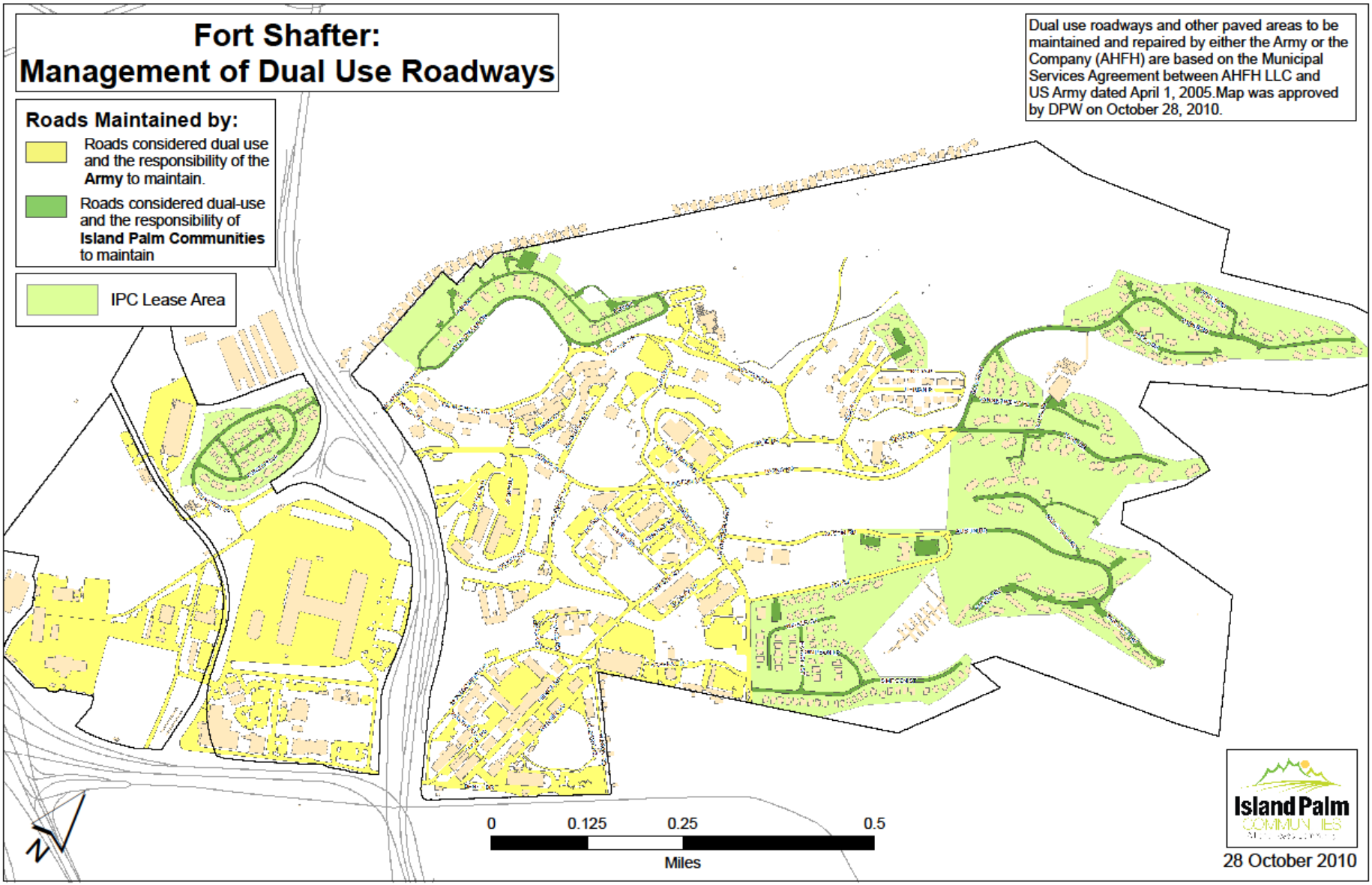
DCBP APPENDIX A
Street Sweeping Routes and Schedules

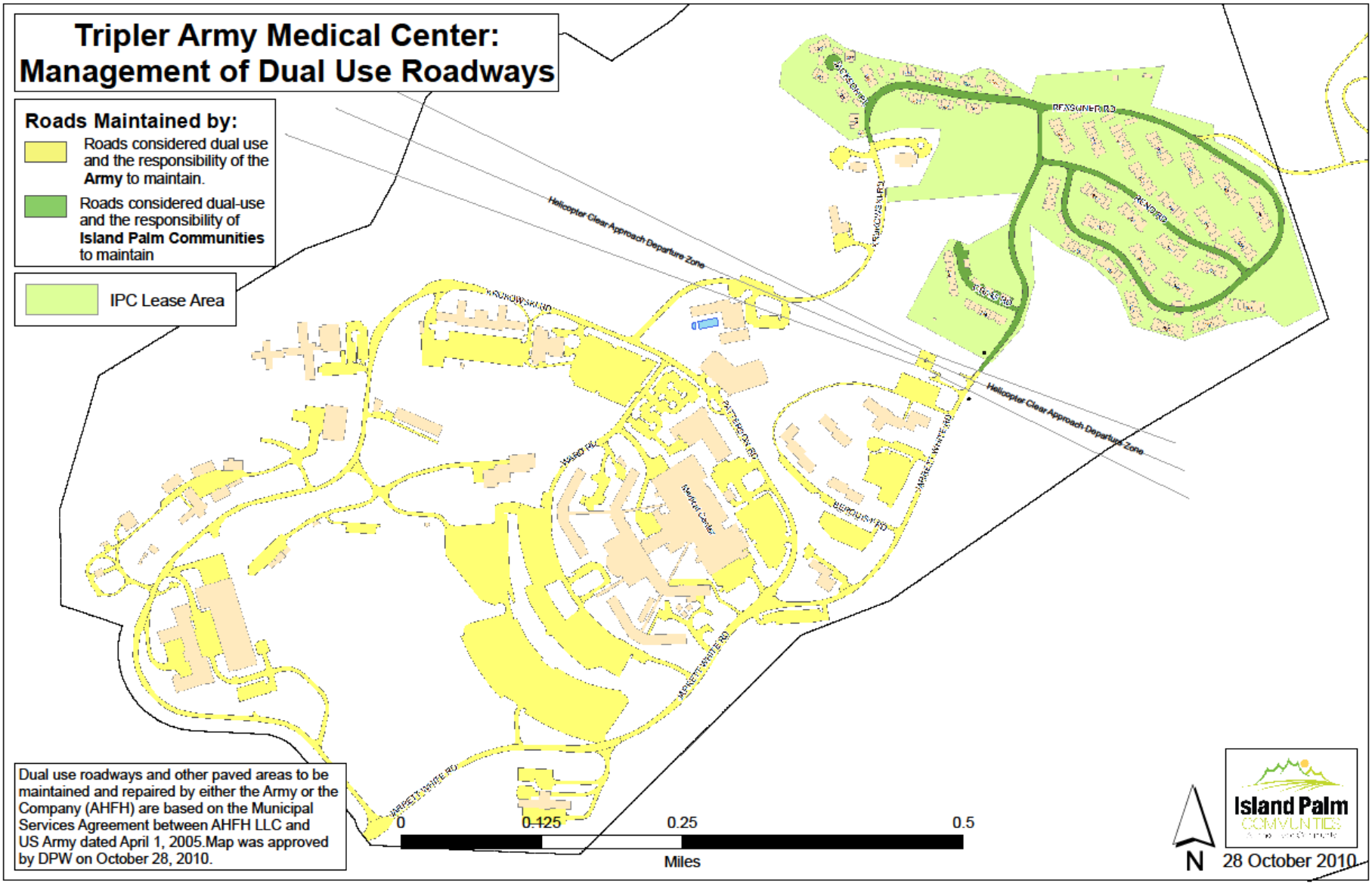
This page intentionally left blank.

SCHEDULES AND ROUTES

Facility	Frequency			Route	
Fort Shafter	Monday	Wednesday	Friday	All roads in YELLOW	See map below
Tripler	Tuesday	Thursday		All roads in YELLOW	See map below
Aliamanu	As requested (Call Customer Service: 656-6741)			N/A	N/A
Wheeler	*	*	*	*	*
Schofield	*	*	*	*	*
Helemano	Tuesday	Thursday		*	*

* Currently being developed


Fort Shafter:
Management of Dual Use Roadways
Dual use roadways and other paved areas to be maintained and repaired by either the Army or the Company (AHFH) are based on the Municipal Services Agreement between AHFH LLC and US Army dated April 1, 2005.Map was approved by DPW on October 28, 2010.
Roads Maintained by:
Roads considered dual use and the responsibility of the Army to maintain.
Roads considered dual-use and the responsibility of Island Palm Communities to maintain
IPC Lease Area
0
0.125
0.25
0.5
Miles
Island Palm
28 October 2010


Tripler Army Medical Center:
Management of Dual Use Roadways
Roads Maintained by:
Roads considered dual use and the responsibility of the Army to maintain.
Roads considered dual-use and the responsibility of Island Palm Communities to maintain
IPC Lease Area
Helicopter Clear Approach Departure Zone
Helicopter Clear Approach Departure Zone
KAUKOWSKI RD
HARO RD
PATTERSON RD
Market Center
MARKET WHITE RD
BERGUS RD
MARKET WHITE RD
MARKET WHITE RD
Dual use roadways and other paved areas to be maintained and repaired by either the Army or the Company (AHFH) are based on the Municipal Services Agreement between AHFH LLC and US Army dated April 1, 2005.Map was approved by DPW on October 28, 2010.
0
0.125
0.25
0.5
Miles
N
Island Palm
COMMUNITIES
28 October 2010

This page intentionally left blank.

DCBP APPENDIX B
Action Plan for Retrofitting Structural BMPs

This page intentionally left blank.

ACTION PLAN FOR RETROFITTING STRUCTURAL BMPs

US ARMY GARRISON, HAWAII
SEPTEMBER 2014

TABLE OF CONTENTS

Page

REQUIREMENT.....1

SELECTION OF RETROFIT SITES 1

SUMMARY OF RETROFIT PROJECTS 2

FUTURE RETROFIT PROJECTS 6

ATTACHMENT 1: PROPOSED RETROFIT SITE SUMMARIES..... A-1

LIST OF TABLES

Number	Title	Page
Table 1	Project Description, Drainage Area, Impervious Area, and Size of LID/BMP Site	3
Table 2	Ranking of LID Retrofit Projects for Various Criteria (Sorted High to Low)	5
Table 3	Estimated Construction Cost, Design Cost, Annual Maintenance Costs for LID Retrofit Projects, and five-year implementation schedule	6

REQUIREMENT

In accordance with the US Army Garrison, Hawaii (USAG-HI) Municipal Separate Storm Sewer System (MS4) Permit Number HI S000090 effective April 7, 2014, Part D.1.f.(1)(iv), USAG-HI is required to developed the following Action Plan for Retrofitting Structural Best Management Practices (BMPs) within their existing MS4. The MS4 Permit requirements are as follows:

> *Pollution Prevention/Good Housekeeping D.1.f.(1)(iv)*
> *"Action Plan for Retrofitting Structural BMPs – Provide the DOH with an Action Plan for Retrofitting Structural BMPs within one (1) year of the effective date of this permit, which shall identify retrofits to be implemented, explanation on the basis of their selection and an implementation schedule. The implementation schedule shall cover a five (5) year period and be updated yearly to include additional retrofit projects with water quality protection measures. The annual updates to the implementation schedule shall be included in the Annual Report with a description of the projects status. The Action Plan may include, but not be limited to projects in compliance with any TMDL implementation and monitoring plan."*

SELECTION OF RETROFIT SITES

The purpose of the Action Plan for Retrofitting Structural BMPs is to reduce storm water pollution by designing and constructing/installing appropriate and cost-effective BMPs (retrofits) in strategic locations and structures within USAG-HI's existing MS4. Potential retrofit sites were selected through a comprehensive study performed by the US Army Corps of Engineers Engineer Research and Development Center (USACE-ERDC). The objective of this study was to identify and rank potential Low Impact Development (LID) projects with the focus at Schofield Barracks and Wheeler Army Airfield. The following tasks were completed to analyze the most appropriate LID projects:

1) Identified potential LID project locations through analysis of available data, such as satellite imagery, drainage maps, and digital elevations maps.
2) Developed a list of preliminary projects.
3) Conducted a series of field visits on USAG-HI facilities to evaluate, photograph, and document potential LID projects.
4) Checked potential LID project sites against the latest (2011) Master Development Plan (MDP) obtained from the USAG-HI Directorate of Public Work Master Planning Division (DPW-MPD).
5) Refined preliminary list of projects based on field visits, including elimination of projects due to issues arising in field checking or conflicts with the MDP, consolidation of some small projects, and the dividing of some large projects.
6) Prepared a table with information on each remaining potential project, including: project description, drainage area divided into three land use areas - impervious, disturbed, and natural surface, BMP types and area.
7) Prepared spreadsheets for each potential project to calculate runoff, sediment (total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP) loads from the sites.
8) Calculated the reductions in flow as well as the reductions in TSS, TN, and TP as a result of the BMPs employed in each project.
9) Prepared an aerial view figure of each potential LID project location, along with a photograph of the location and a summary of load reductions and calculations for each site.

10) Prepared a summary and cost analysis of the LID projects.
11) Ranked each project for hydrologic, water quality, aesthetic, and recreation benefits, as well as construction cost, maintenance costs, and constructability.
12) Final selection of five year implementation projects determined by current and projected funding availability.

SUMMARY OF RETROFIT PROJECTS

A total of **12** individual LID projects were selected for consideration. Projects for consideration were focus at Schofield Barracks because it houses majority of the industrial facilities within USAG-HI's existing MS4. Application of LID retrofits would maximize our benefits at this location. These projects were selected based on the opportunity to potentially provide hydrology and water quality, as well as educational, aesthetic, and recreational benefits. We quantitatively analyzed the potential of these projects to provide for hydrologic and water quality benefits. We also calculated the construction and maintenance costs for each potential project. We used this quantitative information along with qualitative information to rank each of the projects. Final selection of five year implementation projects determined by current and projected funding availability

Table 1 provides a summary of proposed retrofit projects, drainage areas, impervious areas, and size of LID/BMP site. **Table 2** provides the rankings of these proposed retrofit projects based on criteria mentioned in the previous paragraph. **Table 3** provides estimated construction cost, design cost, annual maintenance costs, and proposed five-year implementation schedule. The implementation year is the year in which the proposed retrofit is scheduled to be completed; however, this schedule is subject to change due to funding availability, permitting delays, or other unforeseen circumstances. Changes to the implementation schedule will be provided in the Annual Report.

Table 1. Project Description, Drainage Area, Impervious Area, and Size of LID/BMP Site

Retrofit Number	Location	BMPs	Impervious Surface (m^2)	Natural Ground (including disturbed land) (m^2)	Impervious Surface (%)	Total Area (m^2)	LID Site Size (m^2)	Disturbed Land (m^2)	Natural Land (m^2)
S-1	The drainage and grass covered area located in Lyman Gate	Bioretention, Sand Trench, vegetated swale, & Pocket Wetland	101,363	49,275	67%	150,638	5,283	3,980	45,296
S-3A	A ditch along Lyman Road	Geotextile	500,489	102,510	83%	602,999	5,075	12,111	0
S-3B	A ditch along Lyman Road	Geotextile	464,584	95,156	83%	559,739	1,870	5,098	0
S-3C	A ditch along Lyman Road	Geotextile	42,617	6,971	86%	49,589	3,102	6,971	0
S-3D	Ditch on Lyman Rd	Bioretention, Vegetated Swale, & Gravel Trench	917	175	84%	1,092	197	175	0
S-6	The eroded channel along Humphries Road	Vegetated Swale	43,186	95,219	31%	138,405	1,069	35,070	60,149
S-7	A vegetated swale along Trimble Road	Vegetated Swale	45,188	10,717	81%	55,905	2,867	4,505	6,212
S-12	The eroded culvert along McMahon Road	Vegetated Swale	29,177	41,154	41%	70,331	1,359	0	41,154
S-13	The parking lot along North side of the Menoher Road	Bioretention, & Gravel Trench	25,404	14,922	63%	40,327	2,457	0	14,922
S-14	A badly eroded culvert on the intersection area between McMAHON Rd and Capron Avenue	Vegetated Swale	77,266	2,590	97%	79,856	1,849	4,826	1,849

Table 1. Project Description, Drainage Area, Impervious Area, and Size of LID/BMP Site (continued)

Retrofit Number	Location	BMPs	Impervious Surface (m^2)	Natural Ground (including disturbed land) (m^2)	Impervious Surface (%)	Total Area (m^2)	LID Site Size (m^2)	Disturbed Land (m^2)	Natural Land (m^2)
S-21	The parking lot of Bldg 580 (25 Infantry Division Headquarters)	Bioretention, & Gravel Trench	8,242	3,025	73%	11,268	219	0	3,025
S-22	Solomon Elementary School parking lot	Bioretention, & Gravel Trench	3,680	3,128	54%	6,808	542	87	3,041

Table 2. Ranking of LID Retrofit Projects for Various Criteria (Sorted High to Low)

Retrofit No.	Hydrology	Water Quality Benefits	Construction Cost	Constructability	Long-term Operations & Maintenance Cost	Educational Benefits	Aesthetic Benefits	Recreation Benefits (active and/or passive)	Total
S1	4	4	6	5	4	5	5	5	38
S7	3	4	10	5	5	1	4	1	33
S3C	3	3	10	5	5	1	4	1	32
S14	2.5	3	10	5	5	1	4	1	31.5
S6	2	3	10	5	5	1	4	1	31
S3A	2.5	3	9	5	4	1	4	1	29.5
S12	2.5	3	10	4	4	1	4	1	29.5
S22	4	3.5	6	3	1	5	4	3	29.5
S3B	2	3	8	5	3	1	4	1	27
S3D	3.5	3	6	5	3	1	3	1	25.5
S21	3.5	3.5	3	2	1	5	4	3	25
S13	4.5	4	2	3	4	3	3	1	24.5

Table 3. Estimated Construction Cost, Design Cost, Annual Maintenance Costs for LID Retrofit Projects, and five-year implementation schedule					
Cost are Listed in $1,000 of dollars					
Retrofit No.	Construction Cost	Engineer Design Cost	Total Cost	Annual Maintenance Cost	Implementation Year
S1	80	25	105	2	2019
S3A	11	4	15	1	2016
S3B	12	4	16	1	2016
S3C	2	1	3	0.1	2016
S3D	16	5	21	0.1	2017
S6	1	0.4	2	0.1	2015
S7	1	0.3	1	0.1	2015
S12	4	1	6	1	2017
S13	531	170	701	1	2018
S14	2	1	2	0.1	2017
S21	100	32	132	3	2018
S22	45	14	59	3	2019

A detailed description of each retrofit site, including a vicinity map and a summary of the basis for their selection, is provided in **Attachment 1**.

FUTURE RETROFIT PROJECTS

As required by Part D.1.f.(1)(iv) of the MS4 Permit, this Action Plan for Retrofitting Structural BMPs will be updated annually to identify additional retrofit projects. Future retrofits will be selected through the review and evaluation of sites identified as potential projects in previous studies and from the review of data collected during ongoing inspections of the MS4.

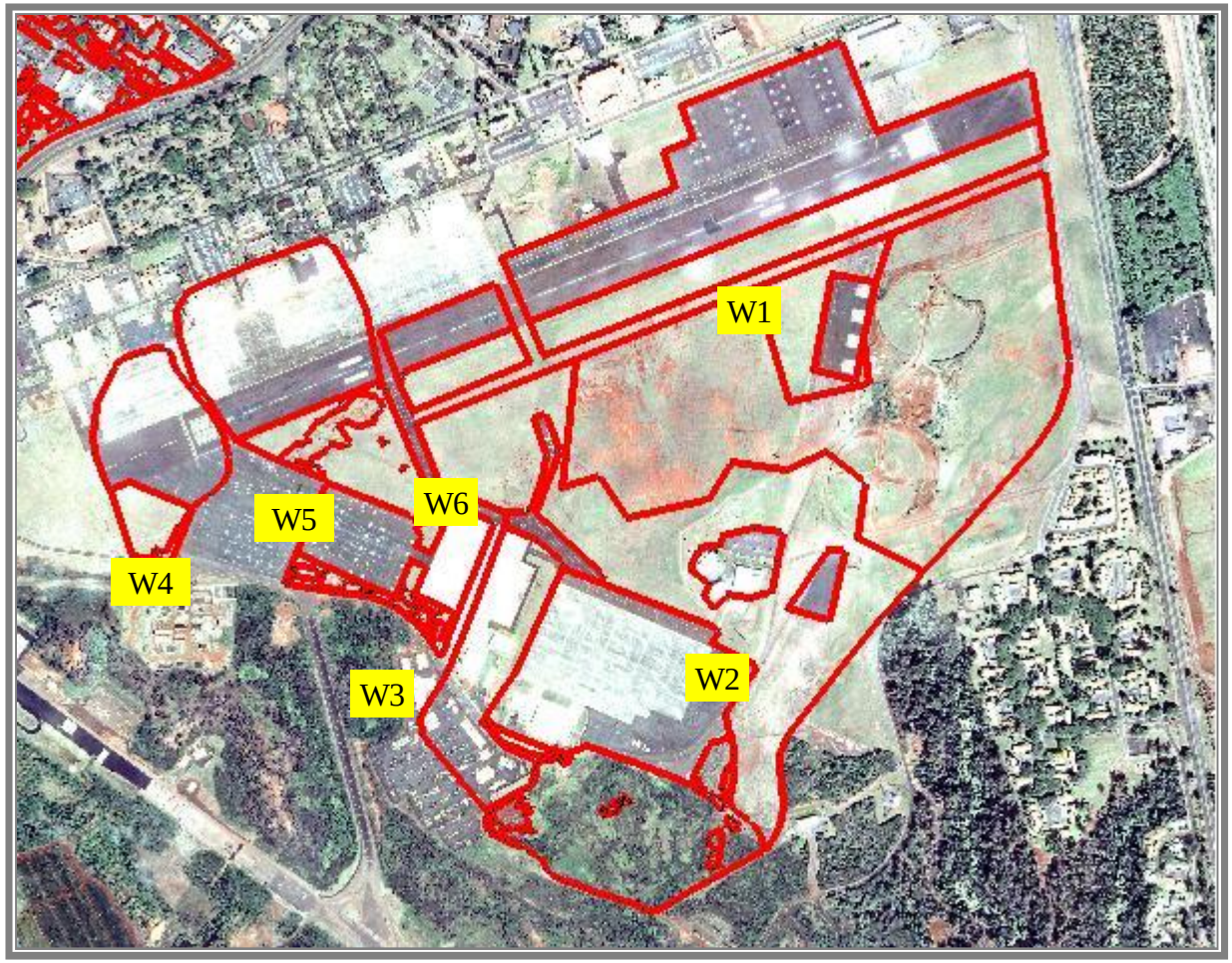
REFERENCES

1. US Army Garrison, Hawaii Municipal Separate Storm Sewer System Permit Number HI S000090, effective April 7, 2014.

2. Stormwater Management LID Retrofit Analysis for US Army Garrison, Hawaii (USAG-HI) NPDES Permit, US Army Corps of Engineers Engineer Research Development Center (USACE-ERDC), dated May 24, 2011.

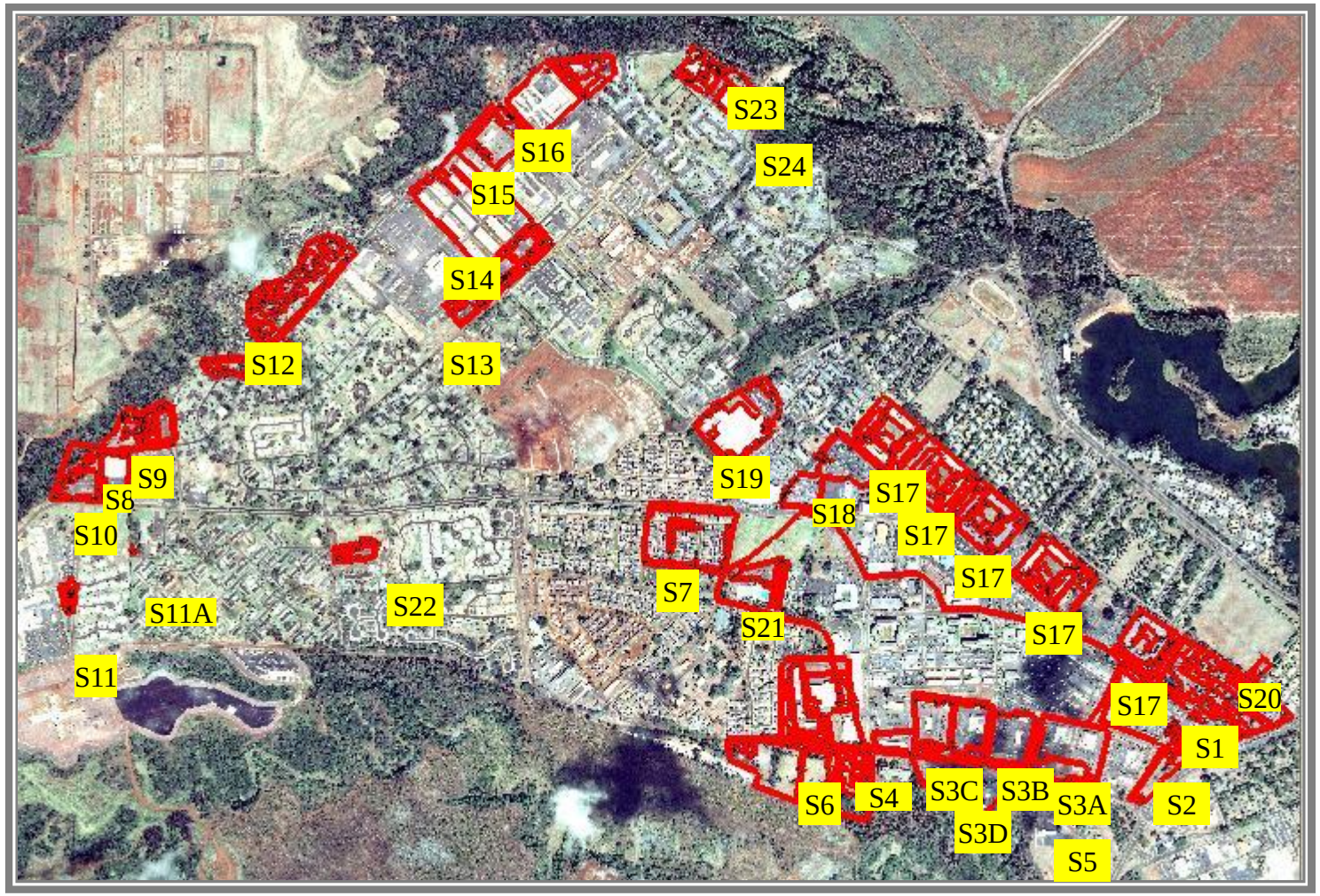
ATTACHMENT 1

PROPOSED RETROFIT SITE SUMMARIES



D---------d
1 cm = 183 m

Figure 1. Location of LID Retrofit Projects on Wheeler Army Airfield



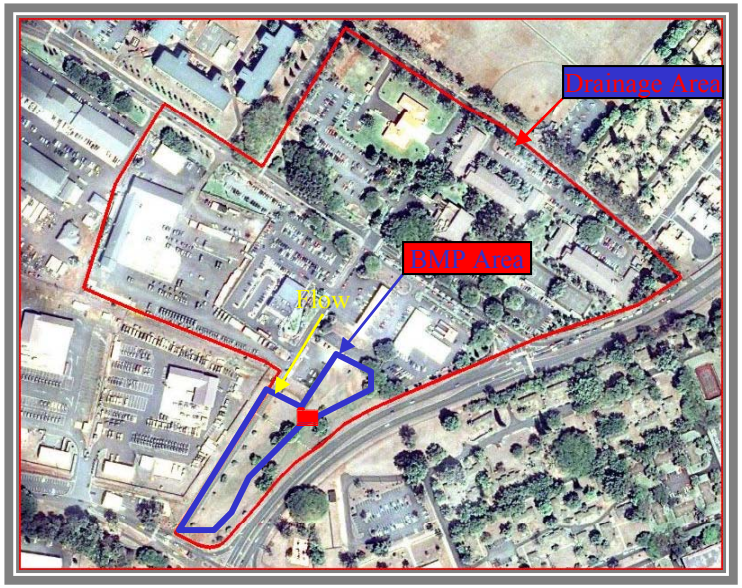
1 cm = 430 m

Figure 2. Location of LID Retrofit Projects on Schofield Barracks

S1

S1 – An undeveloped area near Lyman gate will be used to capture and treat runoff from a large drainage area. The project will consist of bioretention with subsurface gravel/sand trench, pocket wetlands, and a vegetated swale. In addition to treating large amounts of runoff the project will eliminate erosion along a drainage ditch/swale currently circumventing the project area.

Retrofit	S1
Description/ Location	Drainage and grass covered area located in Lyman Gate
BMP	Bioretention, Sand Trench, vegetated swale, & Pocket Wetland
Total Cost	$105,000
Flow Reduction (m^3)	3,675
TSS Reduction (kg)	398
TP Reduction (kg)	1.1
TN Reduction (kg)	9.5
Stream Erosion Reduction/Yr (kg)	4,701
BMPs Area (m^2)	5,283
Bioretention (m^2)	2,089
Pocket Wetland (m^2)	1,528
Vegetated Swale (m^2)	1,666
Drainage Area (m^2)	150,638



1 cm = 70 m

S1, (con't)

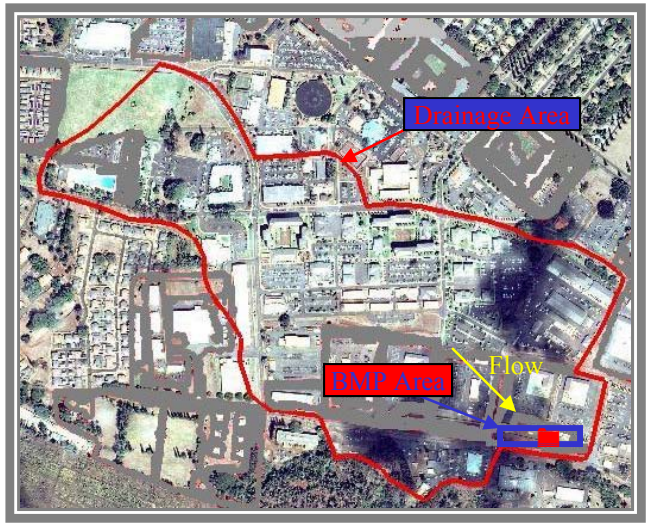
Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S1	4	4	6	5	4	5	5	5	38

S3A

S3 – Ditches along Lyman Road are a major drainage feature at SB. Many of the ditches are eroded, some severely. Due to the varying sizes of the ditches, discharge, and degree of erosion, we propose four separate projects:

- S3A – Geotextile or other channel stabilizing technology.
- S3B – Geotextile or other channel stabilizing technology.
- S3C – Geotextile or other channel stabilizing technology.
- S3D – Vegetated swale and bioretention with gravel trench.

Retrofit	S3A
Description/ Location	Ditches along Lyman Road
BMP	Geotextile
Total Cost	$15,000
Flow Reduction (m^3)	1,203
TSS Reduction (kg)	1,301
TP Reduction (kg)	1.0
TN Reduction (kg)	7.1
Stream Erosion Reduction/Yr (kg)	57,440
BMPs Area (m^2)	5,075
Geotextile (m^2)	5,075
Drainage Area (m^2)	602,999



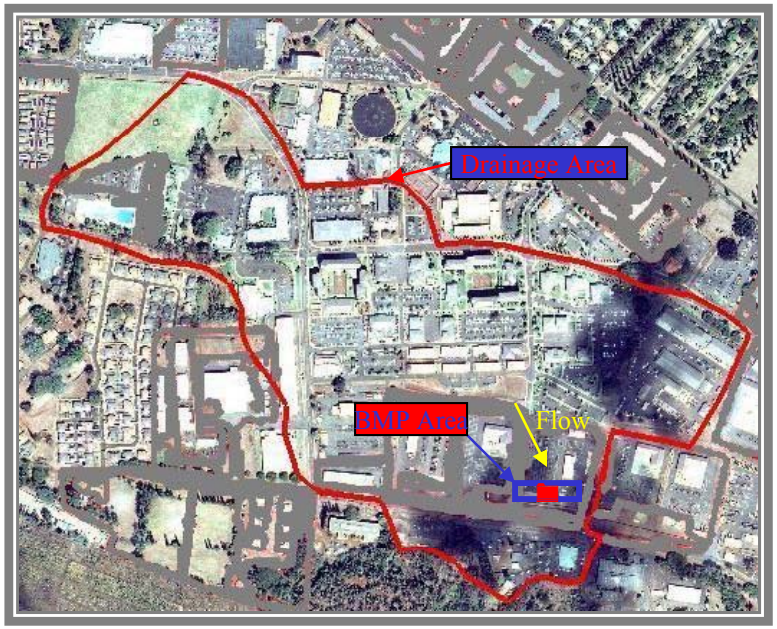
1 cm = 153 m

S3A, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S3A	2.5	3	9	5	4	1	4	1	29.5

S3B

Retrofit	S3B
Description/ Location	Ditches along Lyman Road
BMP	Geotextile
Total Cost	$16,000
Flow Reduction (m^3)	443
TSS Reduction (kg)	1,116
TP Reduction (kg)	0.8
TN Reduction (kg)	5.3
Stream Erosion Reduction/Yr (kg)	51,285
BMPs Area (m^2)	1,870
Geotextile (m^2)	1,870
Drainage Area (m^2)	559,739



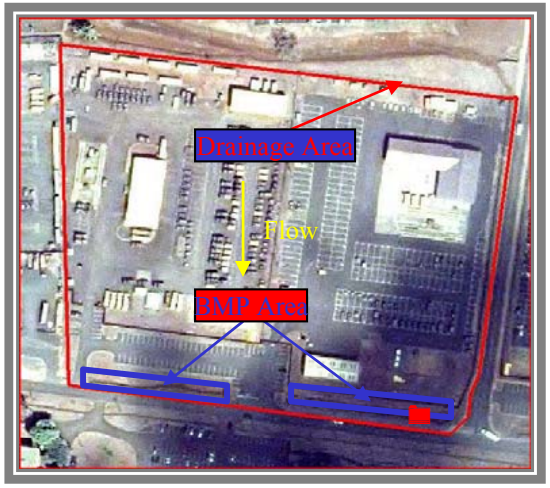
1 cm = 129 m

S3B, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S3B	2	3	8	5	3	1	4	1	27

S3C

Retrofit	S3C
Description/ Location	Ditches along Lyman Road
BMP	Geotextile
Total Cost	$3,000
Flow Reduction (m^3)	736
TSS Reduction (kg)	189
TP Reduction (kg)	0.3
TN Reduction (kg)	1.9
Stream Erosion Reduction/Yr (kg)	24,617
BMPs Area (m^2)	3,102
Geotextile (m^2)	3,102
Drainage Area (m^2)	49,589

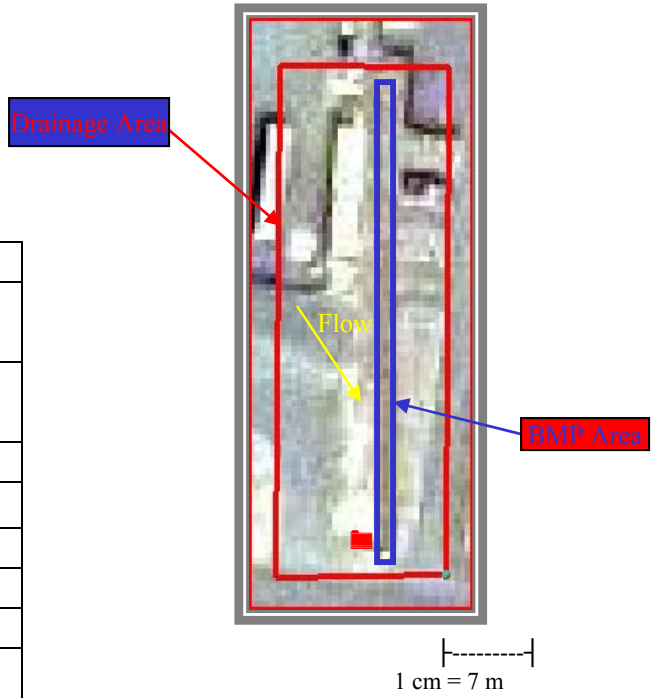


1 cm = 42 m

S3C, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S3C	3	3	10	5	5	1	4	1	32

S3D



Retrofit	S3D
Description/ Location	Small ditch along Lyman Road
BMP	Bioretention, Vegetated Swale, & Gravel Trench
Total Cost	$21,478
Flow Reduction (m^3)	46
TSS Reduction (kg)	5
TP Reduction (kg)	0.0
TN Reduction (kg)	0.1
Stream Erosion Reduction/Yr (kg)	3,693
BMPs Area (m^2)	197
Bioretention (m^2)	79
Vegetated Swale (m^2)	119
Drainage Area (m^2)	1,092

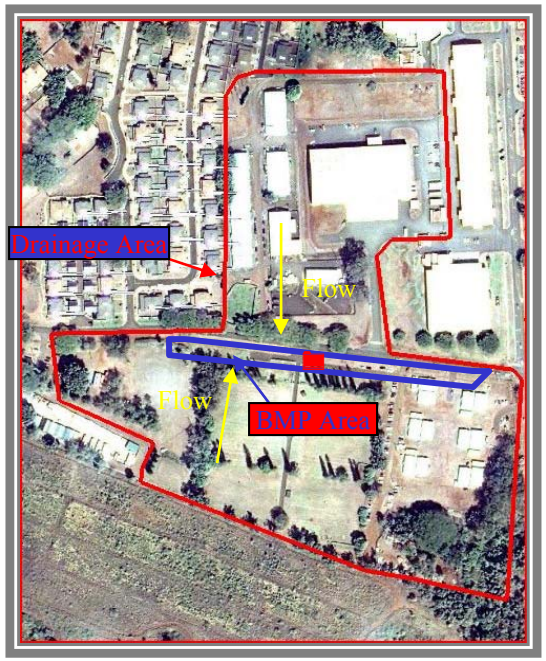
S3D, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S3D	3.5	3	6	5	3	1	3	1	25.5

S6

S6 - The eroded channel along Humphries Road will be retrofitted with a vegetated swale.

Retrofit	S6
Description/ Location	Eroded channel along Humphries Road
BMP	Vegetated swale
Total Cost	$2,000
Flow Reduction (m^3)	253
TSS Reduction (kg)	384
TP Reduction (kg)	0.3
TN Reduction (kg)	1.5
Stream Erosion Reduction/Yr (kg)	3,077
BMPs Area (m^2)	1,069
Vegetated Swale (m^2)	1,069
Drainage Area (m^2)	138,405

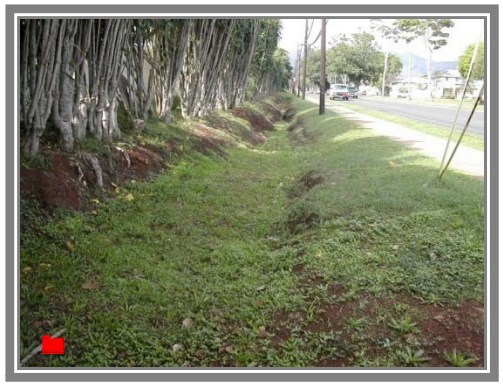


1 cm = 205 m

S6, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S6	2	3	10	5	5	1	4	1	31

S7



S7 – An eroding vegetated swale will be reworked to increase conveyance, reduce erosion, and increase infiltration.

Retrofit	S7
Description/ Location	Vegetated swale along Trimble Road
BMP	vegetated swale
Total Cost	$1,000
Flow Reduction (m^3)	680
TSS Reduction (kg)	174
TP Reduction (kg)	0.2
TN Reduction (kg)	1.7
Stream Erosion Reduction/Yr (kg)	11,471
BMPs Area (m^2)	2,867
Vegetated Swale (m^2)	2,867
Drainage Area (m^2)	55,905

1 cm = 35 m

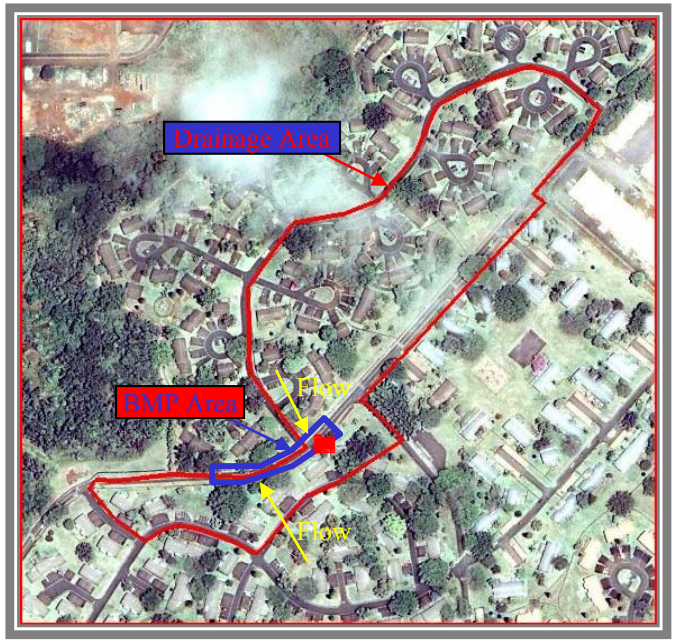
S7, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S7	3	4	10	5	5	1	4	1	33

S12

S12 – Channel erosion near a culvert along McMahon Road will be reduced by retrofitting the channel with a vegetated swale.

Retrofit	S12
Description/ Location	Eroded culvert along Mcmahoh Road
BMP	Vegetated Swale
Total Cost	$6,000
Flow Reduction (m^3)	322
TSS Reduction (kg)	94
TP Reduction (kg)	0.1
TN Reduction (kg)	0.9
Stream Erosion Reduction/Yr (kg)	14,180
BMPs Area (m^2)	1,359
Vegetated Swale (m^2)	1,359
Drainage Area (m^2)	70,331



1 cm = 60 m

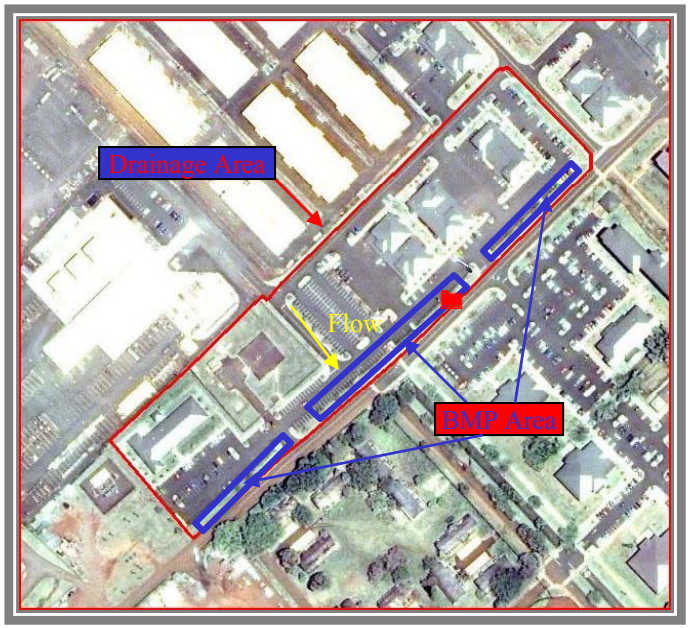
S12, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S12	2.5	3	10	4	4	1	4	1	29.5

S13

S13 – The parking along North side of the Menoher Road will be retrofitted with bioretention and gravel trench using open areas between the parking lot and the road. Flow into the bioretention areas will be accomplished by removing the curb in the parking lot adjacent to the BMPs.

Retrofit	S13
Description/ Location	Parking lot along north side of the Menoher Road
BMP	Bioretention, & Gravel Trench
Total Cost	$701,000
Flow Reduction (m^3)	1,104
TSS Reduction (kg)	91
TP Reduction (kg)	0.3
TN Reduction (kg)	2.3
BMPs Area (m^2)	2,457
Bioretention (m2)	2,457
Drainage Area (m^2)	40,327



1 cm = 47 m

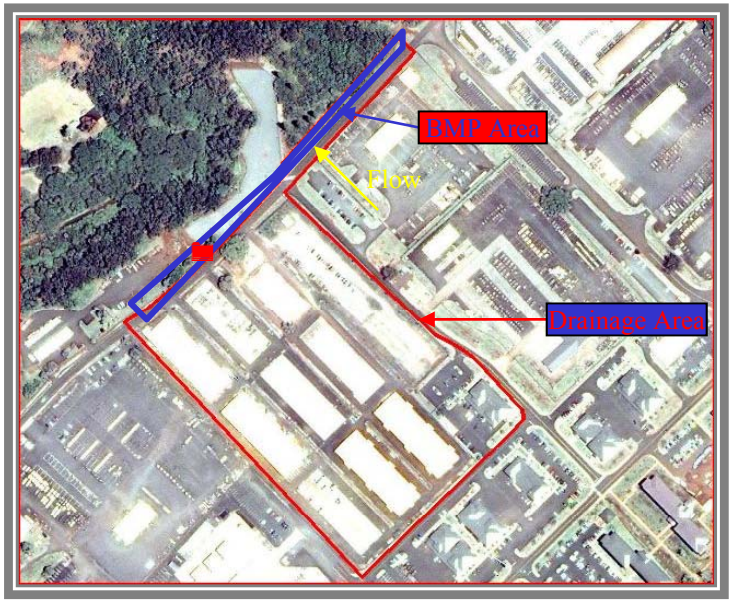
S13, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S13	4.5	4	2	3	4	3	3	1	24.5

S14

S14 – A badly eroded channel will be retrofitted with geotextile to eliminate erosion.

Retrofit	S14
Description/ Location	Badly eroded culvert
BMP	Geotextile
Total Cost	$2,000
Flow Reduction (m^3)	438
TSS Reduction (kg)	238
TP Reduction (kg)	0.2
TN Reduction (kg)	1.6
Stream Erosion Reduction/Yr (kg)	11,488
BMPs Area (m^2)	1,849
Geotextile (m^2)	1,849
Drainage Area (m^2)	79,856



1 cm = 65 m

S14, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S14	2.5	3	10	5	5	1	4	1	31.5

S21

S21 – The parking lot of Bldg 580 (25th Infantry Division Headquarters) will be retrofitted with bioretenion with gravel trench. The BMP will be located in the SE corner of the parking lot, in a paved area currently not used for parking. This retrofit will require removing this pavement. The retrofit will also encompass a small landscaped area between the paved lot and the building. A walkway through the bioretention area will permit access to the building. This retrofit has very high educational benefit.

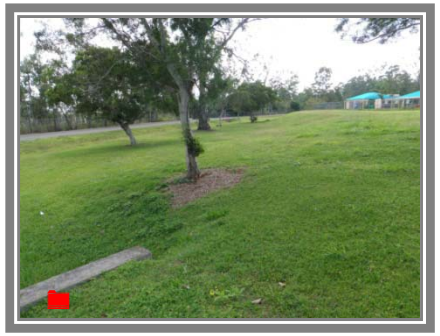
Retrofit	S21
Description/ Location	Bldg 580 parking lot
BMP	Bioretention, & Gravel Trench
Total Cost	$132,000
Flow Reduction (m^3)	301
TSS Reduction (kg)	29
TP Reduction (kg)	0.1
TN Reduction (kg)	0.7
BMPs Area (m^2)	219
Bioretention (m^2)	219
Drainage Area (m^2)	11,268

1 cm = 22 m

S21, (con't)

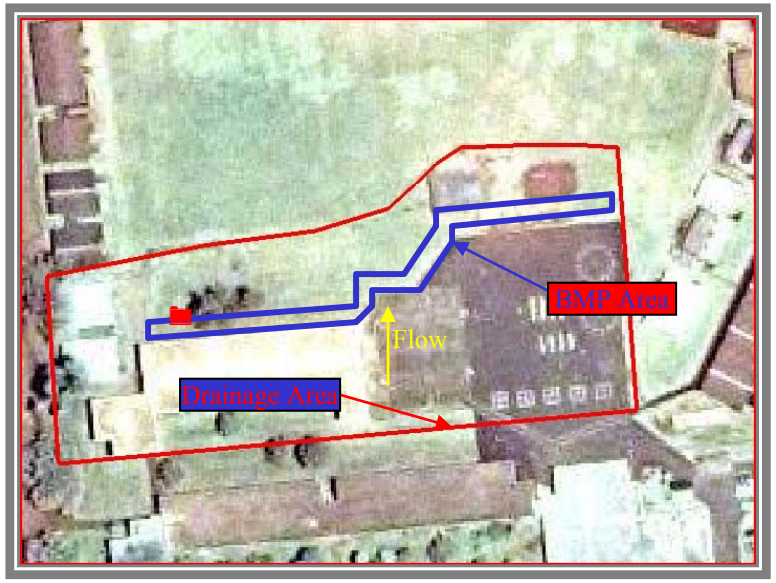
Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S21	3.5	3.5	3	2	1	5	4	3	25

S22



S22 – Landscape areas near the Solomon Elementary School parking lot will be retrofitted with bioretention with gravel trench to reduce and treat runoff from the parking lot. This retrofit has very high educational opportunity.

Retrofit	S22
Description/ Location	Solomon Elementary School parking lot
BMP	Bioretention, & Gravel Trench
Total Cost	$59,000
Flow Reduction (m^3)	171
TSS Reduction (kg)	14
TP Reduction (kg)	0.0
TN Reduction (kg)	0.3
BMPs Area (m^2)	542
Bioretention (m^2)	542
Drainage Area (m^2)	6,808



1 cm = 15 m

S22, (con't)

Ranking of LID Retrofit Projects									
Retrofit No.	**Hydrology**	**Water Quality Benefits**	**Construction Cost**	**Constructability**	**Long-term Operations & Maintenance Cost**	**Educational Benefits**	**Aesthetic Benefits**	**Recreation Benefits (active and/or passive)**	**Total**
S22	4	3.5	6	3	1	5	4	3	29.5

This page intentionally left blank.

CABP APPENDIX A
Integrated Pest Management Plan

This page intentionally left blank.

PEST MANAGEMENT PLAN

FOR

U.S. ARMY GARRISON, HAWAII

April 2008

Prepared by:

ROBIN YAMAMOTO
Pest Management Coordinator

Reviewed by:

ALVIN CHAR
Chief, Environmental Division
Directorate of Public Works

Submitted by:

ALAN K.L. GOO
Director of Public Works

Approved by:

MATTHEW T. MARGOTTA
COL, IN
Commander, USAG-HI

PEST MANAGEMENT PLAN

FOR

U.S. ARMY GARRISON, HAWAII

TABLE OF CONTENTS

	PAGE
EXECUTIVE SUMMARY	5
A. BACKGROUND	6
1. Goal	6
2. Authority	6
3. Objectives	6
B. RESPONSIBILITIES	6
1. Commander	6
2. Director of Public Works	6
3. Director of Community Activities	7
4. Assistant Chief of Staff, Directorate of Plans, Training and Mobilization	7
5. Director of Health Services	7
6. Pest Management Coordinator, DPW	7
7. Building Occupants	8
8. Pest Management Personnel	8
9. Pest Management Quality Assurance Evaluators, DPW	8
C. GENERAL	9
1. Installation Description	9
2. Plan Maintenance	9
D. INTEGRATED PEST MANAGEMENT	9
1. Description	9
2. IPM Approach	9
3. IPM Outlines	10

E. PRIORITY OF PEST MANAGEMENT WORK 10

1. Real Property Pests (Structural/Wood Destroying Pests) 10

2. Disease Vectors and Medically Important Arthropods 11

3. Stored Products Pests 11

4. Ornamental Plant and Turf Pests 12

5. Undesirable Vegetation 12

6. Vertebrate Pests 12

7. Household and Nuisance Pests 13

8. Quarantine Pests 13

9. Other Pest Management Requirements 13

F. SALE AND DISTRIBUTION OF PESTICIDES 13

1. Army Air Force Exchange System Facilities 13

2. Defense Commissary Agency Facilities 13

3. Veterinary Treatment Facility 14

G. HEALTH AND SAFETY 14

1. Requirements 14

2. Hazard Communication 14

3. Personal Protective Equipment 14

4. Pest Control Vehicle 14

5. Spill Kit and Spill Response 14

6. Fire Protection 14

H. ENVIRONMENTAL CONSIDERATIONS 15

1. Protection of the Public 15

2. Sensitive Areas 15

3. Endangered and Protected Species 15

4. Pollution Abatement Procedures 15

I. ADMINISTRATION 15

1. Staffing 15

2. Vehicles 15

3. Materials 15

4. Facilities (storage sites) 15

5. Reports and Records 16

6. Training 16

7. Contracts 16

J. PEST POPULATION MONITORING 17

1. Formosan Subterranean Termites 17

2. German Cockroaches 17

3. Rodents 17

K. PEST MANAGEMENT REFERENCES 17

1. Federal Laws 17

2. Regulations 18

3. USACHPPM Technical Guide No. 138 18

4. Armed Forces Pest Management Board Technical Guides 18

5. Other References, Manuals, Books and Guides 19

6. Periodicals 20

APPENDICES

A. Measures of Merit 21

B. USAG-HI Installations 24

C. Annual Plan Update Form 26

D. Integrated Pest Management Outlines 33

E. Pest Management Plan for Tripler Army Medical Center 58

F. Termite Plan 87

G. Biting Mosquito Species Found in Hawaii 94

H. Golf Course Pest Management Plan 97

I. Aerial Validation Plan 100

J. Work/Financial Plan for Bird Strike Hazard 105

K. Brown Tree Snake Emergency Response Protocol 113

L. Pest Control in the Barracks 125

M. Respirator Program 128

N. Installation Spill Contingency Plan 134

O. Pesticide Inventories 154

P. Pest Management Program for Kilauea Military Camp 162

Q. Endangered/Threatened Species List 164

R. Certified Pesticide Applicator List 170

S. Pest Control Shops Vehicle and Equipment Inventory 172

T. Pesticide Storage Locations 174

U. Family Housing Pest Management Contract 180

V. Memorandum Regarding Installation Management of Pest Control Activities on Residential Communities Initiative (RCI) Properties at Army Installations 199

EXECUTIVE SUMMARY

The Pest Management Plan for U.S. Army Garrison, Hawaii (USAG-HI) describes the installation's pest management requirements, outlines the resources necessary for pest surveillance and control, and describes the administrative, safety, and environmental requirements of the program, and how these resources and requirements will enable USAG-HI to provide effective pest control for all of its customers.

USAG-HI consists of approximately 189,783 acres divided between Schofield Barracks area and the Fort Shafter area on the island of Oahu and the Pohakuloa Training Area (PTA) and Kilauea Military Camp (KMC) on the island of Hawaii. The mission of USAG-HI is to provide quality support to the soldiers and their dependents who live and train in the State of Hawaii.

This plan provides guidance for operating and maintaining an effective pest management program and is to be used as a tool to reduce reliance on pesticides, to enhance environmental protection, and to maximize the use of integrated pest management techniques.

This plan applies to all activities and individuals working, residing, or otherwise doing business on these installations, and will be implemented to the maximum extent practicable. At no time will pest management operations be done in a manner which violates U.S. Environmental Protection Agency laws and regulations or cause harm to personnel or the environment.

There are several objectives to this plan. One is to allow USAG-HI to meet the pest management Measures of Merit (MOMs) approved by the Defense Environmental Security Council in December 1993 and subsequently revised by the Assistant Deputy Under Secretary of Defense (Environment, Safety and Occupational Health) in July 2004. These MOMs have in turn been adopted by Headquarters, Department of the Army (HQDA) and passed down through the Installation Management Command (IMCOM) to all installations. These measures are: 1) to ensure all installations have pest management plans that are reviewed and updated annually by pest management professionals; 2) to maintain pesticide usage at levels equal to the average use for FY 02 and FY 03; and 3) to ensure that all DoD installation pesticide applicators are properly certified within two years of employment.

Other objectives are to ensure effective, economical and environmentally acceptable pest management and maintain compliance with pertinent laws and regulations.

In order to meet these objectives, this plan outlines integrated pest management (IPM) techniques to be used. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. It reflects current Department of Defense (DoD)/Army policies, procedures and standards and incorporates the requirements of the Environmental Protection Agency (EPA) and the State of Hawaii.

A. BACKGROUND

1. Goal. This plan describes the pest management program for U. S. Army Garrison, Hawaii and is based on integrated pest management (IPM) techniques. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks. This plan provides guidance for operating and maintaining an effective pest management program and is to be used as a tool to reduce reliance on pesticides, to enhance environmental protection, and to maximize the use of IPMs. It reflects current Department of Defense (DoD)/Army policies, procedures and standards and incorporates the requirements of the Environmental Protection Agency (EPA) and the State of Hawaii. Federal Agencies are mandated to use IPM.

2. Authority.

a. DoD Instruction 4150.7, DoD Pest Management Program, 22 April 1996.

b. Army Regulation (AR) 200-1, Environmental Protection and Enhancement, 28 August 2007.

3. Objectives. Integrated pest management (IPM) consists of the judicious use of both chemical and non-chemical control techniques to achieve effective pest management with minimal environmental contamination. Adherence to the plan will ensure effective, economical and environmentally acceptable pest management and will maintain compliance with pertinent laws and regulations, and will enable the garrison to continue to meet the objectives of the Measures of Merit (MOMs) approved by the Defense Environmental Security Council in December 1993 and revised by the Assistant Deputy Under Secretary of Defense (Environment, Safety and Occupational Health) in July 2004 (Appendix A). These objectives are 1) to ensure all installations have pest management plans that are reviewed and updated annually by pest management professionals, 2) to maintain pesticide usage at levels equal to the average use for FY 02 and FY 03, and 3) to ensure that all DoD installation pesticide applicators are properly certified within two years of employment.

B. RESPONSIBILITIES

1. Commander, USAG-HI.

a. Designate the Directorate of Public Works (DPW) Entomologist, Mr. Robin Yamamoto, as Pest Management Coordinator (PMC) for all pest management activities.

b. Approve and support the pest management plan.

c. Ensure that installation personnel performing pest control receive adequate training, and achieve pest management certification as required.

d. Ensure that all pest management operations are conducted safely and have minimal impact on the environment.

2. Director of Public Works.

a. Determine the pest management requirements for the installation.

b. Request and monitor contract pest management operations.

c. Obtain and maintain adequate supplies of pesticides and pesticide dispersal equipment, and ensure that the equipment is properly maintained.

d. Maintain adequate records of pest management operations.

3. Director of Community Activities.

a. Obtain and maintain adequate Golf Course supplies of pesticides and pesticide dispersal equipment, ensure that pesticides are properly stored and that the equipment is properly maintained.

b. Ensure that Golf Course personnel performing pest control receive adequate training, and achieve pest management certification.

c. Maintain adequate records of pest management operations.

4. Assistant Chief of Staff, Directorate of Plans, Training and Mobilization (DPTM)

a. Obtain and maintain adequate supplies of pesticides and pesticide dispersal equipment for the training ranges, ensure that pesticides are properly stored and that the equipment is properly maintained.

b. Ensure that range maintenance personnel performing pest control receive adequate training, and achieve pest management certification.

c. Maintain adequate records of pest management operations.

5. Director of Health Services.

a. Chief, Department of Preventive Medicine.

(1) Conduct surveillance for pests which could adversely affect the health and welfare of the installations.

(2) Coordinate with local health officials to determine the prevalence of disease vectors and other public health pests in the area surrounding the installations.

(3) Monitor pesticide sales at the Self-Help Stores, the Commissary, and the Post Exchange.

(4) Evaluate the health aspects of the pest management program.

b. Chief, Veterinary Services.

(1) Conduct surveillance for pests which destroy food stored in installation food storage facilities.

(2) Provide advice to pet owners concerning pests which may adversely affect their animals.

6. Pest Management Coordinator, DPW.

a. Prepare, monitor, and update the installation pest management plan.

b. Coordinate with activities conducting pest surveillance or controlling pests to ensure all applicable information is recorded and reported as required by this plan.

c. Monitor the types, distribution and use of pesticides on the installation, and report the total amount of active ingredient used by the installation each fiscal year.

d. Function as a point of contact between those individuals who store and apply pesticides (e.g., DPW pest control shops, golf course personnel, DPTM personnel, pest control contractors, tenant activities) and activities or individuals who document or deal with pesticide use in their programs (e.g., DPW Environmental Division, Safety Office, Fire Department, Industrial Hygienist).

e. Oversee the technical aspects of the self-help program with respect to pest control items and training of family housing residents.

f. Monitor certification and continuing pest management training for DoD installation pesticide applicators and ensure that all DoD installation pesticide applicators are properly certified within two years of employment.

g. Coordinate and monitor contracts dealing with pesticide application.

h. Coordinate with local, State and Federal agencies, as necessary, to conduct the installation's pest management program.

i. Serve as the initial point of contact for all pest management issues.

7. Building Occupants.

a. Apply good sanitary practices to prevent pest infestations.

b. Use all non-chemical pest control techniques available to the fullest extent before requesting further assistance from DPW.

c. Cooperate fully with DPW personnel and contractors in scheduling pest management operations, to include preparing the areas to be treated.

8. Pest Management Personnel.

a. Use integrated pest management techniques to the maximum extent possible.

b. Control pests according to the provisions of this plan.

c. Operate in a manner that minimizes risk of contamination to the environment and personnel.

d. Ensure that superiors are kept informed of changes in pest management requirements.

e. Request pest management supplies and equipment in a timely manner.

f. Maintain effective liaison with installation health and environmental officials.

9. Pest Management Quality Assurance Evaluators, DPW

a. Ensure that pesticides are properly applied by contractors.

b. Ensure that proper records are maintained.

c. Maintain effective liaison with installation health and environmental officials.

C. GENERAL

1. Installation Description. The United States Army Garrison, Hawaii (USAG-HI) is comprised of twenty-two sub-installations located throughout the Hawaiian Islands sited on fee simple, lease and ceded lands. Total acreage of all installations is 189,782.86 acres. The names of the installations and their size are at Appendix B.

2. Plan Maintenance. The Installation Pest Management Coordinator maintains the pest management plan. Changes are made to the plan throughout the fiscal year as necessary and the entire plan will be reviewed and updated annually. A plan update form (PUF) and pesticide use proposal (PUP) will be submitted to Army Environmental Command (AEC) by October 31 for technical review unless there are major changes to the plan. The latest PUF and PUP submissions are at Appendix C.

D. INTEGRATED PEST MANAGEMENT

1. Description. Integrated pest management (IPM) is the use of multiple techniques to prevent or suppress pests in a given situation. Although IPM emphasizes the use of non-chemical strategies, chemical control may be an option used in conjunction with other methods. Integrated pest management strategies depend on surveillance to establish the need for control and to monitor the effectiveness of management efforts.

2. IPM Approach. The four basic methods of pest control described below are the heart of IPM, and are descriptive of the philosophy used on USAG-HI installations to manage pests. While any one of these methods may solve a pest problem, often several methods are used concurrently, particularly if long term control is needed. For example, screens may be used to prevent mosquitoes from entering buildings, breeding areas may be filled in or drained to eliminate larval habitat, and pesticides may be used to kill adult mosquitoes. Screens will protect people inside, but do little to keep people from being bitten outdoors. Larval control may eliminate mosquito breeding on the installation, but may not prevent adult insects from flying onto the installation from surrounding areas. Insecticides may kill a majority, but not all of the adult mosquitoes, so those remaining can constitute a breeding population. Individually, each control endeavor may reduce the problem to a degree, but will not provide long lasting control.

Although chemical control is an integral part of IPM, non-chemical control is stressed. Chemical control is almost always a temporary measure and, in the long run, more expensive. Non-chemical control, which may initially be more expensive than using chemicals, will usually be more cost effective in the long run. Non-chemical controls also have the added advantage of being non-toxic, thereby reducing the potential risk to human health and the environment.

a. Mechanical and Physical Control. This type of control alters the environment in which a pest lives, traps and removes pests where they are not wanted, or excludes pests. Examples of this type control include: harborage elimination through caulking or filling voids, screening, mechanical traps or glue boards, and nets and other barriers to prevent entry into buildings.

b. Cultural Control. Strategies in this method involve manipulating environmental conditions to suppress or eliminate pests. Elimination of food and water for pests through good sanitary practices may prevent pest populations from becoming established or from increasing beyond acceptable limits. An example of this would be to spread manure from stables onto fields for drying to prevent flies from breeding.

c. Biological Control. In this control strategy, predators, parasites, disease organisms, or modified individuals of the pest species are used to control pest populations. Sterile flies may be released to lower reproduction rates. Viruses and bacteria which control growth or otherwise kill insects may be used.

Parasitic wasps may be introduced to kill eggs, larvae or other life stages. Biological control may be effective in and of itself, but is often used in conjunction with other types of control.

d. Chemical Control. Pesticides kill living organisms, whether plants or animals. At one time, chemicals were considered to be the most effective control available, but pest resistance rendered many pesticides ineffective. In recent years, the trend has been to use pesticides that have limited residual action. While this has reduced human exposure and lessened environmental impact, the cost of chemical control has risen due to requirements for more frequent application. Since personal protection and special handling and storage requirements are necessary with the use of chemicals, the overall cost of using chemicals as a sole means of control can be quite costly when compared with non-chemical control methods.

3. IPM Outlines. Integrated Pest Management Outlines are at Appendix D. These list various pests that may be encountered and non-chemical and chemical controls used to deal with them. New outlines will be added to Appendix D as new pests or sites are encountered that require surveillance or control.

E. PRIORITY OF PEST MANAGEMENT WORK

Pest management performed on USAG-HI by the DPW Pest Control Shop in order of priority are:

1. Real Property Pests (Structural/Wood Destroying Pests).

a. Operations and Maintenance, Army (OMA) structures shall be inspected at least once a year for the presence of wood rots and structural pests such as termites, powder post beetles and for the conditions causing or contributing to these problems. Results of these inspections will be recorded on DD form 1070. Where structural problems exist and contribute to the aforementioned infestations, such areas will be noted and diagrammed to facilitate correction by DPW maintenance personnel. These corrections will be submitted through the DPW Work Management Office and coordinated with the appropriate building custodian or manager. Elimination of termite infestations shall be accomplished by the use of appropriately labeled termiticides at the maximum allowable rate alone or in combination with an inert physical barrier such as Termi-mesh, Basaltic Termite Barrier (BTB), etc. When drywood termites cannot be adequately controlled by chemical "spot-treatments," the DPW Entomologist shall be notified with sufficient information to facilitate tent fumigation via service contract.

Maintenance for buildings occupied by U.S. Army Medical Command (MEDCOM) are the responsibility of MEDCOM. The IPM procedures for MEDCOM facilities are included in the Pest Management Plan for Tripler Army Medical Center (see Appendix E).

Maintenance for Family Housing structures are done under contract through Actus Lend Lease LLC (see Section I.7).

b. New structures should incorporate the latest non-chemical and chemical technologies designed to prevent future termite infestations while at the same time reducing the amount of pesticides used, including the use of plastic and steel building materials and the use of Termi-mesh and BTB. Complete BTB installations have been installed under some structures built by USAG-HI. There have been no reports to date of infestation by subterranean termites where the barrier was properly installed.

c. Baits containing active ingredients that will eliminate Formosan subterranean termite colonies will be placed at selected sites by contract. The DPW Entomologist will select sites to install bait stations based on reports of termite activity by pest control personnel. The current plan for installation of termite colony elimination systems is at Appendix F. If termite colonies are eliminated, it will not be necessary to use pesticides to protect structures.

2. Disease Vectors and Medically Important Arthropods.

a. Mosquito control is aimed at both larval and adult stages. Larval control is primarily performed from 1 November to 30 April via treatments with approved pesticides to stagnant water breeding areas. In some cases mosquitoes breed in containers left out by building occupants. These occupants are instructed on the importance of removing these breeding sites either directly by the PMC or the Tripler Army Medical Center (TAMC) Preventive Medicine Entomologist, or through the Community Commander's office. Adult mosquito populations are currently controlled on an as needed basis, based on customer complaints. A listing of mosquito species which occur in Hawaii, their habits, breeding sites and the diseases they are capable of transmitting is included at Appendix G.

b. The control of house flies, moth flies (psychodidae), blow flies and other such filth flies is primarily directed at eliminating or isolating the source of these pests. Such efforts include: installation of screens for the purposes of exclusion; elimination of breeding material; steam cleaning and frequent change of dumpsters associated with food handling facilities and residences; frequent change of animal bedding and manure elimination at stables; timely disposal of road killed animals; and cleaning of drains to eliminate moth flies. Where pests have entered areas of concern, space spray applications of pyrethrums or their synthetic substitutes are used.

c. Bees, wasps, spiders and other stinging and biting arthropods are found throughout the installation. Although these can sometimes cause allergic reactions in some people, for the most part they are a minor problem. Control measures are initiated based on customer complaints.

3. Stored Product Pests.

a. Primary locations of concern for stored product insects are the Post Exchanges, Commissaries and Dry-goods storage areas of each of the food handling facilities. Inspections are conducted by the Commissary Officer, respective store manager(s), Department of Preventive Medicine personnel, and Veterinary Services personnel. Such inspections, even with negative findings, stress the importance of sanitation and structural repairs conducive to pest elimination.

b. Treatment of infested material and areas consists of a thorough cleaning of the area as directed by the DPW Pest Control Shop, residual treatments in the case of insect infestations, space treatment when appropriate, and removal of the infested material where possible. Where considerable infestation has occurred, fumigation by pallet shall be conducted. The materials will be removed from the building and re-stacked in an unoccupied structure or area through coordination with the DPW Pest Control Shop. Aluminum Phosphide will be introduced to the covered and sealed stack as per labeled rate and directions. The shop will coordinate all aspects of the fumigation with security forces to insure no access during the treatment period. Proper protective equipment and procedures shall be used during all phases of the fumigation. After the proper duration and concentration of fumigant has been achieved, the shop shall certify the site as gas free using the appropriate test equipment.

c. Rodent infestations are controlled by the physical elimination of access and harborage in combination with mechanical traps and poison bait stations. These bait stations must be inspected monthly to insure that they do not provide a source of insect pests of stored products.

4. Ornamental Plant and Turf Pests.

a. Control of turf pests is largely restricted to the golf courses, a non-appropriated fund activity. Golf course personnel perform all pesticide application on the courses following the USAG-HI Golf Course Maintenance Pesticide Management Program. All requests for pesticide use approvals are sent to the USAG-HI Entomologist. A copy of the USAG-HI Golf Course Maintenance Pesticide Management Program is attached at Appendix H.

b. Control of pests on shade trees, specimen plantings and foundation plantings is limited to chemical applications for the control of leaf chewing and scale insects. The major pest problems include various noctuid caterpillars in monkey pod, scale insects on hibiscus and heliconias and Chinese rose beetles on various broadleaf foundation plantings.

5. Undesirable Vegetation.

a. Weed control is largely accomplished through Standing Operations Orders (SOO) and consists of fence lines, ditches, sidewalks, street curbs, roadsides, substations, Area X at Schofield Barracks (SB), the Wheeler Army Airfield (WAAF) airstrip, range control areas, around air conditioning chiller units, bus stops, restrooms, and all main avenues and thoroughfares. Treatment will include spraying 18 inches around all obstacles along fence lines (i.e., trees), utility poles, light poles, fire hydrants, sign post, manholes, guy wires, and meter/utility boxes which are located within improved areas. The approximate total area to be treated, inclusive of all areas mentioned are approximately 50 acres per quarter for Fort Shafter (FS) and TAMC, and 150 acres per quarter for SB and WAAF. Areas not previously mentioned are treated via service contracts on an as needed basis. Such areas require selective or complete weed control and include newly constructed facilities, recreation areas, building entrances, target ranges, impact areas, paved areas and miscellaneous roadsides.

b. The primary chemicals used for complete control of vegetation at the time of this writing include glyphosate (Roundup, Aquamaster, etc) and sulfometuron methyl (Oust), the latter being used in outlying areas not subject to runoff and requiring long term control. The use of all herbicides, whether in-house or by service contract, requires approval of the USAG-HI Entomologist.

c. In FY 07 herbicide/fungicide use totaled 6810 pounds of active ingredient, or almost 79% of total pesticide used. The total herbicide use for the FY 02-03 baseline was 5695 pounds of active ingredient. The increase of 1115 pounds (20%) was due to aerial application of herbicide to the training ranges. Range Maintenance (DPTM) contracted to apply 3000 pounds active ingredient of herbicide by helicopter in FY 07. The Aerial Validation Plan (AVP) for FY 08 is at Appendix I. Usage can be further reduced by increasing mechanical controls (mowing, weed-whacking) of vegetation.

6. Vertebrate Pests.

a. Rodent control is directed at identifying the point of entry into a structure. Once entry has been identified, structural modifications are made or recommended to exclude the rodents. Additional control procedures using traps and/or poison baits may be used to control the existing infestation of rodents. However, this should be done only as a last resort effort. Additional information on rodent control is found at E.3 Stored Product Pests, paragraph c.

b. Other vertebrate pests such as mongooses, cats and dogs are trapped or captured on an as needed basis. Stray animal control in the main post area is accomplished by the game warden.

c. Birds as pests are also of concern. Much more important than the nuisance value of mynah birds and English sparrows is the disease potential carried by manure build up in nesting and roosting areas. Additionally, cattle egrets present a serious air strike hazard at Wheeler Army Airfield (WAAF). These problems have been addressed through an inter-service support agreement with the U.S. Department of Agriculture, Wildlife Service (USDA-WS) (Appendix J).

d. It has also been arranged for the USDA-WS to eliminate other vertebrate pests such as wild pigs from certain areas, and the brown tree snake if it introduced. The Hawaii Brown Tree Snake Emergency Response Protocol is included at Appendix K.

7. Household and Nuisance Pests.

a. In general, jobs are issued to the DPW Pest Control Shops by the Service Order Desk in appropriate priority. The pest controllers contact the customers for information on the problem and to arrange a visit. At that time a survey is conducted to determine whether a chemical application is necessary. All other alternatives are considered at this time, especially where they may directly affect the cause of the problem and not just the symptom. Treatments, if necessary, are usually made using hand compressed air sprayers with appropriate pesticides or ready-to-use aerosols. Occupants are advised as to any pesticide hazards and are instructed on precautions, if necessary, for pets, children, plants, or area re-entry. Additionally, notes on structural deficiencies or other situations leading to pest problems, such as water leakage, lack of screening or entry holes, are reported for corrective action by the Preventive Maintenance workers or other trades. Occupants or employees are educated in the area of pest prevention through sanitation and elimination of harborages. The brochure at Appendix L is provided to occupants as necessary by DPW Facility Managers. Pesticides used for nuisance pest treatment shall be applied in strict accordance with label recommendations.

b. Cockroach control in food handling facilities is of particular importance due to the high visibility and morale support implications. Buildings are scheduled for surveillance operations by Tripler Army Medical Center Department of Preventive Medicine personnel approximately every four weeks. These facilities are inspected regularly to check cockroach populations and advise the management on practices conducive to reducing infestations. Such recommendations include improvements to sanitation and elimination of harborage (to include corrugated cardboard boxes) and operational improvements. Restaurant managers are to be contacted at least three days prior to an anticipated treatment. This facilitates proper cleaning, covering of food and utensils and access to storage rooms.

c. Areas not properly prepared are documented and forwarded to the USAG-HI Entomologist for action. Treatments shall not be made to any facility that has not taken appropriate sanitation preparations for a treatment. Treatments may include a crack and crevice residual treatment, as well as the use of insect growth regulators (IGRs) and baits as part of a multidimensional chemical control program. Each of the treatments shall use approved materials and be coordinated through the restaurant managers.

8. Quarantine Pests. Retrograde cargo may be encountered infrequently, and will be inspected for pests on an individual basis. USDA-WS will be called in if the pest brought in is the brown tree snake (see Section 6. Vertebrate Pests).

9. Other Pest Management Requirements. Pest management technicians are responsible for small non-domestic animal carcass removal. In addition, the pest management technicians provide services for odor control in buildings and other structures on the installation. Odors may arise from: dead animals in walls, crawl spaces, etc.; decaying vegetation, molds and fungi; or from other sources.

F. SALE AND DISTRIBUTION OF PESTICIDES.

1. Army Air Force Exchange System (AAFES) Facilities. All pesticides sold at AAFES stores are registered by the EPA and the State of Hawaii. No restricted use products are sold. A spill cleanup kit is on hand in the immediate vicinity of the home and garden pesticide storage area. Store personnel are familiar with the use of the cleanup kit and with installation spill contingency procedures. Additional guidelines on pesticides in exchanges can be found in paragraph 4-7k(2), Department of the Army Pamphlet (DA PAM) 40-11.

2. Defense Commissary Agency Facilities. All pesticides sold at Commissary stores are registered by the EPA and the State of Hawaii. No restricted use products are sold. Pesticide products are ready-to-use. A spill cleanup kit is on hand. Store personnel are familiar with the use of the cleanup kit and with

installation spill contingency procedures. Additional guidelines on pesticides in commissaries can be found in paragraph 4-7k(2), DA PAM 40-11.

3. Veterinary Treatment Facility (VTF). Products containing pesticides are sold to Veterinary Clinic customers for their own use. These products are registered by EPA and the State of Hawaii, and are labeled for application to animals. Animals are not treated (e.g., dipped) for fleas, ticks or other ectoparasites in the clinic.

G. HEALTH AND SAFETY.

1. Requirements. Pest control personnel, whether employed in-house or contracted, are required to use all appropriate personal protective devices and must apply all materials as per label recommendations. In-house personnel (DPW, DPTM, Golf Course personnel) receive cholinesterase/liver function testing semiannually. Contract personnel receive detailed references to safety requirements through their respective Performance Work Statements as well as during the Pre-Start Conference.

2. Hazard Communication. In-house pest control personnel will be given monthly hazard communication training. Material Safety Data Sheets for all pesticides and substances used in the pest management program will be kept in the pest management shops.

3. Personal Protective Equipment. Approved masks, respirators, chemical resistant gloves and boots, and protective clothing (as specified by applicable laws, regulations, and/or the pesticide label) will be provided to the in-house pest controller by the government. These items will be used as required during the mixing and application of pesticides. Pesticide contaminated protective clothing will NOT be home laundered, but will be laundered at the installations' expense. Severely contaminated clothing will not be laundered but will be disposed of in accordance with current regulatory requirements. A copy of the Pest Control Shop Respirator Program, which describes shop policy for the use, maintenance and fit testing of respirators is at Appendix M.

4. Pest Control Vehicles. Pesticides shall be transported only in lockable storage compartments on designated pest control vehicles. Pesticide will not be transported in the cab of the vehicle at any time. The use of the assigned vehicle for purposes other than pest control is NOT permitted. Transportation of pesticides (from supply, delivery of self-help items, etc.) will be accomplished using the vehicle assigned to the pest controller. Care should be taken to secure pesticides to prevent damage to the containers and spillage of the chemicals. At no time will pesticides be left unsecured in the vehicle when unattended. A portable eye lavage and pesticide spill response kit will be carried in the pest control vehicle when in use. Pest control vehicles will be clearly and permanently marked as "Contaminated with Pesticides".

5. Spill Kit and Spill Response. An adequate pesticide spill cleanup kit shall be maintained at the pesticide storage area of each installation. In addition, spill cleanup kits are kept on all pest control vehicles. Spill cleanup procedures as well as a list of components of the spill kit can be found in the 25th Infantry Division (Light) and U.S. Army, Hawaii Spill Prevention Control and Countermeasures (SPCC) at https://dpwhawaii.army.mil/ECO/. Section 3 of the SPCC which addresses the Installation Spill Contingency Plan is at Appendix N. Additional information can be found in the Armed Forces Pest Management Board Technical Guide (AFPMB TG) #15, Pesticide Spill Prevention and Management.

6. Fire Protection. Pesticide inventories at all storage facilities will be provided to the Fire Department, and will be updated quarterly or as necessary due to major inventory changes. Current inventories are at Appendix O. The Fire Department will prepare pre-fire plans for all such facilities. Evacuation plans will be posted at appropriate locations by the DPW Safety Office.

H. ENVIRONMENTAL CONSIDERATIONS.

1. Protection of the Public. Precautions will be taken during pesticide application to protect the public, both on and off the installations. Care will be taken when applying pesticides outdoors that spray drift is kept away from individuals, including the applicator, and such application will not be performed when the wind speed is greater than 5 miles per hour. Appropriate personal protective equipment will be used at all times. At no time will any pesticide be used in a manner inconsistent with its label.

2. Sensitive Areas. Sensitive areas that must be considered before pest control operations are conducted are listed on each pesticide label. No pesticide will be applied directly to wetlands or water areas (lakes, rivers, etc.) unless use in such sites is specifically approved on the pesticide label. Pest control at Kilauea Military Camp (KMC) must also conform to the guidelines of the National Parks Service. The Pest Management Program for KMC is at Appendix P.

3. Endangered Species and Protected Species. A list of endangered species and protected species found on USAG-HI sub-installations is provided in Appendix Q. Possible effects of pest management operations on these species will be considered by the DPW Natural Resource Manager and the IPMC before pest management operations are conducted.

4. Pollution Abatement Procedures (pesticide spills). Pollution abatement has been already discussed under G.5. Spill Kit and Spill Response.

I. ADMINISTRATION.

1. Staffing. The Schofield Barracks pest control shop has four permanent pest controller positions filled. The TDA for Schofield Barracks calls for six pest controllers and one supervisor. The Fort Shafter pest control shop has two permanent pest controller positions filled. The TDA for Fort Shafter calls for two pest controllers.

In addition to personnel in the pest control shops, personnel from the golf courses, DPTM (Range Maintenance), DPW Environmental Division and KMC apply pesticides as certified applicators. However pest management is not their primary duty.

A list of personnel involved with pest management is provided in Appendix R.

2. Vehicles. The pest control vehicles currently on hand are listed in Appendix S. Vehicles are pickup trucks with a utility bed having external lockable storage compartments.

3. Materials. All materials, buildings and equipment are furnished by the government. Pesticides and pesticide application equipment required for the program are maintained on the installation. Pesticides are ordered as required to maintain at least three months supply with not more than one year supply in stock. Pesticides that are required for use during a specific time of the year will be ordered in a timely manner to ensure effective application.

The pest control supervisor will maintain a current inventory of stored pesticides at all times. Inventories of pesticides are provided in Appendix O. An inventory of pesticide application equipment is also provided in Appendix S. Equipment inventories will be updated as changes occur. A book containing pesticide specimen labels and material safety data sheets for the pesticides used will be available at the storage site.

4. Facilities (pesticide storage sites). Location of each pesticide storage site is provided as Appendix T.

5. Reports and Records. Pesticide applicators will maintain complete, permanent daily pesticide application and surveillance records, DD Form 1532-1 or equivalent. DD Form 1532, Pest Management Report, will be used monthly to report pesticide use and pest control operations. DD Form 1532 will be prepared by the pest control supervisor and maintained permanently at the pest control shop and a copy will be forwarded to the PMC.

6. Training.

a. All in-house pest controllers are required to obtain Department of Defense Certification in pesticide selection and application (DD Form 1826) within two (2) years of employment. Re-certification in the appropriate categories is required every three (3) years thereafter. Personnel who have not been trained and do not possess valid Certification will not be allowed to handle, mix or apply pesticides on their own. However, when under the direct supervision of a certified pesticide applicator, the uncertified person may be allowed to handle, mix and apply pesticides. The PMC and the individuals who evaluate the quality of work of pest control contracts (Quality Assurance Evaluators) are required, at a minimum, to complete the DoD Pest Management Quality Assurance Evaluator/Installation Pest Management Coordinator Course and be accredited. Re-accreditation is required every three years.

b. Personnel who fail to attain a satisfactory grade on the recertification examination or personnel who are not able to attend the training will be given an opportunity to take a follow-up examination within 120 days. Pesticide applicators who fail to attain a satisfactory grade on the follow-up examination will be required to retake the certification training course and obtain a passing grade on the examination before being allowed to perform pest control again.

c. On-the-Job-Training (OJT)

(1) Any new employee who has been assigned to the pest control shop will receive OJT on pest management activities from the shop supervisor and other qualified personnel. This employee will be assigned to the most qualified pesticide applicator who will demonstrate proper and safe application of pesticides as well as the proper use of pesticide dispersal equipment to attain required field experience and learn the responsibilities of the pesticide applicator; biology and identification of common pests requiring control; proper application and safe use of pesticides; proper storage, mixing and disposal procedures of pesticides; and other pertinent information which is required to operate the pest management services effectively and efficiently.

(2) The OJT will continue until the new employee exhibits adequate proficiency in his performance. Verification of his performance and practices at the job sites will be determined through field observations.

(3) The OJT will continue for 6 to 12 months depending upon the capabilities of the new employee. After his tenure in OJT has been completed and his performance has been evaluated by the supervisor as satisfactory, the new employee will be eligible for the pest management certification training course. Personnel who fail to obtain a passing grade on the examination will continue their OJT until they are ready to take the follow-up examination. Pest control personnel who fail to attain a passing grade on the follow-up examination will be considered unqualified as a pesticide applicator and personnel action will be taken to remove the individual from performing pest management functions.

7. Contracts.

a. Family Housing. Pest management in Family Housing areas is done by a sub-contract through Actus Lend Lease LLC. The contract for pest management for Family Housing is at Appendix U.

Pesticide use for Family Housing is not included in the Garrison's report per the memorandum on "Installation Management of Pest Control Activities on Residential Communities Initiative (RCI) Properties at Army Installations" at Appendix V.

b. The Termite Plan is also performed under contract (see section E.1.c and Appendix F). Additional contracts include herbicide use by landscapers and contractors who maintain firebreaks in training areas and pest control at the Pohakuloa Training Area.
One time contracts are let under certain situations, i.e. the need to fumigate a building. Contracts will be executed if the services are economically beneficial to the Government and certified contractors are available, or if application by trained and certified personnel is not feasible because of remote location, project size, or manpower, time or equipment limitations.

In accordance with DoD policy, all pesticide use on Army property shall be recorded and submitted to the PMC. Furthermore, all contract personnel who apply pesticides on USAG-HI installations will be certified as "commercial applicators" by the State of Hawaii Department of Agriculture. Depending on the type of application, certification will be in one or more of 16 different categories or sub-categories. The contractor will provide photo copies of employee certification documents to the QAE before performing services on an installation..

The Service Contract Branch, Engineering Division of the Directorate of Public Works maintains the current files for all such work.

Pesticide misuse-which includes use inconsistent with the label is a violation of Federal Law. In accordance with DoD policy (see DoD 4150.7-P), USAG-HI personnel will record and report any instances of pesticide misuse and falsification of records by contractors to the State of Hawaii. Furthermore, USAG-HI personnel will cooperate with Hawaii regulators and the EPA in any subsequent investigation or actions.

J. PEST POPULATION MONITORING

1. Formosan subterranean termites. Populations of this insect will be tracked either by the annual inspection reports by pest controllers, by reports by building occupants, or by staking and monitoring by the PMC. The resulting data will indicate which structures are susceptible to future attack by the termites, and may also give a measure of how close the installation is to the ultimate goal of eliminating the insect from its boundaries.

2. German cockroaches. Populations of German cockroaches in food handling establishments are monitored by Preventive Medicine technicians utilizing sticky traps. Threshold levels which will trigger a pesticide application by pest controllers have been established by the Preventive Medicine entomologist. Efficacy of the pest control program for each establishment can be measured in the number of times a year that cockroach populations exceed the threshold level.

3. Rodents. A survey of rodent population utilizing sticky traps and snap traps should be done several months prior to demolition of any structure. If rodents are found to be present intensive trapping should be done to prevent infestation of surrounding structures after demolition occurs.

K. PEST MANAGEMENT REFERENCES.

1. Federal Laws.

a. Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947; amended by P.L. 92 516 (82 Stat. 973) and P.L. 94-140 (89 Stat. 751).

b. Federal Environmental Pesticide Control Act of 1972 (7 U.S.C. 135 et. seq.)

c. President Carter's 1979 Executive Order requiring all Federal Agencies to use integrated pest management technology for pest control and to reduce use of toxic pesticides.

d. Migratory Bird Treaty Act.

e. Endangered Species Act.

f. Occupational Health and Safety (OSHA) Hazard Communication Standard (29 CFR 1910.1200) and Respiratory Program Standard (29 CFR 1910.134).

g. Title 40, Code of Federal Regulations, Protection of Environment, parts 150 - 189.

2. Regulations.

a. DoD Dir 4150.7, DoD Pest Management Program, 22 April 1996.

b. AR 11-34, The Army Respiratory Protection Program, 15 February 1990.

c. AR 40-5, Preventive Medicine, 25 May 2007.

d. AR 200-1, Environmental Protection and Enhancement, 28 August 2007.

e. AR 200-3, Natural Resources Land, Forest, and Wildlife Management, 28 February 1995.

3. U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Technical Guide No. 138, Guide to Commensal Rodent Control, December 1991.

4. Armed Forces Pest Management Board Technical Guides.

a. TG Number 1 - AFPMB Publications April 2003

b. TG Number 6 - Delousing Procedures for the Control of Louse-borne Disease During Contingency Operations March 6, 2002 - reviewed October 2005

c. TG 7 - Installation Pesticide Security August 2003

d. TG 11 - Hydrogen Phosphide Fumigation with Aluminum Phosphide

e. TG 13 - Ultra Low Volume Dispersal of Insecticides by Ground Equipment

f. TG 14 - Personal Protective Equipment for Pest Management Personnel

g. TG 15 - Pesticide Spill Prevention and Management

h. TG 16 - Pesticide Fires: Prevention, Control, and Cleanup

i. TG 17 - Military Handbook - Design of Pest Management Facilities

j. TG 18 - Installation Pest Management Program Guide March 11,2003

k. TG 20 - Pest Management Operations in Medical Treatment Facilities November 2005

l. TG 21 - Pesticide Disposal Guide for Pest Control Shops

m. TG 22 - Guidelines for Testing Experimental Pesticides on DoD Property

n. TG 24 - Contingency Pest Management Guide May 2, 2006

o. TG 26 - Tick-Borne Diseases: Vector Surveillance and Control February 2006

p. TG 27 - Stored-Product Pest Monitoring Methods June 2005

q. TG 29 - Integrated Pest Management in and around Buildings July 2003

r. TG 30 - Filth Flies: Significance, Surveillance and Control in Contingency Operations, March 2006

s. TG 31 - Contingency Retrograde Washdowns: Cleaning and Inspection Procedures

t. TG 34 - Bee Resource Manual with emphasis on The Africanized Honey Bee, November 2005

u. TG 36 - Personal Protective Techniques Against Insects and Other Arthropods of Military Importance

v. TG 37 - Guidelines for Reducing Feral/Stray Cat Populations on Military Installations in the United States

w. TG 38 - Protecting Meal, Ready-to-Eat Rations (MREs) and Other Subsistence During Storage June 2005

x. TG 39 - Guidelines for Preparing DoD Pest Control Contracts Using Integrated Pest Management

y. TG 40 - Methods for Trapping and Sampling Small Mammals for Virologic Testing

z. TG 41 - Protection from Rodent-borne Diseases with special emphasis on occupational exposure to hantavirus

aa. TG 42 - Self-Help Pest Management

bb. TG 43 - Guide to Pest Surveillance During Contingency Operations

cc. TG 44 - Bed Bugs - Importance, Biology, and Control Strategies, August 2006

dd. TG 45 - Storage and Display of Retail Pesticides, November 2006

5. Other References, Manuals, Books and Guides.

a. MIL-STD-904B, Guidelines for Detection, Evaluation and Prevention of Pest Infestation of Subsistence, 10 March 2000.

b. MIL-HDBK-1028/8A, Design of Pest Management Facilities, 1 November 1991.

c. MIL-STD-3006A, Sanitation Requirements for Food Establishments, 7 June 2002.

d. TB Med 561, Occupational and Environmental Health, Pest Surveillance, 1 June 1992.

e. Mallis Handbook of Pest Control, 7th Edition, PCT Books, 4012 Bridge Ave, Cleveland, OH 44113.

6. Periodicals.

a. Pest Control (Magazine Published Monthly, $22/YEAR), P.O. Box 6215, Duluth, MN 55806-9915.

b. Pest Control Technology (Magazine Published Monthly, $30/Year), PCT, 4012 Bridge Ave, Cleveland, OH 44113.

c. Pest Management Bulletin, Periodic Publication of .S. Army Center for Health Promotion and Preventive Medicine, Entomological Sciences Program, Aberdeen Proving Ground, MD 21010-5403.

d. Army Pest Management Timely Topics, Periodic Publication of U.S. Army Environmental Command, Pest Management Team, at pestmanagementteam@aec.apgea.army.mil.

APPENDIX A. MEASURES OF MERIT

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION, TECHNOLOGY AND LOGISTICS

JUL 1 - 2004

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY
(INSTALLATIONS AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE NAVY
(INSTALLATIONS AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE AIR FORCE
(INSTALLATIONS, ENVIRONMENT, AND LOGISTICS)
DIRECTOR, DEFENSE LOGISTICS AGENCY (D)

SUBJECT: New Pest Management Measures of Merit

Since 1993, the Department of Defense has made tremendous progress in achieving our Pest Management Measures of Merit (MoMs). These MoMs aim to reduce pesticide risk by maintaining current installation pest management plans, reducing pesticide use, and maintaining certification of pesticide applicators. Our most challenging success was achievement of the 50% reduction in DoD-wide pesticide use from 1993-2000. Since then, we have increased this reduction even further; our data from 2003 indicate a reduction of 56%.

Because the original MoMs in DoDI 4150.7, *DoD Pest Management Program*, have end dates that have already passed, it is time to update them. The new Pest Management MoMs are shown in attachment 1. MoMs #1 and #3 remain the same but with a new end date of 2010. MoM #2 is to maintain our achieved reduction rather than strive for a continued reduction. Attachment 2 includes graphs showing past and projected progress for each MoM.

FY 04 data for the new MoMs is due to this office by 1 February 2005. Please use the format in attachment 3 when submitting this data. My point of contact for this issue is Maj Sharon Spradling, DSN 295-8310, commercial (301) 295-8310, sharon.spradling@osd.mil.

Alex A. Beehler

Alex A. Beehler
Assistant Deputy Under Secretary of Defense
(Environment, Safety and Occupational Health)

Attachments:
As stated

New Pest Management
Measures of Merit (MoMs)

MoM #1.

New Goal: Through the end of FY 2010, 100% of DoD installations will have pest management plans prepared, reviewed, and updated annually by pest management professionals.

Old Goal: By the end of FY 1997, 100% of DoD installations will have pest management plans prepared, reviewed, and updated annually by pest management professionals.

MoM #2

New Goal: Through the end of FY 2010, DoD will maintain the achieved reduction in annual pesticide use on DoD installations. This reduction goal is set at an average of the FY 2002 and 2003 usage, which is 389,000 pounds of active ingredient (45% of the original 1993 baseline- a 55% reduction). Pesticide applications by contractors shall be included.

Old Goal: By the end of FY 2000, the amount of pesticide applied annually on DoD installations will be reduced by 50% from the FY 1993 baseline in pounds of active ingredient. The goal for this MoM shall not be obtained by substituting more toxic pesticides that have lower application rates than the pesticide in use.

MoM #3

New Goal: Through the end of FY 2010, 100% of DoD's installation pesticide applicators will be properly certified (either by DoD or the appropriate state). Direct hire employees have a maximum of 2 years to become certified after initial employment. Contract employees shall have the appropriate state certification when the contract is let.

Old Goal: By the end of FY 1998, 100% of DoD's installation pesticide applicators will be properly certified (either DoD or appropriate State). Direct hire employees have a maximum of 2 years to become certified after initial employment. Contract employees should have the appropriate state certification when the contract is let.

APPENDIX B. USAG-HI INSTALLATIONS

USAG-HI INSTALLATIONS

Installation	total acreage	fee	ceded	lease	license/ permit/ easement	
Aliamanu Military Reservation (AMR)	538.15	524.18	0.00	3.46	10.51	
Fort DeRussy MR	72.79	69.74	1.47	0.00	1.58	
Dillingham MR	663.90	549.87	77.70	0.00	36.33	
Helemano MR	289.73	281.50	0.00	0.00	8.23	
Kahuku Training Area	9,480.22	8,312.54	0.00	1,149.72	17.96	8,215.809 acs purchased 26 Feb 99. 71.48 acs purchased 17 Dec 03.
Kawailoa Training Area	23,347.55	0.00	0.00	23,347.55	0.00	
Kipapa Ammo Storage Site	401.54	370.22	0.00	0.00	31.32	
Makua MR	4,195.47	170.00	3,236.48	782.35	6.64	
Mauna Kapu Communication Station Site	16.14	0.00	0.00	0.00	16.14	Deleted Lot 341 (.125 ac) returned to Campbell Estate
Mokuleia Army Beach	16.58	0.00	14.00	2.58	0.00	
Pupukea-Paalaa-Uka Military Road	109.25	0.00	0.00	0.00	109.25	
Schofield Barracks MR	15,033.56	2,284.43	12,715.89	0.00	33.24	6Sep05 added 1,402 acres fee (South Range & deleted 2,970 acres easement (Dole effluent)
Fort Shafter MR	591.70	52.29	533.09	0.08	6.24	
Signal Cable Trunking System	0.10	0.00	0.10	0.00	0.00	
Tripler Army Medical Center	367.21	358.29	0.00	0.00	8.92	
U.S.A. Field Station, Kunia	95.25	0.00	33.92	0.00	61.33	
Waianae-Kai MR	14.46	0.00	12.37	1.12	0.97	
Waikakalaua Ammo Storage Tunnels Site	312.43	175.77	136.61	0.00	0.05	
Wheeler Army Airfield	1,369.90	0.24	1,369.06		0.60	
Total - Oahu	**56,915.93**	**13,149.07**	**18,130.69**	**25,286.86**	**349.31**	
Big Island	**total acreage**	**fee**	**ceded**	**lease**	**license/ permit/ easement**	
Kawaihae MR	10.81	0.00	3.03	0.00	7.78	
Kilauea MR	71.68	0.50	0.00	0.00	71.18	
Pohakuloa Training Area	132,784.44	23,992.29	84,815.26	23,954.19	22.70	31Oct06 added 23,992.289 acres (West PTA Parker Ranch land)
Total	**132,866.93**	**23,992.79**	**84,818.29**	**23,954.19**	**101.66**	
Grand Total	**189,782.86**	**37,141.86**	**102,948.98**	**49,241.05**	**450.97**	

3/16/2007

APPENDIX C. ANNUAL PLAN UPDATE FORM

FY_2008_ Annual Plan Update Form Submission Date 10/18/07

1. INSTALLATION: The following information describes your installation

Article I. Installation Name	State/Country	County	IMA Region
U.S. ARMY GARRISON, HAWAII	HAWAII	USA	Pacific

Date Plan was last approved	**Dec 2000**
Name and rank/grade of approval authority	**William Puttmann, COL**

2. STAFFING: The following information defines installation resources used to support the pest management (PM) program. Resources can be either in-house or contracted. NOTE: If space in tables is inadequate, list additional staff on a separate page.

	Section 1.01 Name	E-Mail Address	Telephone No.	Organization	Certification or Accreditation Number
PM Coordinator	YAMAMOTO, ROBIN	yamamotr@schofield.army.mil	(808)656-2878 ext 1053	DPW	A-130-96-1005
PM Quality Assurance Evaluator	KALANI, LOUIS			DPW	A-112-96-1005
PM Quality Assurance Evaluator	CHANG, NORMAN			DPW	A-150-88-1005
PM Quality Assurance Evaluator					

Please provide the following information about the pesticide applicators (either in-house or contracted.) NOTE: Also include any Army employees who are in training for certification.

Name	Organization	DoD/State Cert. Number	Category/Subcategory Number(s) or Letter(s)
see file AppList			

3. PEST MANAGEMENT OPERATION:

a. The following table shows the distribution of the pest management workload in terms of specific in-house and contracted operations. (For each area, check the appropriate box or leave blank if not applicable).

Area	In-house	Contract	IMPAC Card Without Formal Contract
Government Housing (Indoors & Outdoors)	☒	☒	☐
Residential Community Initiative Housing (Indoors & Outdoors)	☐	☒	☐
Golf Course	☒	☐	☐
Ranges & Other Training	☒	☒	☐

Areas			
Dependent Schools – (Indoors & Outdoors)	☐	☐	☐
Child Development Centers – (Indoors & Outdoors)	☒	☒	☐
All Food Handling Buildings (Indoors)	☒	☒	☐

4. PESTICIDE USE:

a. The installation baseline (average of FY02 and FY03) was 6652 Pounds Active Ingredient (P.A.I.).
b. Reported P.A.I. for last FY was 8626
c. Additional comments on your pesticide use during the last FY (OPTIONAL)?

Total Pounds Active Ingredient (PAI) =8626

☐	Herbicides/Fungicides	6810
☐	Insecticides	565
☐	Rodenticides	0
☐	Golf Course	1151
☐	Agriculture Out leasing	0
☐	RCI	100.

5. PLAN MAINTENANCE: Please list any minor program changes (i.e., personnel changes, certifications, other programming changes or challenges, etc) to the plan for the new FY. Major plan revisions require re-submittal of the entire updated plan.

New plan submitted for technical review to AEC and awaiting validation pending submission of FY08 PUF and PUP.

6. PESTICIDE USE PROPOSAL (PUP): Please attach the current FY pesticide use proposal.

7. ON-SITE HELP? Please indicate if you would like an assistance visit this year and briefly describe the reason for such a visit..

8. AERIAL APPLICATION OF PESTICIDES PLANNED DURING FY? Yes

U.S. ARMY PESTICIDE USE PROPOSAL - For U.S. ARMY GARRISON, HAWAII, FY 08 - 10/18/07

Product name	EPA Registration Number	% Active Ingredient	Chemical name	Formulation	Pesticide Classification	Signal Word	State Registration Status	Target	lbs/gal lbs/lbs lbs/ea	unit
Avid 0.15EC	100-896	2.000%	Abamectin - 2%	Emulsifiable Concentrate	Acaricide/ Insecticide	Warning	Yes	Mites	0.15	gal
Primo	100-729	12.00%	Trinexapac-ethyl	Emulsifiable Concentrate	Biosynthesis inhibitor	Warning	Yes	Grasses	1	gal
Primo Maxx	100-937	11.30%	Trinexapac-ethyl	Emulsifiable Concentrate	Biosynthesis inhibitor	Caution	Yes	Grasses	1	gal
4 The Birds	8254-5-56	80.000%	Polybutene	Gel	Bird Repellent	Caution	Yes	Birds	0.8	lb
4 The Birds II (discontinued)	1621-17-56	97.000%	Polybutene	Gel	Bird Repellent	Caution	Yes	Birds	0.97	lb
Tisan	1769-227-66114	10.000%	n-alkyl dimethyl benzyl ammonium chloride - 5% n-alkyl dimethyl ethylbenzyl ammonium chloride - 5%	Liquid	Disinfectant		Yes	Germs	0.834	gal
Banrot	58185-10	40.000%	Etridiozole - 15% Thiophanate-methyl - 25%	Wettable powder	Fungicide	Danger	Yes	Phytophthora, pythium, fusarium	0.4	lb
Chipco 26GT	432-888	23.30%	Iprodione	Suspension	Fungicide	Caution	Yes	helminthosporum	2	gal
Daconil Ultrex	50534-202-100	82.50%	Chlorothalonil	Dispersible Granules	Fungicide	Danger	Yes	helminthosporum	0.825	lb
Dithane	707-180	75.000%	Mancozeb	Dry Flowable	Fungicide	Caution	Yes	Algae	0.75	lb
Fore	707-87	80.00%	Mancozeb	Powder	Fungicide	Caution	Yes	Pythium	0.8	lb
Subdue Maxx	100-796	22.00%	mefenoxam	Emulsifiable Concentrate	Fungicide	Caution	Yes	Pythium	2.01828	gal
Aqua Master	524-343	53.800%	Glyphosate	Liquid	Herbicide	Caution	Yes	Weeds, various	5.4	gal
Asulox	264-447	36.20%	Methyl sulfanilycarbamate	Liquid	Herbicide	Caution	Yes	Kikuya grass	3.34	gal
Blade	74477-1-2217	60.00%	Metsulfuron Methyl	Dispersible granules	Herbicide	Caution	Yes	Broadleaf weeds	0.6	lb
Confront	62719-92	45.10%	Triclopyr - 33.0% Clopyralid - 12.1%	Liquid	Herbicide	Danger	Yes	Broadleaf weeds	3	gal
Escort	352-439	60.000%	Metsulfuron methyl	Granules	Herbicide	Caution	Yes	Wild ginger	0.6	lb
Finale	432-1229	11.33%	Glufosinate-ammonium	Liquid	Herbicide	Warning	Yes	Weeds, various	1	gal
Fusilade II (discontinued)	10182-393	24.500%	Fluazifop-P-butyl	Liquid concentrate	Herbicide	Caution	Yes	Grasses	2	gal
Garlon 3A	62719-37	44.400%	Triclopyr	Liquid concentrate	Herbicide	Danger	Yes	Range roads	3	gal
Garlon 4	62719-40	61.600%	Triclopyr	Liquid concentrate	Herbicide	Caution	Yes	Cut stumps	4	gal
Glypro Plus	62719-322	41.000%	Glyphosate	Liquid concentrate	Herbicide	Caution	Yes	Weeds, various	4	gal
Illoxan	432-1231	34.70%	diclofop-methyl	liquid	herbicide	Danger	Yes	Goose grass	3	gal

Image 70DG	241-319	70.00%	Salt of imazaquin	Dispersible granules	Herbicide	Caution	Yes	Kylinga, nut grass	0.7	lb
Kerb WSP	707-159	51.00%	3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-benzamide	Water soluable packet	Herbicide	Caution	Yes	Poa	0.51	lb
Manage	524-465	75.00%	Halosulfuron	Dispersible Granules	Herbicide	Caution	Yes	Nut grass	0.75	lb
MSMA 6 Plus	19713-42	47.60%	Monosodium Acid Methanearsonate	Liquid + surfactant	Herbicide	Caution	Yes	Goose grass	6	gal
Oryzalin 4 Pro	72167-15-74477	41.00%	Oryzalin	Liquid	Herbicide	Caution	Yes	Gppse grass	4	gal
Revolver	432-1266	2.34%	Foramsulfuron	Suspension	Herbicide		Yes	Goose grass	0.19	gal
Roundup Pro	524-475	41.00%	Glyphosate	Liquid	Herbicide	Caution	Yes	Weeds, various	4	gal
Sencor 75 Turf	3125-325	75.00%	Metribuzin	Dry flowable	Herbicide	Caution	Yes	Crab, goose, dallas grasses	0.75	lb
Simazine 4L	19713-60	40.00%	Simazine	Liquid suspension	Herbicide	Caution	Yes	Crab grass	4	gal
Surflan A.S.	62719-113	40.40%	Orizalin	Solid in liquid suspension	Herbicide	Caution	Yes	Crab grass	4	gal
Trimec Plus	2217-709	28.22%	Monosodium Acid Methanearsonate - 18.00% Dimethylamine Salt of 2, 4-Dichlorophenoxyacetic acid - 5.83% Dimethyamine Salt of 2-(2-methyl-4-chlorophenoxy) propionic acid - 2.93% Dimethylamine Salt of Dicamba - 1.46%	Solid in liquid suspension	Herbicide	Warning	Yes	Kylinga, nut grass	2.88	gal
Enstar II	2724-476	65.100%	S-Kinoprene	Liquid concentrate	Insect Growth Regulator	Warning	Yes	Aphids, whiteflies, scales	5	gal
Gentrol Point Source	2724-469	90.600%	Hydroprene	Point Source	Insect Growth Regulator	Caution	Yes	Cockroach	0.24	ea
Advance Carpenter Ant Bait	499-370	0.011%	Abamectin B1	Granular Bait	Insecticide	Caution	Yes	Ants	0.00011	lb
Advance Dual Choice Ant Bait Station	499-459	0.500%	Abamectin B1	Bait Station	Insecticide	Caution	Yes	Ants	2.185E-05	ea
Advance Granular Ant Bait	499-370	0.011%	Abamectin B1	Granular Bait	Insecticide	Caution	Yes	Ants	0.00011	lb
Aero-Cide	499-415	10.000%	Pyrethrins - 1% Allethrin - 1% Piperonyl Butoxide - 4% N-Octyl bicycloheptene dicarboximide - 4%	Aerosol	Insecticide	Caution	Yes	Flies, moths, mosquitoes	0.1	lb
Amdro Fire Ant Bait	73342-1	0.730%	Hydramethylnon	Bait - Granule	Insecticide		Yes	Ants	0.0073	lb

Avert Cockroach Bait Station	499-467	0.050%	Abamectin B1	Bait Station	Insecticide	Caution	Yes	Cockroach	2.152E-06	ea
Avert Dry Flowable Cockroach Bait	499-294	0.054%	Abamectin B1 - 0.05% Related compound - 0.004%	Dry Flowable	Insecticide	Caution	Yes	Cockroach	0.00054	lb
Carbaryl 4L	34704-447	43.00%	Carbaryl	Suspension	Insecticide	Caution	Yes	Armyworm, ants	4	gal
CB D-Force	9444-217	0.060%	Deltamethrin	Aerosol	Insecticide	Caution	Yes	Insects, various	0.0006	lb
CB Invader HPX	9444-186	1.000%	Baygon	Aerosol	Insecticide	Caution	Yes	Termites, wood borers	0.01	lb
CB-80 Extra	9444-175	4.500%	Pyrethrins - 0.5% Piperonyl Butoxide - 4.0%	Aerosol	Insecticide	Caution	Yes	Flies, moths, ants, mosquitoes, roaches	0.045	lb
Delta Dust	432-772	0.005%	Deltamethrin	Dust	Insecticide	Caution	Yes	Wasps, termites	0.00005	lb
Demand CS	10182-361	9.700%	Lambda-cyhalothrin	Micro-encapsulated	Insecticide	Caution	Yes	Ants, centipedes, roaches, fleas, spiders	0.838	gal
Demon TC	100-1006	25.300%	Cypermethrin	Emulsifiable Concentrate	Insecticide	Caution	Yes	Termites, centipedes, flies	2	gal
Diazinon	8845-92	25.000%	Diazinon	Spray concentrate	Insecticide	Caution	Yes	Insects, various	1.95	gal
Dragnet SFR	279-3062	36.800%	Permethrin	Emulsifiable Concentrate	Insecticide	Caution	Yes	Ticks, centipedes, termites	3.2	gal
Home Defense Hi-Power Indoor Insect Fogger	239-2626	0.885%	Pyrethrins - 0.050% Permethrin - 0.400% N-Octyl bicycloheptene dicarboximide - 0.400%	Ready-to-use Spray	Insecticide	Caution	Yes	Ants, roaches	0.00708	gal
Isotox Form IV	239-2595	8.50%	Acephate - 8% Fenbutatin-oxide - .5%	Liquid concentrate	Insecticide	Caution	Yes	Aphids	0.7089	gal
Kicker	4816-707AA	66.000%	Pyrethrins - 6.00% Piperonyl Butoxide - 60.00%	Emulsifiable Concentrate	Insecticide	Caution	No	Cockroach	5.3777988	gal
Malathion 50 Plus	239-739-ZF	50.000%	Malathion	Spray concentrate	Insecticide	Warning	Yes	Aphids, whiteflies, scales	4.4	gal
Marathon	3125-452-59807	1.000%	Imidacloprid	Granules	Insecticide	Caution	Yes	Chinese rose beetle	0.01	lb
Maxforce FC Ant Bait Station	64248-2	1.000%	Hydramethylnon	Bait Station	Insecticide	Caution	Yes	Ants		ea
Maxforce FC Ant Bait Station	432-1256	0.010%	Fipronil	Bait Station	Insecticide	Caution	Yes	Ants		ea
Maxforce Granular Insect Bait (discontinued)	64248-6	1.000%	Hydramethylnon	Granular Bait	Insecticide	Caution	Yes	Ants, crickets	0.01	lb
Merit 75 WP (discontinued)	3125-421	75.000%	Imidacloprid	Wettable Powder	Insecticide	Caution	Yes	Turf insects, aphids, scales	0.75	lb

Permanone 10% EC	432-1132	10.000%	Permethrin	Emulsifiable Concentrate	Insecticide	Warning	Yes	Mosquitoes	0.7	gal
P-O-W Plus	1769-370	0.850%	Tetramethrin 0.1% Permethrin - 0.25% Piperonyl Butoxide - 0.5%	Aerosol	Insecticide	Caution	Yes	Wasps	0.0085	lb
PT Wasp Freeze	499-362	0.249%	Allethrin - 0.129% Phenothrin - 0.12%	Aerosol	Insecticide	Caution	Yes	Wasps	0.00249	lb
SC Ultra (discontinued)	3125-498	11.800%	Cyano (4-fluoro-3-phenoxyphenol)methyl 3-(2,2-di-chloroethenyl)-2,2 dimethylcyclopropanecarboxylate	Suspended concentrate	Insecticide	Caution	Yes	Centipedes, roaches, fleas, stored product pests, ticks	1	gal
Summit BTI Briquets	6218-47	10.000%	BTI	Briquets	Insecticide	Caution	Yes	Mosquitoes	0.00286	ea
Talstar-PL	279-3168	0.20%	Bifenthrin	Granular	Insecticide	Caution	Yes	Ants	0.002	lb
Terro Ant Killer II	149-8	5.400%	Borax	Liquid Bait	Insecticide	Caution	Yes	Ants	0.054	lb
ULD-BP-300	499-450	19.000%	Pyrethrins -3% Piperonyl Butoxide - 6% N-Octyl bicycloheptene dicarboximide - 10%	Liquid	Insecticide	Caution	Yes	Cockroach		gal
Ultracide	499-404	0.985%	Pyripoxyfen - 0.1% Pyrethrins -0.05% N-Octyl bicycloheptene dicarboximide - 0.4% Permethrin - 0.4% Related compounds - 0.035%	Aerosol	Insecticide	Caution	Yes	Fleas	0.00985	lb
Talstar GC Flowable	279-3156	7.90%	Bifenthrin	Liquid	Insecticide/ Acaricide	Caution	Yes	Mites, thrips, whiteflies, scales	0.6666	gal
Deadline T&O	64864-38	4.00%	Metaldehyde	Bait	Molluscicide	Caution	Yes	Slugs/snails	0.04	lb
Oust XP	352-601	75.000%	Sulfometuron methyl	Dispersible Granules	Pre-emergent Herbicide	Caution	Yes	Weeds, various	0.75	lb
Contrac All Weather Blox	12455-79	0.005%	Bromadiolone	Bait	Rodenticide	Caution	Yes	Rodent	0.00005	lb
Fastrac	12455-97	0.010%	Bromethalin	Bait	Rodenticide	Caution	Yes	Rodent	0.0001	lb
Ramik	61282-26	0.005%	Diphacinone	Bait	Rodenticide	Caution	Yes	Rodent	0.00005	lb
Weather Blox XT	100-1055	0.005%	Brodifacoum	Bait	Rodenticide	Caution	Yes	Rodent	0.00005	lb
Weather Blox XT	10182-339	0.005%	Brodifacoum	Bait	Rodenticide	Caution	Yes	Rodent	0.00005	lb

APPENDIX D. INTEGRATED PEST MANAGEMENT OUTLINES

note - Demon TC should be used only when control efforts utilizing other materials and methods fail.

ANTS, HOUSEHOLD

PURPOSE: Control of household nuisance pest.

PRIORITY: 3 - recommend initial usage of sanitation and baits.

SURVEILLANCE:

1. Based on complaints and verified by inspector.
2. Submit specimen to Installation Pest Management Coordinator for identification if necessary.

NON-CHEMICAL CONTROL:

1. Practice good housekeeping such as cleaning-up spilled foods, rinsing out empty beverage cans, and frequently washing counters.
2. Keep food in containers with tight-fitting lids.
3. Dry up possible sources of water.
4. Seal up cracks and crevices that may serve as harborages as well as points of entry.

CHEMICAL CONTROL:

PESTICIDE: Ant Bait Stations

1. EPA Reg #: various
2. Formulation: Bait.
3. AI: various
4. Source: n/a
5. Application:
   a. Strength: various.
   b. Diluent: None.
   c. Rate: Place 3 bait stations in an average size room. For heavier infestations, additional bait stations are to be placed.
   d. Equipment: None.
6. Areas to treated:
   a. Place each bait station next to ant trails or close to areas where ants are numerous. If possible, place baits next to nest or point of entry into building.
   b. Place bait stations in or near wall voids, electrical outlets (if wiring permits), potted plants, waste-paper baskets, garbage cans and sinks.
   c. In cabinets, next to food and dishes, near sensitive equipment.
7. Caution:
   a. Do not spray the bait stations. Avoid placing the bait stations on freshly sprayed surfaces.
   b. Replace all bait stations every 2 weeks until control is achieved.
8. Protective Equipment: Light-weight gloves.

ANTS, HOUSEHOLD (cont.)

PESTICIDE: Borax (Terro Ant Killer II)

1. EPA Reg #: 149-8
2. Formulation: Liquid bait.
3. AI: 5.4%
4. Source: BEI
5. Application:
   a. Strength: 5.4%
   b. Diluent: n/a.
   c. Rate: see label.
   d. Equipment: None.
6. Areas to treated:
   a. Place bait next to ant trails or close to areas where ants are numerous.
   b. Place bait in or near wall voids, electrical outlets (if wiring permits), potted plants, waste-paper baskets, garbage cans and sinks.
   c. In cabinets, next to food and dishes, near sensitive equipment.
7. Caution:
   a. Do not spray the bait. Avoid placing the bait on freshly sprayed surfaces.
   b. Place in areas inaccessible to children and pets.
8. Protective Equipment: None.

PESTICIDE: Hydramethylnon (Amdro Fire Ant Bait)

1. EPA Reg #: 73342-1
2. Formulation: Bait.
3. AI: 0.73%
4. Source: NSN 6840-01-183-3913
5. Application:
   a. Strength: 0.73%
   b. Diluent: n/a.
   c. Rate: see label.
   d. Equipment: none.
6. Areas to treated: see label.
7. Caution: Do not apply directly to water.
8. Protective Equipment: Rubber gloves.

PESTICIDE: Pyrethrins, Piperonyl Butoxide (CB 80 Extra)

1. EPA Reg #: 9444-175
2. Formulation: Ready-to-use aerosol.
3. AI: 4.5%
4. Source: BEI
5. Application: Space spray, contact treatment.
   a. Strength: 4.5%.
   b. Diluent: n/a.
   c. Rate: see label.
   d. Equipment: Ready-to-use aerosol can.
6. Areas to be treated: Indoors as a crack and crevice treatment, and as a space treatment. Also indoors, apply to ant trails, around windows and doors and wherever ants can find entrance to buildings.
7. Caution:
   a. Do not allow children or pets on treated areas until pesticide dries.
   b. Ventilate Medical Care Areas 2 hours before returning patients.
8. Protective Equipment: Respirator, goggles, rubber gloves.

PESTICIDE: Fipronil (Termidor SC)

1. EPA Reg #: 7969-210
2. Formulation: CS
3. AI: 9.1%
4. Source: NSN 6840-01-483-3072
5. Application: Corrective - residual outdoor treatment.
   a. Strength: 0.06%.
   b. Diluent: Water.
   c. Rate: 2 quarts/160 linear feet (1.5 gallons/1000 square feet).
   d. Equipment: hand sprayer.
6. Areas to be treated: Outside where ants enter the structure, trail around the structure or where they crawl and hide.
7. Caution:
   a. Do not allow children or pets on treated areas until pesticide dries.
   b. Harmful if swallowed, absorbed through skin or inhaled.
8. Protective Equipment: Respirator, goggles, coveralls, hat, rubber gloves, rubber boots (outdoors).

PESTICIDE: Lambda-cyhalothrin (Demand CS)

1. EPA Reg #: 100-1066
2. Formulation: CS
3. AI: 9.7%
4. Source: NSN 6840-01-428-6646
5. Application: Corrective - residual indoor/outdoor treatment.
   a. Strength: see label.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: hand sprayer.
6. Areas to be treated: Indoors, apply as a crack and crevice treatment, to ant trails, around windows and doors, and wherever ants can find entrance to buildings. Outdoors, apply as a perimeter spray around buildings.
7. Caution:
   a. Do not allow children or pets on treated areas until pesticide dries.
   b. Do not treat food contact surfaces.
8. Protective Equipment: Respirator, goggles, coveralls, hat, rubber gloves, rubber boots (outdoors).

APHIDS

PURPOSE: Control of pests that attack ornamental plants.

PRIORITY: 3

SURVEILLANCE: Based on complaints and verified by pest controller.

NON-CHEMICAL CONTROL: Biological control allowing natural enemies, predators and parasites, to control aphid populations. It may be necessary to control ants that are protecting the aphids from predators and parasites.

CHEMICAL CONTROL:

PESTICIDE: Imidacloprid (Merit 75 WSP)

1. EPA Reg #: 3125-439
2. Formulation: Wettable powder
3. AI: 75%
4. Source: BEI
5. Application: Corrective.
   a. Strength: see label.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: gallon hand sprayer/power sprayer.
6. Areas to be Treated: Ornamental plants.
7. Caution: Do not apply when plants are in bloom if bees are visiting the area.
8. Protective Equipment: Respirator, goggles, coveralls, hat, and rubber gloves.

BEES/WASPS

PURPOSE: To control possible stinging hazards.

PRIORITY: 1 or 2

SURVEILLANCE:

1. Complaint calls, verify infestation.
2. Historical locations.

NON-CHEMICAL CONTROL:

1. Remove nest or swarm: Contact local professional beekeepers.
2. Ensure infested buildings are properly screened.

CHEMICAL CONTROL:

PESTICIDE: Allethrin, d-phenothrin (PT Brand Wasp Freeze Wasp and Hornet Killer)

1. EPA Reg #: 499-362
2. Formulation: Aerosol - jet stream.
3. AI: 0.249%
4. Source: NSN 6840-00-459-2443
5. Application: Corrective.
   a. Strength: 0.249%
   b. Diluent: None
   c. Rate: Thoroughly wet nest and surrounding area.
      1) Wasps - With wind at back of user spray nest from a distance of 6-15 feet. Spray until all nest and wasps are contacted.
      2) Bees - Spray with a sweeping motion any stirred-up insects around nest opening. Afterwards, move forward to nest opening and spray liquid from 6 to 8 seconds directly into nest hole.
   d. Equipment: Ready-to-use aerosol can.
6. Areas to be treated: Nest and immediate surrounding areas.
7. Caution:
   a. Treat after dark or early morning.
   b. Use only in non-food areas.
   c. Do not eat honey from treated nest.
   d. Avoid drift.
8. Protective Equipment: Respirator, protective head net, goggles, coveralls, and rubber gloves.

CENTIPEDES

PURPOSE: Control of a nuisance household pest that has a painful bite.

PRIORITY: 2

SURVEILLANCE: Based on complaints and verified by pest controller.

NON-CHEMICAL CONTROL. Mechanically crush centipede, use sticky traps, cut back vegetation, remove debris piles from around building.

CHEMICAL CONTROL:

PESTICIDE: Lambda-cyhalothrin (Demand CS)

1. EPA Reg #: 100-1066
2. Formulation: CS
3. AI: 9.7%
4. Source: NSN 6840-01-428-6646
5. Application: Corrective - residual indoor/outdoor treatment.
   a. Strength: see label.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: hand sprayer.
6. Areas to be Treated:
   a. Around door and windowsills.
   b. Baseboards and other sites where pests may enter.
   c. Inside closets, cabinets, openings around water pipes and wall voids.
   d. Outdoors apply spot or band treatment to areas where pests may crawl.
7. Caution: Do not allow children and pets in treated areas until pesticide dries.
8. Protective Equipment: Respirator, goggles, coveralls, rubber gloves, hat, and rubber boots (outdoors).

PESTICIDE: Cypermethrin (Demon TC)

1. EPA Reg #: 100-1006
2. Formulation: EC
3. AI: 25.3%
4. Source: BEI
5. Application: Corrective residual outdoor treatment.
   a. Strength: see label.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: hand sprayer/power sprayer.
6. Areas to be Treated: Outdoors as a 6-10 feet wide band treatment around and adjacent to the structure.
7. Caution: Do not allow children and pets in treated areas until pesticide dries.
8. Protective Equipment: Respirator, goggles, coveralls, rubber gloves, hat, and rubber boots.

COCKROACHES

PURPOSE: Control of potential disease carriers and nuisance pests.

PRIORITY: 3

SURVEILLANCE:

1. Tripler Army Medical Center, Department of Preventive Medicine:
   a. Food-handling facilities are surveyed monthly/quarterly. Signs of cockroach harborage and sanitary conditions that are conductive for cockroach infestations are noted and recorded during scheduled surveys.
   b. Survey results are used to verify control operations performed by the pest control shop.
2. Pest Controller: Verify cockroach infestations prior to conducting residual treatment. A comprehensive crack and crevice survey is conducted using a flushing agent. Visual presence of any flushed cockroaches indicates selective spot treatment of harborage sites.

NON-CHEMICAL CONTROL:

1. Sanitation: The facility occupant is responsible for ensuring that poor sanitation is not a contributing factor for pest infestations. If continued pest infestations are the result of poor sanitation practices:
   a. Contact manager of facility and explain deficiency. If not corrected,
   b. Contact Tripler Army Medical Center, Department of Preventive Medicine or the local preventive medicine activity.
2. Harborage Elimination: Caulking or sealing cockroach harborage sites is primarily the responsibility of the occupant. However, pest controllers can quickly eliminate primary harborage sites using a caulking gun instead of repeated applications of pesticides. Pest controllers need to actively show managers where and how harborage sites can be eliminated.
3. Cockroach Sticky Traps: Sticky traps can provide limited control of minor cockroach infestations. This requires maintenance of traps through a continuous trapping program. Traps can still be used as a surveillance tool.

CHEMICAL CONTROL: DO NOT CONDUCT CHEMICAL TREATMENTS if the primary cause of the infestation is poor sanitation

PESTICIDE: Fipronil (Combat Cockroach Bait Station)

1. EPA Reg # 64240-33 - small
   64240-34 - large
2. <u>Formulation</u>: Cockroach bait station
3. AI: 0.03%
4. <u>Source</u>: NSN 6840-01-180-0167 - Small
   6840-01-224-1269 - Large
5. <u>Application</u>: Corrective/preventive
   a. Strength: 0.03%
   b. Diluent: none
   c. Rate: see label.
   d. Equipment: Ready-to-use bait station
6. <u>Areas to be treated</u>:
   a. Use around hard to control areas such as electrical junction boxes, computers, communication equipment, electrical motors and other pieces of electrical equipment infested with cockroaches.
   b. Use in hospitals and medical treatment facilities.
   c. Use in self-help program.
7. <u>Caution</u>: Do not allow children or pets to play with the bait stations.
8. <u>Protective equipment</u>: None required.

COCKROACHES (cont.)

PESTICIDE: Boric Acid (Perma-Dust)

1. EPA Reg #: 499-384
2. Formulation: Dust in aerosol can
3. AI: 35.5%
4. Source: NSN 6840-01-287-3938.
5. Application: Corrective/preventive
   a. Strength: 35.5%
   b. Diluent: none
   c. Rate: 1 second spray per spot.
   d. Equipment: Aerosol can with crack and crevice device. Use injection tube.
6. Areas to be treated:
   a. Crack and crevice areas of kitchen and bathrooms of food handling facilities and quarters
   b. Under sinks, behind cabinets, around hot water heaters and refrigeration units, under serving lines, along cracks of kitchen and bathroom moldings, around doorjambs, and behind/under counters and drawers (especially those constructed of wood).
7. Caution: Use only as crack and crevice treatment.
8. Protective equipment: Dust mask, goggles, rubber gloves.

PESTICIDE: Pyrethrins, Piperonyl Butoxide (CB 80 Extra)

1. EPA Reg #: 9444-175
2. Formulation: Ready-to-use aerosol
3. AI: 4.5%
4. Source: BEI
5. Application: Space spray, contact treatment.
   a. Strength: 4.5%
   b. Diluent: none
   c. Rate: see label.
   d. Equipment: Ready-to-use aerosol can.
6. Areas to be treated: Indoors as a crack and crevice treatment, and as a space treatment.
7. Caution:
   a. Ensure food, dishes, pans and eating utensils are covered or removed from treatment areas.
   b. Ventilate 2 hour.
8. Protective Equipment: Respirator, goggles, rubber gloves.

PESTICIDE: Pyrethrins, Piperonyl butoxide, N-octyl bicycloheptene dicarboximide (BP-100)

1. EPA Reg #: 499-452
2. Formulation: Ready-to-use or concentrate.
3. AI: 5.94%
4. Source: BEI
5. Application: Corrective
   a. Strength: see label.
   b. Diluent: White mineral oil or odorless light petroleum hydrocarbon.
   c. Rate: see label
   d. Equipment: see label
6. Areas to be Treated: Use as space treatment only when survey results indicate a heavy infestation (10 cockroaches per trap per night) of food-handling and only after performing comprehensive residual treatment; it does not replace the residual crack and crevice treatments.
7. Caution:
   a. ULV treatment can only be used when the area is unoccupied.
   b. Ensure food and eating/cooking utensils are covered prior to fogging.
   c. Leave treated area closed for one hour and ventilate room thoroughly before reentry.

COCKROACHES (cont.)

8. Protective Equipment for ULV treatment: Full-face respirator approved for ULV applied pesticides, rubber gloves, coverall, and hat.

PESTICIDE: Lambda-cyhalothrin (Demand CS)

1. EPA Reg #: 100-1066
2. Formulation: CS
3. AI: 9.7%
4. Source: NSN 6840-01-428-6646
5. Application: Corrective - residual indoor/outdoor treatment.
   a. Strength: see label.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: hand sprayer.
6. Areas to be Treated:
   a. Crack and crevice areas of kitchen and bathrooms of food handling facilities and quarters
   b. Under sinks, behind cabinets, around hot water heaters and refrigeration units, under serving lines, along cracks of kitchen and bathroom moldings, around doorjambs, and behind/under counters and drawers (especially those constructed of wood).
7. Caution:
   a. Avoid spraying electrical devices.
   b. Avoid food contact surfaces such as counter tops.
   c. Do not apply where children are likely to contact treated surfaces.
   d. Apply only as a crack and crevice treatment.
   e. Ensure food, dishes, pans and eating utensils are covered or removed from treatment areas.
8. Protective Equipment: Respirator, goggles, coveralls, rubber gloves, hat.

CRICKETS

PURPOSE: Control of a household nuisance pest.

PRIORITY: 3

SURVEILLANCE: Based on complaints and verified by pest controller.

NON-CHEMICAL CONTROL: Sound cultural pest management can result in complete control.

1. Frequently mow lawns and cut weeds especially next to buildings.
2. Ensure garbage collection areas are free of rubbish.
3. Limit the use of outdoor lighting and use yellow lights when lights are necessary.
4. Ensure the building has tight fitting doors and windows.
5. Fix leaking pipes and correct any damp conditions around buildings.

CHEMICAL CONTROL:

PESTICIDE: Orthoboric Acid (NiBan-FG)

1. EPA Reg #: 64405-2
2. Formulation: Bait
3. AI: 5%
4. Source: BEI
5. Application:
   a. Strength: 5%
   b. Diluent: none
   c. Rate: see label.
   d. Equipment: none.
6. Areas to treated:
   a. Indoors - Areas inaccessible to children and pets such as cracks and crevices and wall voids.
   b. Outdoors - see label.
7. Caution: Avoid contact with skin, eyes or clothing.
8. Protective Equipment: Long-sleeved shirt, long pants, rubber gloves, shoes and socks.

FLEAS

PURPOSE: Control of potential disease carriers and biting nuisance pests.

PRIORITY: 2

SURVEILLANCE:

1. Control based upon complaints.
2. Pest Controller:
   a. Verify the complaint.
   b. Place a large white sheet of paper or cloth on the floor and see if fleas land on the surface.
   c. Look around couches and easy chairs, if pet uses these for bedding. Check the pets' bedding area.
   d. Check around the corners of the floor and rugs.
   e. Inspect the pet for fleas.
   f. Inspect vacuum dirt bag after recent vacuuming.

NON-CHEMICAL CONTROL:

1. Practice good housekeeping. Thoroughly clean under and around furniture and animal bedding.
2. Thorough vacuuming will remove many fleas.
3. Proper pet management will decrease the overall flea problem.

CHEMICAL CONTROL:

PESTICIDE: Pyripoxyfen, Pyrethrins, N-Octyl bicycloheptene dicarboximide, Permethrin, related compounds (Ultracide)

1. EPA Reg #: 499-404
2. Formulation: Aerosol
3. AI: 0.985%
4. Source: BEI
5. Application: Corrective-indoor residual treatment
   a. Strength: 0.985%
   b. Diluent: none
   c. Rate: see label.
   d. Equipment: Ready-to-use aerosol.
6. Areas to be Treated: see label.
7. Caution: Do not allow pets or children on the treated areas until spray dries.
8. Protective Equipment: None if used properly.

PESTICIDE: Lambda-cyhalothrin (Demand CS)

1. EPA Reg #: 100-1066
2. Formulation: CS
3. AI: 9.7%
4. Source: NSN 6840-01-428-6646
5. Application: Corrective - outdoor treatment.
   a. Strength: 0.03%.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: hand sprayer/power sprayer.
6. Areas to be Treated: see label
7. Caution:
   a. Do not apply to pasture or cropland.
   b. Do not allow pets or children on the treated areas until spray dries.
8. Protective Equipment: Respirator, goggles, coveralls, rubber gloves, hat, rubber boots.

HOUSE FLIES AND FILTH FLIES

PURPOSE: Control of nuisance insects and potential disease carriers.

PRIORITY: 2 - for food handling establishments.
3 – non-food handling establishments.

SURVEILLANCE

1. Tripler Army Medical Center, Department of Preventive Medicine:
   a. Visually observe around food-handling facilities monthly/quarterly for conditions conducive for fly infestations, such as inadequate screening, and poor garbage/trash management.
   b. Report findings to facility manager and to pest control personnel.
2. Pest Controller:
   a. Report sanitary/structural conditions and non-chemical measures to facility managers.
   b. For continued problems contact the Tripler Army Medical Center, Department of Preventive Medicine, so that medical authority can be used to correct structural and/or sanitary deficiencies.

NON-CHEMICAL CONTROL:

1. Solid waste management.
   a. Ensure trash cans and waste receptacles have tight fitting lids.
   b. Ensure trash cans and garbage collection points are cleaned each time when garbage is removed for disposal.
   c. Use sealed plastic bags to the maximum extent possible to contain spilled food.
   d. Ensure adequate numbers of trash receptacles are present to contain all the garbage.
2. Fly Exclusion
   a. Ensure all doors and windows close tightly and are screened if opened.
   b. Ensure doors have self-closing devices and are not propped open.
   c. Ensure air curtains are operational when doors are open.
3. Fly swatters should be used to control minor infestations.
4. Primary control emphasis must be placed into non-chemical control.

CHEMICAL CONTROL:

PESTICIDE: Permethrin/Allethrin

1. <u>EPA Reg #:</u> 46515-48-8845
2. <u>Formulation:</u> Aerosol
3. <u>AI:</u> 0.4%
4. <u>Application:</u> Corrective-space treatment
   a. Strength: 0.4%
   b. Diluent: None
   c. Rate: 10 seconds space treatment/1000 cubic ft. (10ft x 10ft x 10ft)
   d. Equipment: Ready-to-use aerosol can
5. <u>Areas to be Treated:</u>
   a. Inside of building by the occupant.
   b. Pest controllers do not provide fly control inside of buildings.
   c. This is a self-help item.
6. <u>Caution:</u> Cover food, eating and cooking utensils, fish tanks, etc.
7. <u>Protective Equipment:</u> Not necessary for limited use.

HOUSE FLIES AND FILTH FLIES (cont.)

PESTICIDE: Cypermethrin (Demon TC)

1. EPA Reg #: 100-1006
2. Formulation: EC
3. AI: 25.3%
4. Source: BEI
5. Application: Corrective residual outdoor treatment.
   a. Strength: see label.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: hand sprayer/power sprayer.
6. Areas to be Treated: see label.
7. Caution: Do not allow children and pets in treated areas until pesticide dries.
8. Protective Equipment: Respirator, goggles, coveralls, rubber gloves, hat, and rubber boots.

PESTICIDE: Methomyl (Golden Malrin)

1. EPA Reg #: 2724-274
2. Formulation: Bait
3. AI: 1.149%
4. Source: NSN 6840-01-183-7244
5. Application: Corrective
   a. Strength: 1.149%
   b. Diluent: None
   c. Rate: see label.
   d. Equipment: Use in commercial bait stations following label instructions.
6. Areas to be Treated: Use only in areas described on the label.
7. Caution: Do not allow children or pets into treated area.
8. Protective Equipment: Long-sleeved shirt, long pants, rubber gloves, shoes and socks.

MOSQUITOES - ADULT

PURPOSE: Control of nuisance pest and potential vector of mosquito-borne diseases. Controlling nuisance biting mosquitoes to improve health, welfare and morale of installation personnel.

PRIORITY: 2

SURVEILLANCE:

1. Tripler Army Medical Center, Department of Preventive Medicine will conduct routine mosquito surveillance to include the following:
   a. Sex and identify mosquito species.
   b. Provide recommendations for control.
   c. Evaluate light trap locations.
2. Pest Controller:
   a. Modify control program based on surveillance results provided to Installation Pest Management Coordinator.
   b. Complaints will be evaluated to determine if there is a need for control. If trapping is deemed necessary, complaints will be forwarded Tripler Army Medical Center, Department of Preventive Medicine.

NON-CHEMICAL CONTROL:

1. Ensure occupied buildings are screened.
2. The use of fly swatters (NSN: 3740-00-252-3383) will control minor infestation indoors (self-help item).
3. Mowing/cutting of grass and cutting back foliage to reduce resting sites.
4. Elimination of standing water that provides breeding sites.

CHEMICAL CONTROL:

PESTICIDE: Permethrin/Allethrin

1. <u>EPA Reg #</u>: 46515-48-8845
2. <u>Formulation</u>: Aerosol
3. <u>AI</u>: 0.4%
4. <u>Application</u>: Corrective space treatment
   a. Strength: 0.4%
   b. Diluent: none
   c. Rate: 10 second space treatment / 1000 cubic feet (10 ft x 10 ft x 10 ft).
   d. Equipment: Ready-to-use aerosol can.
5. <u>Areas to be Treated</u>:
   a. Inside of building by the occupant.
   b. Pest controllers do not provide mosquito control inside of buildings.
   c. This is a self-help item.
6. <u>Caution</u>: Use IAW label instructions
7. <u>Protective Equipment</u>: Not necessary for limited use.

MOSQUITO - LARVAE

PURPOSE: To control immature larvae in their breeding sites.

PRIORITY: 2

SURVEILLANCE:

1. Tripler Army Medical Center, Department of Preventive Medicine.
   a. Monthly survey of potential mosquito breeding sites.
   b. At each breeding site, larvae will be surveyed using a dipper and the number larvae/dip will be recorded.
   c. Installation Pest Management Coordinator will be informed of survey results. Any necessary actions will be forwarded to Pest Controllers.
2. Pest Controller: Report breeding sites to the Office of the Project Manager for possible corrective actions.

NON-CHEMICAL CONTROL:

1. Water management to include draining ditches and draining or filling in sites that contain standing water.
2. Remove trash such as cans, barrels and old tires to eliminate these breeding sites. Turn-over water containing devices when not in use.
3. Control aquatic weeds and weeds in ditches that restrict water flow.

CHEMICAL CONTROL:

PESTICIDE: Bacillus thuringiensis israelensis (Summit B.t.i. Briquets)

1. EPA Reg #: 6218-47
2. Formulation: Slow release briquette.
3. AI: 10%
4. Source: BEI
5. Application: Corrective
   a. Strength: 10%
   b. Diluent: None
   c. Rate: see label.
   d. Equipment: Ready-to-use briquettes.
6. Areas to be treated: Apply to stagnant pools, road and irrigation ditches, catch basins, artificial containers, lake shore lines, quarries, and marshy areas.
7. Caution: For outdoor use only.
8. Protective Equipment: Light-weight rubber gloves

RODENTS

PURPOSE: Control of a pest capable of damaging buildings and destroying quantities of stored products.

PRIORITY: 1 or 2 - depending on the current presence of a rodent.

SURVEILLANCE:

1. Tripler Army Medical Center, Department of Preventive Medicine:
   a. Food Handling Facilities
      1) Conduct quarterly inspection of interior and exterior, observing sanitation and other conditions capable of sustaining pest infestations.
      2) The survey will be visual, looking for signs of rodent presence such as droppings, runways, rubmarks and burrows, and for live rodents.
      3) Surveillance results will be provided to the pest controllers and to the facility manager.
   b. Food Storage Facilities. Tripler Army Medical Center, Department of Preventive Medicine personnel, in conjunction with veterinary service personnel, will conduct semi-annual visual surveys and report findings to the facility manager and to the pest control shop.
2. Veterinary personnel will conduct surveys of food storage facilities.
   a. Monthly comprehensive survey performed by Veterinarian.
   b. Surveillance results will be coordinated with pest control personnel.
3. Pest Controller:
   a. Food Handling Facilities and Food Storage Facilities
      1) Conduct visual survey of building interior and exterior looking for signs of rodent activity in conjunction with surveys provided by medical personnel.
      2) ensure baits in traps are fresh.
   b. All other facilities and separate trash collection points
      1) Visual survey will be performed in response to report of rodent activity.
      2) The building exterior will be observed for burrows, runways, potential harborage sites and potential building entrance.

NON-CHEMICAL CONTROL:

1. Sanitation - Preventive
   a. Ensure garbage/trash is placed inside trash receptacles having tight-fitting lids. Report deficiencies to Tripler Army Medical Center, Department of Preventive Medicine.
   b. Ensure food is placed in rodent-proof containers.
2. Rodent-Proofing - Preventive
   a. The single most important factor in preventing a rodent infestation inside a building.
   b. All potential rodent entrance sites greater than 1/4 inch should be sealed.
   c. Contact the facility manager and the preventive maintenance section to inform them of the needs for rodent-proofing.
   d. Tripler Army Medical Center, Department of Preventive Medicine can provide additional assistance.
3. Trapping - Corrective
   a. Glue boards: Place glueboards on both sides of potential rodent entrance sites, along the perimeter walls. Glueboards can be used with other trapping methods. Placing a small quantity of peanut butter on the center of the glueboard will encourage crossing onto the trap.
   b Snap traps and Live-catch traps: These traps should be baited with dried fish, bacon, nut, meats, dried fruit or bread products. Baits must be changed at least monthly. Bacon and bread baits require more frequent changing to ensure that the bait is fresh. Position traps adjacent to walls.
   c A single trap of glueboard should be positioned every 25 to 50 feet along the interior perimeter of the building, especially in food storage facilities.

RODENTS (cont.)

CHEMICAL CONTROL:

PESTICIDE: DIPHACINONE: Anticoagulant - multiple-dose

1. EPA Reg #: various
2. Formulation: Bait block
3. AI: 0.005%
4. Source: BEI
5. Application: Preventive - routine baiting program
   a. Strength: 0.005%
   b. Diluent: None
   c. Rate: 2 - 4 oz bait every 50 ft., along exterior building perimeter
   d. Equipment: Tamper-proof bait station where necessary.
6. Areas to treated:
   a. Use around food-handling and food storage facilities.
   b. Not greatly affected by bird feeding and wet-weather.
   c. Can be placed in trees, sewers or other likely places rodents may be active.
7. Caution:
   a. Do not spray the bait stations. Avoid placing the bait stations in areas accessible to children, pets, domestic animals, and wildlife.
   b. Do not place bait in areas where there is a possibility of contaminating food or surfaces that come in direct contact with food.
   c. Replace all baits every 2 weeks for continuous control of rodents.
8. Protective equipment: Light-weight rubber gloves.

PESTICIDE: Bromadiolone: Anticoagulant - single-dose

1. EPA Reg #: various
2. Formulation: Bait block
3. AI: 0.005%
4. Source: BEI
5. Application: Remedial - for active infestations
   a. Strength: 0.005%
   b. Diluent: None
   c. Rate: 4-16 oz bait every 15-30 ft. along exterior building perimeter
   d. Equipment: Tamper-proof bait station where necessary.
6. Areas to treated:
   a. Use around food-handling and food storage facilities.
   b. Not greatly affected by bird feeding and wet-weather.
   c. Can be placed in trees, sewers or other likely places rodents may be active.
7. Caution:
   a. Do not spray the bait stations. Avoid placing the bait stations in areas accessible to children, pets, domestic animals, and wildlife.
   b. Do not place bait in areas where there is a possibility of contaminating food or surfaces that come in direct contact with food.
   c. Maintain supply of fresh bait for 10 days or until signs of rodent activity disappears.
8. Protective equipment: Light-weight rubber gloves.

SPIDERS

PURPOSE: Control of a household nuisance pest.

PRIORITY: 3

SURVEILLANCE: Based on complaints and verified by pest controllers.

NON-CHEMICAL CONTROL:

1. Ensure doors and windows are screened.
2. Vacuum or mechanically crush spiders and sweep away webbing and egg masses.

CHEMICAL CONTROL:

PESTICIDE: Lambda-cyhalothrin (Demand CS)

1. EPA Reg #: 100-1066
2. Formulation: CS
3. AI: 9.7%
4. Source: NSN 6840-01-428-6646
5. Application: Corrective - outdoor treatment.
   a. Strength: 0.03%.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: hand sprayer/power sprayer.
6. Areas to be Treated: see label
7. Caution:
   a. Do not apply to pasture or cropland.
   b. Do not allow pets or children on the treated areas until spray dries.
8. Protective Equipment: Respirator, goggles, coveralls, rubber gloves, hat, rubber boots.

STORED PRODUCTS PESTS

PURPOSE: Control of pests that can damage subsistence products.

PRIORITY: 3

SURVEILLANCE:

1. Veterinary personnel:
   a. Conduct routine surveillance of commodities.
   b. Receive complaints from customers of commissaries and Class I subsistence supply.
   c. Coordinate findings with pest controllers.
   d. Submit specimens to Tripler Army Medical Center, Preventive Medicine Entomologist for identification.
2. Preventive Medicine:
   a. Conduct semi-annual survey.
   b. Spot check high-risk products by opening boxes and looking for stored products pests.
3. Pest Controller:
   a. Check glueboards, if used, for the presence of stored products pests.
   b. Submit specimen to Tripler Army Medical Center, Preventive Medicine Entomologist for identification.

NON-CHEMICAL CONTROL:

1. Clean up spilled food items.
2. Seal cracks in the floors that may hold food.
3. Rotate stock and ensure a short holding time.
4. Isolate infested products.
5. Cold storage can be used to kill pests.

CHEMICAL CONTROL:

PESTICIDE: Aluminum Phosphide (Phostoxin) RESTRICTED USE PESTICIDE

1. EPA Reg #: 72959-4
2. Formulation: Concentrated tablets
3. AI: 55%
4. Source: NSN: 6840-00-442-5698
5. Application: Corrective
   a. Strength: 55 %
   b. Diluent: None
   c. Rate: See label
   d. Equipment: Plastic tarp or fumigation chamber.
6. Areas to be treated:
   a. Infested products can be treated in place or,
   b. Move infested products to fumigation chamber.
   c. Allow several days for fumigation to ensure fumigant penetrates the infested products.
7. Caution:
   a. Have self-contained breathing apparatus (SCBA) immediately available while handling the fumigant.
   b. Post warning signs.
8. Protective equipment: SCBA, coveralls, light-weight rubber gloves.

TERMITES

PURPOSE: Control of a pest that can damage and destroy buildings.

PRIORITY: 2

SURVEILLANCE:

1. Based on complaints by building occupants.
2. Observed by building maintenance personnel during building remodeling and/or repair.
3. Noted by pest controllers during semi-annual/annual inspection.

NON-CHEMICAL CONTROL:

1. Design termite-proof buildings for new construction.
2. Use of non-chemical barriers such as Basaltic Termite Barrier and Termi-mesh.
3. Remove old wood and wood scraps.
4. Repair termite damaged wood and replace with treated lumber.
5. Ensure areas around buildings are properly drained.

CHEMICAL CONTROL:

PESTICIDE: Baygon (Invader HPX)

1. EPA Reg #: 9444-186
2. Formulation: Aerosol
3. AI: 1.0%
4. Source: BEI
5. Application: Treatment to damaged/infested wood.
   a. Strength: 1.0%
   b. Diluent: None
   c. Rate: see label..
   d. Equipment: Ready-to-use aerosol can.
6. Caution: Use IAW label instructions
7. Protective Equipment: Use of safety glasses recommended.

PESTICIDE: Cypermethrin (Demon TC)

1. EPA Reg #: 10182-107
2. Formulation: EC - Special formulation for termite control
3. AI: 25.3%
4. Source: BEI
5. Application: Corrective/preventive; long-term residual control
   a. Strength: see label.
   b. Diluent: Water
   c. Rate: see label.
   d. Equipment: Hand sprayer, power sprayer, sub-slab/soil injection rods, roto-hammer.
6. Areas to be treated:
   a. Pre-slab of new construction.
   b. Sub-slab injection of existing building.
   c. Along foundation of buildings with crawl spaces.
   d. Voids of masonry type walls.
   e. Wood in place.
7. Caution: see label
8. Protective equipment: Respirator (Half-mask), goggles, rubber boots, rubber gloves, coveralls, and hat.

TICKS

PURPOSE: Control of nuisance biting pest.

PRIORITY: 3

SURVEILLANCE:

1. Performed by Tripler Army Medical Center, Department of Preventive Medicine or Pest Control Personnel.
2. Based on complaints of indoor biting pest.
3. Inspect bedrooms, around pet bedding, under cushions of upholstered furniture, under edge of carpets. Check walls especially wall corners and molding and curtains or drapes.

NON-CHEMICAL CONTROL

1. Remove pet from premises.
2. A few ticks can be hand-picked and destroyed.
3. Vacuuming will remove numerous ticks.

CHEMICAL CONTROL:

PESTICIDE: Lambda-cyhalothrin (Demand CS)

1. EPA Reg #: 100-1066
2. Formulation: CS
3. AI: 9.7%
4. Source: NSN 6840-01-428-6646
5. Application: Corrective - residual indoor/outdoor treatment.
   a. Strength: see label.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: hand sprayer.
6. Areas to be Treated:
   a. See label for indoor pest control.
   b. Outdoors apply spot or band treatment to areas where pests may crawl.
7. Caution:
   a. Avoid spraying electrical devices.
   b. Avoid food contact surfaces such as counter tops.
   c. Do not apply where children are likely to contact treated surfaces.
   d. Apply only as a crack and crevice treatment.
   e. Ensure food, dishes, pans and eating utensils are covered or removed from treatment areas.
8. Protective Equipment: Respirator, goggles, coveralls, rubber gloves, hat.

TURF PESTS (GENERAL)

PURPOSE: Control of most pests attacking lawns and turf such as armyworms, cutworms, sod webworms, trips, chinch bugs, crickets and earwigs.

PRIORITY: 3

SURVEILLANCE: Based on complaints and verified by pest controllers.

NON-CHEMICAL CONTROL: Not applicable.

CHEMICAL CONTROL:

PESTICIDE: Lambda-cyhalothrin (Demand CS)

1. EPA Reg #: 100-1066
2. Formulation: CS
3. AI: 9.7%
4. Source: NSN 6840-01-428-6646
5. Application: Corrective - outdoor treatment.
   a. Strength: 0.03%.
   b. Diluent: Water.
   c. Rate: see label.
   d. Equipment: hand sprayer/power sprayer.
6. Areas to be Treated: see label
7. Caution:
   a. Do not apply to pasture or cropland.
   b. Do not allow pets or children on the treated areas until spray dries.
8. Protective Equipment: Respirator, goggles, coveralls, rubber gloves, hat, rubber boots.

WEEDS

PURPOSE: Control of unwanted vegetation.

PRIORITY: 3

SURVEILLANCE: Improved grounds are inspected quarterly for unwanted vegetative growth.

NON-CHEMICAL CONTROL:

1. Mowing or cutting unwanted plants.
2. Hand removal of unwanted plants.
3. Selective growing of preferred plant species.
4. Fertilization and watering practices to reduce plant growth.

CHEMICAL CONTROL:

PESTICIDE: Glyphosate (Roundup)

1. EPA Reg #: 524-475
2. Formulation: EC
3. AI: 41%
4. Source: NSN: 6840-01-108-9578
5. Application: Corrective - control of grasses and other plants.
   a. Strength: 1.0% unless otherwise specified.
   b. Diluent: Water
   c. Rate: 1-1/3 oz /gal water, 1 qt/25 gal water.
   d. Equipment: 2 gallon hand sprayer, power sprayer with spray gun or spray boom.
6. Areas to be treated: Along drainage ditches, around buildings, and along fence rows.
7. Time of application: Any time plants are actively growing.
8. Caution:
   a. Avoid drift.
   b. Do not mow or till prior to treatment.
   c. Do not apply if rainfalls is imminent.
9. Protective equipment: Respirator, goggles, rubber gloves, rubber boots, coveralls, and hat.

WOOD BORERS

PURPOSE: Control of pest that attack seasoned wood and wood products.

PRIORITY: 2 - for infestations of the building structure and government furniture.

SURVEILLANCE:

1. Based on complaints and verified by pest controllers.
2. Submit specimens to the Installation Pest Management Coordinator for identification.

NON-CHEMICAL CONTROL: Removal and destruction of infested wood.

CHEMICAL CONTROL:

PESTICIDE: Baygon (Invader HPX)

1. EPA Reg #: 9444-186
2. Formulation: Aerosol
3. AI: 1.0%
4. Source: BEI
5. Application: Treatment to damaged/infested wood.
   a. Strength: 1.0%
   b. Diluent: None
   c. Rate: see label..
   d. Equipment: Ready-to-use aerosol can.
6. Caution: Use IAW label instructions
7. Protective Equipment: Use of safety glasses recommended.

APPENDIX E. PEST MANAGEMENT PLAN FOR TRIPLER ARMY MEDICAL CENTER

PEST MANAGEMENT PLAN

FOR

TRIPLER ARMY MEDICAL CENTER

Prepared by:

John D. Nelson, B.C.E

Entomologist

01 November 2006

Table of Contents

TABLE OF CONTENTS **60**

EXECUTIVE SUMMARY **61**

INTRODUCTION **62**

GENERAL PROVISIONS **63**

- INSTALLATION DESCRIPTION 63
- PLAN MAINTENANCE 63

INTEGRATED PEST MANAGEMENT **64**

- IPM PRINCIPLES 63
- IPM PROCEDURES 64

HEALTH AND SAFETY **64**

- FEDERAL LAWS AND REGULATIONS 64
- STATE LAWS AND REGULATIONS 65
- DOD REGULATIONS AND DIRECTIVES 65

ENVIRONMENTAL CONSIDERATIONS **65**

- PROTECTION OF THE PUBLIC 65
- ENDANGERED AND PROTECTED SPECIES 65
- PROHIBITED ACTIVITIES 66

ADMINISTRATION **66**

- CONTRACTS 66
- RECORD KEEPING 65
- TRAINING 66
- QUALITY ASSURANCE/QUALITY CONTROL 66
- COORDINATION - DOD, OTHER FEDERAL, STATE AND LOCAL 66

REFERENCES **67**

APPENDIX A **68**

APPENDIX B **709**

Executive Summary

Tripler Army Medical Center (TAMC) is the largest military medical treatment facility in the Pacific and provides outpatient and inpatient care to over 250,000 persons including active duty personnel of all branches of military service and their families, retirees, as well as beneficiaries of the Veterans Administration. TAMC includes the main structure located on the Moanalua Ridge on Jarrett White Road in Honolulu as well as clinics at Schofield Barracks and Fort Shafter.

This plan applies to all activities and individuals working or otherwise doing business in any of TAMC facilities. At no time will pest management operations be done in a way that is either injurious to personnel or the environment. Any pest management actions taken within TAMC will conform to the principles of integrated pest management (IPM). The responsibility for proper use of pest management will begin with those individuals occupying or maintaining buildings or open spaces within TAMC facilities. Non-chemical control measures will be used as the primary means of pest control and only when exhausted will any pesticide treatment be considered. Within the medical treatment facility, special provisions will be made for patient sensitive areas and laboratories with infectious agents.

Pests addressed in the plan include blood-sucking insects (fleas, mosquitoes) crawling insects (ants, cockroaches) filth flies and other flying insects, spiders, stinging insects (wasps and bees) termites, rodents and feral animals. Without control these pests could interfere with the military mission, damage real property, increase maintenance costs and expose personnel to disease pathogens.

Introduction

Tripler Army Medical Center (TAMC) is a tenant of U.S, Army Garrison Hawaii (USAG-HI). General pest management guidelines are contained in the Pest Management Plan (PMP) for USAG-HI, which is maintained by the Installation Pest Management Coordinator, Environmental Division, Directorate of Public Works, USAG-HI. TAMC, due to its unique and sensitive role as a medical treatment facility, has an autonomous pest management program under this plan. The TAMC facilities pest management program is administered by the TAMC Entomologist.

This plan is designed to augment the USAG-HI PMP and together act as a framework through which pest management is defined and accomplished on TAMC properties. The plan identifies elements of the program to include health and environmental safety, pest management, and administration that are unique to TAMC.

General provisions

Installation description

This pest management plan covers all TAMC facilities contained in the Operations and Maintenance Management Plan for TAMC:

Bldg.	Type	Sq. footage	Installation
1	Hospital, wing A, B, C	599,578	TAMC
3	Hospital, wing D / Hospital Clinic	134,966	TAMC
4	Hospital, wing F, G, H Hospital Clinic Lab.	467,573	TAMC
6	MRI Facility	1,200	TAMC
9	Central Med. In-Processing / Keiki Coop	4,500	TAMC
25	DPW	4,200	TAMC
673	Health Clinic Med. Lab / Comm. Health Nursing	14,136	Schofield
676	Health Clinic Radiology / Comm. Mental Health	9,840	Schofield
677	Health Clinic Medical Supply / Optometry	14,400	Schofield
679	Health Clinic	6,531	Schofield
680	Health Clinic	14,876	Schofield
681	Health Clinic FP #1 / TMC #3 / Occup. Therapy	11,270	Schofield
682	Health Clinic FP #2 / Immunization / Mental Health	13800	Schofield
683	Urgent Care Clinic / Administration Headquarters	6580	Schofield
684	Dental Clinic #6 / TMC / Medical Clinic #1	14490	Schofield
685	Health Clinic	13500	Schofield
686	Health Clinic Physical Therapy / Med Co C Orderly Rm	14700	Schofield
687	Health Clinic Audiology	14700	Schofield
691	Health Clinic Pharmacy / Patient Administration	4390	Schofield
660	Dental Clinic	17,930	Schofield
934	Veterinary Services Branch Office	1520	Schofield
935	Veterinary Treatment Facility	1894	Schofield
936	Veterinary Treatment Facility	1728	Schofield
435	Veterinary Facility	5093	Shafter
137	Central Plant / Emergency Generator	22,213	TAMC
141	Hospital Support Shop / Wave	3400	TAMC
143	Hospital Support Shop / Wave	3500	TAMC
145	Hospital Support Shop / Wave	3592	TAMC
10	Hospital Support Shop / oxygen tank	100	TAMC
315	Fisher House	5120	TAMC
2	Storage GP Inst.	986	TAMC
40	Clinical Investigation	38,673	TAMC
147	Clinical Investigation / Preventive Medicine	2320	TAMC
148	Clinical Investigation	2925	TAMC

Plan maintenance

This pest management plan is maintained by the TAMC Entomologist. Pen and ink changes are made to the plan throughout the fiscal year. The plan is annually updated by the TAMC Entomologist and approved by the Chief of Environmental Health, TAMC, COR for Pest Control, TAMC, and the USAG-HI Pest Management Coordinator to reflect all changes made in the pest management program during the fiscal year. Annual updates of this plan will be sent to the USAG-HI Pest Management Coordinator not later than 15 October.

Integrated Pest Management

IPM principles

IPM is the judicious use of non-chemical and chemical means to reduce pest populations to tolerable or safe levels. One of the key elements of urban IPM is monitoring pest population levels so that an effective decision making process can be used to determine if or when treatment is needed and subsequently, the effectiveness of those treatments. Additionally, preference is placed on nonchemical means such as sanitation and exclusion, then low-impact pesticide treatments, such as enclosed bait stations, and finally direct pesticide applications, only when all other options have been exhausted or are not feasible.

Mechanical and Physical Control. This type of control alters the pest's environment, traps and removes pests, or excludes pests. Examples of this type control include: harborage elimination through caulking or filling voids, screening, mechanical traps or glue boards, and nets and other barriers to prevent entry into buildings.

Cultural Control / Sanitation. This method involves the elimination of food, water and shelter from the human environment, thus making it inhospitable to pest organisms.

Chemical Control. Pesticides are chemicals that are designed to kill living organisms. As such they do pose some risks to humans and the environment. Modern chemistry has both maximized safety and minimized the risks associated with newer cutting-edge pesticides. When considering the use of pesticides, the benefits due to the reduction in pest organisms must be weighed against the risk posed by these chemicals. In general, pesticide application is the last resort when dealing with most pest management situations.

IPM procedures

Due to the sensitive mission of TAMC facilities, comprehensive plans have been designated for common pest problems. Flow charts for all the major pest groups are contained in Appendix B.

Health and Safety

All pesticide applications will be made by the Pest Control Contractor. Thus safety and health issues such as hazard communication, personal protective equipment, pest control vehicle, spill kit and spill response, and fire protection are the responsibility of the Pest Control Contractor and will be provisioned for in the Pest Control Contract. All pesticide use will be done in accordance with the following laws and regulations:

Federal Laws and Regulations

1. Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) as outlined in Title 40, Code of Federal Regulations (40 CFR).

2. Federal Environmental Pesticide Control Act (FEPCA) "amended FIFRA".

3. Food Quality Protection Act (FQPA).

4. Federal Food, Drug and Cosmetic Act (FDCA).

5. Clean Water Act

6. Safe Drinking Water Act

7. Endangered Species Act

8. Resource Conservation and Recovery Act (RCRA)

9. Superfund Amendments and Reauthorization Act (SARA)

10. Occupational Safety and Health Act (OSHA)

11. Coastal Zone Management Act

State Laws and Regulations

1. Hawaii Pesticide Law (Chapter 149A, Hawaii Revised Statutes) as outlined in Title 4, Chapter 66, Administrative Rules on Pesticides, Hawaii Department of Agriculture.

DOD Regulations and Directives

1. Army Regulation 40-5, Preventive Medicine, Chapter 10, Pest and Disease Vector Prevention and Control

2. Army Regulation 200-1, Environmental Protection and Enhancement

3. Armed Forces Pest Management Board Technical Information Memorandum No. 29, Integrated Pest Management in and Around Buildings

4. Armed Forces Pest Management Board Technical Information Memorandum No. 20, Pest Management Operations in Medical Treatment Facilities.

5. Armed Forces Pest Management Board Technical Information Memorandum No. 39, Guidelines for Preparing DOD Pest Control Contracts using Integrated Pest Management.

Environmental Considerations

Protection of the Public
Due to the sensitive nature of the medical treatment facilities, all pesticide applications will be made in accordance with Armed Forces Pest Management Board TIM 20, Pest Management Operations in Medical Treatment Facilities, October 1989. These directives will be included in the pest control contract.

Endangered and Protected Species
Orangeblack Hawaiian Damselfly (*Megalagrion xanthomelas*) - Habitat of this species is in the gulch next to D-wing of TAMC main hospital. For details see Evenhuis et al. 1995. At no time will any pesticide be used in any TAMC facility that will impact this species.

Prohibited Activities
a. At no time will a pesticide be used in any manner that is inconsistent with its label.
b. No pesticide will be used that is not currently registered by the EPA and the State of Hawaii.
c. No pesticides will be used in patient sensitive areas unless all other options have been exhausted and then only when such areas have been isolated from patients and subsequently cleaned to remove any residue of the treatment.
d. No pesticide will be used in any medical treatment facility unless it is approved for use in hospitals or medical treatment facilities.

Administration

Contracts
All pest control activities are done by a subcontractor administered under J & J Maintenance (Medcam), the maintenance contractor for all TAMC Facilities.

Record Keeping
All pest complaints are reviewed by the TAMC Entomologist, who does an inspection and/or consultation to determine the proper course of action. A Pest Management Report (PMR) is used as the conduit for all pest control actions (See Appendix A). This report details the findings of the TAMC Entomologist in addition to any recommendations for action. If structural modifications or pesticide applications are required then the PMR is submitted to TAMC Logistics Division along with a copy to the complainants. The PMR is also used for the collection of pesticide-use data. Upon the application of a pesticide, the information is recorded on the form, which is then signed by the pesticide applicator and submitted back to the TAMC Entomologist. Any and all pesticide applications are subject to this approval process prior to a work order being issued.

All pesticide applications are recorded and archived via DD Form 1532-1 (or equivalent). Pesticide use is summarized on a monthly basis on DD Form 1532 (or equivalent) and is submitted to the USAG-HI Pest Management Coordinator.

Training
a. The TAMC Entomologist, John D. Nelson, is a GS-11 civilian employee and is a DOD certified pesticide applicator as well as a Board Certified Entomologist in Medical Entomology, Entomological Society of America. The pest control subcontractor is Tropical Termite and Pest Control (Phone: 808-487-2667). All contract pest control technicians that will be applying pesticides within TAMC facilities are certified pesticide applicators in the State of Hawaii.

Quality Assurance/Quality Control
a. TAMC will have a QAE for pest control. That QAE for TAMC pest control is Mr. Clarence Saito, who is also the Contract Officer Representative for J and J Maintenance.
b. A written quality assurance surveillance plan is maintained by TAMC Logistics Division and used to evaluate the work being performed by Tropical Termite and Pest Control personnel.

Coordination - DOD, Other Federal, State and Local
The TAMC Entomologist acts as the Pest Management Coordinator for TAMC facilities as well as the Medical Entomologist for Pacific Regional Medical Command. As Pest Management Coordinator, the TAMC Entomologist administers the pest management plan, oversees the day-to-day pest management activities and tracks all pesticide use for all TAMC facilities. In addition, as Medical Entomologist, the TAMC Entomologist directs all vector surveillance activities throughout USAG-HI and provides expert consultation to PRMC in medical entomological matters. TAMC Logistics administers the maintenance contractor via a Contract Officer Representative (COR) and administers the day-to-day pest control operations that are recommended by the TAMC Entomologist.

USAG-HI is responsible for any pest management issue outside of a 5-ft radius of any structure listed within TAMC facilities.

References

Armed Forces Pest Management Board TIM 20, Pest Management Operations in Medical Treatment Facilities October 1989.

Evenhuis, N., D. Polhemus and S. Swift. 1995. A study of the biology of the Orangeback Hawaiian damselfly (Megalagrion xanthomelas) with special reference to conservation of the population at Tripler Army Medical Center, Oahu. Bishop Museum: Hawaii Biological Survey Final Report.

Appendix A

Pest Management Report

PEST MANAGEMENT / INSPECTION REPORT
(Attach to Work Order Request)

Pest Complaint / Inspection

Point of Contact _____
(Name, Position) (Phone Number) (Signature)

Date of Sighting_____ Room (area)_____

Inspector Name and Phone #_____

Date and Time of Inspection_____ Pest I.D. _____

Findings_____
_____
_____
_____
_____

Recommendations_____
_____
_____
_____
_____
_____

Actions Taken

Date_____
Work Order Reference Number_____Time in_____Time out_____

Nonchemical Control (specify)_____

Chemical Control - Pesticides:

	Pesticide #1	Pesticide #2	Pesticide #3
Product Name			
EPA Registration #			
Active Ingredient			
% Finished Spray			
Amount Applied			

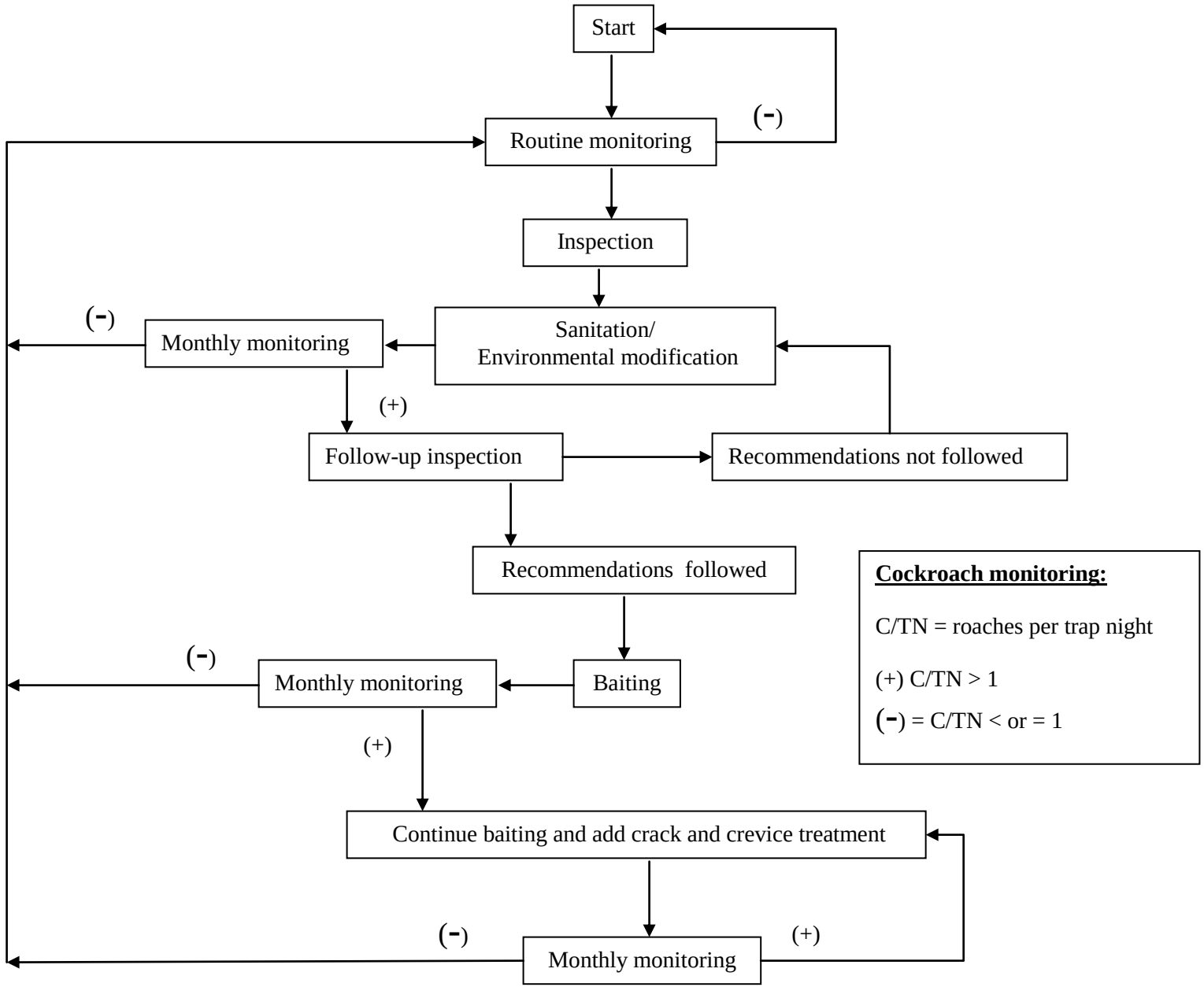
_____
Workers Signature

Return Completed Form to: Pest Management Coordinator / John D. Nelson, TAMC Entomologist MCHK-PVN; Bldg. 147, Phone 433-9944; Pager 574-7786; Fax 433-2964.

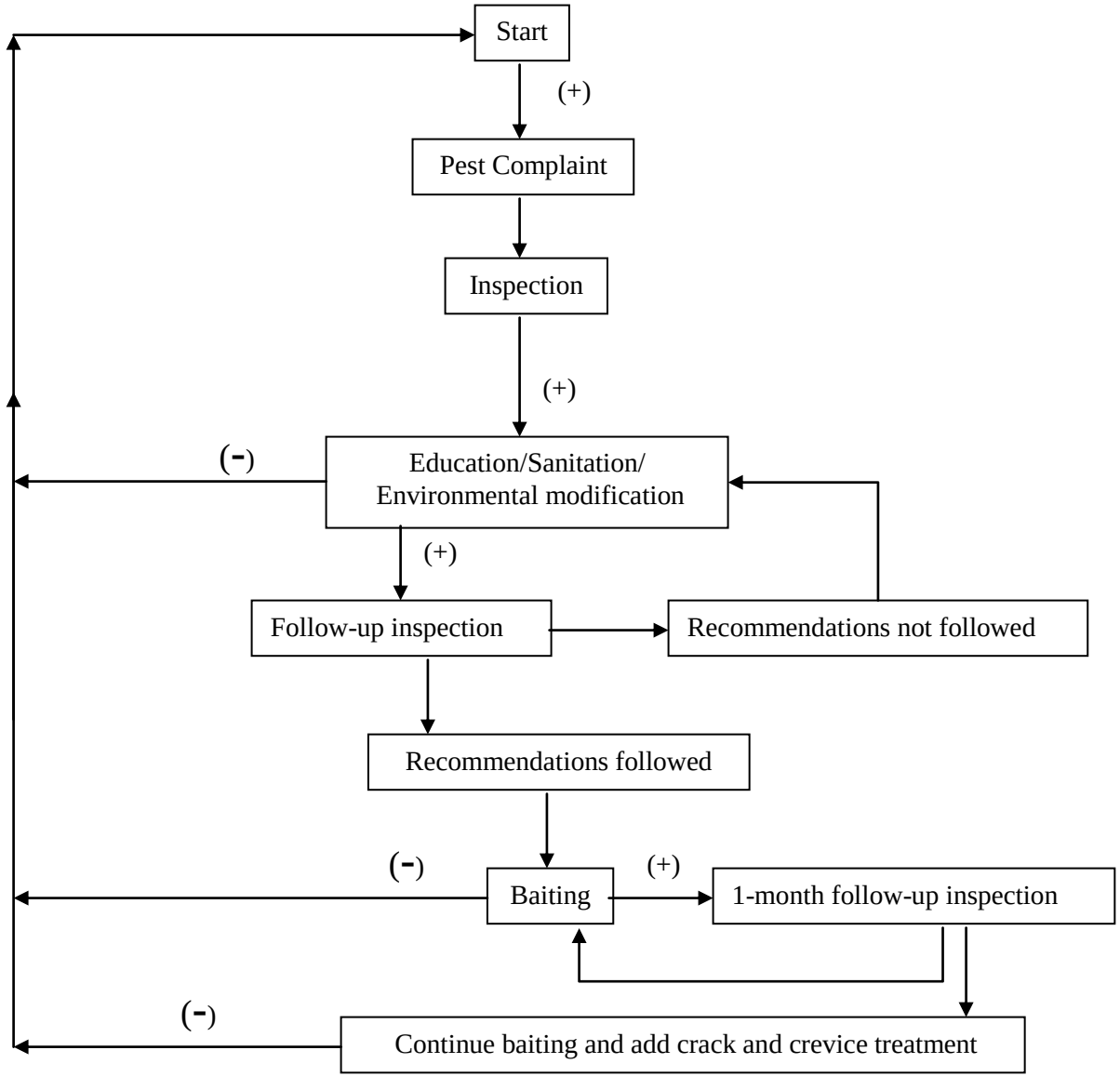
Appendix B

Pest Management Flow-Charts

Integrated Cockroach Management Program for Food Service Facilities



Integrated Domiciliary Cockroach Management Program for TAMC Facilities



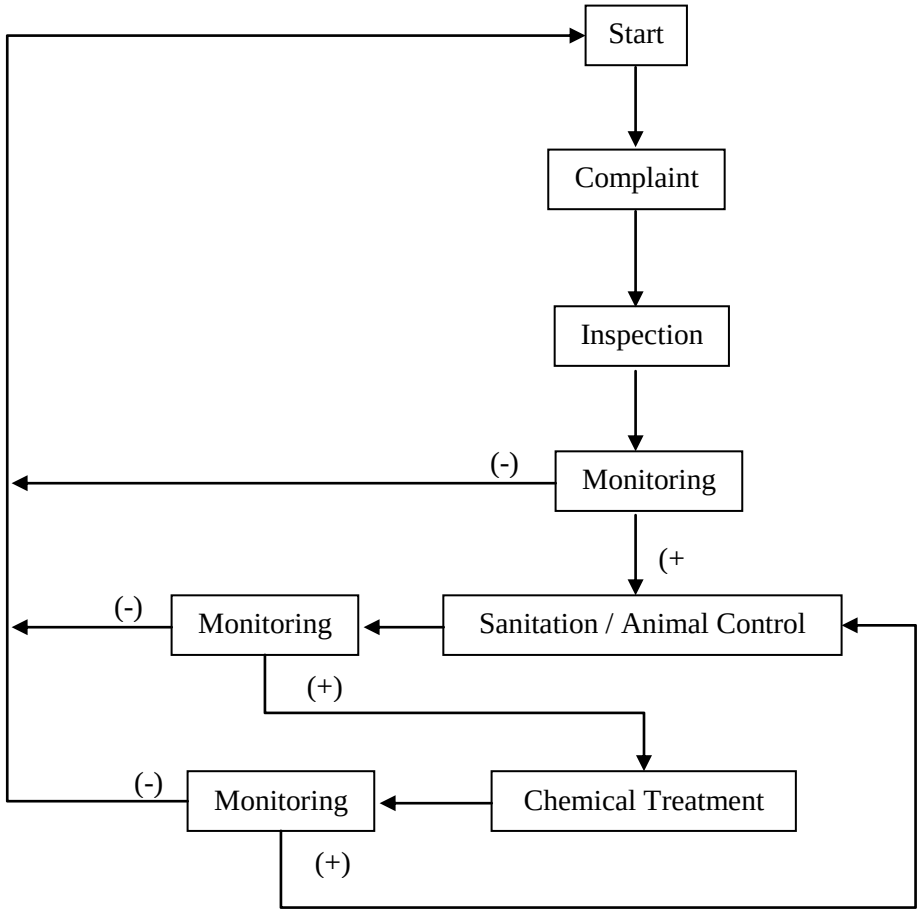
Cockroach Aesthetic Threshold:

R/D = roaches sightings per day

(+) R/D > or = 1 (Complaint)

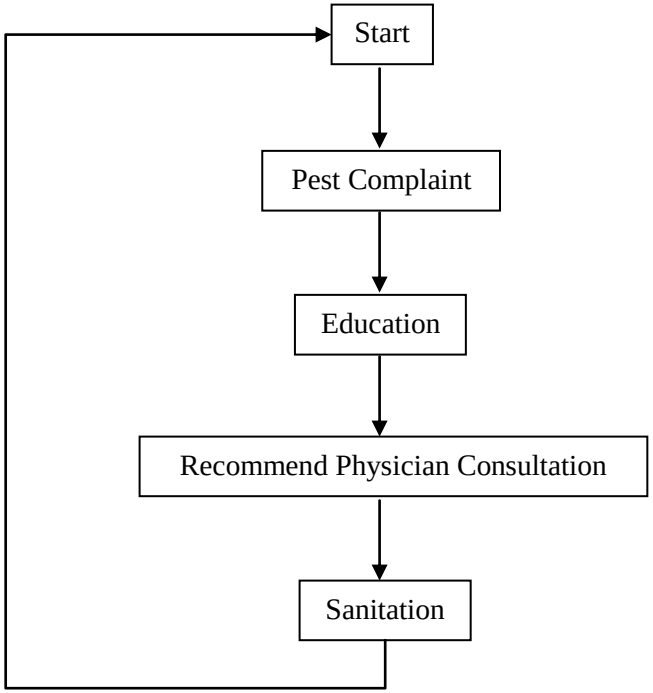
(-) R/D = 0 (Satisfaction)

Integrated Flea Management Program for TAMC Facilities



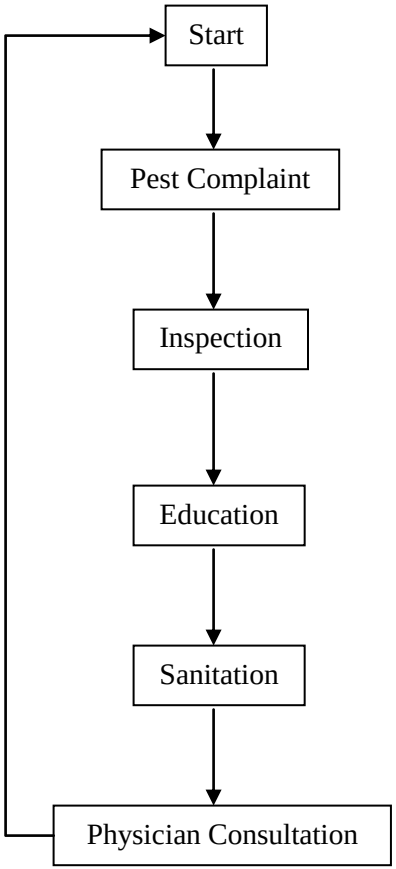
(+) = Evidence of active infestation
(-) = No evidence of active infestation

Integrated Lice Management Plan for TAMC Facilities



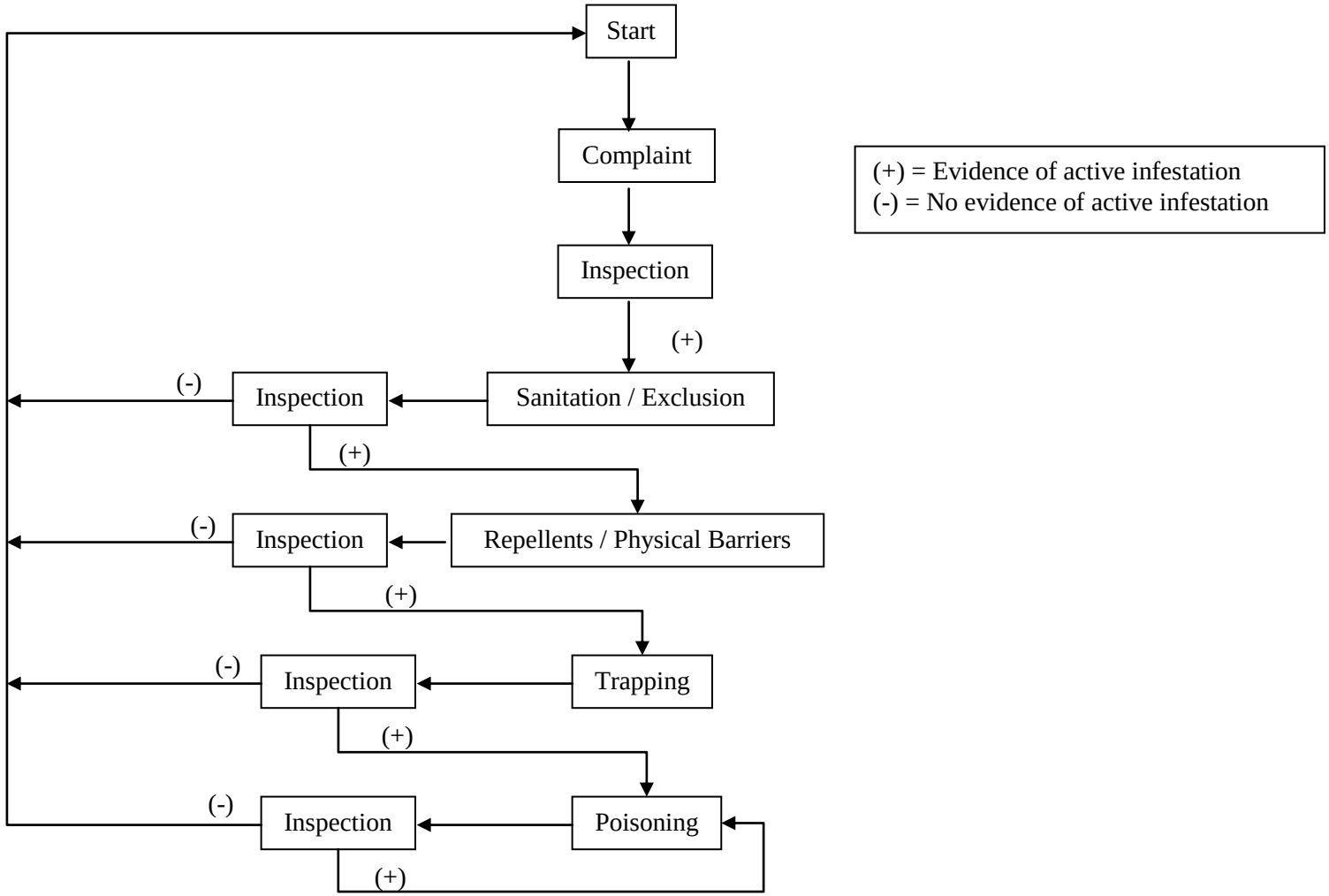
(+) = Evidence of active infestation
(-) = No evidence of active infestation

Integrated Bedbug Management Plan for TAMC

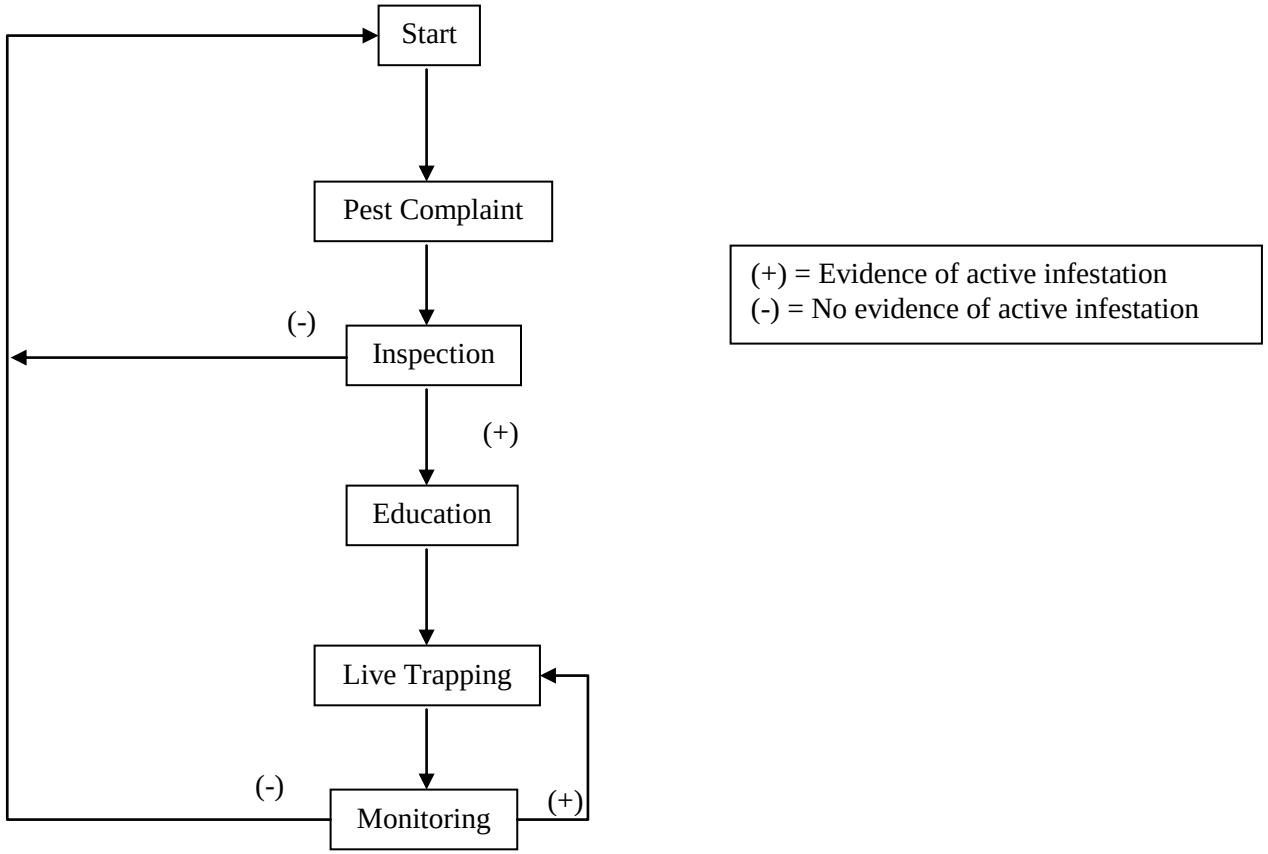


(+) = Evidence of active infestation
(-) = No evidence of active infestation

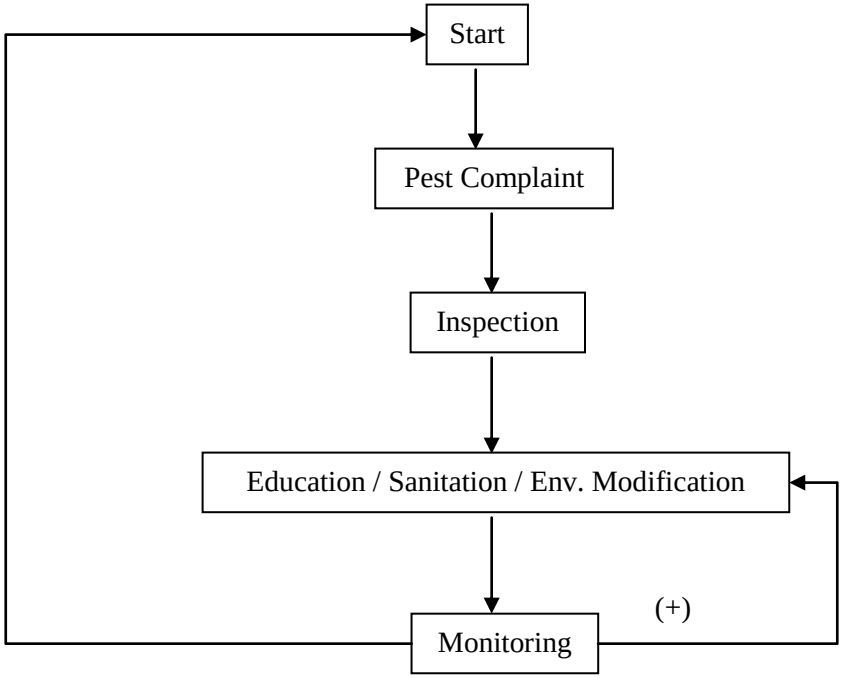
Integrated Bird Management Plan for TAMC Facilities



Integrated Feral Cat Management Program for TAMC Facilities

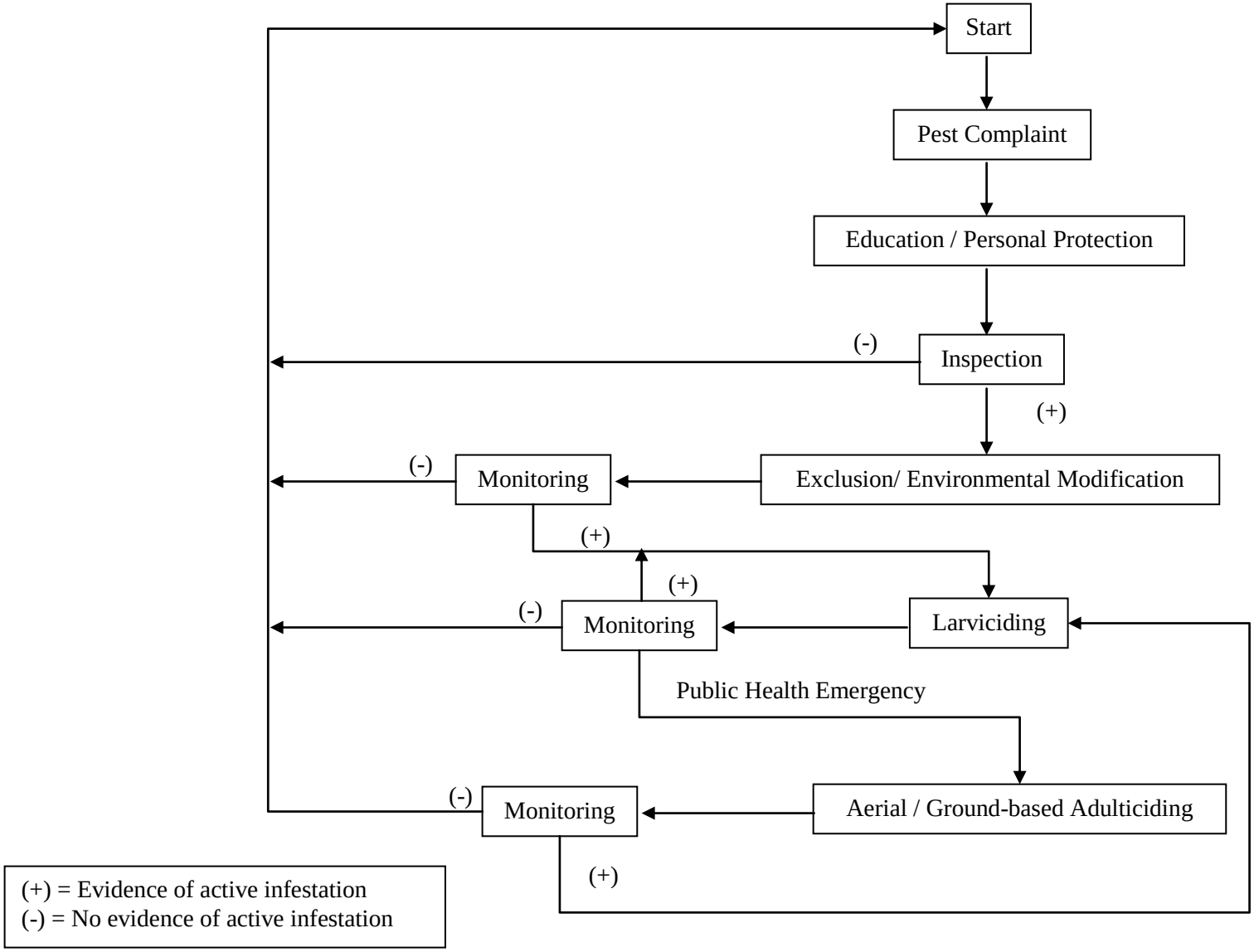


Integrated Stored-Products Pest Management Program for TAMC

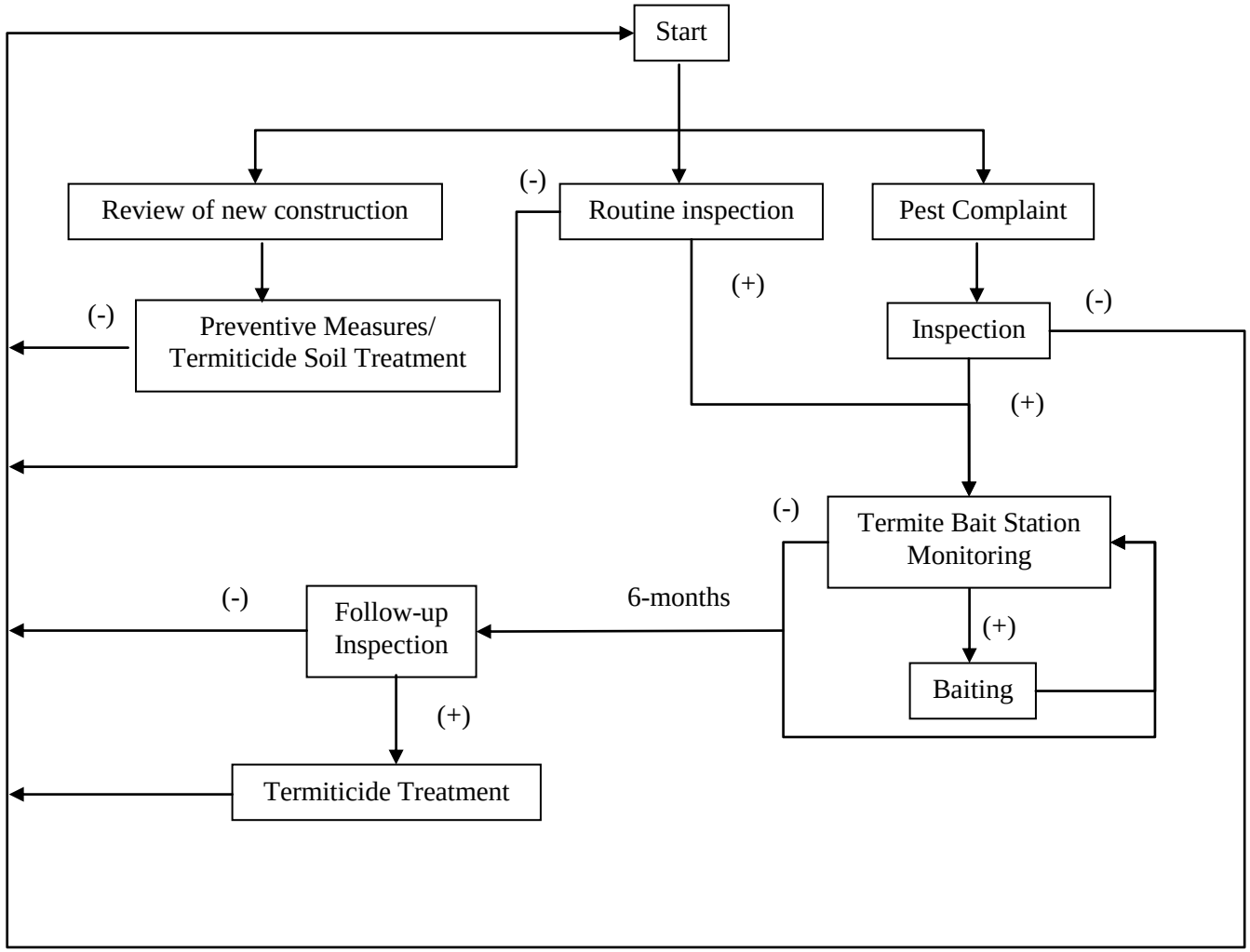


(+) = Evidence of active infestation
(-) = No evidence of active infestation

Integrated Mosquito Control Program for TAMC Facilities

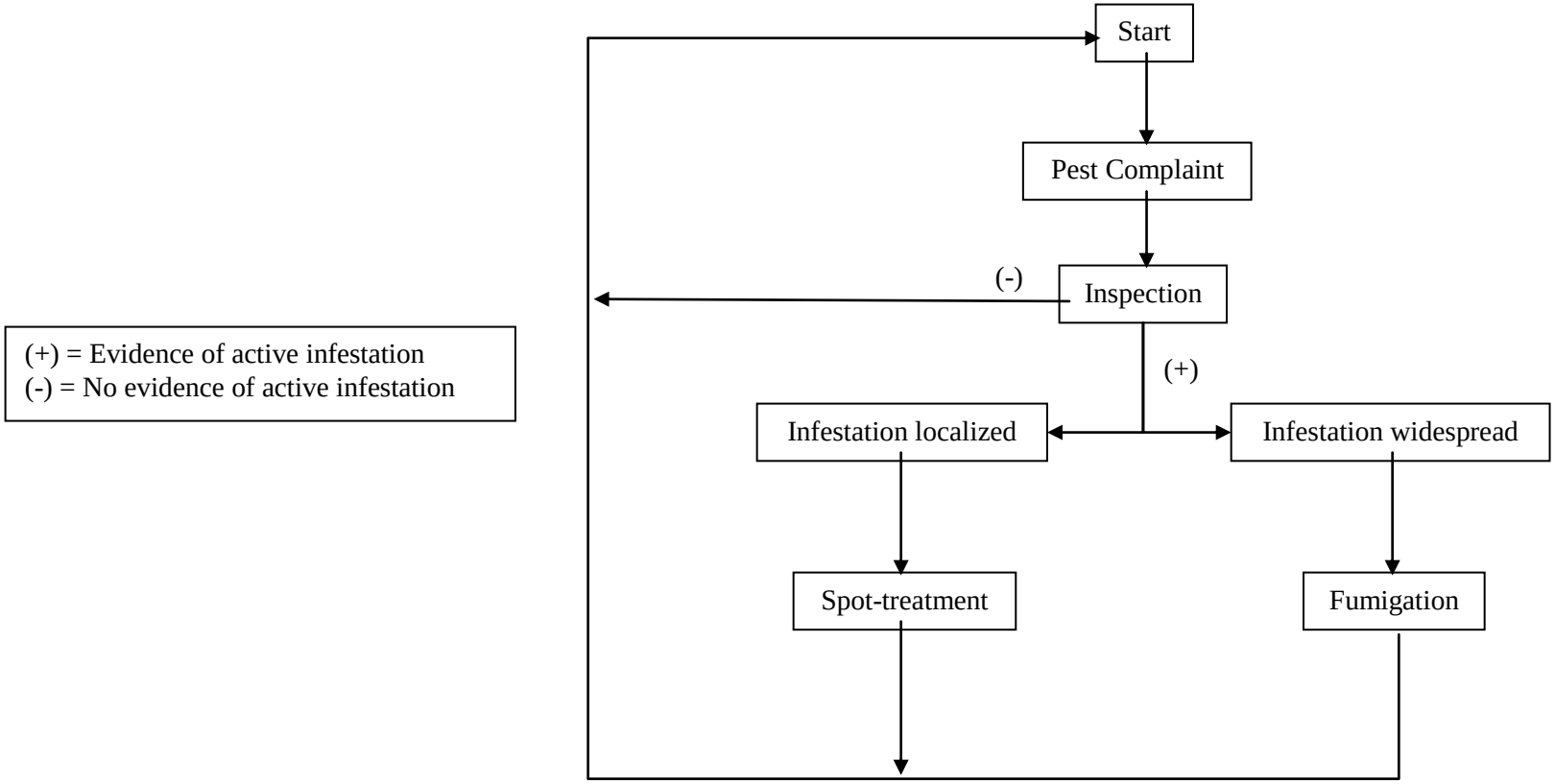


Integrated Subterranean Termite Management Plan for TAMC Facilities

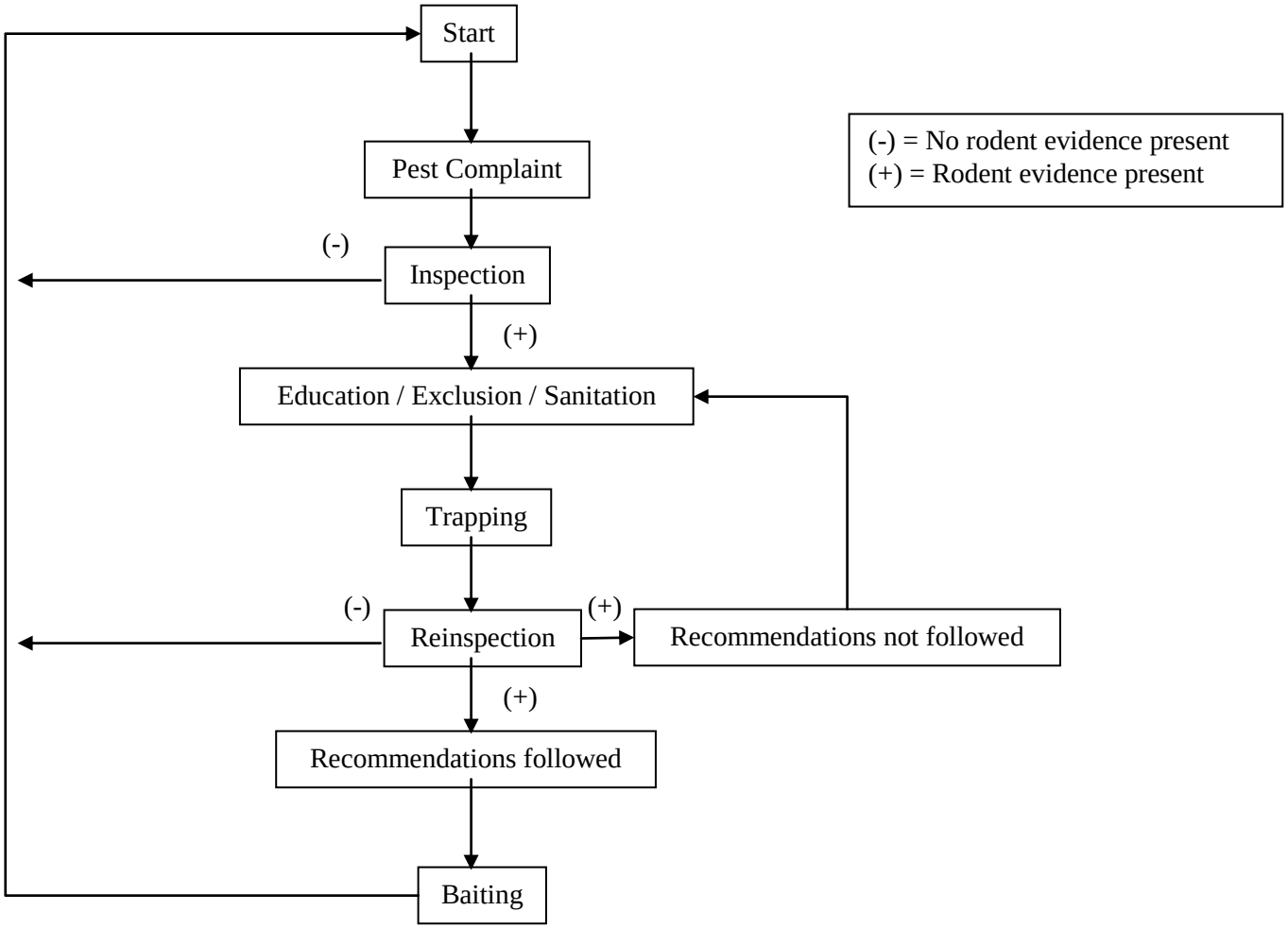


(+) = Evidence of active infestation
(-) = No evidence of active infestation

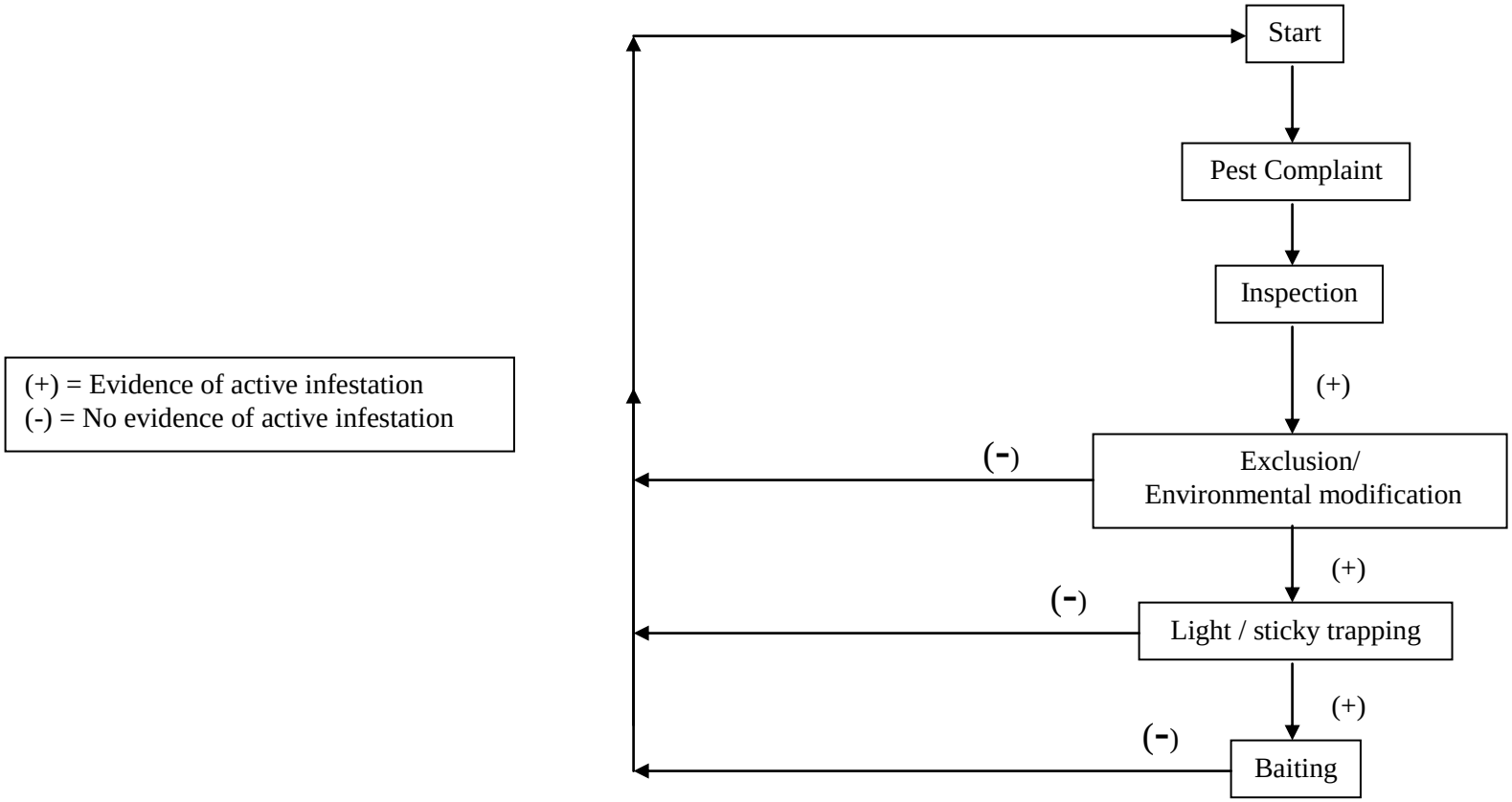
Integrated Drywood Termite Management Plan for TAMC



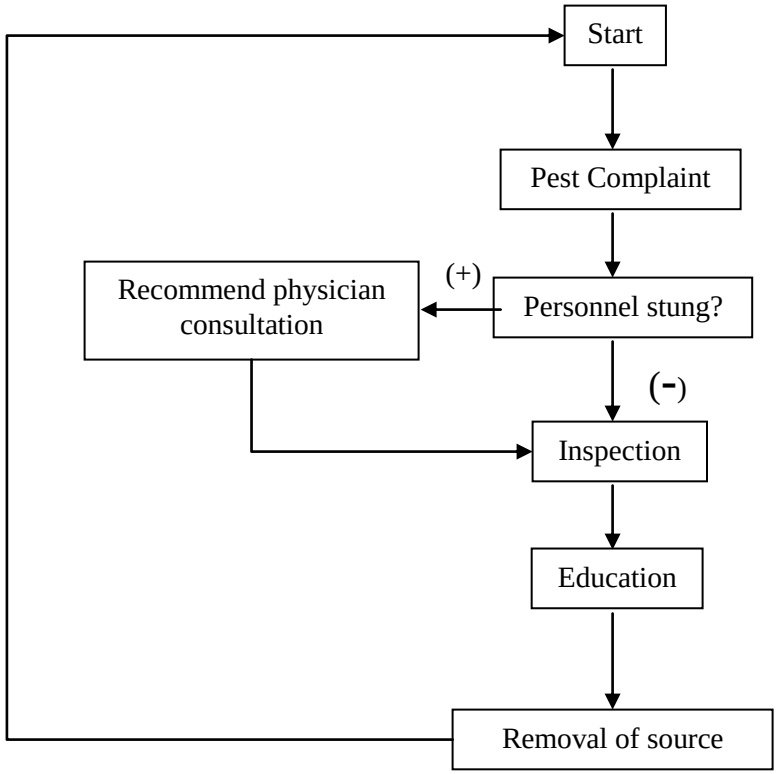
Integrated Rodent Management Program for TAMC Facilities



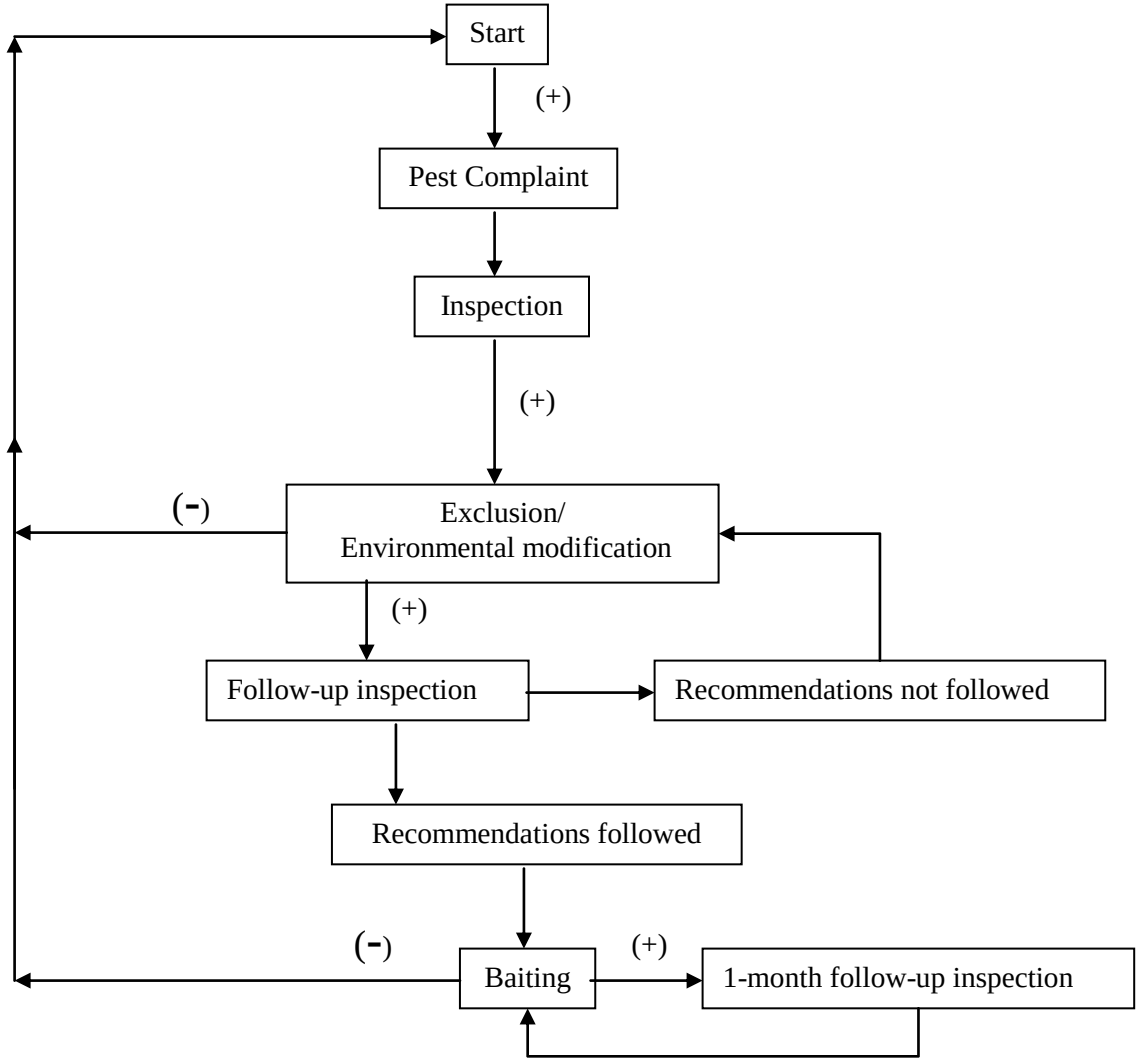
Integrated Filth Fly Management Program for TAMC



Integrated Biting/Stinging Insect Management Program for TAMC Facilities



Integrated Peridomestic Cockroach Management Program for TAMC Facilities



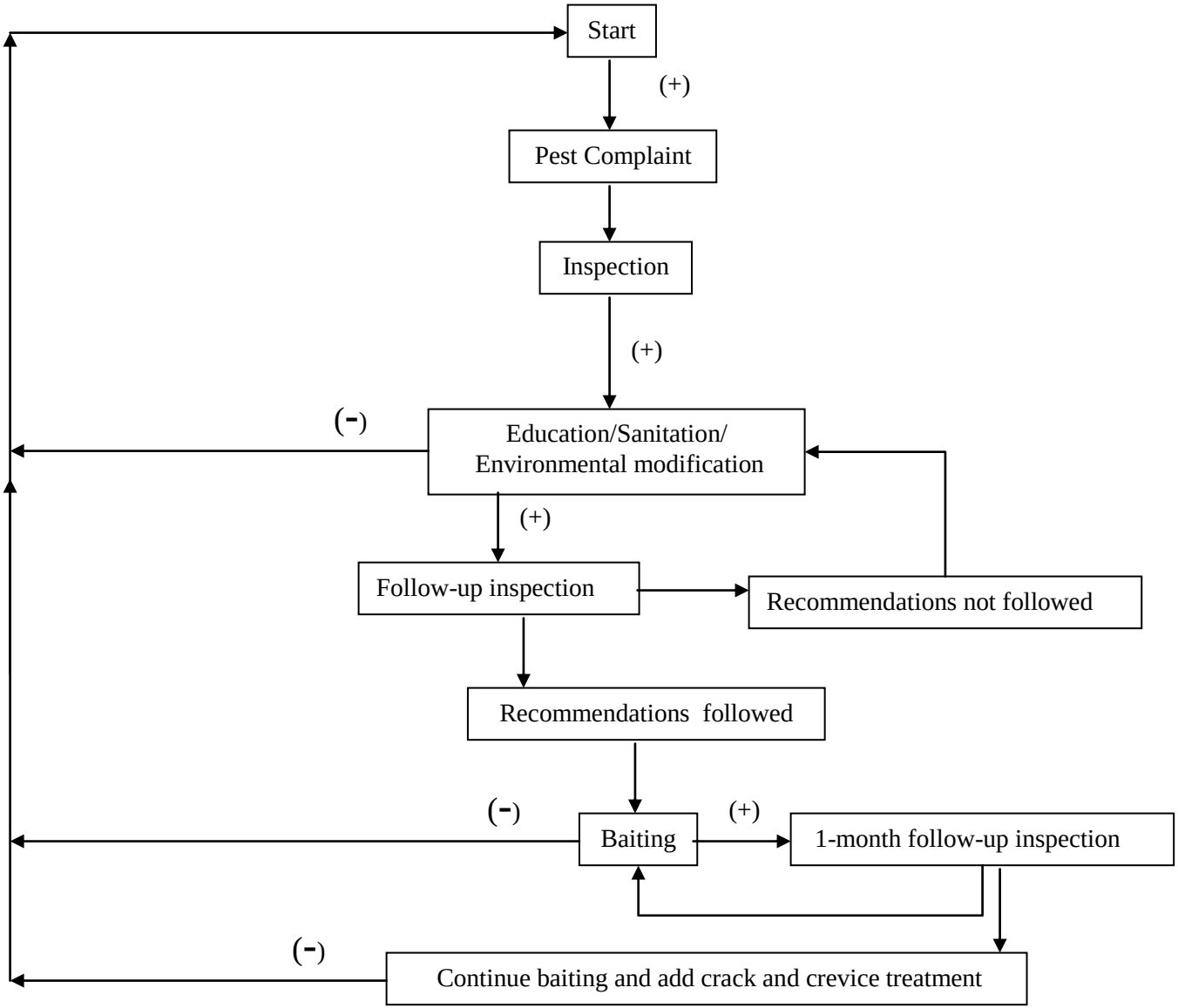
Cockroach Aesthetic Threshold:

R/D = roaches sightings per day

(+) R/D > or = 1 (Complaint)

(-) R/D = 0 (Satisfaction)

Integrated Ant Management Program for TAMC Facilities



Ant Aesthetic Threshold:

A/D = Ants per day

(+) A/D > 10 (Complaint)

(-) A/D < or = 10 (Satisfaction)

APPENDIX F. FIVE YEAR TERMITE MANAGEMENT PLAN

FIVE YEAR TERMITE MANAGEMENT PLAN

Facilities are chosen for treatment based on current termite infestation and a history of termite infestation. Historical significance of the facility and proximity to other buildings/areas known to have termite infestations are also factored in. Facilities in bold type are Tier I facilities (Barracks, DFACs, Admin (General Purpose Admin, COFs, HQs), Training Facilities, CDCs, Youth Centers).

PRIORITY FY 08	INSTALLATION / FEWR NO.	BLDG. NO.	EST. LINEAR FT.	EST. INSTALLATION (1ST yr) COST	EST. COST SUBSEQUENT YEARS
1	**SB-RZ000997J**	**580**	1200		3,200
2	**WA-RZ000997J**	**106**	480		1,280
3	WA-RZ000997J	203	636		1,700
4	FS-RZ000997J	500			2,700
5	**FS-RZ000997J**	**100**	630		1,680
6	**FS-RZ000997J**	**101**	830		2,220
7	**FS-RZ000997J**	**102**	464		1,240
8	**FS-RZ000997J**	**104**	400		1,070
9	**FS-RZ000997J**	**112**	465		1,240
10	**FS-RZ000997J**	**117**	430		1,150
11	**FS-RZ000997J**	**118**	540		1,440
12	**FS-RZ000997J**	**122**	430		1,150
13	**FS-RZ000997J**	**128**	460		1,230
14	**FS-RZ000997J**	**115**	490		1,310
15	**FS-RZ000997J**	**116**	280		750
16	**FS-RZ000948J**	**123**	510		1,360
17	**FS-RZ000948J**	**127**	225		600
18	**FS-RZ000948J**	**121**	200		530
Sub-total					**25,850**
19	SB-RZ000987J	699A	300	2,400	*(1,500)*
20	**SB-RB000356J**	**647**	450	3,600	*(2,700)*
21	**WA-RZ001676J**	**600**	1220	9,760	*(6,100)*
22	**SB-RZ001596J**	**500**	500	4,000	*(2,500)*
23	SB-RZ001606J	560	1042	8,340	*(5,210)*
24	SB-RZ001636J	582	630	5,040	*(3,150)*
25	**SB-RZ001586J**	**6056**	332	2,660	*(1,660)*
26	SB-RZ001576J	583	586	4,690	*(2,930)*
27	FS-RZ001696J	711	541	4,330	*(3,300)*
28	**SB-RA000098J**	**2026**		10,000(fumigation)	
29	SB-MM073128J	582		18,500(fumigation)	
Sub-total				**73,320**	
TOTAL					**$99,170**

PRIORITY FY 09	INSTALLATION / FEWR NO.	BLDG. NO.	EST. LINEAR FT.	EST. INSTALLATION (1ST yr) COST	EST. COST SUBSEQUENT YEARS
1	**SB-RZ001058J**	**580**	1200		3,600
2	**WA-RZ001058J**	**106**	480		1,440
3	WA-RZ001058J	203	636		1,910
4	FS-RZ001058J	500	660		1,980
5	**FS-RZ001058J**	**100**	630		1,890
6	**FS-RZ001058J**	**101**	830		2,490
7	**FS-RZ001058J**	**102**	464		1,390
8	**FS-RZ001058J**	**104**	400		1,200
9	**FS-RZ001058J**	**112**	465		1,400
10	**FS-RZ001058J**	**117**	430		1,290
11	**FS-RZ001058J**	**118**	540		1,620
12	**FS-RZ001058J**	**122**	430		1,290
13	**FS-RZ001058J**	**128**	460		1,380
14	**FS-RZ001058J**	**115**	490		1,470
15	**FS-RZ001058J**	**116**	280		840
16	**FS-RZ001058J**	**123**	510		1,530
17	**FS-RZ001058J**	**127**	225		670
18	**FS-RZ001058J**	**121**	200		600
19	SB-RZ001058J	699A	300		900
20	**SB-RZ001058J**	**647**	450		1,350
21	**WA-RZ001058J**	**600**	1220		3,660
22	**SB-RZ001058J**	**500**	500		1,500
23	SB-RZ001058J	560	1042		3,130
24	SB-RZ001058J	582	630		1,890
25	**SB-RZ001058J**	**6056**	332		1,000
26	SB-RZ001058J	583	586		1,760
27	FS-RZ001058J	711	541		1,620
28	**FS-RZ001058J**	**330**	1070		3,210
Sub-total					**48,010**
29	FD-RZ001128J	32	1060	8,480	*(3180)*
30	**WA-RZ001128J**	**224**	380	3,040	*(1140)*
31	**SB-RZ001128J**	**494**	180	1,440	*(540)*
32	**TAMC-RZ001128J**	**228**	980	7,840	*(2940)*
33	**TAMC-RZ001128J**	**222**	690	5,520	*(2070)*
34	**TAMC-RZ001128J**	**220**	500	4,000	*(1500)*
35	**FS-RZ001128J**	**520**	980	7,840	*(2940)*
36	**SB-RZ001128J**	**156**	870	6,960	*(2610)*
37	**FS-RZ001128J**	**900**	470	3,760	*(1410)*
38	**SB-RZ001128J**	**692**	800	6,400	*(2400)*
Sub-total				**55,280**	
TOTAL					**$103,290**

PRIORITY FY 10	INSTALLATION / FEWR NO.	BLDG. NO.	EST. LINEAR FT.	EST. INSTALLATION (1ST yr) COST	EST. COST SUBSEQUENT YEARS
1	**SB**	**580**	1200		3,600
2	**WA**	**106**	480		1,440
3	WA	203	636		1,910
4	FS	500	660		1,980
5	**FS**	**100**	630		1,890
6	**FS**	**101**	830		2,490
7	**FS**	**102**	464		1,390
8	**FS**	**104**	400		1,200
9	**FS**	**112**	465		1,400
10	**FS**	**117**	430		1,290
11	**FS**	**118**	540		1,620
12	**FS**	**122**	430		1,290
13	**FS**	**128**	460		1,380
14	**FS**	**115**	490		1,470
15	**FS**	**116**	280		840
16	**FS**	**123**	510		1,530
17	**FS**	**127**	225		670
18	**FS**	**121**	200		600
19	SB	699A	300		900
20	**SB**	**647**	450		1,350
21	**WA**	**600**	1220		3,660
22	**SB**	**500**	500		1,500
23	SB	560	1042		3,130
24	SB	582	630		1,890
25	**SB**	**6056**	332		1,000
26	SB	583	586		1,760
27	FS	711	541		1,620
28	**FS**	**330**	1070		3,210
29	FD	32	1060		3,180
30	**WA**	**224**	380		1,140
31	**SB**	**494**	180		540
32	**TAMC**	**228**	980		2,940
33	**TAMC**	**222**	690		2,070
34	**TAMC**	**220**	500		1,500
35	**FS**	**520**	980		2,940
36	**SB**	**156**	870		2,610
37	**FS**	**900**	470		1,410
38	**SB**	**692**	800		2400
Sub-total					**68,740**
39	FS	341	520	4,160	*(1560)*
40	FS	537	360	2,880	*(1080)*

41	FS	347	780	6,240	*(2340)*
42	SB	556	1080	8,640	*(3240)*
43	SB	555	930	7,440	*(2790)*
Sub-total				**29,360**	
TOTAL					**$98,100**
PRIORITY FY 11	INSTALLATION / FEWR NO.	BLDG. NO.	EST. LINEAR FT.	EST. INSTALLATION (1ST yr) COST	EST. COST SUBSEQUENT YEARS
1	**SB**	**580**	1200		3,600
2	**WA**	**106**	480		1,440
3	WA	203	636		1,910
4	FS	500	660		1,980
5	**FS**	**100**	630		1,890
6	**FS**	**101**	830		2,490
7	**FS**	**102**	464		1,390
8	**FS**	**104**	400		1,200
9	**FS**	**112**	465		1,400
10	**FS**	**117**	430		1,290
11	**FS**	**118**	540		1,620
12	**FS**	**122**	430		1,290
13	**FS**	**128**	460		1,380
14	**FS**	**115**	490		1,470
15	**FS**	**116**	280		840
16	**FS**	**123**	510		1,530
17	**FS**	**127**	225		670
18	**FS**	**121**	200		600
19	SB	699A	300		900
20	**SB**	**647**	450		1,350
21	**WA**	**600**	1220		3,660
22	**SB**	**500**	500		1,500
23	SB	560	1042		3,130
24	SB	582	630		1,890
25	**SB**	**6056**	332		1,000
26	SB	583	586		1,760
27	FS	711	541		1,620
28	**FS**	**330**	1070		3,210
29	FD	32	1060		3,180
30	**WA**	**224**	380		1,140
31	**SB**	**494**	180		540
32	**TAMC**	**228**	980		2,940
33	**TAMC**	**222**	690		2,070
34	**TAMC**	**220**	500		1,500
35	**FS**	**520**	980		2,940
36	**SB**	**156**	870		2,610
37	**FS**	**900**	470		1,410

38	**SB**	**692**	800		2400
39	FS	341	520		1,560
40	FS	537	360		1,080
41	FS	347	780		2,340
42	SB	556	1080		3,240
43	SB	555	930		2,790
Sub-total					**79,750**
44	FS	1507	3180	25,440	*(9540)*
Sub-total				**25,440**	
TOTAL					**$105,190**
PRIORITY FY 12	INSTALLATION / FEWR NO.	BLDG. NO.	EST. LINEAR FT.	EST. INSTALLATION (1ST yr) COST	EST. COST SUBSEQUENT YEARS
1	**SB**	**580**	1200		3,600
2	**WA**	**106**	480		1,440
3	WA	203	636		1,910
4	FS	500	660		1,980
5	**FS**	**100**	630		1,890
6	**FS**	**101**	830		2,490
7	**FS**	**102**	464		1,390
8	**FS**	**104**	400		1,200
9	**FS**	**112**	465		1,400
10	**FS**	**117**	430		1,290
11	**FS**	**118**	540		1,620
12	**FS**	**122**	430		1,290
13	**FS**	**128**	460		1,380
14	**FS**	**115**	490		1,470
15	**FS**	**116**	280		840
16	**FS**	**123**	510		1,530
17	**FS**	**127**	225		670
18	**FS**	**121**	200		600
19	SB	699A	300		900
20	**SB**	**647**	450		1,350
21	**WA**	**600**	1220		3,660
22	**SB**	**500**	500		1,500
23	SB	560	1042		3,130
24	SB	582	630		1,890
25	**SB**	**6056**	332		1,000
26	SB	583	586		1,760
27	FS	711	541		1,620
28	**FS**	**330**	1070		3,210
29	FD	32	1060		3,180
30	**WA**	**224**	380		1,140
31	**SB**	**494**	180		540
32	**TAMC**	**228**	980		2,940
33	**TAMC**	**222**	690		2,070

34	**TAMC**	**220**	500		1,500
35	**FS**	**520**	980		2,940
36	**SB**	**156**	870		2,610
37	**FS**	**900**	470		1,410
38	**SB**	**692**	800		2400
39	FS	341	520		1,560
40	FS	537	360		1,080
41	FS	347	780		2,340
42	SB	556	1080		3,240
43	SB	555	930		2,790
44	FS	1507	3180		9,540
Sub-total					**89,290**
45	SB	645	390	3,100	*(1170)*
46	AMR	1790	600	4,800	*(1800)*
47	FD	T-111	300	2,400	*(900)*
Sub-total				**10,300**	
TOTAL					**$99,590**

APPENDIX G. BITING MOSQUITO SPECIES FOUND IN HAWAII

Biting Mosquito Species Found In Hawaii

Aedes aegypti (Yellow Fever Mosquito)

The yellow fever mosquito is a small dark species that can be recognized by the lyre-shaped silver-white lines on the thorax and the white bands on the tarsal segments. Although previously well distributed in the State of Hawaii, it has apparently disappeared from the islands of Oahu, Kauai, and Maui. The adults prefer the blood of man to that of other animals, and bites principally during the morning and late afternoon. This mosquito is semi-domesticated, breeding almost exclusively in artificial containers in and around human habitations. Eggs are able to withstand drying for several months and hatch quickly when in contact with water. The larvae can complete their development in 6 to 10 days under favorable conditions. This species has a short flight range, and usually will not travel further than 100 yards. It is also very susceptible to cold.

This mosquito is the vector of urban yellow fever, dengue and west nile virus.

Aedes albopictus (Forest Day Mosquito)

The Forest Day Mosquito is primarily a woodland species that has adapted to the urban environment. It breeds in tree-holes, leaf axils, rock holes, and other natural as well as manmade containers that hold water. The mosquito has a short flight range, usually not traveling further than 100 yards.

This species is a vector of dengue and west nile virus.

Aedes nocturnes (Night Biting Mosquito)

This mosquito occasionally becomes abundant in grassy lowland areas subject to flooding. However, due to its long flight range (greater than 5 miles) it may become a pest some distance away from its breeding site. As its common name implies, feeding is done primarily at night.

The Night Biting Mosquito is suspected as a potential vector of encephalitis.

Culex pipiens quinquefasciatus (Southern House Mosquito)

This mosquito is a troublesome domesticated species that commonly infests houses and <u>bites at night</u>. It is said to display a preference for avian blood. The larvae are found in water in rain barrels, tubs, catch basins, cesspools, ditches, ground pools, and other similar habitats. Heavy production is often found in water with high organic content. In warm weather, eggs hatch within a day or two of laying. Eight to ten days are required for completion of the larval and pupal stages. Although these mosquitoes generally migrate only short distances, the effective <u>flight range of this mosquito is greater than one mile</u>.

This species is an important vector of the filarial nematode parasite, *Wuchereria bancrofti*, as well as the St. Louis encephalitis virus. The Western equine encephalitis virus and west nile virus has also been isolated from this mosquito. It is also a known vector of the parasites causing bird malaria.

Wyeomyia mitchellii (Bromeliad Mosquito)

This is the latest accidental introduction of a immigrant mosquito species to Hawaii. The larvae of this mosquito are found in water collections at the bases of the leaves of bromeliads. They also occur in tree-holes, bamboo stumps, and the leaf axils of aroids such as dry land taro.

W. mitchellii is not a known vector of any serious human diseases.

APPENDIX H. GOLF COURSE PEST MANAGEMENT PLAN

II. Pest Management Program

The USAG-Hi Golf Pest Management Program is a guide to insure that handlers follow procedures consistent with the label use restrictions established by the EPA and manufacturers, with the highest concern given to preserving the environment.

It is an integrated pest management program (IPM) for controlling weeds, diseases and insects based on surveying a need and using the least toxic product for adequate control. Cognizance of DoD mandates to reduce pesticide use (Ai/Ac) is one of the guiding principles. Golf has elected to use non restricted use pesticides, and selects products which pose the least amount of hazard to the applicator, golfers and the environment.

The following are general procedures and products used on Army golf courses in the USAG-Hi.

A. Pest surveying
   1. Surveys are conducted to monitor weed pressure. Surveys should identify where weed pressures are moderate to heavy.
   2. Seasonal surveys are done to check for disease pressure on green surfaces. If a disease is identified, an appropriate control measure is selected.
   3. Surveying is also done when insect damage is expected. With significant damage, the insect is identified and an appropriate control measure is selected.

B. Pest control measures
   1. Weed control-cultural or mechanical control measures are the first option in selection of a control measure. This may include mulching, or hand weeding. When chemical control is necessary, spot or broadcast applications are generally made to specific areas.
   2. Generally spot treatments are done year around, weather permitting; to control escapes and keep the total weed seed population under control.
   3. Twice a year, if irrigation is available, pre emergent herbicide to control goosegrass is applied.
      a. Goosegrass/crabgrass/Hilo grass
         1. a combination of MSMA (40oz/A) and metribuzin (2.5 oz/A) not to exceed 1.3 #/Ac/yr, is made in 2 applications 7-10 days apart. Usually 2 broadcast applications in a year on fairway and rough areas that required the broadcast application. are sufficient.
         2. An alternative is to use an MSMA (40oz/Ac) application followed by an application of MSMA (30oz/Ac) in combination w/revolver (20 oz/Ac) 7-10 days later.
         3. Trimec plus in place of MSMA can be selected if broadleaf weeds are also present.
         4. Ronstar at 1 to 2#/Ac, for pre-emergent control, is the herbicide of choice for goosegrass control. This product is used in a fertilizer/herbicide combination.

      b. Nutsedge/kyllinga
         1. MSMA/Image at 40 (oz/Ac) / 32 (oz/Ac)
         2. Trimec Plus/Image at 64 (oz/Ac) / 32 (oz/Ac)
         3. Manage at 1.3 (oz/Ac). All control methods are acceptable for controlling sedges, with Manage being the primary choice because of the total amount of herbicide used per acre.
      c. Star grass, smutgrass, lovegrass- Spot or wick applications of Roundup (1.5%) or Finale (2oz/G) are made directly to weed surface for selective control.
      d. Poa annua, overseeded poa trivialis-Revolver at 17.5(oz/Ac) post emergent on green surfaces.

4. Fungus Control-whenever possible, cultural practices such as reducing watering or keeping the wetting window to less than 10 hours by watering later in the night(includes estimated dew time), reducing N fertilizer applications, raising the cutting height mechanical practices such as verticutting and soil aeration are used to minimize disease pressure before chemical methods are employed. When environmental conditions overwhelm non chemical practices an appropriate fungicide is selected.
    a. Helminthosporium/Rizoctonia-the following 3 treatments are alternated in sequence for preventive maintenance control and to reduce chances of developing a specific disease resistance
        1. 26 GT (Iprodione at 4 to 8 oz/1000sf) at 10-14 day intervals
        2. Daconil Ultrex (chlorothalonil at 4lb/Ac) 7-10 day intervals
        3. Fore (mancozeb 4 oz/1000sf) at 7 day intervals
    b. Pithium-Subdue Maxx (1 qt /ac) plus Fore (10 lbs/Ac). A maximum of 2 applications may be made per year.
    c. Fairy Rings-
        1. Insignia (pyraclostrobin at 40 oz/Ac)
        2. Prrostar (flutolanil at 4.5oz/1000sf)
5. Insect Control
    a. Army worms/cutworms-Sevimol at 2 to 4 quarts/Ac

C. Record Keeping
1. Monthly (DD form 1532-1)
    a. Daily applications are recorded and reflect all applications made for 1 month
    b. Records are compiled for a 3 month period.
2. Quarterly record (1532) is submitted to the installation pest management coordinator.
3. Annual record is summary of 4 quarters and reported at end of fiscal year.
4. Inventory records-recorded quantities of stored pesticide are kept.
5. Total fertilizer use is reported to the DPW environmental storm water permit coordinator annually.

D. Training requirements
1. DoD pesticide certification-required for applicators and re-certification required every 3 years.
2. Respirator fit training-required annually to ensure proper use and condition.

APPENDIX I. AERIAL VALIDATION PLAN

AERIAL VALIDATION PLAN FOR HERBICIDE APPLICATIONS FOR PRESCRIBED BURNS FOR FY 08

Activity Preparing Request: Installation Fire & Safety Office, U.S. Army Garrison Hawaii (USAG-HI), Department of the Army.

Preparation Date: 2 July 2007.

Preparer: Steve Lai, Range Planner, DPTM, U.S. Army Garrison, Hawaii.

Purpose: Execution of this herbicide application plan is necessary to augment the prescribed burn plan in support of training requirements. Execution of this prescribed burn is required to reduce fuel hazards subject to potential wildfires, and enhance ground visibility essential to conduct UXO surface clearance. Prescribed Burn Plans will be written for each proposed action and an Aerial Validation Plan specific to that proposed burn will be included as part of the Burn Plan.

The objective of this plan is to dry vegetation to the degree that a complete burn will result, allowing the prescribed fire objectives to be met.

If herbicide application is not done prior to the burn, an incomplete burn may result, and the objectives of the burn plan may not be met.

Because the proposed burn area is within an impact area, herbicide application can only be done by aerial application.

Pests Identified: The primary targets are Guinea Grass, *Panicum maximum*, 4-6 feet tall, Haole Koa, *Leucaena leucocephalal*, 4-6 feet tall, Molasses Grass, 2.5 feet tall, and Christmas Berry, *Schinus*, 8-10 feet tall.

Surveillance: Areas requiring herbicide are not accessible by ground application due to potential of life threat to personnel from UXO in the designated burn areas. Pre- and post- surveillance procedures are predicated on known impact areas where access is prohibited.

Target Area Description: The area proposed for treatment is located in the designated impact area of the Schofield Barracks Military Reservation (SBMR), West Range, north of Kolekole Road and within the Schofield Firebreak Road (see map).

A total of approximately 1100 acres may be treated in the designated impact area of the Schofield Barracks (West Range) and within the Schofield firebreak road network.

Proximity to Inhabited Areas: Military Family Housing units located approximately 750-meters east of treatment area.

Affected Natural Resources: There are no endangered species, wildlife communities, agriculture, livestock areas, etc., in the treatment area. Higher elevation forests immediately up-slope and to the west of the target area contains several endangered plant species, and the elepaio (an endangered bird) and portions of its critical habitat. Other forested areas further to the south include parts of The Nature Conservancy of Hawaii's Honouliuli Preserve and also contain endangered plants and the elepaio. Drift to these surrounding areas will be controlled by adding a drift retardant (Airex DC at 0.75%) to the spray,

and by applying only when wind speeds are below threshold limits, and by limiting the height at which the application is done.

Affected Area Water Resources: There are no areas where surface water is present. Drainage gullies are present. If heavy rains occur prior to application, it will be postponed until there is complete drainage.

Drift Affecting Natural Resources: Application will only occur when wind speeds are between 2-10 mph and no precipitation. According to the label for Roundup Pro, drift potential is lowest when wind speeds are between 2-10 mph. The label also states that application should be avoided below 2 mph due to variable winds and high inversion potential. The Army will cease all application operations if conditions exceed the above parameters. Also, the Army will cease all application operations if it is observed that there is risk of drift affecting elepaio Critical Habitat or areas occupied by threatened and endangered species (see attached map).

Pesticide Information: The herbicide to be used is Roundup Pro (41% glyphosate), NSN: 6840-01-108-9578, EPA Registration Number: 524-475.

The material is to be applied at a rate of 3 quarts/acre (3% solution per acre). Total amount of product for 1100 acres is 825 gallons of Roundup Pro concentrate.

The attached MSDS describes toxicity, stability and degradation characteristics.

The main restrictions on the use of the product are to avoid areas where surface water is present and not to mix store or apply the product or spray solutions in galvanized steel or unlined steel (except stainless steel) containers or spray tanks.

Application Information: Application of the material will be done by contract under Pacific Helicopter Services, LLC FAA Operating Certificate No. DBZG128D. The applicator will be Mr. Howard Esterbrook, FAA 576940421 COMM, Pesticide Applicator Certification #C40314, expiration May 3, 2009, Category 11.

Application will be done utilizing a Jet Ranger helicopter at airspeeds of approximately 70 mph. Application will be done at a height not greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. The spray swath will be approximately 40 feet.

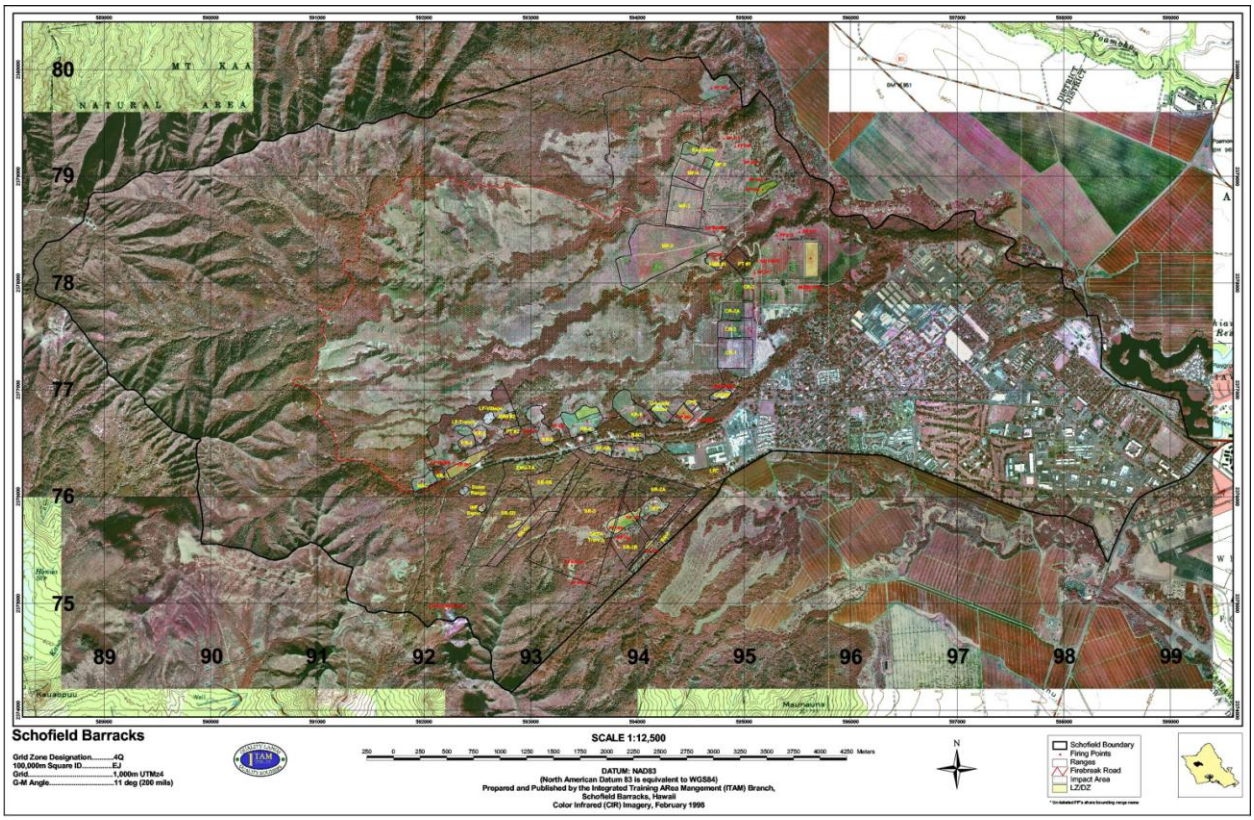
Two sprays are proposed for FY 08. Timing of the burns will be dependent on rate of plant growth and weather conditions.

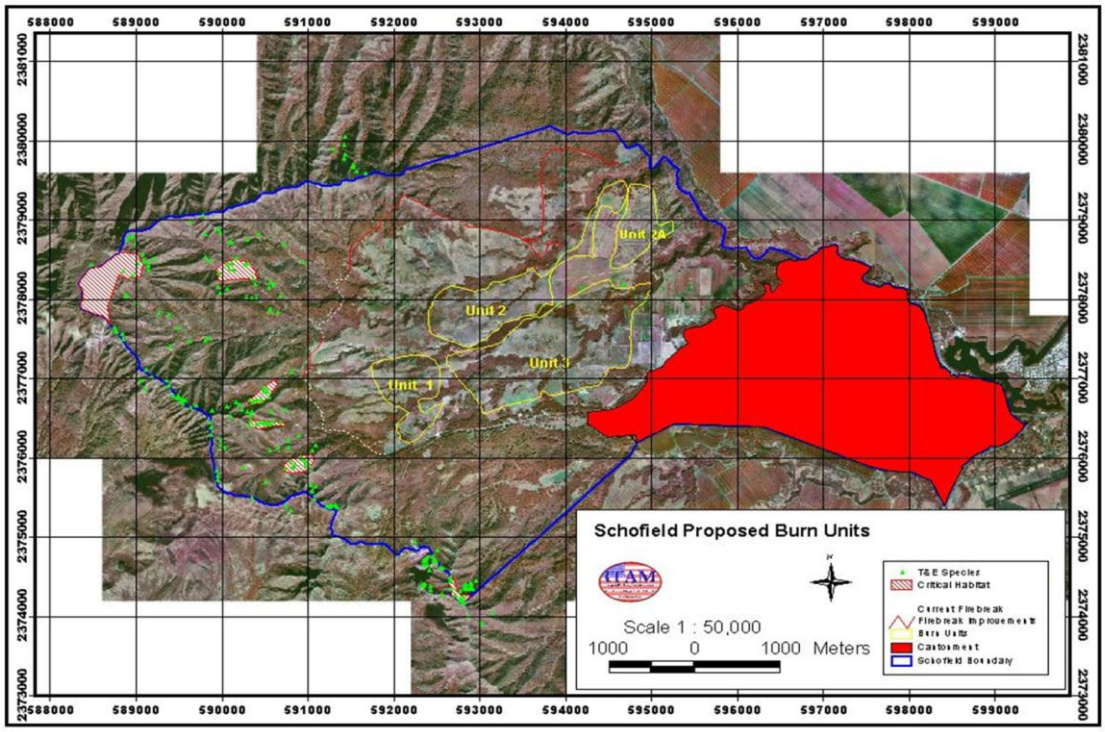
Alternative Control Methods: As an alternative, the range may be burned without the use of an herbicide; however, as discussed previously, an incomplete burn may result and the objectives of the burn plan may not be met.

Sensitive Areas: There are no protected species habitats, crop lands, lakes, rivers, running streams, etc., in the treatment area.

Agency Coordination: NEPA documentation and consultation with USFWS will be done prior to treatment.

Environmental Documentation: This Aerial Validation Plan will be included in the Integrated Pest Management Plan for USAG-HI. The Record of Environmental Consideration submitted for each Prescribed Burn will include an Aerial Validation Plan and a Prescribed Burn Plan specific for that event.


Schofield Barracks
SCALE 1:12,500
DATUM: NAD83
(North American Datum 83 is equivalent to WGS84)
Prepared and Published by the Integrated Training ARea Mangement (ITAM) Branch,
Schofield Barracks, Hawaii
Color Infrared (CIR) Imagery, February 1996
Schofield Boundary
Firing Points
Ranges
Firebreak Road
Impact Area
LZ/DZ
80
79
78
77
76
75
89
90
91
92
93
94
95
96
97
98
99


Schofield Proposed Burn Units
Scale 1 : 50,000
1000 0 1000 Meters
T&E Species
Critical Habitat
Current Firebreak
Firebreak Improvements
Burn Units
Cantonment
Schofield Boundary
Unit 2A
Unit 2
Unit 3
Unit 1

APPENDIX J. WORK/FINANCIAL PLAN FOR BIRD STRIKE HAZARD

07-73-15-0219-IA
758-7315-851 (WAAF)
758-7315-823 (PTA)

WORK/FINANCIAL PLAN
between
UNITED STATES ARMY GARRISON HAWAII
DIRECTORATE OF PUBLIC WORKS
and
U.S. DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WILDLIFE SERVICES

COOPERATOR ADDRESS	Directorate of Public Works, USAG-HI ATTN: IMPA-HI-PWE Schofield Barracks, HI 96857-5013
COOPERATIVE CONTACT	Alan K. L. Goo, Director of Public Works Phone: (808) 656-1289 ext. 2201 Fax: (808) 656-6471 Email: alan.goo@us.army.mil
POINT OF CONTACT	Robin Yamamoto, Entomologist Phone: (808) 656-2878 ext. 1053 Fax: (808) 656-1039 Mobile: (808) 864-1010 Email: robin.yamamoto@us.army.mil
SITE CONTACT **(Wheeler Army Airfield)**	James Ware, Wheeler Army Airfield Commander Phone: (808) 656-2656 Fax: (808) 656-2057 Email: james.e.ware@us.army.mil
SITE CONTACT **(Pohakuloa Training Area)**	Marlene Amantiad, Contract Performance Representative Phone: (808) 969-2496 or (808) 523-2455 (Honolulu Direct) Fax: (808) 969-9024 or (808) 523-2007 (Honolulu Direct) Email: Marlene.A.Amantiad@us.army.mil
AGENCY LOCATOR NUMBER	00-00-5570
COOPERATIVE AGREEMENT NUMBER	07-73-15-0219-IA
ACCOUNT NUMBER	758-7315-851 (Wheeler Army Airfield) 758-7315-823 (Pohakuloa Training Area)
LOCATION	Wheeler Army Airfield, Oahu, Hawaii Pohakuloa Training Area, Island of Hawaii, Hawaii
AGREEMENT PERIOD	October 1, 2006 to September 30, 2007

Pursuant to Cooperative Service Agreement No. 07-73-15-0219-IA between the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (APHIS-WS) and the United States Army Garrison Hawaii, Directorate of Public Works (USAG-DPW), this Work/Financial Plan defines the objectives, plan of action, and budget for the Wildlife Services program to be conducted during FY 2007.

I. OBJECTIVES/GOALS

a) To provide wildlife damage management (WDM) operations at Wheeler Army Airfield (WAAF) to effectively reduce the threat of wildlife strikes to military aircraft.

b) To control nuisance wildlife (introduced birds, feral cats, feral dogs, feral pigs and rodents) problems in and around buildings and facilities at Pohakuloa Training Area (PTA) which pose human health and safety threats.

II. PLAN OF ACTION

a. WAAF

APHIS-WS will provide personnel to conduct WDM operations on a part-time basis at least 3 days per week. Control operations will include an active Bird/Wildlife Air Strike Hazard (BASH) program. Most of the control operations will be conducted during daylight hours, however occasional night operations will be conducted to focus on nocturnal avian and mammalian species. Control methods will include, but are not limited to, shooting, trapping, and hazing. Wildlife censuses will be conducted at least once a month to identify and monitor wildlife populations on the airfield. APHIS-WS will also compile all pertinent bird/wildlife strike records and prepare the necessary U.S. Fish and Wildlife Services Migratory Bird Depredation Permit applications and reports for the WAAF Commander. All control operations will be coordinated with the WAAF Base Operations staff.

b. PTA

APHIS-WS will provide personnel to conduct WDM operations to control nuisance wildlife in and around buildings and facilities. Introduced birds will be controlled using pellet guns. Nests will be removed and repellants applied where appropriate. Nuisance feral mammals will be trapped and relocated or humanely euthanized and appropriately disposed of off site. APHIS-WS will consult with the PTA Contract Performance Representative or her designee(s) before employing alternate control methods.

APHIS-WS personnel will also conduct searches/surveys for the presence of mice in and around structures/buildings, offices, food/supply storages and in surrounding non-crop areas. Detection surveys will be followed up by non-toxic tracking stations to determine the relative size of the mouse population. Various control methods will be implemented depending on the severity and locality of the mice infestation. Methods will include toxicants, snap kill traps and the use of glue boards.

III. REPORTS

APHIS-WS will be responsible for the preparation of periodic reports as specified in the Cooperative Service Agreement.

IV. STIPULATIONS AND RESTRICTIONS

a. All operations shall have the joint concurrence of APHIS-WS and the USAG-DPW and shall be under the direct supervision of APHIS-WS. APHIS-WS will conduct the program in accordance with its established operating policies and all applicable state and federal laws and regulations.

b. Control on Public Lands: An Agreement for Control of Animal Damage on Non-Private Property (ADC Form 12C) or an appropriate NEPA document will be executed between APHIS-WS and the public land administrator(s)/manager(s) before any APHIS-WS work is conducted.

c. The performance of WDM actions by APHIS-WS under this agreement is contingent upon a determination by APHIS-WS that such actions are in compliance with the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and any other applicable environmental statutes. APHIS-WS will not make a final decision to conduct the requested WDM actions until it has made the determination of such compliance.

d. The USAG-DPW agrees that it is responsible for compliance with the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), and other environmental compliance laws for the specific projects and actions it requests APHIS-WS to perform for it under this agreement.

e. APHIS-WS will use only APHIS-WS employees and APHIS Volunteer Program participants. All APHIS-WS employees and APHIS volunteers have successfully met APHIS firearm safety standards and have received official National Rifle Association certifications. Certificates are available upon request.

f. In accordance with Federal Governing Regulations (OPM Reg. 4610), federal employees, other than those on intermittent (on-call) status, are entitled to and accrue annual and sick leave on a bi-weekly basis. Therefore, there may be times when coverage on this project may be minimal to none as employees elect to use accrued leave.

g. The WAAF program will be supervised by Mark Ono, HI District Supervisor (808-861-8575 ext. 21), and monitored by Mike E. Pitzler, HI/GU/Pacific Islands State Director (808-861-8575 ext.18).

h. The PTA program will be supervised by Shayne Veriato, HI Area Supervisor (808-933-6955), and monitored by Mike E. Pitzler, HI/GU/Pacific Islands State Director (808-861-8575 ext.18).

V. COST ESTIMATE FOR SERVICES

The cooperator will reimburse APHIS-WS for expenses incurred. Such costs include, but are not limited to, salary/benefits, vehicle use, supplies/equipment and administrative costs. An estimated itemization of expenses is listed below, however funds may be distributed between itemized categories at the discretion of APHIS-WS if required. Any equipment and supplies purchased under the terms of this agreement will remain the property of APHIS-WS.

	WAAF	PTA
Salary/Benefits	$24,160	$10,419
Vehicle Use	$5,040	$2,150
Equipment/Supplies	$5,000	$3,600
APHIS Administrative Overhead	$5,521	$2,610
SUBTOTAL	**$39,721**	**$18,779**

GRAND TOTAL = $58,500

NOTES:

In accordance with the Debt Collection Improvement Act (DCIA) OF 1996, bills issued quarterly by APHIS-WS are due and payable within 30 days of receipt.

VI. AUTHORIZATION

DIRECTORATE OF PUBLIC WORKS, USAG-HI
ATTN: APVG-GWV
SCHOFIELD BARRACKS, HI 96857-5013

Director of Public Works — Date: 13 Oct 06

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WILDLIFE SERVICES

State Director, HI/GU/Pacific Islands — Date: 9/28/06

Director, Western Region — Date: 11/2/06

DIRECTORATE OF PUBLIC WORKS

FACILITIES ENGINEERING WORK REQUEST

FEWR_New.rpt

Printed On: 27-Nov-2006

DOCUMENT	POST	BLDG	SUFFIX	SHORT DESCRIPTION	ROUTING CODE	PROCESS DESCRIPTION
RZ001566J	SB	M		FY07 Bird/Animal Ctrl BASH	EM 024 70	ENTOMOLOGIST REVIEW

REQUESTOR NAME	PHONE	POC NAME	POC ORGANIZATION	POC PHONE
ROBIN YAMAMOTO	656-2878	ROBIN YAMAMOTO	DPW ENV	656-2878

Requestor Email:

POC Email:

ESTIMATED COST		APPROVAL	APPROVAL ACTION	PROCESSING DATES	WORK TO BE PERFORMED
K -	0	0	A - Action	Creation Date: 06-Sep-2006	N - In-House Y - Contract
L -	0	0	N - Permission Only	Approval Date: 06-Sep-2006	N - Self-Help N - Troops
M -	61,000	61,000	N - Design Only	Last Modified: 31-Oct-2006	N - Attachments

APPROVAL AUTHORITY	PROG	FY	PRIORITY
CAMILLE HOWE	RS	7	6,996.00

REMARKS

WORKS DESCRIPTION / JUSTIFICATION

To conduct bird/aircraft strike hazard control at WAAF to reduce or eliminate the presence of cattle egrets and other birdstrike threats, and to control nuisance birds and feral animals which present health, safety and maintenance problems at PTA and WAAF. Period - 01 Oct 06 to 30 Sep 07 (FY 07).

Nuisance birds/animals may cause thousands of dollars in damage to aircraft and facilities and may cause air crashes resulting in injuries or deaths.

ROUTING HISTORY

ROUTING DATE	ROUTING CODE	ROUTING DESCRIPTION	USER ID
06-Sep-2006 08:07 AM	BOD 001 01	REO PGM MGR	lee.humes
06-Sep-2006 11:37 AM	BOD 001 01	REO PGM MGR	camille.howe
06-Sep-2006 11:38 AM	EM 001 01	ENV FUNDING ACTIONS	camille.howe
31-Oct-2006 09:54 AM	EM 024 70	ENTOMOLOGIST REVIEW	wendy.himalaya

APPROVAL HISTORY

DATE	K AMOUNT	L AMOUNT	M AMOUNT	A/D	DSN	PRM	UID	APPROVAL AUTHORITY
06-Sep-2006	0.00	0.00	61,000.00	A	N	N	camille.howe	CAMILLE HOWE

WORK REQUEST COMMENTS

E-mail to Robin Yamamoto. CC: Somera, Crite & Humes.
lee.humes 06-Sep-2006

WORK ATTACHMENTS

FILE NAME	ATTACHED BY	ATTACHED DATE	COMMENTS

Printed By: ROBIN YAMAMOTO

1 of 1

DPW-01-019

MILITARY INTERDEPARTMENTAL PURCHASE REQUEST				1. PAGE 1 OF 1 PAGES
2. FSC	3. CONTROL SYMBOL NO.	4. DATE PREPARED 29 NOV 2006	5. MIPR NUMBER MIPR7BO12MM301	6. AMEND NO. BASIC

7. TO:	8. FROM: (Agency, name, telephone number of originator)
State Director **United States Department of Agriculture** **APHIS-Wildlife Services** **3375 Koapaka St., H-420** **Honolulu, HI 96819**	**Directorate of Resource Management** **ATTN: IMPC-HI-RMB, Stop 125** **Schofield Barracks, HI 96857-5018** **E. Hee, 656-4902, FAX: 656-3591**

9. ITEMS☐ ARE ☐ ARE NOT INCLUDED IN THE INTERSERVICE SUPPLY SUPPORT PROGRAM AND REQUIRED INTERSERVICE SCREENING ☐ HAS ☐ HAS NOT BEEN ACCOMPLISHED.

ITEM NO. a	DESCRIPTION (FEDERAL STOCK NUMBER, NOMENCLATURE, SPECIFICATION AND/OR DRAWING NO., ETC.) B	QUANTITY c	UNIT d	ESTIMATED UNT PRICE e	ESTIMATED TOTAL PRICE f
	PROJECT I.D. Cooperative Agreement No.: 07-73-15-0219-IA, Bird Strike Hazard at WAAF & PTA. Reference: FEWR, Work/Financial Plan and Cooperative Service Agreement from USDA, 07-73-15-0219-IA. Purpose: Renew Bird Aircraft Strike Hazard operations at WAAF and PTA and to control nuisance feral animals which present health, safety and maintenance problems for the period 1 Oct 06 – 30 Sep 07. Funds breakdown as follows: WAAF APC: CQFM $39,721.00 (758-7315-851) PTA APC: CQFP $18,779.00 (758-7315-823) TOTAL $58,500.00 POC: DPW, R. Yamamoto, 656-2878 USDA – WS, Mark Ono, 861- 8575 DRM, E. Hee, 656-4902 FAX: (808)656-3591 **REQUEST 1 COPY OF ACCEPTANCE BE FAXED TO DRM, (BLOCK 8) & ALL BILLINGS.**				**$58,500.00**

10. SEE ATTACHED PAGES FOR DELIVERY SCHEDULES, PRESERVATION AND PACKAGING INSTRUCTIONS, SHIPPING INSTRUCTIONS AND INSTRUCTIONS FOR DISTRIBUTION OF CONTRACTS AND RELATED DOCUMENTS.

11. GRAND TOTAL $58,500.00

12. TRANSPORTATION ALLOTMENT (USED IF FOB CONTRACTOR'S PLANT)

13. MAIL INVOICES TO (PAYMENT WILL BE MADE BY)
DFAS PACIFIC OPLOC
477 ESSEX STREET
PEARL HARBOR, HI 96860-5806
PAY OFFICE DODAAD

14. FUNDS FOR PROCUREMENT ARE PROPERLY CHARGEABLE TO THE ALLOTMENTS SET FORTH BELOW, THE AVAILABLE BALANCES OF WHICH ARE SUFFICIENT TO COVER THE ESTIMATED TOTAL PRICE.

ACRN	APPROPRIATION	LIMIT/ SUBHEAD	SUPPLEMENTAL ACCOUNTING CLASSIFICATION	ACCTG STA DODAAD	AMOUNT
	2172020	0000	0 B8 B8AE 13100000000 25GY 000000 MIPR7BO12MMM301 012175 CQFM2P $39,721.00 CQFP2P $18,779.00		$58,500.00

15. AUTHORIZING OFFICER (TYPE NAME AND TITLE)	16. SIGNATURE	17. DATE
for SHAR KAINA, Director of Resource Mgmt	Kari Honda	NOV 29 2006

IFSM/WORKS CMT

DPW MIPR FUNDING REQUEST

TO: State Director
United States Department of Agriculture
APHIS-Wildlife Services
3375 Koapaka St., H-420
Honolulu, HI 96819

FROM: DPW

Block 7 (Description) Information:

a. **Project I.D.** Cooperative Agreement No.: 07-73-15-0219-IA, Bird Strike Hazard at WAAF & PTA.

b. **References**: FEWR, Work/Financial Plan and Cooperative Service Agreement from USDA, 07-73-15-0219-IA.

c. **Purpose**. Renew Bird Aircraft Strike Hazard operations at WAAF and PTA and to control nuisance feral animals which present health, safety and maintenance problems for the period 1 Oct 06 - 30 Sep 07.

RZ001566J (M Funds)
$58,500

d. **Point of Contact (POC).** USDA-WS - Mark Ono, 861-8575 / DPW - R. Yamamoto, 656-2878.

e. **Funding Classification.** M

f. **Approvals.** See attached.

DIRECTORATE OF PUBLIC WORKS
FIN PROG MGT _____ 11/29/06
DIRECTOR APPROVAL _____

APPENDIX K. BROWN TREE SNAKE EMERGENCY RESPONSE PROTOCOL

USDA United States Department of Agriculture

Animal and Plant Health Inspection Service

Wildlife Services

3375 Koapaka St.,
Suite H420
Honolulu, HI 96819
Phone: (808) 861-8575/8576
Fax : (808) 861-8570

October 23, 1998

Robin

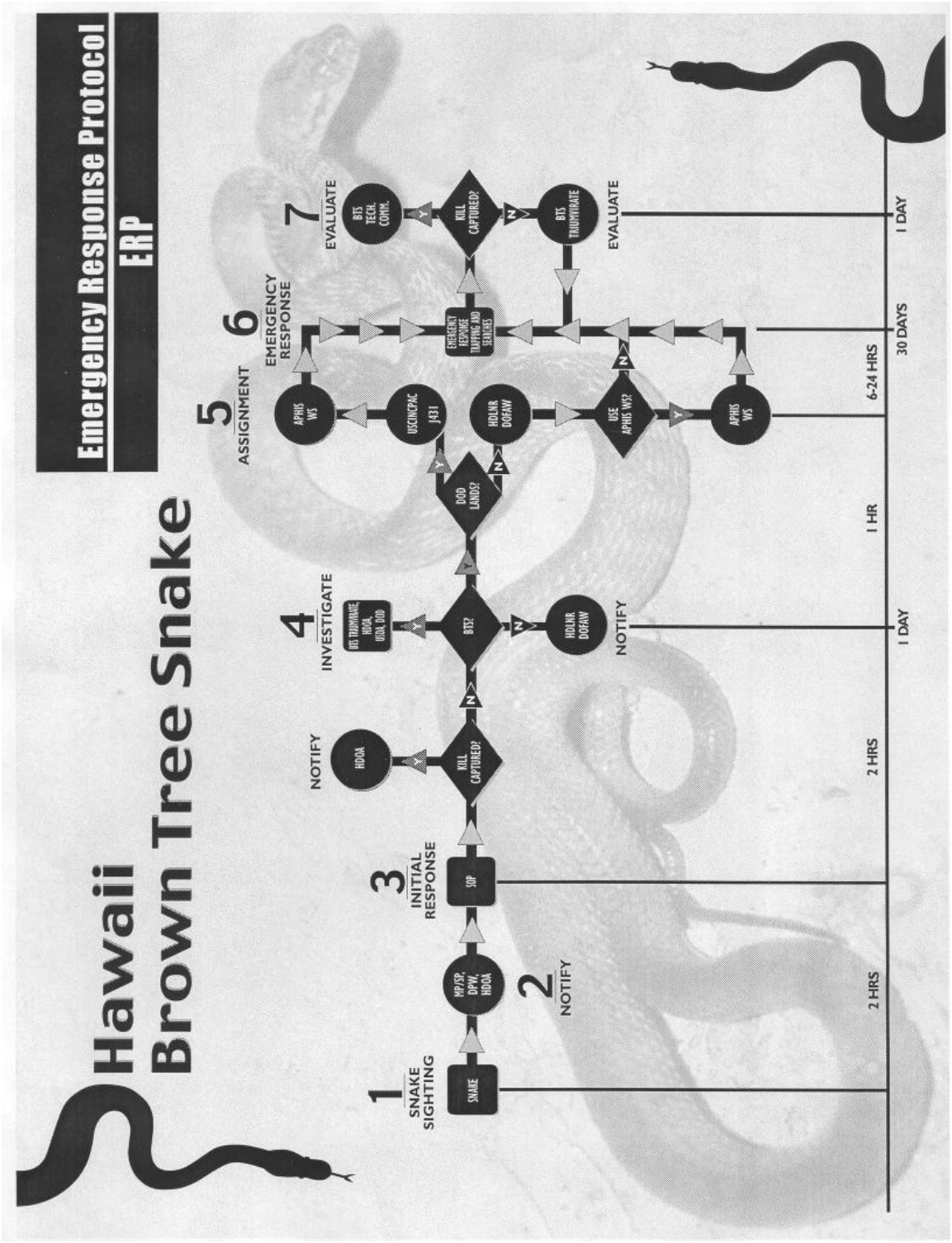
To: BTS ERP Principals

Enclosed is the current version of the Brown Tree Snake Emergency Response Protocol for Hawaii. This ERP was developed by the members of the Brown Tree Snake Technical Committee and produced by Wildlife Services and Tetra Tech. The ERP incorporates the overall emergency response of State of Hawaii agencies, USDA APHIS Wildlife Services and individual responses of the Army, Navy and Air Force. As a recipient of the ERP you have a direct responsibility to implement your portion of the ERP to prevent the Brown Tree Snake from becoming established in the Hawaiian Islands. Use the binder as an operational reference. Any revisions should be directed to Wildlife Services in Hawaii. If you have any questions please call me at 861-8576.

Tim J. Ohashi
ASD

Distribution:
Mr. Lance Bookless, Marine Corps Nat. Res. Spec.
Dr. Fred Kraus, Hawaii Department of Land and Natural Resources Alien Species Coordinator
Commander Jim May, J431-USCINCPAC
Mr. Gary O'Donnell, Air Force Environmental Planner
Mr. Tim Ohashi, Wildlife Services Assistant State Director
Mr. James Murphy, Wildlife Services District Supervisor
Mr. Darrell Robertson, Navy Reg. Environmental Coordinator
Dr. Lyle Wong, Hawaii Department of Agriculture Chief Division of Plant Industry,
Mr. Robin Yamamoto, Army Alien Species Coordinator

APHIS - Protecting American Agriculture


Emergency Response Protocol
ERP
Hawaii
Brown Tree Snake
1
SNAKE SIGHTING
SNAKE
2
NOTIFY
MP/SP, DPW, HDOA
3
INITIAL RESPONSE
SOP
NOTIFY
HDOA
KILL CAPTURED?
Y
N
4
INVESTIGATE
BTS TRIUMVIRATE, HDOA, USDA, DOD
BTS?
Y
N
NOTIFY
HDLNR, DOFAW
DOD LANDS?
Y
N
USCINCPAC J431
HDLNR DOFAW
5
ASSIGNMENT
6
EMERGENCY RESPONSE
APHIS WS
EMERGENCY RESPONSE TRAPPING AND SEARCHES
USE APHIS WS?
Y
N
APHIS WS
7
EVALUATE
BTS TECH. COMM.
KILL CAPTURED?
Y
N
BTS TRIUMVIRATE
EVALUATE
2 HRS
2 HRS
1 DAY
1 HR
6-24 HRS
30 DAYS
1 DAY

Brown Tree Snake EMERGENCY RESPONSE PROTOCOL
NARRATIVE TO FLOW CHART

ACRONYMS

APHIS WS	Animal & Plant Health Inspection Service, Wildlife Services
BTS	Brown Tree Snake
DPW	Department of Public Works
DOD	Department of Defense
HDLNR DOFAW	Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife
HDOA	Hawaii Department of Agriculture
MP	Military Police
POC	Point of Contact
PQ	Plant Quarantine
SP	Security Police
USAG	United States Army Garrison

1 ☐ SNAKE SIGHTING

Public reports snake sighting.

2 ○ NOTIFY MP/SP/DPW/HDOA

Snake Sighted on Military Lands:

- Public notifies Operator (military police, security police, public works).
- The Operator will provide instructions (see reverse side of the attached Snake Report Form) to the caller.
- The Operator will complete the Snake Report Form.
- The Operator will contact and fax the report to the appropriate service point of contact:

(Rev. 10/08/98)

Mr. Robin Yamamoto, Army Alien Species Coordinator. 656-2878 ext. 1053, 656-1039 (fax)
Mr. Gary O'Donnell, Air Force Environmental Planner. 449-1584 ext. 110, 449-9723 (fax)
Mr. Darrell Robertson, Navy Reg. Environmental Coordinator. 471-0326, 474-2328 (fax)
Mr. Lance Bookless, Marine Corps Nat. Res. Spec. 257-6920 ext. 226, 257-2794 (fax)

- The Operator will also fax the report *to* ***HDOA, Plant Quarantine Branch, at 836-6380*** and follow up with a phone call to ***586-7378*** within 15 minutes.
- If a BTS is suspected, the operator must notify supervisor IMMEDIATELY.

Snake Sighted on Non-Military Lands:

- Public notifies Operator at the HDOA PQ.
- The Operator will provide instructions (see reverse side of the attached Snake Report Form) to the caller.
- The Operator will complete the Snake Report Form.
- If the BTS is sighted on military lands, HDOA operator will contact and fax the report to the appropriate service point of contact (see above).
- If a BTS is suspected, the operator will contact the HDOA supervisor IMMEDIATELY.

3 INITIAL RESPONSE

☐ STATEMENT OF PROCEDURES (SOP)

Military:

- Army: See the attached USAG-HI Brown Tree Snake Response Protocol.
- Air Force - Hickam AFB: See the attached Snake Response Protocol at Hickam Air Force Base.

- Navy and Marine Corps: See the attached Navy Snake Response Protocol.

HDOA:

- If the snake is at the port or on military lands, send out dog teams.
- If snake is on non-military lands, send out inspectors.
- If dog teams or inspectors suspect BTS is likely, notify supervisor IMMEDIATELY.
- Supervisors, upon concurrence with the inspector that a BTS is likely, IMMEDIATELY contact ALL of the following:

Lyle Wong, Chief Division of Plant Industry. 973-9535 (wk), 973-9533 (fax)
Fred Kraus, HDLNR DOFAW, Alien Species Coordinator. 587-0166 (wk), 587-0160 (fax), 521-4064 (hm)
Tim Ohashi, Assistant State Director, APHIS WS. 861-8576 (wk), 861-8570 (fax), 261-2290 (hm), 383-2421 (pager)

- For snakes other than BTS, fax information to HDLNR DOFAW and APHIS WS before next working day.

◇ SNAKE CAPTURED OR KILLED?

IF **Yes,** GO TO ○ NOTIFY HDOA
IF **No,** GO TO ◇ IS BTS LIKELY?

○ NOTIFY HDOA

All snakes captured or killed should be turned over to HDOA Plant Quarantine Branch.

4 INVESTIGATE

◇ IS BTS LIKELY?

IF **Yes,** GO TO □ BTS TRIUMVIRATE, AND GO TO ◇ IS IT DOD LANDS?

IF **No,** GOTO ○ NOTIFY HDLNR DOFAW

□ BTS TRIUMVIRATE*:

1) Lyle Wong, Chief Division of Plant Industry
2) Fred Kraus, HDLNR DOFAW Alien Species Coordinator
3) Tim Ohashi, APHIS WS Assistant State Director

*If on military land, add Commander Jim May, J431, USCINCPAC.

The decision to activate Emergency Response requires the concurrence of at least two BTS Triumvirate member's concurrence. If the decision is made to activate Emergency Response on military lands, contact *Commander Jim May, J431, USCINCPAC* , at *477-0850 (wk), 477-0851 (fax)*, or HDLNR DOFAW alien species coordinator for all other lands.

If BTS is suspected, APHIS WS and HDOA will investigate mode of entry.

◇ IS IT DOD LANDS?

IF **Yes,** GO TO ○ NOTIFY J431-USCINPAC

IF **No,** GO TO ○ NOTIFY HDLNR DOFAW

5 ASSIGNMENT

○ NOTIFY J431-USCINCPAC

Commander Jim May, 477-0850 (wk), 477-0851 (fax)

Activate APHIS WS Operations for Military Lands by notifying the APHIS WS-District Supervisor.

○ NOTIFY APHIS WS-DISTRICT SUPERVISOR

Jim Murphy, APHIS WS, 861-8575 (wk), 623-4913 (hm), 578-5951 (pager).

Conduct Emergency Response Trapping and Searches.

○ NOTIFY HDLNR DOFAW

Fred Kraus, HDLNR DOFAW, Alien Species Coordinator 587-0166 (wk), 587-0160 (fax).

If BTS is suspected, coordinate with HDLNR DOFAW District Wildlife Biologist to conduct Emergency Response Trapping and Searches. If not BTS, HDLNR DOFAW will determine and carry out appropriate response.

◇ USE APHIS WS?

If **YES**, GO TO ○ NOTIFY APHIS WS-DISTRICT SUPERVISOR

If **NO**, GO TO ○ BTS EMERGENCY RESPONSE TRAPPING AND SEARCHES

6 EMERGENCY RESPONSE

☐ BTS EMERGENCY RESPONSE TRAPPING AND SEARCHES

- Place 100 traps baited with live mice
- Operate for 30 nights
- Conduct night fenceline searches
- APHIS WS operations should be coordinated with Military POC and HDLNR DOFAW
- HDLNR DOFAW operations should be coordinated by the District Wildlife Biologist. On Oahu, APHIS WS will provide mice and supplies.

7 EVALUATE

◇ IS SNAKE CAPTURED OR KILLED?

If **Yes,** report to ○ BTS TECHNICAL COMMITTEE.

If **No,** confer with TRIUMVIRATE and determine if Emergency Response should continue.

○ BTS TECHNICAL COMMITTEE

Evaluate Emergency Response for incident; make recommendations for improvements.

(To be printed on DOA letterhead)

SNAKE REPORT FORM

OFFICE: _____ OPERATOR: _____

Date Received: _____ Time: _____AM/PM

CALLER INFORMATION: _____
Full Name

_____
Address

_____
Phone (H) Phone (B)

Other Contact Information for the Next 48 Hours: _____

DESCRIPTION OF SIGHTING: _____

_____

_____

Sighting Location (address if applicable): _____

Date & Time of Sighting: _____

Distance From Snake at Time of Sighting: _____

Snake's Actions: _____

Other Witnesses (name, address & phone number): _____

Has the Caller Seen a Snake Before? _____

What is Your Previous Experience With Snakes? _____

_____

Instructions Given to the Caller by the Operator (as outlined on the other side): _____

_____

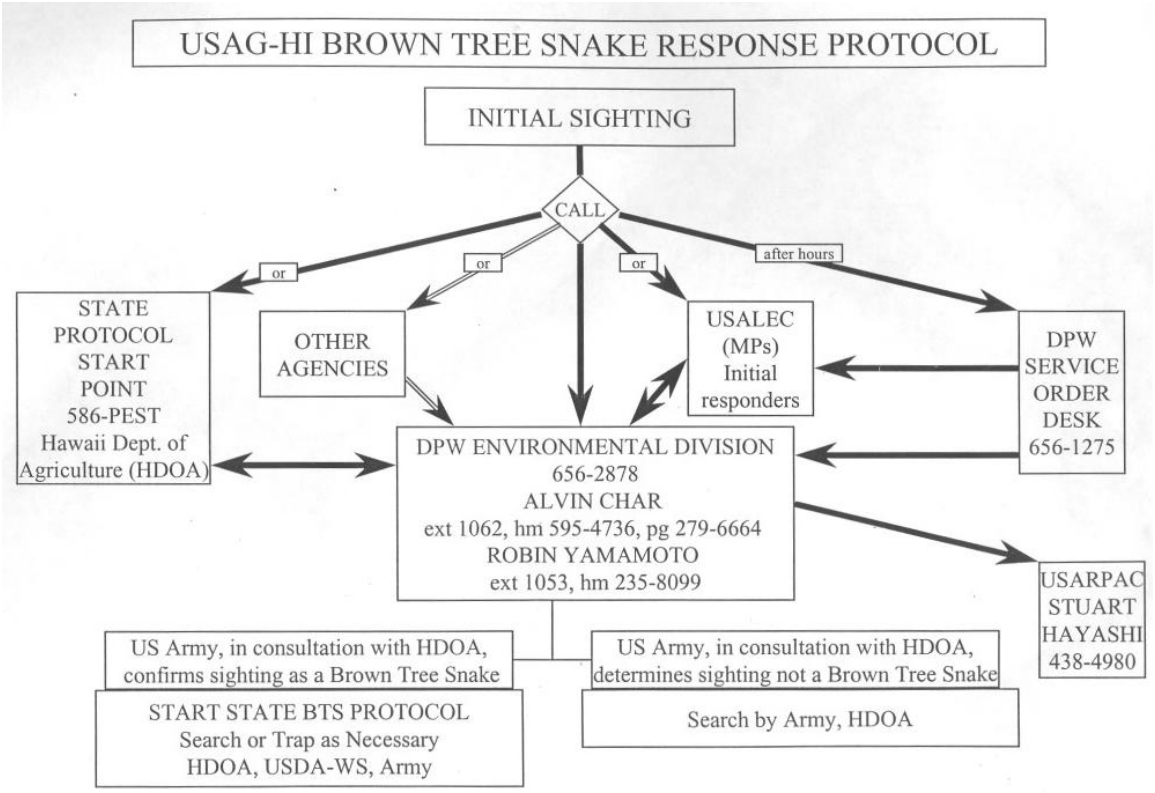
_____

(over)

INSTRUCTIONS

The caller is provided with the following instructions:

1. If snake is resting/hiding or in an enclosed area, do not disturb it.
2. If unable to contain the snake, track its location until authorities arrive.


USAG-HI BROWN TREE SNAKE RESPONSE PROTOCOL
INITIAL SIGHTING
CALL
or
or
or
after hours
STATE PROTOCOL START POINT 586-PEST Hawaii Dept. of Agriculture (HDOA)
OTHER AGENCIES
USALEC (MPs) Initial responders
DPW SERVICE ORDER DESK 656-1275
DPW ENVIRONMENTAL DIVISION 656-2878 ALVIN CHAR ext 1062, hm 595-4736, pg 279-6664 ROBIN YAMAMOTO ext 1053, hm 235-8099
USARPAC STUART HAYASHI 438-4980
US Army, in consultation with HDOA, confirms sighting as a Brown Tree Snake
US Army, in consultation with HDOA, determines sighting not a Brown Tree Snake
START STATE BTS PROTOCOL Search or Trap as Necessary HDOA, USDA-WS, Army
Search by Army, HDOA

APPENDIX L. PEST CONTROL IN THE BARRACKS

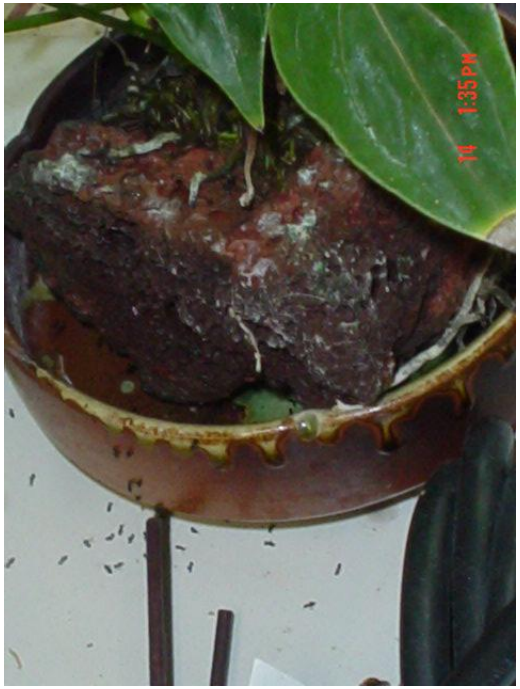
Various pests are occasionally found in the same areas inhabited by people. Among these are rodents, cockroaches, flies, mosquitoes, ants, and other miscellaneous crawling pests. Control of these pests, although sometimes difficult, can usually be obtained by following simple, common sense guidelines.

The first step to any successful pest management program is proper sanitation. This includes:

- removing all food sources. All food should be stored in sealed containers. Clean surfaces on which food is prepared or consumed. Do not leave unwashed dishes.

Brown banded cockroach in unwashed mug.

- removing all water sources. Wipe up splashed water. Fix drips. Do not leave damp towels lying in piles.



Ants attracted to water in a potted plant.

- eliminating unnecessary storage and debris. The interior and exterior of buildings should be kept free as possible of debris that pests can use for shelter. Anything soft, such as rolled carpeting, insulation, or padded furniture, is particularly attractive to rats. Corrugated cardboard provides excellent harborage (places where pests live and hide) for cockroaches.

- securing garbage and trash. Since trash may contain food scraps, all collected waste should be disposed of in pest-proof containers.

Open trash and recycle containers are an invitation to rats, ants, cockroaches and other pest to dine.

The second step is eliminating access to buildings. This can be done by:

- finding and correcting building deficiencies such as open or poorly fitted doors and windows, unscreened vents, cracks in masonry, or holes gnawed in weather stripping or utility entrances. If found, these deficiencies should be reported to the Military Maintenance Team. Corrections should include screening, caulking or applying new weather stripping.

Space along pipes running between floors provide an avenue for rodents and other pests.

- clearing away plants growing to close to the building. Vegetation in contact with the building exterior, such as tree limbs or climbing ivy, should be removed. Again, report this to your Military Maintenance Team.

Plants touching buildings provide pathways for pests to enter. Rats can easily jump 4 feet from tree to roof and back. Ants will readily trail up trees and enter upper floors.

<u>The third step is to eliminate harborage</u> (places where pests live and hide).

Nooks and crannies, such as where sinks and fixtures are mounted to the wall or floor, around all types of plumbing, baseboard molding and corner guards, where shelves and cabinets meet walls or door frames, around electrical fixtures, and any cracks on or near food preparation surfaces may harbor cockroaches, silverfish and ants. If pest problems consistently occur near such areas, report this information to your Military Maintenance Team. Simply caulking the area may solve the problem.

By following these steps you should be able to keep pest problems to a minimum. If you cannot minimize a problem after 30 days of following the three steps, report it to your Military Maintenance Team and they will submit a Service Order to DPW for pest control services.

PEST CONTROL IN THE BARRACKS.

Three Steps in Making a Difference

Robin Yamamoto
Entomologist
Directorate of Public Works
656-2878 ext 1053

APPENDIX M. RESPIRATOR PROGRAM

RESPIRATOR PROGRAM

The respiratory tract - (the lungs and other parts of the breathing system) - is much more absorbent than the skin, thus this respirator program was developed for your safety.

1. SHOP POLICY: ALL PERSONNEL MUST wear an approved respiratory device when the label directs them to do so. Even if the label does not require use of a respirator, you should always wear a respiratory protective device:

   a. if the pesticide you are mixing or applying has a precautionary statement such as "do not breath vapors or mists" or " harmful or fatal is inhaled".
   b. during calibration and adjusting of equipment if you are using pesticides with the above precautionary statements.
   c. if you will be exposed to a pesticide for a long time.
   d. if you are working in an enclosed area.

All personnel will be issued a respiratory protection device (normally a cartridge respirator). It is the responsibility of the individual to ensure that his/her respirator is kept in clean and good operating condition in accordance with this respirator program.

2. Standard Operating Procedures for selection and use: Use only those respirators which carry a seal of approval for pesticide use from the National Instituto for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA). Read the manufacturer's instruction on the use and care of any respirator and it's parts before you use it. Respirator selection is based on the hazards to which the worker is exposed.

TYPES OF RESPIRATORS :

Negative Pressure Respirators: This type of respirators rely on the wearer's ability to draw air through filters in normal breathing. The respirator must fit the face well. Long sideburns, a beard, or glasses may prevent an adequate seal.

CARTRIDGE RESPIRATORS: Used when worker is intermitently exposed to a pesticide. The inhaled air is drawn through both a fiber filter and a cartridge to absorb pesticide vapors. Most harmful vapors, gases, and particles are removed. These are usually half-face type masks which cover the mouth and nose. To cover the eyes also, use either a full face cartridge respirator, one that is combined with goggles, or wear seperate goggles.

CANISTER RESPIRATOR (GAS MASK): Used when worker is continuously exposed to a pesticide. The canister has longer-lasting absorbent material and filters than the cartridge respirator. Gas masks usually provide full-face protection. Neither canister of cartridge respirators will protect you from high concentrations of vapor, and neither kind is effective when oxygen supply is low, for example, during fumigation inside buildings, railroad cars, holds of ships or grain bins.

SUPPLIED-AIR RESPIRATORS: Used when m ixing or applying pesticides when the oxygen supply is low, when you are exposed to high concentrations of a highly toxic pesticide. You must work close to the supply of clean air, since this type of respirator works by pumping air through a hose to the face mask.

SELF-CONTAINED BREATHING APPARATUS: Used under same conditions as the supplied-air respirators. Operates similar - only difference is you carry the oxygen supply (or air supply) with you. This allows you to move more freely and over a wider area. Seek training from compentent insturctors before using self-contained breathing equipment. These devices contain a limited air supply, which may be used up even more quickly in high temperatures or with excessive exertion.

POSITIVE PRESSURE RESPIRATORS: - Uses a lightweight blower to draw the contaminated air through the filter. It forces the clean air into a loose-fitting helmet-like head covering. The outflow prevents contaminants from entering the helmet. The filtered air circulates over the head, neck and upper body of the applicator, providing some cooling.

MEDICAL EXAMINATIONS:

All pest management personnal shall be medically checked semi-annually as per AR 40-5.

RESPIRATOR TRAINING CHART

NAME	COURSE	DATE	INSTRUCTOR	FIT TEST DATE

FIT TESTING OF RESPIRATORS;

ISOAMYL ACETATE (banana oil) FIT TEST

The chemical isoamyl acetate, commonly refered to as "banana oil" ia available from major chemical suppliers and is widely used to check respiratoe fit. It's odor is easy to detect and the chemical can be used with any pesticide respirator equipped with organic vapor cartridges or canister.

When conducting a fit test, it is important to know that some brands of respirators are available in in small, medium,and large sizes. If possible, have several different sizes available during the test to ensure proper fit. Try respirators from different manufacturers since one brand may fit better than others.

If a respirator does not fit properly, the applicator will not be adequately protected. Therefore, be sure to follow the test procedures outlined below:

1. Be sure there is no banana oil odor in the test area that may influence the wearer's ability to detect it's presence. Once a respirator is selected, have the wearer adjust it until there is a good face-to-mask seal.
2. Saturate a piece of cotton or cloth with banana oil. The person performing the test should wear rubber gloves and avoid skin contact with the wearer. Recommend the construction of a fit test chamber.
3. Pass the saturated material close to the respirator in a clockwise and counterclockwise motion. Have the wearer stand still and breath normally and then deeply. If the wearer smells banana oil, readjust the respirator or select a different size or style before starting again.
4. If the odor cannot be detected while the wearer is standing still, have them perform side-to-side and up-and-down head movements. Also have the wearer talk loudly enough to be heard by someone standing nearby. Then have the person make other movements,(such as bending over), that may occur during spray application.
5. If the banana oil odor cannot be detected during the above movements, it indicates a satisfactory fit. Seal the respirator in a plastic bag marked with the wearer's name. Keep a record of when the fit test was conducted, along with the size and brand of the respirator selected for each user. Recommend the use of a "fit test card" to be carried by each user.

RESPIRATOR MAINTENANCE & INSPECTION: No matter how well the respiratory device is designed and made, unless it is properly cared for and maintained, it may fail to provide proper protection. It is recommended that respirators be cleaned daily (if used). The two most common failings are; 1. failure to occasionally wash the facepiece with soap and water - (Protective equipment is only effective as long as it is free from pesticide contamination and works properly). 2. Neglecting to change the filter cartridges or canisters regularly - (The ability of a respirator to protect you from harmful pesticide dusts, mists, and vapors depends in part on how well you maintain it. Cartridges are normally good for aproximatly 8 hours of use in a chemical atmosphere.

INSPECTIONS; Before cleaning your respirator at the end of each day, inspect it for wear and damage. Use the following as a check list for inspection.If damaged parts are found, the defective part must be replaced.

PART	FRAYING	TEARS/CUTS	CRACKS	LOSS OF ELASTICITY
HEADBAND				
GASKETS				
VALVES				
HOLDERS				
FACEPIECE				

When replacing items on a respirator, use only approved replacement parts for that SPECIFIC BRAND AND MODEL. If unapproved parts are used, the respirator will not be in compliance with the law (OSHA standard 1910.134) and the respirator may be dangerous to use.

CLEANING:

1. Disassemble the respirator - remove all part except the out-let valve.

2. Wash all parts in a solution of warm water and mild liquid detergent. (DO NOT USE ABRASIVES OR CLEANING COMPOUNDS CONTAINING ALCOHOL OR OTHER ORGANIC SOLVENTS).

3. Use a soft brush or a cloth to remove any pesticide residue.

4. Rinse the respirator and valve parts in clean water.

5. Air dry rather than using applied heat.

6. After respirator is completely dry, reassemble and store in a clean plastic bag to protect it from dirt and environmental deterioation. (Remember store the respirator with the cartridges faced up).

7. RESPERATORS MUST BE STORED IN A CONVEINIET LOCATION THAT IS CLEAN AND SANITARY !!

PROGRAM MAINTENANCE ;

Shop foreman shall provide surveillance of this program. He shall inspect and evaluate the program for compliance and effectiveness.

APPENDIX N. CONTROL AND RESPONSE, INSTALLATION SPILL CONTINGENCY PLAN
(Section 3 of the 25th Infantry Division (Light) and U.S. Army, Hawaii Spill Prevention Control and Countermeasures)

Article II. 3.0 CONTROL AND RESPONSE, INSTALLATION SPILL CONTINGENCY PLAN

Section 2.01

Section 2.02 3.1 MISSION

The Installation Spill Contingency Plan (ISCP) establishes responsibilities, duties, procedures, and resources to be employed to contain, mitigate, and clean up petroleum product and hazardous substance spills on United States Army installations in Hawaii. It has been developed and implemented in order to minimize hazards to human health and the environment in the event of fires, explosion, or releases of hazardous substances or petroleum, oil, or lubricant (POL) products to the environment.

Federal Regulations require activities that use petroleum products or hazardous substances, or generate hazardous wastes, to develop contingency plans to respond to spills of these materials. The ISCP was developed to meet the Federal requirements for spill response and contingency plans.

The following statutes and regulations address contingency planning and reporting requirements:

- Army Regulation 200-1, Environmental Protection and Enhancement, 21 Feb 1997

- Title 40, Code of Federal Regulations, Part 300, National Oil and Hazardous Substance Pollution Contingency Plan

- Public Law 96-510, CERCLA of 1980 and the Superfund Amendments and Reauthorization Act (SARA) of 1986

- RCRA Regulations, Title 40 Code of Federal Regulations Part 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities; Part 262, Standards Applicable to Generators of Hazardous Wastes; Part 280, Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks

- Title 40 Code of Federal Regulations Part 110, Discharge of Oil

3.2 RESPONSIBILITIES FOR SPILL RESPONSE

(a)

(b) 3.2.1 Introduction

All units and activities on USAG-HI installations handling oil and hazardous substances in their daily operations shall be familiar with the information contained in this plan for its successful execution. Furthermore, these organizations shall provide basic spill prevention and response training to their personnel on an annual basis.

The provisions of this plan are to be carried out immediately in the event of an emergency or other situation that threatens human health or the environment.

(c)

(d) 3.2.2 Categorizing and Classifying Spills

WARNING: When a spill or leak of an unknown material or fluid is discovered, immediately contact the installation Fire Department. If there is any reason to suspect the discharge may have been deliberate or the result of an act of sabotage or terrorist activity, inform the Fire Department when reporting the spill. Do not attempt to recover the spill. Leave the area immediately, request further guidance from the Fire Department, and report the spill to DPW Environmental.

The best spill response is prevention. Performing routine inspections and maintenance, training personnel to follow existing work procedures, and fostering an atmosphere of attention to detail, will prevent a spill from occurring in the first place. All spills shall be immediately reported upon discovery to the DPW Environmental Office. The most common causes for spills are operator error or equipment failure.

When notified of a discharge or spill, the Spill Coordinator shall determine the appropriate level of response and dispatch or request the necessary resources. Successful resolution of a spill event largely depends on prompt appropriate action. This plan discusses minor and major spills: minor spills typically being handled by the unit, tenant, or contractor; major spills requiring assistance from IRT or other emergency response personnel.

(e)

(f) **3.2.3 Minor Spills**

(i)

(ii) 3.2.3.1 What Are Minor Spills?

1) For the purposes of this plan and as a general guideline, minor spills are those releases of oil, paints and other substances, that are 1) stored and used at facilities, 2) that can be readily cleaned up by unit personnel with available equipment, and 3) that do not require specialized recovery techniques or advanced personal protective equipment. Report all spills immediately to the DPW Environmental Office.

2) Minor spills involve small quantities of oil (less than 25 gallons), or paints and hazardous substances that do not require advanced personnel protective equipment, released indoors, to the ground, or to paved areas. Minor spills also include spills less than the reportable quantities (see Appendix D).

3) If there is any question regarding if the spill is a major or minor spill, assume the spill is a major spill.

4) All minor spills will be immediately cleaned up the same day the release is discovered. A minor spill of POL not cleaned up within 72 hours becomes a major spill and must be reported to the State and the LEPC.

5) Releases of any amount of these materials into water bodies or drainage systems shall be considered as major spills due to their potential environmental impact and the need for reporting releases of certain hazardous substances and petroleum products to regulatory agencies.

(iii) 3.2.3.2 Who Cleans Up Minor Spills?

Minor spills are cleaned up by the unit/activity, tenant, or contractor that caused the spill.

Although in some instances DPW Environmental will supervise recovery, cleanup of minor spills are not the responsibility of the USAG-HI IRT.

Prompt cleanup actions, including reporting and follow-through are essential. Any amount of petroleum or fuel oil released to the environment which is less than 25 gallons, but is not contained or cleaned up within 72 hours must be reported to the State and the LEPC.

1) Each activity, tenant, or contractor using or storing POL, hazardous substances, or hazardous wastes will designate a spill coordinator and an alternate that will be responsible for spill response and reporting. The spill coordinator, generally the ECO, will be identified to all personnel in the work area, and listed conspicuously on official bulletin boards.

2) The ECO will be responsible for coordinating and overseeing responses to minor spills, and calling the point of contact listed in Table 3-2. The ECO shall have a Memorandum of Appointment by the Unit Chain of Command, and attend the ECO training within 30 days of appointment. Contractors and tenant units should contact DPW Environmental with question regarding training requirements for their designated ECOs.

TABLE 3-2. Points of Contact to Activate IRT
All spills will be reported directly to the Environmental Division Spill Response Line Primary POCs.

Title	Directorate/Activity	Location and Telephone Number
DPW Environmental Division Emergency Spill Response Line (24-Hour)	DPW	**PH: 656-1111** 572 Santos Dumont Ave, WAAF
Alternate DPW Emergency Spill Response Line – Work Order Desk	All spills	947 Wright Ave, WAAF PH: 656-1275
PRIMARY POCS:		
Chief, Compliance/ Pollution Prevention Branch	DPW	572 Santos Dumont Ave, WAAF PH: 656-2878 ext. 1049
Hazardous Waste Program Manager	DPW	572 Santos Dumont Ave, WAAF PH: 656-2878 ext. 1022
Emergency Planning and Community Right-to-Know Act Program Manager	DPW	572 Santos Dumont Ave, WAAF PH: 656-2878 ext. 1019

3.2.3.3 How Are Minor Spills Cleaned Up?

See Appendix E of this Plan.

(iv) 3.2.3.4 What Are Major Spills?

1) For the purposes of this plan, major spills involve more than 25 gallons of oil or fuel or more than 1 gallon of a hazardous substance to the ground, and any quantity of oil, fuel or a hazardous substance that is spilled to a drain or a water body. It also includes any spill that exceeds the reportable quantities of items listed in Appendix D.

2) Any release of a POL, hazardous substance, or hazardous waste that enters or has the potential to enter a stream, lake, river, canal, wetland, bay, ocean, storm drain, drainage ditch, or sewer manhole.

3) Any release of a reportable quantity to the ground.

4) A release of a petroleum product in excess of 25 gallons or any amount of POL not cleaned up within 72 hours.

5) Any spills thought to be beyond the capabilities of activity personnel or equipment.

6) Suspected leaks from underground storage tanks or piping that are discovered from discrepancies in inventory records.

Table 3-3. Installation Response Team (IRT) Members

Title	Directorate/ Activity	Location and Telephone Number
INSTALLATION ON-SCENE COORDINATORS (IOSC)		
Chief, Compliance/ Pollution Prevention Branch	DPW	572 Santos Dumont Ave., WAAF PH: 656-2878 ext. 1049
Hazardous Waste Program Manager	DPW	572 Santos Dumont Ave., WAAF PH: 656-2878 ext. 1022
Emergency Planning and Community Right-to-Know Act Program Manager	DPW	572 Santos Dumont Ave., WAAF PH: 656-2878 ext. 1019
Clean Water Program Manager	DPW	572 Santos Dumont Ave., WAAF PH: 656-2878 ext. 1031
Drinking Water, Air Pollutants Program Manager	DPW	572 Santos Dumont Ave., WAAF PH: 656-2878 ext 1059
Underground Storage Tanks Program Manager	DPW	572 Santos Dumont Ave., WAAF PH: 656-2878 ext. 1017
Asbestos, Lead Paint, PCBs Program Manager	DPW	572 Santos Dumont Ave., WAAF PH: 656-2878 ext. 1018
DPW POCs		
DPW Hazardous Waste Transfer and Accumulation Point (TAP) Manager	DPW	Bldg. 6040, Schofield Barracks, East Range PH: 656-0866
Environmental Support Section, Engineering Branch	DPW	Bldg. 2624, Schofield Barracks PH: 655-0551
Supervisor, Maintenance & Repair Branch	DPW	Bldg. 2624, Schofield Barracks PH: 655-0592
Supervisor, Schofield Barracks Maintenance & Repair Section	DPW	Bldg. 2624, Schofield Barracks PH: 655-0591
Supervisor, Fort Shafter Maintenance & Repair Section	DPW	Bldg. 346, Fort Shafter PH: 438-1325
Chief, Engineering Plans & Services Division	DPW	572 Santos Dumont Ave, WAAF PH: 656-1410 ext. 1201

Title	Directorate/ Activity	Location and Telephone Number
Operations Officer	DPW	947 Wright Ave., WAAF PH: 656-1288 ext. 2205
Lead, Contract Performance Evaluator, Contracts Branch	DPW	Bldg. 113, WAAF PH: 656-1410 ext. 2042
Cultural Resource Manager	DPW	572 Santos Dumont Ave, WAAF PH: 656-2878 ext. 1052
Chief, Purchasing & Construction Div, Regional Contracting Office-HI	RCO-HI	Bldg. 520, Fort Shafter PH: 438-6535 ext. 136
ADDITIONAL ACTION OFFICERS:		
Hazardous Waste Program Manager	DPW	656-2878 ext. 1022
HMCC Contracting Officer Representative	DOL	656-2381
Range Officer, Range Control	G-3 25th ID(L)	655-1404
Assistant S-4	45th CSG	655-9089
Chief, Operations Division	TAMC	224-2350 Cellular
Logistics Management Officer	POD	438-8316
Environmental Manager	9th RSC	438-1600 ext. 3247
Safety & Security Officer, Hawaii Exchange	AAFES	423-8815
Battalion XO	65th Engineer Bn	655-2881
Battalion XO Staff Duty	84th Engineer Bn	655-6533 655-2895
FIRE DEPARTMENTS:		
Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation, Fort Shafter, TAMC, Aliamanu Military Reservation, Fort DeRussy		471-7117
Pohakuloa Training Area		969-2441
Kilauea Military Camp		967-8377/8378
MILITARY POLICE:		
Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation		655-0911
Fort Shafter, Tripler Army Medical Center, Aliamanu Military Reservation		438-0911
Fort DeRussy		438-2650
Pohakuloa Training Area		969-2425
Kilauea Military Camp		967-8368
AMBULANCE:		
Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation		911
Fort Shafter, Tripler Army Medical Center, Aliamanu Military Reservation		911
Fort DeRussy		911
Pohakuloa Training Area		969-2433
Kilauea Military Camp		967-8367

Title	Directorate/ Activity	Location and Telephone Number
SUPPORT STAFF:		
Staff Judge Advocate		438-2845/6722
Installation Fire & Safety Officer		656-1331/0616
Director of Health Services		433-6693
Public Affairs Office		655-2918
COMMUNITY COMMANDERS:		
Schofield Barracks, Wheeler Army Airfield, Helemano Military Reservation		655-0216
Fort Shafter, Tripler Army Medical Center, Fort DeRussy		438-6996
Pohakuloa Training Area, Kilauea Military Camp		969-2400

(v) 3.2.3.5 Who Cleans Up Major Spills?

1) Major spills will generally be managed and/or cleaned up by the USAG-HI IRT. However, common sense and prompt spill containment and emergency response in all situations should be practiced when it is safe to do so. A spill contractor will be used whenever the spill is outside the capabilities of in-house support. A copy of all spill response contracts will be maintained by the EPCRA Program Manager.

2) In some instances of spills of large quantities of POL or where excavation is required, the responsible unit may still be able to perform recovery of the spill but shall be supervised by the DPW Environmental Office.

3) For major spills at Pohakuloa Training Area and Kilauea Military Camp, DPW IOSCs will provide guidance and support whenever possible and will make the necessary agency notifications. A spill contractor will be used whenever outside the capabilities of in-house support

(vi) 3.2.3.6 How to Activate the IRT In the Event of A Major Spill?

Refer to section 3.3.2 for notifying the IRT. The IOSC will activate the IRT if necessary, upon receiving notification of a major spill.

(g)

(h) 3.2.4 Installation Response Team (IRT)

1) The IRT is tasked with spill containment, clean up, and site restoration, until a stable condition is reached for all spills that cannot be readily handled by the personnel and/or organization directly responsible for the spill.

2) The DPW supervises the IRT. Members of the IRT are listed in Table 3-3.

3) Units of the IRT are responsible for mobilizing and assembling promptly with the necessary materials and equipment at the location designated by the IOSC. The containment and clean up of the spill shall have priority over all DPW efforts.

4) The IRT shall participate in a simulated spill event training exercise on an annual basis. The IRT members shall receive formal training and refresher training as per 29 CFR 1910.120

5) The IRT will conduct all emergency responses in accordance with OSHA regulations governing health and safety practices for emergency operations at hazardous waste sites except when dealing with non-hazardous materials. The Installation Fire and Safety Office will ensure that proper OSHA procedures are practiced by monitoring response activities.

6) Specific responsibilities for IRT members and support functions are described below.

(i)

(ii) **3.2.4.1 Installation On-Scene Coordinator (IOSC)**

The IOSC is responsible for managing the spill response effort. The designated IOSCs are listed in Table 3-3. The IOSC will:

1) Ensure that reportable spills are reported immediately to the EPA, U.S. Coast Guard, the State Emergency Response Commission (SERC), the Local Emergency Planning Committee (LEPC), or the Pacific Region Office (PARO), as required by regulation. For spills suspected of being classified as a serious incident in accordance with AR 190-40, Serious Incident Report, immediately notify the DPW Operations Officer.
2) Maintain a current list of resources available for spill contingencies. Request construction equipment and vehicle support when needed from the 65th and 84th Engineering Battalions and Schofield Barracks Area Engineers, via the DPW Operations Officer. Resources of other non-Army agencies, along with telephone numbers, are included in Table 3-4.

Table 3-4. Other DOD Organizations with Spill Response Capabilities

Organization	Telephone No.
COMNAVBASE	471-8481
Base Civil Engineer Office, Hickam AFB	449-1660
SPILL HOTLINE NUMBERS	
National Response Center	800-424-8802
CHEMTREC	800-424-9300
CERCLIS Hotline	703-538-7234
EPA Emergency Planning and Community Right-to-Know	800-724-9346
RCRA/UST Superfund	800-424-9346
TSCA	202-554-1404
Solid Waste Information Clearinghouse	900-659-7000
CFC's	800-296-1996
Air RISC Hotline	919-541-0888
Pesticides Information	800-858-7378
General Environmental Questions (Construction Energy Research Lab, U.S. Army R&D Center, Environmental Processing Branch)	800-USA-CERL ext. 5424

3) Designate a location for an installation response operations center at each installation that will be used in the event of a major spill.
4) Identify available communications equipment that can be used during an emergency (such as Military Police radios, cellular telephones, etc.). Electronic communication and testing equipment must be intrinsically safe for use in explosive atmospheres.
5) Maintain a list of potential sources of spills at USAG-HI installations, including the capacity, type of substance stored, and remarks on relative risk of spills. Appendix A contains a list of

current oil or hazardous substances/wastes that are potential sources of spills or leaks and complete inventory reports can be obtained from the DPW EPCRA program manager.
6) Identify water resources to be protected in the event of a significant spill. First priority resources include drinking water sources, which are presently all sub-surface. Second priority resources include sensitive streams and navigable waters.
7) Serve as a primary point-of-contact with other agencies to provide Army resources for assistance in Regional Response Plans for clean up or containment of non-Army spills. Initial request from outside agencies for Army assistance will be through the Director of Plans and Training, USAG-HI. Appendix H provides guidance when Army assistance is requested by the Regional Response Team, or when there is imminent danger to life and property requiring Army action to be taken for a non-Army spill.
8) Schedule a simulated spill event annually. Appendix I establishes procedures for conducting the annual spill response exercise.
9) Maintain a library of reference materials pertinent to the ISCP. These materials should include Material Safety Data Sheets, emergency response resource information, general information on chemicals, etc.
10) Procure and maintain a supply of absorbent materials for absorbing spills and necessary equipment for spill response at IOSC installation.
11) Maintain records pertaining to major and minor spill events and response actions.

(iii) 3.2.4.2 [Section Reserved]

(iv) 3.2.4.3 Responders At Remote Installations

1) For major spills at Pohakuloa Training Area, and Kilauea Military Camp, DPW IOSCs will provide guidance and support whenever possible and will make the necessary agency notifications. A spill contractor will be used whenever outside the capabilities of in-house support.

2) Spill responders will keep the DPW IOSC apprised of cleanup actions.

(v)

(vi) 3.2.4.4 DPW Unit

1) The unit will respond to spills as directed by the DPW IOSC, within their capabilities.

2) Mobilization responsibilities and procedures are contained in DPW SOP Number APVG-GWV-C No. 300, Notification and Initial Mobilization for Spills of POL, Hazardous Materials/Waste, or Air Pollutants and Wastewater.

3) Generally, the DPW Unit will only respond to spills where advanced Personal Protective Equipment is not required. However, properly trained DPW Unit personnel may be required to respond to spills requiring advanced PPE under the direction of the IOSC.

(vii) 3.2.4.5 Fire Department

1) The Fire Department will respond to spills and releases of unknown substances.

2) Where there is a threat of fire, the Fire Department will immediately respond to an oil or hazardous substance spill in accordance with established procedures and COMNAVBASE Pearl Harbor letter 5090.POL42 of 10 Dec 92. The Fire Department will also respond to incidents where entry of oil or hazardous substance into a stormdrain or waterway is imminent. The Fire Chief or his representative will direct the incident response operations and will coordinate operations with the Military Police. After

threats to life and property are eliminated, command of the incident is transferred to the IOSC. The Fire Chief will also provide technical assistance to the IOSC with respect to the response to and handling of combustible or flammable substances**.**

3) The Fire Department will also respond **to major spills that cannot be handled by organizations that caused the spill or the IRT**. After arrival of a private spill contractor, the command of the incident is transferred to the IOSC.

4) The Fire Department will make available fire department personnel with protective clothing and equipment (e.g., SCBA) under its control. It will direct the emergency dispatch operator to obtain emergency medical services (if required) and call in the spill to the IOSC, if these actions have not already been accomplished. The Fire Department will also develop and maintain agreements for use of the City and County Hazardous Material Team.

5) For spills at PTA and KMC, respond at the first responder operations level, containing the spill from a distance to keep it from spreading and to protect and minimize exposure to nearby persons, property, and the environment.

(viii)

(ix) 3.2.4.6 Military Police

1) Request ambulance, fire department, and Installation On-Scene Coordinator (IOSC) support as appropriate. IOSC activation contacts are at Table 3-2.

2) Provide site security to prohibit entry of unauthorized persons to a spill site and to provide for safe flow of vehicular traffic in and around the spill site.

3) Evacuate military personnel within the Army installation and coordinate evacuation of civilian personnel with the Civil Defense and local police if necessary.

(x) 3.2.4.7 Commanders 65th and 84th Engineering Battalions

The Engineering Battalions will provide available equipment and operators for response actions, when requested by the DPW Operations Officer. Available equipment includes small equipment excavators, backhoes, bulldozers, road graders, and scoop loaders.

(xi) 3.2.4.8 Other Units and Activities on USAG-HI Installations

Units and activities are represented on the IRT by the action officers as indicated in Table 3-3. Action officers become members of the IRT on an ad-hoc basis, when a spill involving the IRT occurs at one of their facilities. In a spill situation, the ECO and the activity-specific emergency response coordinator and/or alternate will provide detailed information to the IRT on the nature of the spill and the steps already taken to control the spill. The ECO and coordinator will also assist the IRT, as appropriate. The ECO will also advise on the proper procedures for disposal of the spill residues.

(xii)

(xiii) 3.2.4.9 Support Staff to the IRT

1)

2) 3.2.4.9.1 Staff Judge Advocate

1) The SJA will respond to oil and hazardous substance pollution spills at the request of the IOSC.

2) Provide guidance to ensure that information, records, and samples adequate for legal purposes are obtained and safeguarded for future use by appropriate responding agencies. The SJA will also advise the IOSC on all the legal aspects of spill response.

3) 3.2.4.9.2 Public Affairs Office

1) The PAO will provide an on-site PAO spokesperson for oil or hazardous substance spills when requested by the IOSC.

2) Upon notification of an oil or hazardous substance spill, or in response to media query, the PAO will prepare and coordinate appropriate media releases. Detailed procedures, responsibilities, and methods for releasing information to the public are described in Appendix G.

4) 3.2.4.9.3 Director, Installation Fire and Safety

1) The Director, Installation Fire and Safety, will respond to all major spills that present hazards to personnel and facilities.

2) Provide technical assistance to the IOSC with respect to the safety of personnel during response operations and ensure compliance with applicable OSHA regulations.

5) 3.2.4.9.4 Director of Health Services

1) Upon request from the IOSC, the Director of Health Services (DHS) will provide medical support consistent with the emergency.

2) On-site care will normally be limited to emergency medical treatment necessary to preserve life and limb. Although patient evacuation by military ambulance may be desired, use of on-site transportation assets may provide a more expedient means. If on-site transportation is used, consideration must be given to the additional potential spread of hazardous substances.

3) The DHS will also advise the IOSC regarding the potential threat to personnel and civilians in the surrounding area and the need for evacuation to protect human health.

4) The DHS will also assist the Director, Installation Fire and Safety, with respirator fit testing, as needed, for response personnel. DHS may also provide guidance to identify chemical hazards and protective equipment.

Section 2.03 3.3 SPILL DISCOVERY AND INITIAL NOTIFICATION PROCEDURES

These procedures are summarized in quick reference tables in Appendix E for various types of chemicals typically found at USAG-HI facilities.

(a) 3.3.1 Initial Defensive Actions

The following initial defensive actions shall be implemented as necessary upon discovery of a spill:

1) Evacuate the area of non-essential personnel and direct personnel to notify DPW Environmental, the Military Police, and Fire Department.
2) Summon emergency medical services if personnel are injured.
3) Remove ignition sources (cigarettes, torches, etc.) and turn off electric power in the case of a flammable spill to minimize fire hazards.

4) Ventilate the area in the case of the presence of volatile materials or dense vapors spilled inside a building.
5) Stop flow of material, **if it is safe to do so**, by plugging the leak, activating any emergency shut offs, reorienting the container, placing the container in a drip pan, placing the container in an over-pack container, or using any other expedient method available.
6) Contain spilled material to keep spill from spreading and flowing beyond the immediate area or into drains, by using plugs, mats, absorbents, spill booms, or any other expedient method available.
7) As the spill area is isolated, the "hot zone" should be expanded in a DOWNWIND DIRECTION, paying particular attention to sensitive populations (e.g. schools, child-care center, medical facilities, etc.) if spilled materials are volatile, or there is a short-term danger if material is inhaled.

(b)

(c) 3.3.2 Initial Notification Procedures

The person discovering the spill shall report it immediately to the organization's designated spill response coordinator, who will immediately notify DPW Environmental. The Military Police and/or the Fire Department shall be contacted 1) if there is a threat of fire, 2) danger to public health, or 3) it could affect a sensitive environmental area (such as entering a water body).

All spills shall be immediately reported to DPW Environmental (Table 3-3) by the organization spill response coordinator, Military Police, Fire Department or anyone with knowledge of a spill.

(i)

(ii) 3.3.2.1 Notification For Major Spills

1) The Military Police are to be notified of spills immediately by the person discovering the spill. Any instructions provided by the Military Police regarding evacuation procedures shall be followed. The Military Police will notify the Environmental Division if not already done (Table 3-2).
2) The Fire Department will be notified either by the person discovering the spill or by the Military Police when the threat of fire is present. The Fire Department will notify DPW Environmental if not already done (Table 3-2).
3) Medical/ambulance support will be requested either by the person discovering the spill or by the Military Police, if needed.

(iii)

(iv) 3.3.2.2 Information to Be Provided

As a minimum the following information shall be provided prior to activation of the IRT whenever possible (Use the Spill Notification Form in Appendix B of this plan if available):

- Name and organization of individual reporting spill
- Location of spill
- Number of injured personnel and the nature of their injuries (if applicable)
- Substance spilled (if known)
- Time spill occurred (if known)

- Amount of material spilled (if known)
- Surface on which spill occurred (soil, pavement, concrete etc.)
- Rate of material spill (estimated)
- Media on which material was spilled
- Direction and extent to which the spill has traveled
- Any additional pertinent information (i.e., fire or other potential hazards)

Section 2.04

Section 2.05 3.4 SPILL RESPONSE ACTIONS

The Fire Department will immediately respond as necessary to protect life and property with due respect for the environment. Oil or hazardous substances shall not be flushed into drains except as an emergency measure to prevent imminent danger to life or property. When time permits, the decision to flush a spill shall be coordinated with the IOSC.

For major spills or where deemed necessary, the IOSC or designee will immediately proceed to the spill site and evaluate the severity of the spill and determine the response necessary for containment and recovery. If necessary the IOSC will:

- Activate the IRT and/or involve a private contractor.
- Mobilize the DPW response team.
- Direct the DPW/Tenant Activity Response Units in accordance with this plan.
- Report reportable spills to the National Response Center, U.S. Coast Guard, SERC, LEPC, PARO, and DPW Operations Officer as described in Section 3.4.3.
-

(a) 3.4.1 IOSC/IRT Response

The response actions of the IOSC and IRT will include the following:

(i)

(ii) 3.4.1.1 Activation of the IRT

The IOSC will activate and authorize action of appropriate members of the IRT based on information relayed during initial notification. If insufficient information is available to activate the IRT, the IOSC will immediately investigate the reported spill.

(iii)

(iv) 3.4.1.2 Identification of the Spilled Material

The IRT will determine the source, type, and appropriate quantity of spilled substance if not already determined. For releases of unknown substances, the Fire Department will conduct initial field tests to identify the substance. Samples will be collected for laboratory analysis as necessary.

(v)

(vi) **3.4.1.3 Evaluation of the Severity of the Spill**

The IOSC will evaluate the magnitude and severity of the threat to public health, welfare, and natural resources. Response organization expertise such as that possessed by the Fire Department, along with technical references, such as the "NIOSH Pocket Guide to Chemical Hazards," the "Chemical Hazard Response Information System (CHRIS) Manual," and the "DOT Hazardous Materials Emergency Guidelines" will be used as required. In addition, computer programs can be used as resources. Available programs include the EPA's "CAMEO" and "ALOHA" programs and the Federal Emergency Management Agency's "ARCHIE" program.

(vii)

(viii) 3.4.1.4 Protection of Personnel

The IRT, in consultation with the DHS and the Director, Installation Fire and Safety, will ensure that appropriate safety precautions are implemented to protect response personnel and any additional personnel located in close proximity to the probable spill vulnerability zone. Safety precautions will be site-specific, but will include generic actions as restricting access to the area, use of personal protective equipment, and evacuation.

WARNING

It is the responsibility of the IOSC to ensure only trained and qualified personnel perform spill response activities involving major releases of oil and hazardous substances. Aggressive response, such as to a fire in conjunction with an oil tank, shall only be performed by trained first responders such as the fire department. The IOSC must keep a current record of IRT member training and qualifications, and only use the members of the IRT within the limits of their technical capability. The IOSC shall clearly determine the specific hazards before employing non-first responder trained personnel in responding to a spill.

(ix)

(x) 3.4.1.5 Determination of the Responsible Party (RP)

If the responsible party (RP) for the spill is other than the U.S. Army (e.g., tenant, contractor, etc.), the RP shall be informed of the spill, and is responsible for cleaning up the spill. The RP's subsequent response actions will be evaluated by the IOSC. In cases involving Army contractors, the IOSC shall immediately notify the appropriate contracting office of the spill. If the contractor's response action is inadequate or not completed in a timely fashion in the judgment of the IOSC, the IOSC shall inform the Contracting Officer. The Contracting Officer shall direct the contractor to provide adequate response action or face the termination of the contract. In all cases, if the RP's response action is inadequate or not completed in a timely fashion in the judgment of the IOSC, the IOSC shall assume control of the spill response, and the RP shall make reimbursement as directed by the IOSC.

(xi)

(xii) 3.4.1.6 Determination of the Nature and Cause of the Spill

The IRT will document the cause of the spill and take samples as required to determine the chemical identity, concentration, and extent of the spill for response actions and documentation for possible future legal action.

(xiii)

(xiv) 3.4.1.7 Implementation of Spill Containment Procedures

Spill containment procedures, as directed by the IOSC, are to be implemented in order to confine the spill as close to the source as practicable and, if at all possible, prevent spills from exiting the property limits of the installation, or from entering storm drains, sewer line, or navigable waters. Whenever safe to do so, these procedures include, but are not limited to:

- Plugging or patching leaking drums or containers
- Repositioning the container to stop or reduce the leak
- Placing the leaking container in an appropriate overpack
- Using of mats, absorbents, spill booms, or containment vessels to control the spill
- Preventing/diverting the flow path of the spill from entering storm drains or sewer lines
- Building earth dikes, or using sandbags in the case of large spills

If the spill cannot be contained, the IOSC will determine if highly vulnerable areas, water supplies, waste treatment plants, or recreational waters might be adversely affected. Appropriate personnel or organizations will be notified by the IOSC if such conditions exist (e.g. the U.S. Coast Guard if navigable waters are threatened, the wastewater treatment plant if spills could enter the sewer system, etc.).

(xv)

(xvi) 3.4.1.8 Initiation of Clean up Actions

Once the spill has been contained, clean up actions will be initiated using Army resources, if possible. Troop support from the 65th and 84th Engineering Battalions if needed shall be coordinated through the DPW Operations Officer. In those cases where the IRT alone cannot meet the required needs for clean up and disposal, the IOSC will request additional resources. The services of commercial clean up contractors will be used when their expertise and services are warranted under emergency service contracts. All pollutants will be collected and disposed of in accordance with hazardous waste regulations.

(xvii)

(xviii) 3.4.1.9 Additional Internal Notification

Whenever excavation is required to clean up a spill, the DPW Cultural Resource Manager will be consulted prior to excavation to ensure proper management of areas which may contain historical artifacts.

Because of the potential damage that can be caused to a sewage treatment plant, in the event of a release to a sanitary sewer system, the IOSC shall notify the appropriate sewage treatment plant as soon as possible after a spill has occurred.

The IOSC will also notify the appropriate Community Commander, if deemed necessary, as soon as practical, of the spill and the steps taken to control the spill.

The IOSC will advise the PAO if deemed necessary, as soon as practical, of the nature of the spill and any response actions taken. Notification procedures are described in Appendix K.

Organizational Action Officers shall be notified, as soon as practical, of spills relating to waste POL or hazardous wastes.

(b) 3.4.2 Incident Log

The IOSC or designee will maintain an Incident Log detailing all actions taken during the course of the spill response. The log will satisfy the written notice requirements of SARA Title III. The log will include, but are not limited to:

- Identification of the substance(s) and volumes of substances released
- Location of the spill, cause of spill, time of day, and duration of the release
- Where the release occurred, sensitive environmental areas affected, and the extent of any environmental damage, if any
- Actions taken to recover the substance(s) and restore the environment
- Personnel involved in the response
- Health and safety precautions and measures employed
- Injuries or exposures that occurred and medical attention received by injured/exposed persons
- Known or anticipated acute or chronic health risks
- Internal notifications performed
- Regulatory status of the release and agencies notified
- Samples collected and analyzed
- Property damage, if any
- Disposal of spill residuals
- Decontamination procedures used

(c)

(d) 3.4.3 Reporting

(i)

(ii) 3.4.3.1 Hazardous Substances/Hazardous Waste Releases

The IOSC will determine if a reportable hazardous substance release has occurred in accordance with 40 CFR 302: EPA Designation, Reportable Quantities and Notification Requirements for Hazardous Substances Under CERCLA. Spills of hazardous substances as defined in this regulation must be reported immediately to the National Response Center or the U.S., Coast Guard. Telephone numbers are provided in Table 3-5. EPA may require a written follow-up report for a hazardous substance spill.

The IOSC will also determine if an extremely hazardous substance, as defined in the SARA Title III requirements (40 CFR Part 355), has been released outside of the installation boundary. Releases of extremely hazardous substances in excess of reportable quantities that expose persons outside the

installation boundaries require immediate notification to the State of Hawaii Emergency Response Commission (SERC) and the Local Emergency Planning Committee (LEPC) as required in SARA Title III, 40 CFR Part 355: Emergency Planning and Notification. Telephone numbers are provided in Table 3-5. A written follow-up report is also required, containing the information detailed in the previous Section (Incident Log).

The regulatory reportable quantities (RQs) of hazardous and extremely hazardous substances used and stored at USAG-HI facilities is available upon request from the EPCRA Program Manager at DPW Environmental. Complete lists of RQs of hazardous substances, as defined in CERCLA, 40 CFR Part 302, and SARA Title III, 40 CFR Part 355, are provided in Appendix D.

Releases of unlisted hazardous wastes in excess of the RQ also requires reporting under CERCLA regulations and in some cases reporting of releases of hazardous wastes to EPA under the RCRA regulation in 40 CFR 265 Subpart C.

Spills of reportable quantities under the State Contingency Plan (Hawaii Administrative Rules, Title 11, Department of Health, Chapter 451) will be reported to the State and to the LEPC.

Releases which, based on the nature, gravity, potential for adverse publicity, or potential serious consequences, will also be reported to PARO in accordance with AR 190-40, Serious Incident Report, and also to the DPW Operations Officer.

(iii)

(iv) 3.4.3.2 Releases of Oil to Navigable Waters

Releases of oil into navigable waters must immediately be reported to the National Response Center or the U.S. Coast Guard in accordance with 40 CFR 110: EPA Regulations on Discharge of Oil. Reportable releases are defined as those in excess of water quality standards or cause a visible sheen on the water surface, a discoloration of adjoining shorelines, or form a sludge or emulsion beneath the water surface or on adjoining shorelines. A follow-up written report to EPA, within 60 days, is required for oil spills of 1,000 gallons or more, or if two oil spills of any quantity occur within a 12-month period.

Table 3-5. List of Persons/Agencies to be Notified of Spills

Name/Agency	Telephone Number
Sewage Treatment Plants:	
Schofield Barracks/Wheeler Army Airfield (SB, Wheeler, Kunia, and Helemano Wastewater)	656-1330/864-0842
Sand Island Wastewater Treatment Plant (Ft. Shafter, Ft. DeRussy,TAMC, and Aliamanu wastewater)	847-8307
IMA-Pacific Region Office, Environmental Office	438-3080 (phone) 438-8688 (fax)
REGULATORY AGENCIES:	
National Emergency Response Center:	800-424-8802 (24 hours)
Environmental Protection Agency (Region IX, San Francisco)	415-947-4400 (emergency

	response team)
U.S. Coast Guard, Marine Safety Office (Honolulu)	541-2477
State Emergency Response Commission, Hawaii Department of Health, Hazard Evaluation and Emergency Response	586-4249 / 247-2191 (after hours)
Local Emergency Planning Committees (notification required by SARA Title III) Hawaii Oahu	 935-2785 523-4121
Local Fire Departments (notification required by SARA Title III) Hawaii Oahu	 961-8297 831-7771

(v) 3.4.3.3 Underground Tank Releases

Release reporting, investigation, and confirmation requirements for underground tanks are listed in Subpart E of the EPA Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (40 CFR 280). The State of Hawaii has adopted its own UST regulations, HAR, Chapter 11-281. The Hawaii Department of Health responsible for administering the State UST program has published the document the "Technical Guidance Manual For Underground Storage Tank Closure and Release Response." This manual describes release response, notification, and reporting requirements for releases from USTs.

(e)

(f) 3.4.4 Restoration of Spill Sites

The ECO or IRT as applicable, will assure the proper disposal of spilled oil and other petroleum wastes. If the spilled material can be classified as a hazardous waste under RCRA, it must be disposed of in accordance with the 25th ID(L) and USARHAW Installation Hazardous Waste Management Plan.

For releases, spills, or leaks from underground tanks, initial abatement measures, site characterization, free product removal, investigations for soil and groundwater clean up, and corrective action must be in accordance with EPA Underground Tank Regulations, 40 CFR 280.60 through 280.66. The HDOH "Technical Guidance Manual For Underground Storage Tank Closure and Release Response" reflects federal requirements and includes Hawaii specific requirements. The State of Hawaii Office of Environmental Quality Control has established general soil and groundwater action levels for contaminants that are commonly associated with releases from UST systems. A listing of these action levels is provided in Table 3-6.

Remedial procedures and clean up levels for other contaminants in soils or water are governed by the National Oil and Hazardous Substances Pollution Contingency Plan under CERCLA (40 CFR 300).

Table 3-6. Tier 1 Action Levels for Soil and Groundwater

Contaminant	Groundwater (mg/L)	Soil (mg/Kg)
Benzene	0.005	0.05
Toluene	1.0	16
Ethylbenzene	0.14	0.50
Xylenes	10	23
MTBE	0.020	0.005
Benzo(a)pyrene	0.0002	1.0
Acenaphthene	0.32	18

Contaminant	Groundwater (mg/L)	Soil (mg/Kg)
Fluoranthene	0.013	11
Naphthalene	0.24	41
PCE	0.005	0.29
1,1-DCE	0.046	0.47
Vinyl chloride	0.002	0.18
TCE	0.005	0.01
1,1,1-TCA	0.20	0.10
PCBs (all)	0.0005	1
Lead (total)	0.0056	400
Cadmium (total)	0.005	38
TPH-residual fuels	5,000	5,000
TPH-middle distillates	5,000	5,000
TPH-gasoline	2,000	2,000

Source: State of Hawaii "Technical Guidance Manual For Underground Storage Tank Closure and Release Response," March 2000 (Drinking Water Source Threatened), p. 5-29.

3.5 SPILL RESPONSE SUPPLIES

(g) 3.5.1 Response Kit for Minor Spills

Each activity responsible for management of oil or hazardous material will maintain a spill response kit compatible with the material stored for containing and cleaning-up minor spills and for controlling major spills until the IRT can respond. The contents of the kit should be tailored to the needs of each activity (i.e., appropriate for the amount of oil, fuel or hazardous substances stored at the activity and the proximity of surface water or drains). It is recommended that a basic kit include the following:

- A supply of granular absorbent that will absorb both oil-based and water-based liquids, including oils, solvents, caustics, and acids. The granular absorbent can also be used for over packing leaking drums or other containers.

- Absorbent pillows/pads and booms

- Straight edge, non-sparking shovels (fabricated with non-ferrous metal, with a polypropylene coating on the blade, or fully fabricated from polypropylene).

- At least two empty DOT approved open-head overpack/salvage drums.

- Open head DOT approved containers of assorted sizes for packaging spill residues (such as 10 gallons and 55-gallons).

- Grounding equipment for transfer of flammable materials.

- Brooms and non-sparking dustpans.
- Polyethylene bags with ties.
- Rubber gloves, rubber aprons, rubber boots (or clothing recommended by the Safety Officer).
- Goggles.
- Absorbent rags or paper towels.

Items in the spill kit should be stored together in a well-marked and accessible location. Typically, spill response materials are stored in yellow over pack drums and are readily accessible and identifiable by facility personnel. The unit ECO or alternate person at each activity/organization shall maintain the kit, replenishing supplies as needed. The location of the kit should be posted with the list of emergency contacts.

It is not necessary to purchase commercially available spill kits, which are costly and do not contain all the supplies necessary. Nor is it necessary to purchase specialized protective clothing (such as Tyvek suits), unless it is specifically recommended by the Installation Safety Officer; the protective clothing that is normally used in the workplace when handling hazardous substances should be sufficient for response to minor spills.

Personnel shall be trained in the use of the equipment and supplies contained in the kit.

(h)

(i) 3.5.2 IRT Spill Supplies

The DPW Environmental and the DPW Unit will maintain a supply of absorbent materials and spill clean up equipment to supplement the spill kits to be maintained by individual organizations. A back-up supply should include those items suggested above for the minor spill kits. DPW Environmental supplies are stored at Building 6054, Schofield Barracks East Range, and DPW Unit supplies will be maintained at the DPW maintenance and TAP facilities. IRT support units will provide an inventory of spill recovery material to DPW Environmental annually by October 1 of each year. The list will detail type and quantity of material on hand.

APPENDIX O. PESTICIDE INVENTORIES

PC- SB.

Pesticide list MC2 for SB05.xls

Product name	EPA Registration Number	% Active Ingredient	Chemical name	Formulation	Pesticide Classification	lbs/gal lbs/lbs lbs/ea	unit	Shop Stock
Amdro Fire Ant Bait	73342-1	0.730%	Hydramethylnon	Bait - Granule	Insecticide	0.0073	lb	45X50LB
CB-80 Extra	9444-175	4.500%	Pyrethrins - 0.5% Piperonyl Butoxide - 4.0%	Aerosol	Insecticide	0.045	lb	4CNS
Demand CS **(discontinued)**	10182-361	9.700%	Lambda-cyhalothrin	Micro-encapsulated	Insecticide	0.838	gal	
Demon TC	100-1006	25.300%	Cypermethrin	Emulsifiable Concentrate	Insecticide	2	gal	1 GLS
Gentrol IGR Concentrate **(discontinued)**	2724-351-50809	9.000%	Hydroprene	Liquid	Insect Growth Regulator			12 BTLX
Invader HPX	9444-186	1.000%	Baygon	Aerosol	Insecticide	0.01	lb	52CNS
Maxforce FC Roach Bait Station	64248-11	0.050%	Fipronil	Bait Station	Insecticide		ea	
Maxforce FC Roach Bait Station	64248-12	0.030%	Fipronil	Bait Station	Insecticide		ea	
Oust	352-601	75.000%	Sulfometuron methyl	Water Dispersible Granules	Herbicide	0.75	lb	3X2LB
Roundup Pro	524-475	41.000%	Glyphosate	Liquid	Herbicide	4	gal	30 GLS
Terro Ant Killer II	149-8	5.400%	Borax	Liquid Bait	Insecticide	0.054	lb	52 PINTS
ULD-BP-300	499-450	19.000%	Pyrethrins -3% Piperonyl Butoxide - 6% N-Octyl bicycloheptene dicarboximide - 10%	Liquid	Insecticide		gal	8 GLS
Ultracide	499-404	0.985%	Pyriproxyfen - 0.1% Pyrethrins -0.05% N-Octyl bicycloheptene dicarboximide - 0.4% Permethrin - 0.4% Related compounds - 0.035%	Aerosol	Insecticide	0.00985	lb	12X20
PT Wasp Freeze	499-362	0.249%	Allethrin - 0.129% Phenothrin - 0.12%	Aerosol	Insecticide	0.00249	lb	52CNS
~~Contrac Super Size Blox~~	~~12455-82~~	0.005%	Bromadiolone	Bait	Rodenticide	0.00005	lb	8X11LBS
4 The Birds II	1621-17-56	97.000%	Polybutene	Gel	Bird Repellent	0.8	lb	31 TUBES

CLORITE- DEODORIZER 7 1/2 GALS

D-FORCE- 0.006 8 BX-X-8 CNS 14 OZ

BRIMSTONE 200 BTU.— 50 LBS

HANDI TOAM 3 CLS- 14 OZES

Sept. 2007

FORT SHAFTER PEST CONTROL SHOP INVENTORY

INSECTICIDES/BAITS

NAME/FORMULATION	UNIT	QUANTITY	ISSUED	Total Used	Total Rec'd	End Inventory
Max Force Fine Grn, Insect bait	10 oz./btl	bottles				1
Max Force Ant Bait Stations	24/bag	bags				5
Terro-Ant Killer	2 oz/btl	bottles				4
Max Force Roach Bait Station Lg	48/bag	bags				Ø
Max Force Roah Bait Station Sm	72/bag	bags				2
Dead Line MP's	50 lb. Bag	bags				3
Tempo Utra SC	8 oz/btl	bottles				3
ULD-BP-100	1gal/jug	jugs				1
Ultracide	20 oz/cn	cans				30
CB-80	17 oz/cn	cans				5
Invader HPX	14 oz/can	cans				1
Wasp A Foam	17.5 oz/can	cans				10
Wasp Freeze-PT-515	17.5 oz/can	cans				30
Ficam W	1 lb/pail	pails				3
Delta Dust	16 oz/btl	bottles				1
Permanone 10-EC	2.5 gal/jug	jugs				1
B.T.I. Brisquetts	20 /pkg	pkgs				5
Talstar G	25 lb/bag	bags				1
Merit 75- UP	2 oz/btl	bottles				1
Bird Shield	2.25 gal/jug	jugs				2

FORT SHAFTER PEST CONTROL SHOP INVENTORY

TERMICIDES

NAME/FORMULATION	UNIT	QUANTITY	ISSUED	Total Used	Total Rec'd.	End Inventory
Demon T.C.	1 gal/jug	jugs				3
Dragnet	1.25 gal/jug	jugs				Ø

RODENCIDES

NAME/FORMULATION	UNIT	QUANTITY	ISSUED	Total Used	Total Rec'd.	End Inventory
Contrac	1 oz/blox	blox				3
Contrac	8 oz/blox	box				1
Fastrac	15 g./each	each				Ø

TRAPS/STATIONS

NAME/FORMULATION	UNIT	QUANTITY	ISSUED	Total Used	Total Rec'd.	End Inventory
Protecta LP Bait Station	1 ea.	each				
Victor Snap Trap-Rats	1 ea.	each				
Victor-Snap Traps-Mice	1 ea.	each				
Stick-Em Glue Trap-Rat	48/box	box				
Stick-Em Glue Trap-Mice	96/box	box				
Trapper rat traps	1 ea.	each				
Trapper mice traps	1 ea.	each				
Trapper glue traps	1 ea.	each				

HERBICIDES/FERTILIZERS

FORT SHAFTER PEST CONTROL SHOP INVENTORY

NAME/FORMULATION	UNIT	QUANTITY	ISSUED	Total Used	Total Rec'd.	
Excel 90-NF	1 gal./jug	jugs				1
Round-Up Pro	2.5 gal/jug	jugs				
OUST	3 lb/container	container				1
Sunburst	2 gal/jug	jugs				
Dithane	12 lb/bag	bags				1½
Finale	2.5 gal/jug	jugs				
AQUA Master	2.5 gal/jug	jugs				3
Sedgehammer	1.3 oz/btl	btl.				1
	DEODORIZER/DISINFECTANTS					
NAME/FORMULATION	UNIT	QUANTITY	ISSUED	Total Used	Total Rec'd.	End Inventory
TISAN	2.5 gal/jug	jugs				4
Superior	1 pt/bottle	bottles				
Nokomis	1 gal/jug	jugs				2
	MISCELLANEOUS					
NAME/FORMULATION	UNIT	QUANTITY	ISSUED	Total Used	Total Rec'd.	End Inventory
Bird Repellent	10.5 oz/tube	tubes				
Denatured Alcohol	1 gal/jug	jugs				8
Gasoline	gallon	gallon				
Stick-A-Fly	each	each				0
	CLEANERS					

FORT SHAFTER PEST CONTROL SHOP INVENTORY

NAME/FORMULATION	UNIT	QUANTITY	ISSUED	Total Used	Total Rec'd.	End Inventory
Scrubs	pail	pails				0
Clean-em's	pail	cans				
Stainless Steal Polish	16 oz/cans	cans				7
Meter mist	10 oz/cans	bottles				0
Zep Drain aid	32 oz/btl	bottles				
Zepaseptic	1 gal/jug	jugs				1
Head to toe	1 gal/jug	jugs				1

PESTICIDE INVENTORY

NIAGARSKI GOLF COURSE BLDG. NO. 725 FS MAINTENANCE SUPPLIES INVENTORY

PRODUCT NAME / FORMULATION MANUFACTURER	2006 INVENTORY DATE / QUANTITY (TOTAL				2007 GAL., ETC.)			
	3/31	6/30	9/30	12/31	3/31	6/30	9/30	12/31
IMAGE (11.43oz)					1	1		
TRIMEC PLUS (1qt)					3	8		
CONFRONT (1gal)					1/2			
SENCOR 75 (5lb)					2/3	2		
DIMENSION (2.5gal)					1 1/4			
SURFLAN A.S.					1 1/4			
PENDULUM (2.5gal)					1	12		
MSMA (2.5gal)					1	12		
ROUNDUP PRO DRY 1.156lbs					1	1		
Surfactant DELUX					1	1		
Surfactant SYI'C 16oz					4	4		
Surfactant SPEED (PRECISION) 1gal					1	1		
Surfactant EXCEL 90 NF 1gal					1	1		
AMDRO 4.5lbs					1	1		
Surfactant TIRF MARK 2.5gal					1	3		
Surfactant FOMALOT					1 1/2	2		
PRIMO MAXX (Surfactant)					1/2	1		

PESTICIDE INVENTORY

NAGORSKI GOLF COURSE BLDG. NO. 725 FS MAINTENANCE SUPPLIES INVENTORY

PRODUCT NAME / FORMULATION MANUFACTURER	2006 INVENTORY DATE / QUANTITY (TOTAL GAL., ETC.)				2007			
	3/31	6/30	9/30	12/31	3/31	6/30	9/30	12/31
Fertilizer TURF SCIENCE 12-0-0					1	3		
Fertilizer THATCH LESS					2	2		
Fertilizer CPR					2	2		
Fertilizer RESPONDO 3					2	2		
QUALI-PRO Chlorothalonil					2			
Fertilizer P.K. Plus					1			
[illegible]					4	4		
[illegible] 2.5 gal					2	2		
SEDGE HAMMER 1.1/3 oz					4	4		
ILLOVAN					1	1		

PESTICIDE 1 TORY
Hawaii area instl.

HERBICIDE

QUARTERLY PESTICIDE INVENTORY

PRODUCT NAME / FORMULATION MANUFACTURER ACTIVE INGREDIENT	CONT. SIZE	EPA REGIS. NUMBER	PERCENT ACTIVE INGRED.	20 00 INVENTORY DATE / QUANTITY (TOTAL LBS., GAL., ETC.)				20 07			
				3/31	6/30	9/30	12/31	3/31	6/30	9/30	12/31
ASULOX	2.5 GAL	264-447	36.2%	1 GAL	1 GAL	1 GAL	1 GAL	1 GAL	1 GAL		
BARRICADE 65WS	5 lb	55947-143	65%	3 lb	3 lb	3 lb	3 lb	3 lb	3 lb		
BLADE	2 oz	74477-1-2217	60%	4 oz	-0-	2.5 oz	1.75 oz	6 oz	1 oz		
CONFRONT	1 GAL	62719-92	45.1%	32 oz	32 oz	-0-	-0-	-0-	-0-		
DIMENSION ULTRA 40WP	8 oz WSP	62719-445	40%	40 oz	80 oz	125 oz	95 oz	55 oz	15 oz		
DIMEX 4L	2.5 GAL	1812-257	40%	32 oz	-0-	-0-	-0-	-0-	-0-		
FINALE	2.5 GAL	432-1229	11.33%	2.5 GAL	1.5 GAL	1.5 GAL	.5 GAL	.5 GAL	.5 GAL		
FUSILADE	1 GAL	34704-MS-1	13%	40 oz	40 oz	40 oz	40 oz	40 oz	40 oz		
GLYMAX 70DG	11.43 oz	241-319	70%	22.86	22.86 oz	22.86 oz	22.86 oz	34.29 oz	-0-		
KEEP	3 lb	707-159	51%	3 lb	3 lb	3 lb	3 lb	3 lb	3 lb.		
MANAGE	1 1/3 oz	524-465	75%	2 oz	1 2/3 oz	1 1/3 oz	1 oz	1 oz	1 oz		
MONUMENT	25 oz.	100-1134	75%	55 oz.	55 oz.	10 oz.	10 oz	10 oz	10 oz		
MSMA 6 PLUS	2.5 GAL	12713-42	47.6%	5 GAL	3 GAL	-0-	6 GAL	12 GAL	11.5 GAL		
PRIMO MAXX	1 GAL	100-937	11.3%	80 oz	64 oz	1 GAL	.5 GAL	2 GAL	48 oz		
REVOLVER	1 Qt	432-1266	2.34%	64 oz	64 oz	-0-	96 oz	-0-	-0-		
ROUNDUP PRO	2.5 GAL	524-475	41%	-0-	4.5 GAL	3 GAL	3.5 GAL	.5 GAL	160 oz		
ROUNDUP PRO DRY	23.25 lbs.	524-505	71.4%	7.5 lb	-0-	-0-	-0-	-0-	-0-		
SENCOR	5 lb	3125-326	75%	7.5 lb	5 lb	8 lb	7 lb	13 lb	8 lb		

PESTICIDE 1 TORY
Hawaii area instl.

HERBICIDE

QUARTERLY PESTICIDE INVENTORY

PRODUCT NAME / FORMULATION MANUFACTURER ACTIVE INGREDIENT	CONT. SIZE	EPA REGIS. NUMBER	PERCENT ACTIVE INGRED.	2006 INVENTORY DATE / QUANTITY (TOTAL LBS., GAL., ETC.)				2007			
				3/31	6/30	9/30	12/31	3/31	6/30	9/30	12/31
SNAPSHOT 2.5 TG	50 lb	62719-175	2.5%	30 lbs	30 lbs	30 lb	30 lbs	30 lb	30 lb		
SPEEDZONE	1 Qt	2217-835	14.36%	32 oz	32 oz	-0-	-0-	-0-	-0-		
TRANXIT GTA	3 oz	1812-449	25%	3 oz	3 oz	3 oz	-0-	-0-	-0-		
TRIMEC PLUS	1 Qt	2217-709	28.2%	21 Qts	18 Qts	14.5 Qts	11.5 Qts	4 GAL	7 Qts		
RONSTAR 50 WSP	1 lb WSP	432-893	50%	-0-	-0-	-0-	8 x 1 lb WSP	10 lbs	10 lbs		
CERTAINTY	1.25 oz	524-534	75%	-0-	-0-	-0-	-0-	3.75 oz	3.75 oz		
ARSENAL	1 Qt	241-346	28.7%	-0-	-0-	-0-	-0-	16 oz	16 oz		

PESTICIDE 1 TORY
Hawaii area instl.

FUNGICIDE

QUARTERLY PESTICIDE INVENTORY

PRODUCT NAME / FORMULATION MANUFACTURER ACTIVE INGREDIENT	CONT. SIZE	EPA REGIS. NUMBER	PERCENT ACTIVE INGRED.	INVENTORY DATE / QUANTITY (TOTAL LBS., GAL., ETC.) 20 06				20 07			
				3/31	6/30	9/30	12/31	3/31	6/30	9/30	12/31
CHIPCO 26GT	2.5 GAL	432-888	23.3%	10 GAL	5 GAL	5 GAL	5 GAL	5 GAL	5 GAL		
DACONIL ULTREX	5 lb	50534-200-100	82.5%	40 lbs	-0-	-0-	40 lb	40 lb	40 lb		
FORE	4 lb	707-87	80%	16 lbs	16 lbs	16 lbs	16 lbs	0	0		
FORE POWP	5 lb WSP	62719-388	80%	30 lbs	-0-	-0-	0	6 lbs			
HERITAGE	1 lb	100-1093	50%	3 lbs	-0-	-0-	0	0	0		
INSIGNIA	2.4 lb	7969-184	20%	0	7.2 lbs	-0-	0	0	0		
PROSTAR 70WP	1 lb WSP	432-1223	70%	0	-0-	-0-	0	0	0		
SUBDUE MAXX	1 QT	100-796	22%	64 oz	-0-	-0-	96 oz	96 oz	54 lbs		
CHLOROTHALONIL DF	5 lbs	72167-25-73220	82.5%	0	0	0	0	35 lbs	35 lbs		

PESTICIDE 1 TORY
Hawaii area instl.

INSECTICIDE

QUARTERLY PESTICIDE INVENTORY

PRODUCT NAME / FORMULATION MANUFACTURER ACTIVE INGREDIENT	CONT. SIZE	EPA REGIS. NUMBER	PERCENT ACTIVE INGRED.	INVENTORY DATE / QUANTITY (TOTAL LBS., GAL., ETC.) 20 06				20 07			
				3/31	6/30	9/30	12/31	3/31	6/30	9/30	12/31
CARBARYL 4L	2.5 GAL	34704-447	43%	3 GAL	3 GAL	3 GAL	3 GAL	3 GAL	3 GAL		
DEADLINE T.O.	50 lb	64864-38	4%	30 lb	30 lbs	30 lb	30 lb	30 lb	30 lb		
TALSTAR GC	1 GAL	279-3156	7.9%	64 oz	64 oz	64 oz	64 oz	64 oz	64 oz		
TALSTAR PL	25 lbs	279-3168	0.2%	25 lb	25 lbs	25 lb	25 lb	25 lb	25 lb		
VENDEX 50WP	1 lb	352-480	50%	1 lb	1 lb	1 lb	1 lb	1 lb	1 lb		
WASP FREEZE	17.5 oz	499-362	0.24%	7 CANS	5 CANS	6 CANS	6 CANS	3 CANS	3 CANS		

APPENDIX P. PEST MANAGEMENT PROGRAM FOR KILAUEA MILITARY CAMP

Pest control operations at Kilauea Military Camp (KMC) on the island of Hawaii requires less than 0.5 man-years. An individual pest management plan is not required under DoDI 4150.7.

Pest control operations at KMC is performed as additional duties by one Maintenance Worker and one Gardener. The workload consists of control of cockroach and other crawling pests, rodent control, and weed control.

At present, german cockroach control in the kitchen of the dining facility presents the most difficult task for the pest controller. Any pesticide use at KMC must follow the guidelines set by the National Parks Service (NPS), thus the materials available for use is limited.

Cockroach control in the dining facility kitchen shall consist of the following steps:

1. Identification of cockroach harborage areas through visual surveys and the use of sticky traps. Surveys are to be conducted monthly. Results from sticky trap surveys are forwarded to the installation entomologist.

2. Treatment of harborage areas with an appropriate boric acid based pesticide. Pesticides shall be applied according to label direction.

3. Elimination of harborage sites by:

a. removing all clutter from walls - including posters, signs, etc.

b. sealing all cracks and crevices in walls, doors, windows, etc., with an appropriate caulking material or expanding polyurethane foam.

4. Prevention of further cockroach population buildup through the use of boric acid or hydramethylnon baits. Bait stations will be replaced at least every three months to prevent empty stations from being used as harborage. If cockroach populations are high, bait stations may have to be replaced monthly.

Pest management policies and guidelines for the National Parks System are addressed in the Department of Interior NPS's Management Policies 2006, The Guide to Managing the National Park System, at http://www.nps.gov/policy/mp/policies.html#_Toc157232684 and in the NPS's Integrated Pest Management Manual at http://www.nature.nps.gov/biology/ipm/manual/ipmmanual.cfm.

APPENDIX Q. ENDANGERED/THREATENED SPECIES LIST

Table 1 Federally Listed species within the Oahu Installation Action Areas
SBMR= Schofield Barracks Military Reservation, MMR= Makua Military Reservation, SBER= Schofield Barracks East Range, KLOA= Kawailoa Training Area, KTA= Kahuku Training Area,DMR= Dillingham Military Reservation

Scientific Name	Common Name	Status	Plant or Animal	Installations
Abutilon sandwicense		E	Plant	SBMR
Achatinella apexfulva	*Pupu Kuahiwi*	E	Snail	KLOA
Achatinella bulimoides	*Pupu Kuahiwi*	E	Snail	KLOA
Achatinella byronii/ decipiens	*Pupu Kuahiwi*	E	Snail	KLOA, SBER
Achatinella curta	*Pupu Kuahiwi*	E	Snail	KTA, KLOA
Achatinella lila	*Pupu Kuahiwi*	E	Snail	KLOA
Achatinella livida	*Pupu Kuahiwi*	E	Snail	KLOA
Achatinella mustelina	*Pupu Kuahiwi*	E	Snail	MMR
Achatinella pulcherima	*Pupu Kuahiwi*	E	Snail	KLOA
Achatinella sowerbyana	*Pupu Kuahiwi*	E	Snail	KLOA, SBER, KTA
Alectryon macrococcus var. macrococcus	`Ala `alahua, mahoe	E	Plant	MMR, SBMR
Alsinidendron obovatum		E	Plant	MMR
Alsinidendron trinerve		E	Plant	SBMR
Bonamia menziesii		E	Plant	MMR
Cenchrus agrimonioides var. agrimonioides	Kamanomano	E	Plant	SBMR, MMR
Chamaesyce celastroides var. kaenana	`Akoko	E	Plant	MMR
Chamaesyce herbstii	`Akoko	E	Plant	MMR
Chamaesyce rockii	`Akoko	E	Plant	KLOA, SBER
Chasiempis sandwichensis ibidis	Oahu `Elepaio	E	Bird	MMR, SBMR,

Ctenitis squamigera	Pauoa	E	Plant	MMR, SBMR
Cyanea acuminata	Haha	E	Plant	KLOA, SBER, SBMR
Cyanea crispa	Haha	E	Plant	KLOA
Cyanea dentata	Haha	E	Plant	MMR
Cyanea grimesiana spp. obatae	Haha	E	Plant	SBMR, MMR
Cyanea humboldtiana	Haha	E	Plant	KLOA
Cyanea koolauensis	Haha	E	Plant	SBER, KTA, KLOA
Cyanea longiflora	Haha	E	Plant	MMR
Cyanea st.-johnii	Haha	E	Plant	KLOA, SBER
Cyanea superba spp. suberba	Haha	E	Plant	MMR
Cyperus trachysanthos		E	Plant	DMR
Cyrtandra dentata	Ha`iwale	E	Plant	KLOA, MMR
Cyrtandra subumbellata	Ha`iwale	E	Plant	SBER
Cyrtandra viridiflora	Ha`iwale	E	Plant	KLOA, SBER
Delissea subcordata	Haha	E	Plant	MMR, SBMR
Diellia falcata		E	Plant	MMR, SBMR
Dubautia herbstobatae	Na`ena`e	E	Plant	MMR
Eugenia koolauensis	Nioi	E	Plant	KTA
Euphorbia haeleeleana		E	Plant	MMR
Flueggea neowawraea	Mehamehame	E	Plant	MMR, SBMR
Gardenia mannii	Nanu, na`u	E	Plant	KTA, KLOA, SBER, SBMR
Hedyotis degeneri degeneri		E	Plant	MMR

Hedyotis parvula		E	Plant	MMR
Hesperomannia arborescens		E	Plant	KLOA, SBER, SBMR
Hesperomannia arbuscula		E	Plant	MMR
Hibiscus brackenridgei spp. *mokuleianus*	Ma`o hau hele	E	Plant	DMR, MMR
Isodendrion longifolium	Aupaka	E	Plant	SBMR, SBER
Labordia cyrtandrae	Kamakahala	E	Plant	SBMR
Lasiurus cinereus semotus	`Ope`ape`a	E	Bat	MMR, KLOA, SBER
Lepidium arbuscula	`Anaunau	E	Plant	MMR, SBMR
Lipochaeta tenuifolia	Nehe	E	Plant	MMR
Lobelia gaudichaudii spp. *koolauensis*	Haha	E	Plant	SBER
Lobelia niihauensis	Haha	E	Plant	MMR, SBMR
Lobelia oahuensis	Haha	E	Plant	KLOA, MMR, SBER, SBMR
Melicope lydgatei	Alani	E	Plant	KLOA
Myrsine juddii	Kolea	E	Plant	KLOA
Neraudia angulata	Ma`aloa	E	Plant	MMR, SBMR
Nototrichium humile	Kulu`l	E	Plant	MMR
Phlegmariarus nutans		E	Plant	KLOA, SBER
Phyllostegia hirsuta		E	Plant	KLOA, SBER, SBMR
Phyllostegia kaalaensis		E	Plant	SBMR, MMR
Phyllostegia mollis		E	Plant	SBMR
Phyllostegia parviflora		E	Plant	KLOA
Plantago princeps princeps	Ale	E	Plant	SBMR, MMR

Pritchardia kaalae	Loulu	E	Plant	MMR, SBMR
Pteris lidgatei		E	Plant	KLOA, SBER
Sanicula mariversa		E	Plant	MMR
Sanicula purpurea		E	Plant	KLOA, SBER
Schiedea hookeri		E	Plant	MMR, SBMR
Schiedea kaalae		E	Plant	MMR, SBMR
Schiedea kealiae		E	Plant	DMR
Schiedea nuttallii var. nuttallii		E	Plant	MMR, SBMR
Silene lanceolata		E	Plant	MMR
Spermolepis hawaiiensis		E	Plant	MMR
Stenogyne kanehoena		E	Plant	SBMR
Tetramolopium filiforme		E	Plant	MMR
Tetraplasandra gymnocarpa	`Ohe`ohe	E	Plant	KLOA,KTA, SBER
Urera kaalae	Opuhe	E	Plant	SBMR
Viola chamissoniana spp. chamissoniana	Pamakani	E	Plant	MMR, SBMR
Viola oahuensis		E	Plant	KLOA, SBER

Table 2. Federally listed species within the PTA action area.

Scientific Name	Common Name	Status	Plant or Animal
Asplenium fragile var. *insulare* [a.k.a. *Asplenium rhomboideum*]	fragile fern	E	Plant
Haplostachys haplostachya	honohono,	E	Plant
Hedyotis coriacea	kio`ele	E	Plant
Isodendrion hosakae	Aupaka	E	Plant
Lipochaeta venosa	Nehe	E	Plant
Neraudia ovata	ma`aloa,	E	Plant
Portulaca sclerocarpa	`ihi	E	Plant
Silene hawaiiensis	Hawaiian catchfly	T	Plant
Silene lanceolata	lanceleaf catchfly	E	Plant
Solanum incompletum	popolu	E	Plant
Spermolepis hawaiiensis	Hawaiian parsley	E	Plant
Stenogyne angustifolia	creeping mint	E	Plant
Tetramolopium arenarium var. *arenarium*	None	E	Plant
Vigna o-wahuensis	Cowpea	E	Plant
Zanthoxylum hawaiiense	a`e	E	Plant
Branta sanvicensis	Nene	E	Bird
Buteo solitarius	`Io,	E	Bird
Hemignathus munroi	`Akiapola`au	E	Bird
Loxioides bailleui	Palila	E	Bird
Pterodroma phaeopygia sandwichensis	Ua`u	E	Bird
Lasiurus cinereus semotus	`ope`ape`a	E	Bat

APPENDIX R. CERTIFIED PESTICIDE APPLICATOR LIST

EXPIRATION DATE	NAME	CERT. NO.	CATEGORIES	ORGANIZATION
10/31/2007	MILARII, ANTHONY	A-168-91-1004	3,5,6,7,8	USAG-HI-DPW-FS
10/31/2008	WILEY, JESS	A-189-91-1005	3,5,6,7,8	USAG-HI-DPW-FS
2/29/2008	DUMLAO, ROBERT	NB-005-05	3,5,6,7,8	USAG-HI-DPW-SB
10/31/2008	SOUZA, DONN JAY	A-125-96-1005	3,5,6,7,8	USAG-HI-DPW-SB
10/31/2008	WHITE, BRIAN	A-128-96-1005	3,5,6,7,8	USAG-HI-DPW-SB
10/31/2008	HAMADA, GUY	NP-660-94-1005	3,5,6,7,8	USAG-HI-DPW-SB
10/31/2009	PEREIRA, VICTOR	A-015-88-1006	3,5,6,7,8	USAG-HI-DPW-SB
10/31/2008	ROBERTS-KAUKA, TOMMY	A-262-91-1005	3,5,6,7,8	USAG-HI-DPW-HI
12/8/2007	FYRBERG, SPRINGER	St. of Haw A14317	2	USAG-HI-DPW-ENV
1/2/2008	LASHA-LYNN SALVOSA	St. of Haw A14346	2	USAG-HI-DPW-ENV
4/28/2008	BURT, MATTHEW	St. of Haw A14406	2	USAG-HI-DPW-ENV
10/31/2008	KAWELO, KAPUA	A-113-96-1005	2,3,5,6,7,8	USAG-HI-DPW-ENV
10/31/2008	YAMAMOTO, ROBIN	A-130-96-1005	2,3,5,6,7,8	USAG-HI-DPW-ENV
3/8/2009	KEIR, MATT	St. of Haw A13646	2	USAG-HI-DPW-ENV
5/29/2011	MORGAN, LUCAS	St. of Haw A14909	2	USAG-HI-DPW-ENV
6/4/2011	COSTELLO, VINCENT	St.of Haw A14012	2	USAG-HI-DPW-ENV
10/13/2007	KAWAKAMI, KATHY	St.of Haw H71884	2	USAG-HI-PTA-ENV
3/1/2009	EVANS, STEVE	St.of Haw H71967	2	USAG-HI-PTA-ENV
4/18/2009	TUCKER, BRIAN	St.of Haw H71971	2	USAG-HI-PTA-ENV
3/20/2010	BRESELL, MICHAEL	St. of Haw H72037	2	USAG-HI-PTA-ENV
7/28/2010	MAHUKA, BRADDEN	St. of Haw H72054	2	USAG-HI-PTA-ENV
7/28/2010	MORALES, ROSS	St. of Haw H72055	2	USAG-HI-PTA-ENV
4/23/2011	MONTGOMERY, MARK	St.of Haw H72101D	2	USAG-HI-PTA-ENV
11/5/2011	JABOBS, JEFFERSON	St.of Haw H72098	2	USAG-HI-PTA-ENV
11/5/2011	SUDDUTH, TIANA	St.of Haw H72099	2	USAG-HI-PTA-ENV
11/5/2011	FOLEY, ERIN	St.of Haw H72100	2	USAG-HI-PTA-ENV
12/10/2011	RANDALL, JENNIFER	St.of Haw H72102	2	USAG-HI-PTA-ENV
12/10/2011	KNOX, SARAH	St.of Haw H72103	2	USAG-HI-PTA-ENV
10/31/2008	KALANI, LOUIS	A-112-96-1005	3,5,6,7	USAG-HI-DPW-SCIB
10/31/2008	CHANG, NORMAN	A-150-88-1005	3,5,6,7,8	USAG-HI-DPW-SCIB
10/31/2008	CHING, PATRICK	A-155-91-1005	3,5,6	USAG-HI-DPW-TSB
10/31/2008	UFANO, PEDRO	A-126-96-1005	3,5,6	USAG-HI-DCA
10/31/2008	TAKASHIGE, STEPHEN	A-185-91-1005	3,5,6	USAG-HI-DCA
10/31/2009	KAAI, ALFRED	A-091-94-1006	3,5,6	USAG-HI-DCA
10/31/2009	LILLIE, ROBERT	A-190-94-1006	3,5,6	USAG-HI-DCA
10/31/2009	MILLS, JIMMY K.	NB-022-98-1006	3,5,6	USAG-HI-DPTMSEC
10/31/2007	GERONIMO, CRISPULO	NB-025-02-1004	3.5.6	USAG-HI-DPTMSEC
10/31/2007	IMAOKA, GLENN T.	NB-026-02-1004	3.5.6	USAG-HI-DPTMSEC
10/31/2007	KALAI, EDWIN S.	NB-027-02-1004	3.5.6	USAG-HI-DPTMSEC

APPENDIX S. PEST CONTROL SHOPS VEHICLE AND EQUIPMENT INVENTORY

PEST CONTROL SHOPS VEHICLE AND EQUIPMENT INVENTORY

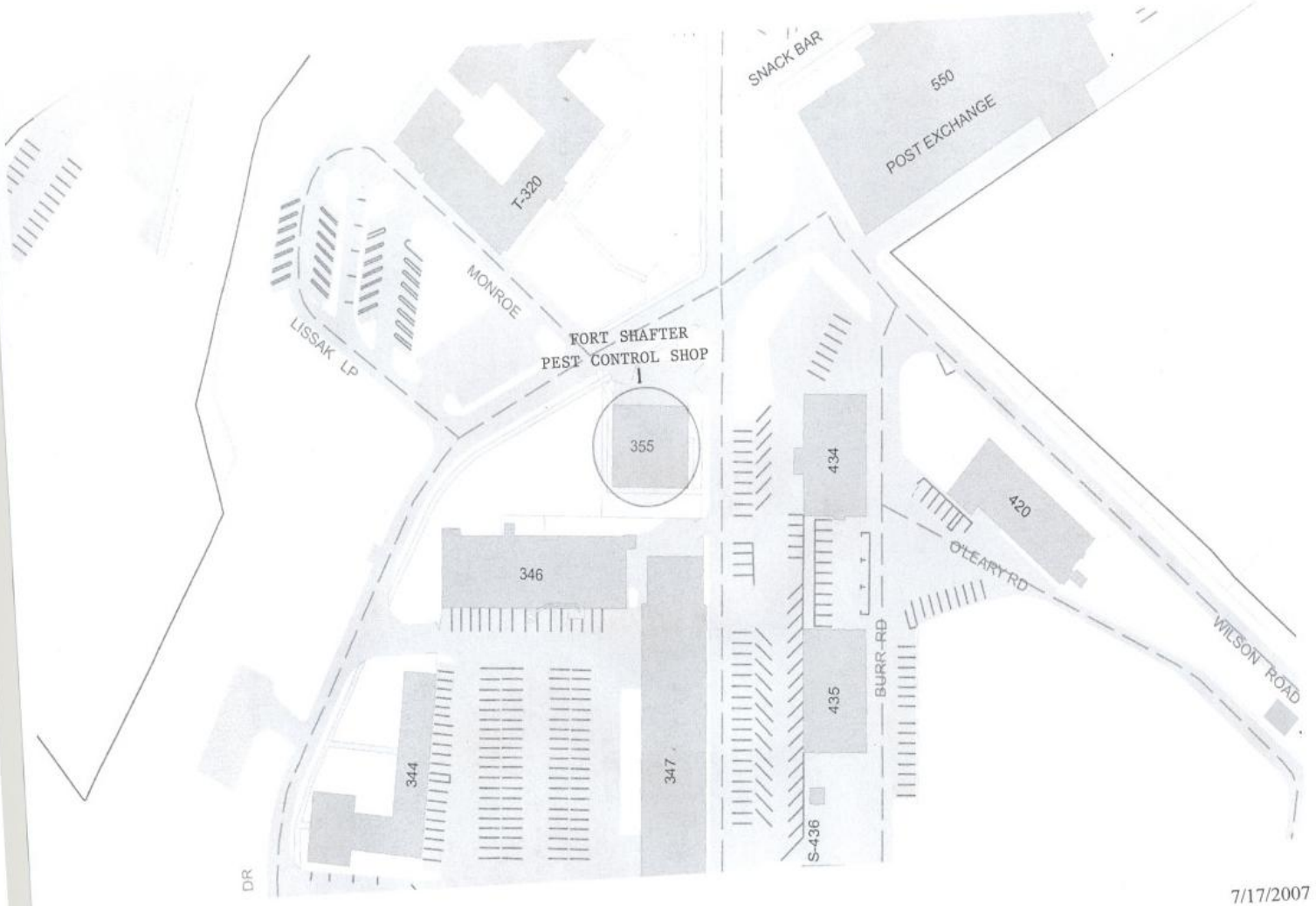
Schofield Barracks

Truck, 3/4 Ton (Dodge)	6 ea.
Truck, 4x4 Ton (Chevy)	1 ea.
ULV Fog Generator, Hand held	2 ea.
ULV Fog Generator, Hand held (Thermo)	2 ea.
ULV Fog Generator, Cart mtd	1 ea.
Sprayer, 200 gal	2 ea.
Sprayer, 100 gal	4 ea.
Sprayer, 2 gal, Hand held	2 ea.
Sprayer, 1 gal, Hand held	8 ea.
Sprayer, 2 gal, Hand held (plastic)	4 ea.
Hammer Drill, 1-1/2" (Skil Macho)	7 ea.
Drill, Hand held (cordless)	1 ea.

Fort Shafter

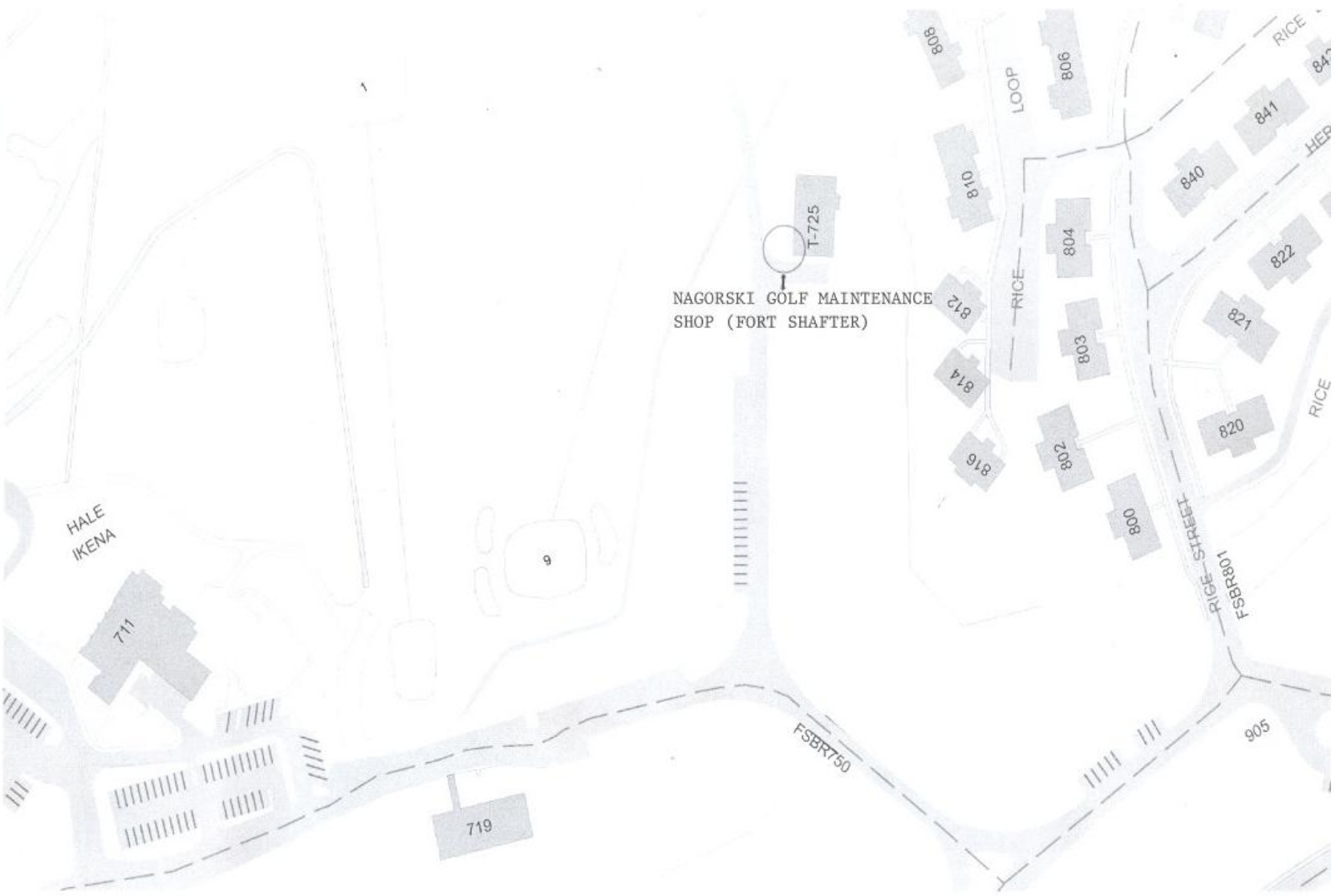
Truck, 3/4 Ton	3 ea.
ULV For Generator, Hand held	3 ea.
Sprayer, 100 gal, Skd mtd	2 ea.
Sprayer, 150 gal, Trailer mtd	1 ea.
Sprayer, 2 gal, Hand held	6 ea.
Sprayer, 1 gal, Hand held	6 ea.
Chemical Injector, Sub-slab	7 ea.
Hammer Drill, Black & Decker (Macho II)	2 ea.
Drill, Hand held	1 ea.
Ladder, 12' Extension	1 ea.
Ladder, 12' Step	1 ea.
Ladder, 8' Step	2 ea.
Ladder, 6' Step	4 ea.
Gas Mask	6 ea.
Grd Fault Circuit Breaker	2 ea.
Grinder	1 ea.
Vise	1 ea.
Flowmeter	2 ea.
Aneomometer	1 ea.

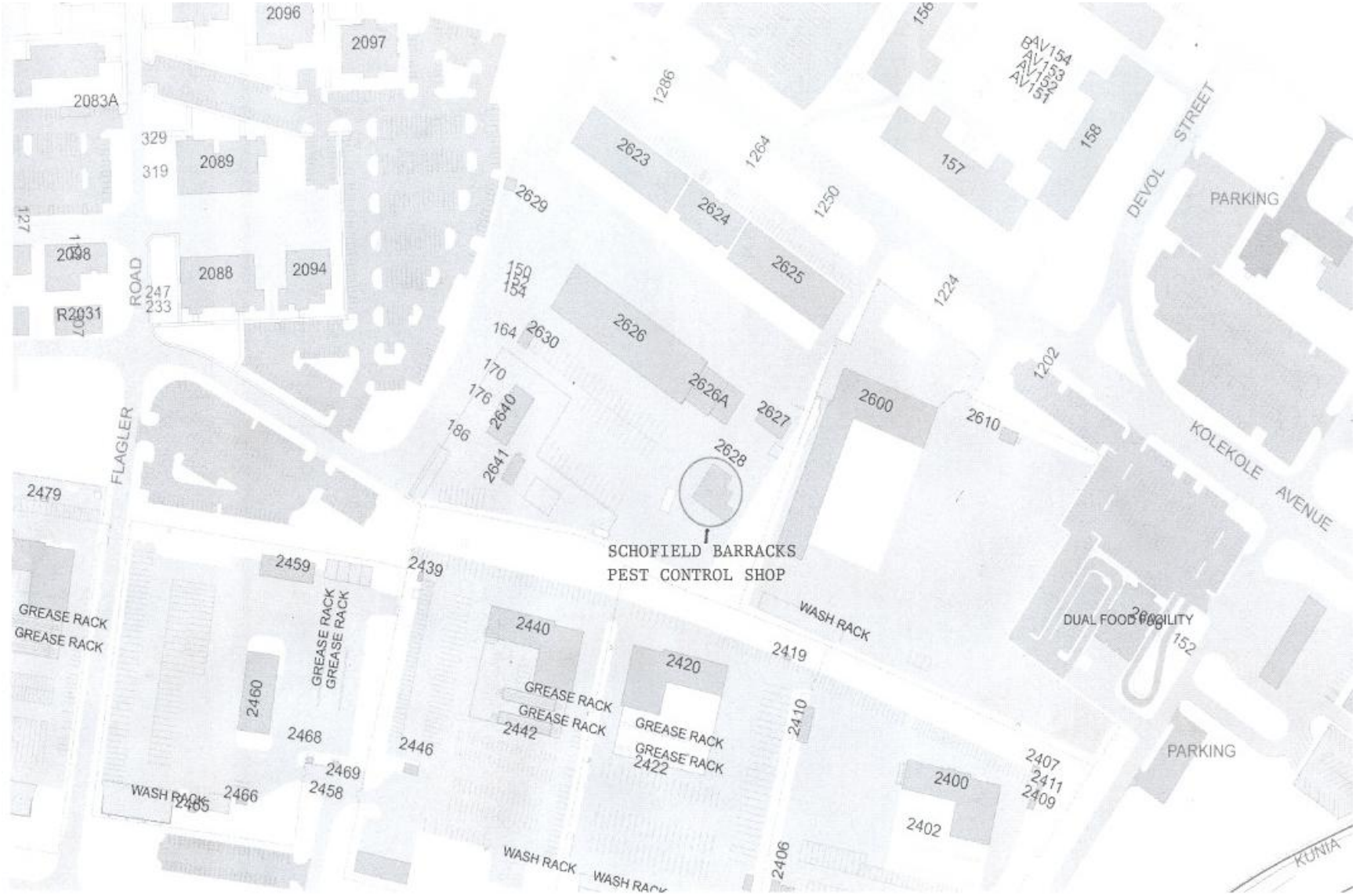
APPENDIX T. PESTICIDE STORAGE LOCATIONS

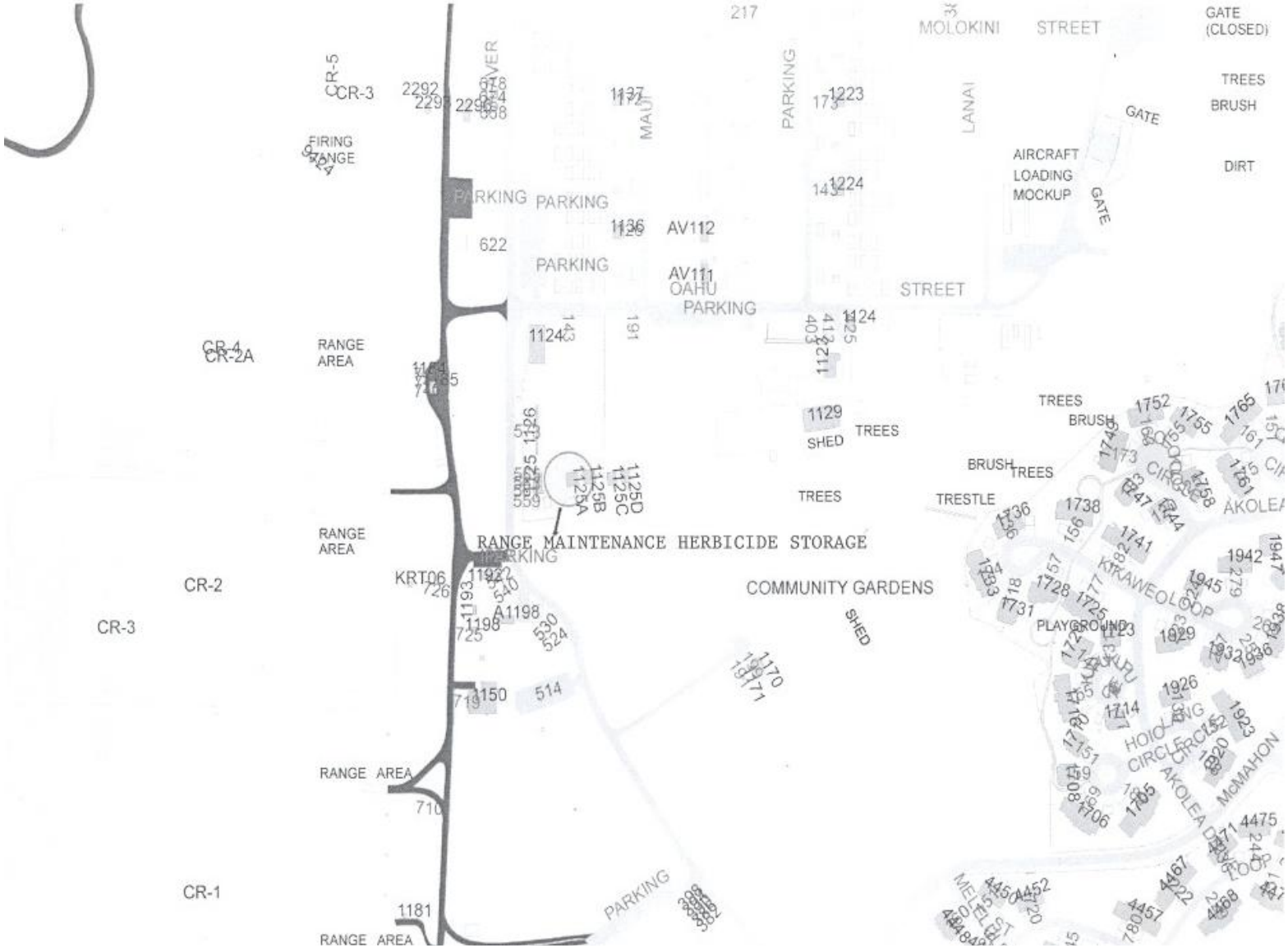


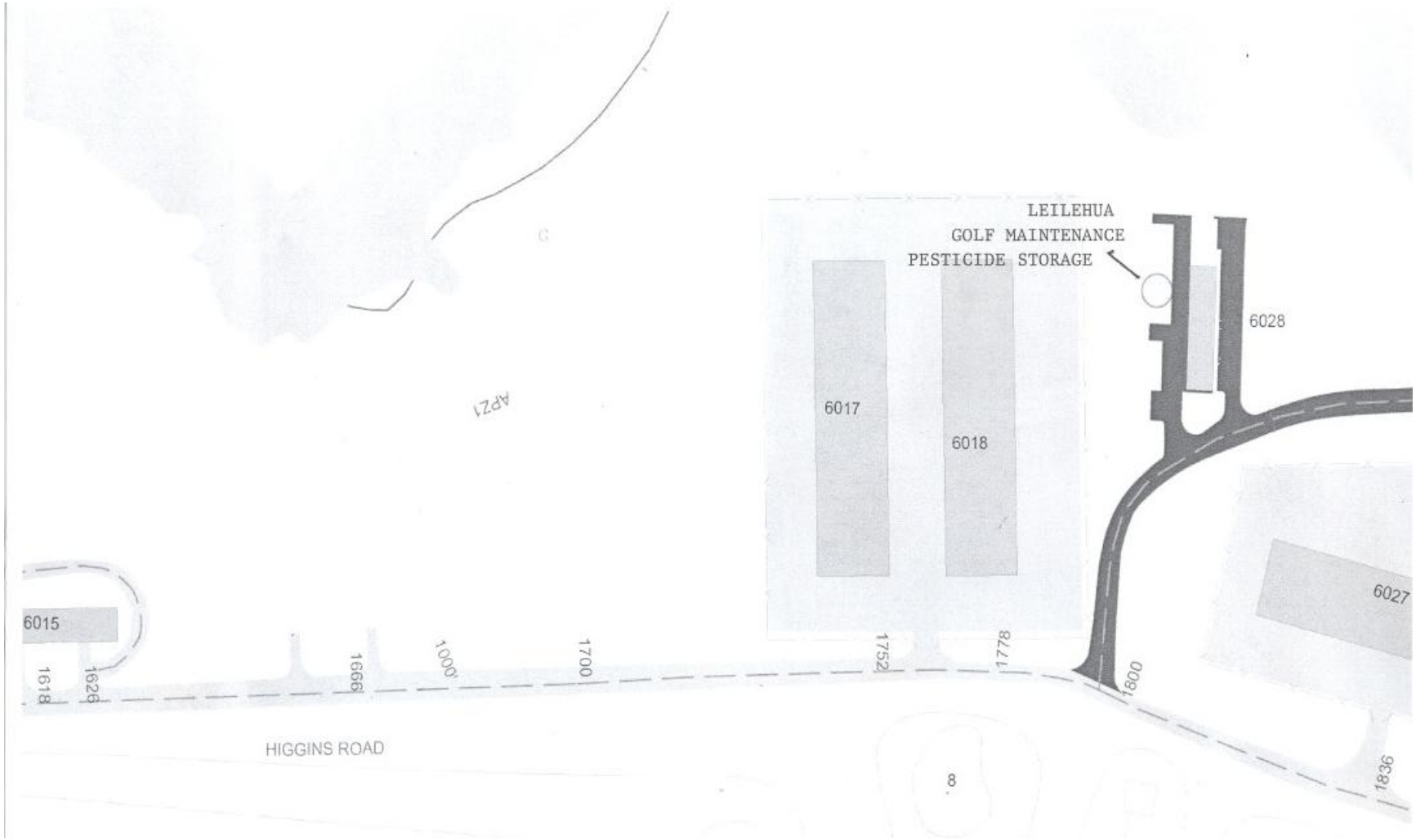
7/17/2007

https://usaghi-gis.hi.pac.army.mil/ArmyDPWWebMap/FS/system/loadmap.asp


NAGORSKI GOLF MAINTENANCE
SHOP (FORT SHAFTER)
T-725
HALE
IKENA
711
719
9
FSBR750
FSBR801
RICE STREET
RICE
LOOP
808
806
810
804
812
803
814
816
802
800
840
841
822
821
820
905


2096
2097
2083A
329
319
2089
127
2098
ROAD
2088
2094
247
233
R2031
FLAGLER
2479
1286
2623
1264
2624
1250
2625
2629
150
154
164
2630
2626
170
176
2640
186
2641
2626A
2627
2628
1224
2600
2610
1202
156
AV154
AV153
AV152
157
158
DEVOL STREET
PARKING
KOLEKOLE AVENUE
SCHOFIELD BARRACKS
PEST CONTROL SHOP
2459
2439
GREASE RACK
GREASE RACK
GREASE RACK
GREASE RACK
2440
2420
2419
WASH RACK
DUAL FOOD FACILITY
152
2460
GREASE RACK
GREASE RACK
2442
GREASE RACK
GREASE RACK
2422
2410
2468
2446
2469
2458
WASH RACK
2465
2466
2400
2407
2411
2409
2402
PARKING
WASH RACK
WASH RACK
2406
KUNIA


MOLOKINI STREET
GATE (CLOSED)
TREES
BRUSH
DIRT
GATE
AIRCRAFT LOADING MOCKUP
PARKING
LANAI
MAUI
OAHU
STREET
AV112
AV111
CR-5
CR-3
CR-4
CR-2A
CR-2
CR-1
FIRING RANGE
RANGE AREA
SHED
TRESTLE
RANGE MAINTENANCE HERBICIDE STORAGE
COMMUNITY GARDENS
PLAYGROUND
KRAWEOLOOP
HOIOLANI CIRCLE
McMAHON
AKOLEA


LEILEHUA
GOLF MAINTENANCE
PESTICIDE STORAGE
6028
6017
6018
6027
6015
1618
1626
1666
1000
1700
1752
1778
1800
1836
HIGGINS ROAD
8

APPENDIX U. FAMILY HOUSING PEST MANAGEMENT CONTRACT

Army Hawaii Family Housing

SERVICE AGREEMENT

SUBJECT:	**PEST CONTROL**
PRINCIPAL:	Army Hawaii Family Housing LLC 215 Duck Road, Bldg. 950 Schofield Barracks, Hawaii 96857
CONTACT:	Mark Crabtree, Director of Maintenance
PHONE NUMBER:	(808) 275-3189

SERVICE PROVIDER:	ECOLAB, Inc.
ADDRESS:	1600 Kapiolani Blvd, #524 Honolulu, HI 96814
CONTACT:	David Lau, District Manager
PHONE NUMBER:	(808) 325-1671
E-MAIL:	david.lau@ecolab.com

This agreement is made and entered into on the 1st day of March, 2007 by and between Army Hawaii Family Housing hereinafter referred to as "AHFH" and Ecolab, Inc., herein after referred to as "Service Provider" doing business at 1600 Kapiolani Blvd #524, Honolulu, HI 96814. Army Hawaii Family Housing and Service Provider do hereby agree as follows:

NOW, THEREFORE, in consideration of the covenants, representations and warranties contained herein and other good and valuable consideration the receipt and sufficiency of which is hereby acknowledged, the parties hereto hereby agree as follows:

1. **Scope of Services:** Service Provider agrees to perform all of the services required by AHFH for the Premises (hereafter defined in Paragraph 2) as such services are described and incorporated herein by this reference (the "Services" and the Statement of Work). Service Provider shall diligently perform the Services in a first class manner, to the satisfaction of AHFH, and in compliance with all applicable rules, regulations, ordinances, codes, laws, and court orders or hereafter in effect. Service Provider shall obtain and furnish, as appropriate, all permits applicable, standards of care, licenses, equipment, tools, materials, labor and supervision to perform the Services in a careful, workmanlike, first class and lawful manner. Service Provider shall take all appropriate precautions to protect Service Provider's and AHFH's employees, contractors, agents and representatives, and tenants of the Premises, invitees, the general public, any private or public property and the environment. AHFH, may at any time, in its sole discretion, request a change in the scope of the Services. Any such change shall only be effective if both parties execute a written amendment to this Agreement.

   Service Provider agrees to perform the services specified in exhibit "A" Statement of Work and those included in this agreement.

   All activities other than emergencies will occur between 8:00 AM and 5:00 PM. Activities other than emergencies will not be permitted outside of these hours.

   Service Provider vehicles shall be properly maintained, painted, in good working order, and in good appearance. Adequate spill kits will be available at all times for any loss of fluids. Spills are the Service Provider's responsibility to immediately clean up according to state and federal rules and guidelines.

   All Service Provider employees shall be professionally uniformed with appropriate company and personal identification.

2. **Description of the Premises:** Service Provider agrees to perform the Services for the following communities: AMR East, AMR Rim, AMR West, Canby, Ft. Shafter, Helemano (HMR), Hamilton, Kalakaua, Leader Field, Lyman, Red Hill, Santa Fe, Solomon, Tripler, and Wheeler, part of Army Hawaii Family Housing, (the "Premises").

3. **Term:** The term of this Agreement shall consist of one base year with two option years.

Base period:	March 1, 2007 through June 30, 2007
Option 1 period:	July 1, 2007 though June 30, 2008
Option 2 period:	July 1, 2008 though June 30, 2009

   This Service Agreement shall commence on 1 January 2007 and terminate on 30 June 2007, at 5:00 p.m., HST, unless earlier terminated as set forth herein. This Agreement may be terminated by either party at any time during the term of this Agreement upon the delivery to the other party of thirty (30) calendar day's written notice. Notwithstanding the foregoing, if Service Provider shall persistently fail to perform the Services in a manner satisfactory to AHFH, this Agreement may, at AHFH's option, be terminated upon AHFH's delivery to

Service Provider written notice of termination (the "Termination Notice"). Upon the exercise of the right of termination under this paragraph, Service Provider shall not be entitled to any sums or compensation in excess of those accrued as of the date specified in said Termination Notice (the "Termination Date"). AHFH may exercise the option to terminate under this paragraph at any time. If such Termination Notice results in a Termination Date prior to the end of a compensation period, then Service Provider shall only be entitled to its pro rata share of the compensation. In no event shall Service Provider be entitled to receive compensation for expenses incurred by Service Provider in excess of the compensation accruing in said thirty (30) day notice period. Upon the Termination Notice, this Agreement shall remain in full force and effect through and including the Termination Date; thereafter, all obligations of the parties shall cease under this Agreement.

4. **Compensation:** Total compensation for performing the Scope of Work for the term of this Service Agreement, shall be at the prices set forth below:

Schedule Rates:

Interior/Exterior Rodent and Pest Control Program
(Includes urgent and routine service call requirements)

AMR East	**= $ 4,725.60 per month**
AMR Rim	**= $ 3,696.00 per month**
AMR West	**= $ 3,643.20 per month**
Canby	**= $ 6,177.60 per month**
Ft Shafter	**= $ 4,989.60 per month**
Helemano	**= $ 5,649.60 per month**
Hamilton	**= $ 2,824.80 per month**
Kalakaua	**= $ 2,349.60 per month**
Leader Field	**= $ 818.40 per month**
Lyman	**= $ 2,428.80 per month**
Red Hill	**= $ 2,455.20 per month**
Santa Fe	**= $ 4,672.80 per month**
Solomon	**= $ 3,801.60 per month**

Tripler	**= $ 1,056.00 per month**
Wheeler	**= $ 6,177.60 per month**

Indefinite Quantity Work (to be ordered as necessary):

Whitmire Advance Termite Bait System:

Installation ***(Includes monitoring for 1 year from installation)***	**= $ 5.60 per linear ft**
Monitoring of existing systems	**= $ 3.70 per linear ft**
Concrete Coring for a bait station	**= $ 10.00 per unit**
Tent Fumigation: ***(Drywood Termites)***	**= $ 45.98 per unit (1,000 cubic ft)**
Ground Treatment: ***(Subterranean Termites)***	**= $ 5.52 per linear ft**
Wood Infestation Inspection:	**= $ 200.00 per unit**
Carcass Disposal/Odor Abatement:	**= $ 90.00 Each**
Flea Treatment:	**= $ 98.00 per unit**
Feral Cat Control:	**= $ 136.00 Each**

Note: Rates include Hawaii State General Excise Tax.

Payment will be made by AHFH within thirty (30) days of AHFH's receipt of an invoice for work performed during the preceding month. Service Provider shall deliver invoices to AHFH twice a month unless otherwise specified by AHFH. The invoices shall be addressed to AHFH with a detailed description of the work performed, including the date(s) of performance and service/work order number. Any additional services performed by Service Provider without the prior written consent of the AHFH Property Manager will be deemed to be basic services and Service Provider will not be entitled to any compensation for such additional services. Payment of such additional services shall not be construed as a material change to the contract as a whole.

5. **Invoicing:** Provide an invoice for work performance from the 1st day through and including the 15th day of each month and the 16th day to the last day of each month (inclusive). Service Provider shall submit its invoice within seven (7) calendar days of the period for which compensation is sought. Invoices shall be submitted as follows:

Original to:

Army Hawaii Family Housing LLC
215 Duck Road, Bldg. 950
Schofield Barracks, Hawaii 96857
Attn: Mark Crabtree, Director of Maintenance

Service Provider shall invoice AHFH twice a month for the work actually performed and for authorized reimbursable(s). AHFH shall provide no compensation to Service Provider for preparation of invoices. The invoice shall state the completion of the Scope of Work (i.e. the number of units X rate);

AHFH shall retain the right to withhold all payments should any provision of this Subcontract not be completed in a satisfactory manner or in accordance with the schedule. If payment is withheld, AHFH shall notify Service Provider in writing of the reasons and what action is required before payment will be made. Service Provider shall have 30 days from the date of notification to correct the deficiencies identified by AHFH. Upon satisfactory completion of such deficiencies, AHFH shall release the previously withheld payment. Otherwise, AHFH shall make payment within 30 days of receipt of payment of AHFH's invoice for the work performed by Service Provider. Only payment for disputed services will be withheld. All undisputed amounts will be paid in accordance with this paragraph.

6. **Final invoice:** Service Provider, at the time of final payment under this contract, shall execute and deliver, at the time of and as a condition precedent to final payment under this contract, a release discharging AHFH, its officers, agents, and employees of and from all liabilities, obligations, and claims arising out of or under this subcontract. The final invoice should not be submitted until all work is complete and all reports filed, and accepted by AHFH. Final payment may be held pending resolution of any open issues or claims.

7. **Deductions:** It is understood and agreed between the parties that any reductions for unsatisfactory performance, or any other reason, taken by the Government from AHFH invoices, due to services required of Service Provider by virtue of this Subcontract, will likewise be reduced from Service Provider's invoices.

   The Service Provider shall indemnify AHFH for any cost incurred and any payments made by AHFH resulting from false claims submitted by the Service Provider under this Subcontract or as a result of a Service Provider misrepresentation of fact or fraud relating to any claim or dispute arising under or relating to this Subcontract.

8. **Waiver of Claims:** Unless a shorter time is specified elsewhere in this Subcontract at least annually and, on or before making his/her final request for payment, Service Provider shall submit to AHFH, in writing, all claims for compensation under or arising out of this Subcontract. The acceptance by Service Provider of final payment shall constitute a waiver of all claims against AHFH under or arising out of this Subcontract except those previously made in writing and identified by Service Provider as unsettled at the time of his/her final request for payment.

9. **Wage Rates:** Service Provider will comply with all applicable provisions of the Fair Labor Standards and any State or local laws and regulations government wages and hours.

10. **Licenses:** Service Provider hereby represents, warrants and covenants that it has obtained, and will obtain at all times during the term of this Agreement, all federal, state and local licenses required under all applicable rules, regulations, ordinances, codes and laws. Upon AHFH's request, Service Provider shall deliver to AHFH a true and complete copy of all licenses maintained by Service Provider. Service Provider hereby represents and warrants that its Federal taxpayer identification number is 41-0231510, and its State Tax number is W20086976-01. Service Provider will promptly notify AHFH in writing of any changes in such licenses, including, but not limited to, the status of such licenses or additional licenses. Service Provider shall ensure that all of its employees, vendors, agents and representatives also obtain and maintain the licenses required of Service Provider hereunder. Notwithstanding anything to the contrary contained herein, if at any time Service Provider fails to maintain the licenses required anything to the contrary contained herein, AHFH may immediately terminate this Agreement upon delivery to Service Provider of written notice.

11. **Indemnity and Insurance:** See Exhibit "B" incorporated herein by reference.

12. **Independent Contractor:** Service Provider shall be an independent contractor with respect to the performance of the Services hereunder, and neither Service Provider nor anyone employed or acting on behalf of Service Provider shall be deemed for any purpose to be the employee, agent, servant or representative of AHFH or Owner in the performance of any Services. Service Provider shall be solely responsible for the compensation, benefits, contributions and taxes, if any, or its employees, vendors, agents and representatives. AHFH shall have no direction or control of Service Provider or its employees, vendors, agents and representatives except in the results to be obtained. The Services shall meet the approval of AHFH and be subject to the general right of inspection by AHFH and be subject to the general rule of inspection by AHFH to secure the satisfactory completion thereof.

13. **Schedule:** At the time of Service Provider's execution of this Agreement, Service Provider shall deliver to AHFH a written schedule (the "Schedule") specifying (a) the number of days within each month services are to be performed, (b) the actual days on which all or any portion of the Services will be performed, (c) the number of personnel anticipated for the work, and (d) the individual personnel designated to be perform each portion of the work comprising the Services. The Schedule shall also include any other detailed information as required by AHFH. Service Provider shall not materially change the Schedule without first obtaining AHFH's written consent, which shall not be unreasonably withheld.

14. **Arbitration:** All claims, disputes, and other matters in question between the parties to this Agreement arising out of or relating to this Agreement or the breach thereof, which are not disposed of by mutual agreement, shall be decided by arbitration in accordance with the Arbitration Rules of the American Arbitration Association. Service Provider expressly agrees on behalf of its employees, vendors, agents and representatives to have such parties be joined in any arbitration proceedings between AHFH and/or Owner and Service Provider (if such

joining is requested. This agreement to arbitrate shall be specifically enforceable under prevailing arbitration law. Notice of demand for arbitration shall be filed in writing with the other party to this Agreement and with the American Arbitration Association. The demand shall be made within a reasonable time after the claim, dispute, or other matter in question has arisen, but in no event after the date when the institution of legal or equitable proceedings would be barred by the applicable statute of limitations. The award rendered by the arbitrators shall be final, and judgment may be entered in accordance with the applicable law in any court having jurisdiction thereof.

15. **Assignment:** Service Provider may not assign its rights and obligations hereunder without the prior written consent of AHFH. If Service Provider assigns its rights and obligations hereunder without first obtaining AHFH's written consent thereto, said assignment shall be null and void and ineffective as to AHFH. This Agreement shall be assignable to Owner or Owner's nominee, at Owner's option, upon ten days' prior written notice to Service Provider. This Agreement shall be binding upon and inure to the benefit of the successors and permitted assigns of the parties hereto.

16. **Notices:** All notices and demands shall be given in writing by personal service, certified mail, postage prepaid and return receipt requested, by Federal Express, Express Mail or any other commercial delivery service which guarantees overnight delivery (an "Overnight Service"), or by facsimile or telecopies. Notices and payments required hereunder, shall be considered given when served, when deposited in the United States mail, when deposited with an overnight Service marked for overnight delivery or when received by facsimile or telecopier. Notices shall be addressed as appears below for the respective parties, provided that if any party gives notice of a change in name or address, notices to the giver of such notice shall thereafter be given as demanded in such notice.

    Principals:
    Army Hawaii Family Housing LLC
    215 Duck Road, Bldg. 950
    Schofield Barracks, Hawaii 96857
    Attn: Mark Crabtree, Director of Maintenance

    Service Provider:
    Ecolab, Inc.
    1600 Kapiolani Blvd, #524
    Honolulu, HI 96814
    Attn: David Lau, District Manager

17. **Authority:** Service Provider hereby represents and warrants to AHFH that Service Provider, and the person signing this Agreement on behalf of Service Provider, has the full right and authority to enter into this Agreement, to consummate the transactions contemplated herein, that no other persons are required to sign this Agreement to effectuate the provisions of the Agreement and that this Agreement is valid, binding and enforceable.

18. **Standard Provisions:**

A. This Agreement is made in the State of Hawaii and its validity, construction, and all rights under it shall be governed by the laws of the State of Hawaii.

B. This Agreement supersedes any prior agreements and contains the entire agreement of the parties on the matters covered. No other agreement, statement or promise made by any party or agent of any party that is not in writing and signed by all the parties to this Agreement shall be binding. Any amendments to this Agreement shall be in writing and signed by all parties hereto. If any inconsistency exists between this Agreement and any change order or purchase order for additional work, the term and conditions of this Agreement shall prevail.

C. The provisions of this Agreement were negotiated by all the parties hereto and this Agreement shall be deemed to have been drafted by all the parties hereto.

D. The paragraph headings throughout this Agreement are for convenience and reference only and the words contained herein shall not be held to expand, modify, simplify, or aid in the interpretation, construction, or meaning of this Agreement.

E. Time is of the essence of this Agreement.

F. If any provision of this Agreement or the application thereof to any person or in any circumstance shall be invalid or unenforceable to any extent, the remainder of this Agreement and the application of such provision to other persons or in other circumstances shall not be affected thereby and shall be enforced to the greatest extent permitted by law.

G. If either party institutes an action to enforce its rights under this Agreement, the losing party shall pay to the prevailing party the attorneys' fees and costs incurred by the prevailing party in such action.

H. Nothing in this Agreement shall be construed to waive, limit or otherwise alter the rights or remedies available to any party, in law or equity, absent this Agreement.

I. This Agreement may be executed in counterparts, each of which shall be deemed to be an original, but such counterparts when taken together shall constitute but one agreement.

ATTACHMENTS: Exhibit A - The Statement of Work
Exhibit B - Insurance Addendum

19. <u>Acceptance</u>: This AGREEMENT and its EXHIBITS constitute the entire understanding of the parties and supersedes any prior proposals, understandings or agreements.

Army Hawaii Family Housing, its affiliates, subsidiaries, agents, and employees, (collectively "Army Hawaii Family Housing") is solely responsible for payment of all

amounts due you under this Agreement. This notice includes and extends to both written as well as verbal contracts and/or orders given by AHFH on behalf of Army Hawaii Family Housing. By your execution of this Agreement you acknowledge the foregoing disclaimer of liability and agree to look only to Army Hawaii Family Housing for any payment under this Agreement.

Dated: 13 Feb, 07

Jerry Schmitz, Asset Manager
Army Hawaii Family Housing LLC

Dated: FEBRUARY 5, 2007

David Lau, District Manager
Ecolab, Inc.

Army Hawaii Family Housing LLC
Statement of Work: Pest Control

DESCRIPTION OF SERVICES

The service provider shall provide all management, tools, supplies, equipment, parts and labor necessary to provide termite elimination, rodent, and pest control services at Army Hawaii Family Housing Units on the Island of Oahu, Hawaii. AHFH housing areas include locations at Aliamanu Military Reservation (AMR) East, AMR Rim, AMR West, Canby, Hamilton, Kalakaua, Leader Field, Lyman, Santa Fe, Solomon, Ft. Shafter, Helemano, Red Hill, Tripler, and Wheeler. The service provider shall use industry standards and practices in the performance of services provided.

Resident satisfaction is critical to the viability and a prerequisite of this contract.

1. **Interior/Exterior Rodent and Pest Control Program.** Service provider shall implement a comprehensive interior/exterior rodent and pest control program. The program shall provide for scheduled proactive treatments as required to optimize effectiveness and will include responding to service calls at no additional cost. Service provider shall assign a primary point of contact for each community, collaborate to identify critical areas, and prepare a service schematic for equipment placement.

   At a minimum, rodent control will consist of multi-defense methods such as frontline rodent equipment, suspended bait block in storm sewers and drains, and building of defense barriers. Equipment shall be bar coded to provide real-time on-site reporting. Service provider shall perform on-going interior and exterior inspections to determine pest presence and activity. Housing exterior 4' perimeter treatments shall be performed to treat ants, centipedes, etc.

   Service provider shall work closely with AHFH staff offering training as needed for the website reporting system, barcode processes, and other topics relative to this program. The program shall include brochures, flyers, etc. to help promote resident awareness of the preventive plan.

2. **Service Calls (SCs).** SCs will be divided into two categories of priority (e.g., urgent and routine). AHFH reserves the right to change priorities placed upon the work control documents as deemed appropriate. Service provider shall obtain occupant signature, date and time upon completion of work and annotate the following information on each SC:

   a. Date and Time the Work Started (Travel time shall not be included under manhours).
   b. Date and Time the Work Completed.
   c. Description of Work Performed and Detailed Breakdown of Materials, etc.
   d. Workman Identification/Service provider's Signature.
   e. Resident Endorsement/Signature.

Urgent. Urgent work takes priority over other calls and requires immediate action, including diversion of personnel from other jobs. This work is necessary for the protection of the health and safety of the residents. The service provider shall be notified of urgent SCs by AHFH via telephone. The service provider shall commence corrective action at the work site within two (2) hours after notification of the call and shall remain on the job until the urgent situation has been successfully neutralized, and the problem alleviated. If AHFH is unable to contact the Service provider for an urgent call, AHFH reserves the right to use AHFH employees or other commercial service providers. The service provider will be billed for all expenses incurred. The service provider shall submit the completed SC to AHFH the next business day after work completion. After normal duty business operating hours, the service provider shall provide, at his or her own expense, a telephone answering service or contact telephone number, which shall refer calls for urgent service to a designated individual.

Routine. The service provider shall respond to routine work within 1 day after receipt of an approved SC and shall complete the work within two (2) work days after response. The service provider shall submit the completed SC to AHFH no later than one (1) business day after the work has been completed. Routine calls are done Monday through Friday 8:00 am – 5:30 pm.

Service Call Response. The service provider shall respond to service requests within the times specified below:

CATEGORY	RESPONSE TIME	COMPLETION TIME
URGENT	2 Hours	Continue until complete
ROUTINE	1 day	2 days

Hours of Operation. Urgent and Routine service call work shall be accomplished in the following time periods:

CATEGORY	DAYS OF WORK	TIMES
URGENT	7 days per week*	24 hrs per day
ROUTINE	Monday through Friday**	8am- 5:00 pm

* Including Federal Holidays ** Excluding Federal Holidays

Responsible Resident Present: If the resident or responsible adult is not present to complete the service call, leave a courtesy tag on the door (with the time, date, address, and service call identified on it) informing the resident to call and reschedule the appointment. If the resident fails to contact the service provider within 24 hours, document the missed appointment and return the SC to AHFH.

3. **Whitmire Advance Termite Bait System.** The service provider shall be responsible for monitoring and maintaining the system in accordance with the manufacturer's specifications to control and eliminate the presence of subterranean termites. Submission of a monthly monitoring report shall be required. Service provider shall replace existing Sentricon Colony Elimination Systems with Whitmire Advance Termite Bait Systems at no additional cost.

4. **Tent Fumigation.** Service provider shall completely enclose the building, including any addition, lean-to, and other miscellaneous structures attached to the main structure. Fumigant shall be used in accordance with manufacturer's specifications for the control and elimination of

dry wood termites. Original copies of the Dow Fumiguide B and Y calculations and Fumiscope figures shall be submitted to AHFH upon completion.

Reoccupation. A detector reading must be made before any seals are broken. After expiration of the exposure period, seals or covers shall be removed and the structure, equipment, or property shall be ventilated to dissipate all of the fumigant. The area shall not be entered until aeration is complete. The service provider shall take appropriate readings in the most confined spaces where there is little or no ventilation. These readings shall be taken at the end of the aeration period after the tarpaulin is removed. Safe readings as listed by the applicable State standards shall be required before re-entry. The final determination of the reoccupation of the building will be made and authorized by the service provider Supervisor to AHFH. The security of the structure from the time of tenting until six (6) hours after breaking of the seals is the responsibility of the service provider, at which time the lock boxes will be removed from structure.

Warranty. The service provider shall provide a warranty on tent treatment for not less than two (2) years from the completion of work. The building shall be refumigated or spot-treated at no additional cost to AHFH.

5. **Ground Treatment.** Service shall include drilling into concrete slab within the building structure, drilling and trenching outside the building structure and residency of 1% concentration permethrin or comparable into the drilled and trenched areas. The service provider shall provide a copy of the termiticide usage report to AHFH, stating the brand name and total amount of termiticide used, and the rate of application per linear feet. The termicide shall be used in accordance with the manufacturer's specifications.

   Warranty. The service provider shall provide a warranty on ground treatment for not less than three (3) years from the completion of work. The area/building shall be retreated at no additional cost to AHFH.

6. **Wood Infestation Inspection.** The service provider shall inspect AHFH structures to identify termite infestation, wood rot, visible damage or conditions detrimental to wood structural components when requested by AHFH. All parts of the structure must be inspected. A written report shall be submitted to AHFH for each structural unit. Problem areas shall be sketched, or reported in sufficient detail to allow for follow-up chemical and/or structural correction.

7. **Miscellaneous Health Related Pests Outdoors.** The service provider is to provide control for pests such as bees, ants, wasps, centipedes, ticks mosquitoes, fleas, spiders, and other organisms as required.

8. **Carcass Disposal / Odor Abatement.** Remove all dead or dying rodents or other animals from the installation and dispose of in accordance with applicable State of Hawaii regulations. AHFH shall order such work via Service Call. In accessible areas, locate and remove the carcass and apply an effective deodorizer. Odors shall be treated with or without the discovery of cause. Follow-up deodorant applications shall be made by the service provider at no additional cost to AHFH and as directed by AHFH based on treatment failure.

9. **Feral Cat Control.** Service provider shall provide a plan to address control methods for communities affected by a high feral cat population.

10. **Miscellaneous Pest Control.** Provide standard corrective measures to pest management problems not covered under previous categories.

11. **Clean Up.** All debris caused or related to the performance of work under this contract shall be picked-up daily and properly disposed of by the Contractor. No debris shall be left at a site overnight. Clean up shall be included as part of each task performed under this contract.

12. **Disposal.** The Contractor shall properly dispose of waste, resulting from this contract at an approved disposal/recycling site off AHFH property at no additional cost to AHFH. The Contractor shall store, handle, transport, and dispose of the designate waste in accordance with all applicable Federal, State, and local laws and regulations

13. **Special Qualifications.** Employees performing services under this contract shall meet all local, state and federal licensing requirements.

14. **Employee Training.** Service provider shall provide environmental, health and safety training to employees to ensure compliance with local, state and federal laws and regulations.

15. **Safety and Health.** The service provider shall initiate and maintain programs to comply with the provisions of the Occupational Safety and Health Standards Act concerning entry requirements in confined spaces and handling potential hazardous substances.

16. **Installation Access.** Upon award, the service provider shall be responsible for providing AHFH with Installation Access Pass applications and a copy of a picture ID for each employee requiring base access for performance under this contract. Service Provider shall also identify a point of contact for badge requests. Background checks will be conducted before an access pass can be issued. Upon employee termination, Service Provider will be required to collect his or her badge and notify AHFH within 1 business day. Badges shall be returned to the attention of the AHFH Contract Manager at 215 Duck Rd., Bldg 950, Schofield Barracks, HI 96857 within 3 business days.

17. **Protection of Environmental Resources.** The service provider shall accomplish the measures necessary to avoid creating environmental pollution through its activities. For the purpose of this specification, environmental pollution is defined as the presence of chemical, physical or biological elements or agents which adversely affect human health or welfare; affect other species of importance to man; or degrade the utility of the environment for aesthetic and recreational purposes. The control of environmental pollution requires consideration of air, water, and land. The service provider shall make every effort to prevent contamination of persons, pets, private and AHFH property. All spills of pesticides used shall immediately be reported to AHFH. The spill shall be immediately cleaned up by the service provider to the satisfaction of AHFH at no additional cost.

18. **Demolition & New Construction.** AHFH housing inventory is subject to change as old neighborhoods are demolished and newly developed areas become available for occupancy. Service provider can expect to revisit monthly firm-fixed pricing to coincide with significant changes to service areas within a community.

19. **Exclusion Areas:** Ama, Bougainville, Red Hill Mauka, and Kaena. The exclusion of these neighborhoods affect services areas within AMR East, AMR West, Leader Field, and Red Hill communities.

INSURANCE REQUIREMENTS

Owner or its affiliates, at its sole expense, will implement a CIP to furnish certain insurance coverage(s) – General Liability, Worker's Compensation, Employer's Liability, and Excess Liability – for on-site activities. The CIP will be for the benefit of Owner and its affiliates, and the Enrolled Subcontractors. Such coverage applies only to work performed under the Subcontract at the Site and all Enrolled Subcontractors must provide their own insurance for "off-site activities" and during the warranty period at the policy limits. The CIP does not cover refuse operators, environmental/remediation firms, pesticide applicators, consultants, suppliers, or material dealers.

Enrollment in the CIP is not automatic. Each subcontractor, upon notice of award, must submit Enrollment Forms as outlined in the Insurance Manual, if requested to Enroll in the CIP program by the Owner or its affiliates and the insurance carrier(s). Upon acceptance, the subcontractor will receive a CIP Certificate of Insurance evidencing coverages (General Liability, Worker's Compensation, Employer's Liability and Excess Liability) provided by the CIP.

For subcontractors and sub tier subcontractors enrolled in the CIP, it is hereby agreed that the Subcontract Price does not include any amount or allowance for reimbursement for any premium for the insurance specified herein for on-site exposures, which insurance is being furnished by Owner or its affiliates. **Subcontractor certifies that, in the previously provided Insurance Credit Worksheet, the amount of premium has been excluded from the Subcontract Price.**

For Per Unit or Time & Materials contracts, subcontractors have the option of providing an insurance bid credit by completing the Per Unit or Time & Materials Alternative form, without separately reporting payrolls. This provides the Owner or its affiliates with the ability to deduct an insurance cost from each payment requisition based on the subcontractor's trade.

Subcontractor Furnished Insurance

For any work under this agreement, and until completion and final acceptance of the work , each Subcontractor (except for those coverages stated below that are provided by the CIP, if enrolled), at its own expense, must promptly furnish to Owner or its affiliates certificates of insurance for itself and any of its sub-subcontractors of any tier, from an underwriter acceptable to Owner or its affiliates (which herein is defined as any carrier having at least an A.M. Bests rating of A-:VII), providing evidence that the following coverages are in force:

a. **Automobile Liability Insurance** *(on-site and off-site)*

Comprehensive Automobile Liability insurance covering the use of all owned, non-owned, and hired vehicles used in connection with the project of not less than the following limits of coverage:

Per Person	$1,000,000
Per Occurrence	$1,000,000

Property Damage	$1,000,000 per occurrence or combined single limit of $1,000,000

Parties referenced in d.1.shall be covered as additional insured

b. **Workers' Compensation Insurance** *(Off-site Activities if enrolled in the CIP, and On-site and Off-site if not enrolled in the CIP).* As required by Federal and State Workers Compensation and occupational disease statutes.

c. **Employer's Liability Coverage.** *(Off-site Activities if enrolled in the CIP, and On-site and Off-site if not enrolled in the CIP).* Minimum limit of $1,000,000

d. **Commercial General Liability Insurance** *(Off-site Activities if enrolled in the CIP, and On-site and Off-site if not enrolled in the CIP).* Insurance for operations by the Subcontractor, or any tier of subcontractor (including products liability for any product manufactured, assembled or otherwise worked upon away from the Project Site including such manufacturing, assembly or otherwise is called for by the contract documents between the Owner or its affiliates and Subcontractor), under a form providing coverage not less than that of the Standard Commercial General Liability insurance policy form ("Occurrence Form") for operations of the party required to furnish same, including hazards of operations (including explosion, collapse and underground coverage), elevators, independent contractors, contractual liability, products and completed operations, for claims arising out of the Work hereunder for personal injury, bodily injury and property damage in policy or policies of insurance such that the per occurrence and $2,000,000 General Aggregate including Products/Completed Operations. Coverage shall also provide and encompass at least the following:

1. Endorsement naming Actus Lend Lease LLC, Army Hawaii Family Housing LLC, AHFH Managing Member LLC, AHFH Property Management LLC, Actus Lend Lease Holdings LLC, The United States of America, by the Secretary of the Army, U.S. Bank National Association, MBIA Insurance Corporation, All Star Housing Services LLC, and any of their respective successors or assigns, and any other entity as required in the Contract as Additional Insureds. ISO Form CG 2010 10 3 (or equivalent form) shall be used to provide this coverage.

2. Waver of Subrogation in favor of all Additional Insureds.

3. Policy to be primary and not excess of or contributing with any other insurance available to the Additional Insureds.

e. Where applicable, Environmental Liability coverage for Asbestos Testing/Asbestos Abatement coverage (for contracts involving the Testing/Abatement of Asbestos) or Lead paint abatement coverage (for contracts involving the Abatement of Lead) or any other Environmental subcontractor in the amount of $5,000,000. Such coverage will include as Additional Insureds those entities listed in d.1. Where applicable,

Environmental/Remediation Liability shall contain an endorsement for transporting hazardous material by auto and MSC-90 endorsement.

f. Where applicable, Professional Liability (for Professional Contracts only) errors and omissions coverage with a limit of liability of $1,000,000 per claim or per occurrence.

Certificates of Insurance

Except for Enrolled Contractors with respect to coverages maintained under the CIP for on-site activities, a Certificate of Insurance indicating coverages applicable to the Project and providing for 30 days written notice prior to cancellation, non-renewal or material modification in any policy must be submitted, approved, and available to Owner or its affiliates prior to commencement of work. The policies evidencing required insurance shall contain an endorsement to the effect that any cancellation or any material change will not occur until 30 days after the insurer gives written notice to the Owner or its affiliates. Certificates and insurer notices should be sent to the following offices:

Army Hawaii Family Housing
Attn: Contracts Manager
215 Duck Road, Bldg 950
Schofield Barracks, HI 96857

With a copy to:

Marsh USA, Inc.
Attn: CIP Administrator
200 Clarendon Street
Boston, MA 02116

Termination/Modification of the CIP for Enrolled Subcontractors only

While it is the intent of Owner or its affiliates to keep the CIP in force throughout the term of the Project, Owner or its affiliates reserves the right to terminate or modify the CIP or any portion thereof. To exercise this option, Owner or its affiliates shall provide 30 days advance written notice to each Enrolled Subcontractor, which is covered under the CIP. Enrolled Subcontractors shall immediately obtain replacement insurance coverage and the reasonable cost of such replacement insurance will be reimbursed by Owner or its affiliates at the rates indicated in the Insurance Premium Worksheet. Written evidence of such insurance shall be provided to Owner or its affiliates prior to the actual termination date of the CIP.

Cooperation for Enrolled Subcontractors only

The Subcontractor and each of its subcontractors of any tier for whom insurance is provided by the Owner or its affiliates pursuant to this Section shall:

a. Furnish to the CIP Administrator, its designees or the insurance carriers all information and documentation which the CIP Administrator may require from time to time in connection with the issuance of any policies, pursuant to this agreement, in such form and substance as the Administrator may prescribe;

b. Furnish to the CIP Administrator, its designees or the insurance carriers certified payroll and accident summary reports as required once a month on the forms provided by the CIP Administrator and any payroll records required to assist the carriers in any audits. The Subcontractor will be required under this subsection to segregate its respective reports relating to the Project from records relating to any other work which it may be performing and for which insurance is not provided by the Owner or its affiliates pursuant to this Agreement;

c. Promptly comply with the recommendations of the insurance carriers so that said insurance carriers will continue to provide the coverage to be maintained by the Owner or its affiliates pursuant to this Section at a reasonable premium.

d. The subcontractor shall assist and cooperate in every manner possible in connection with the adjustment of all claims arising out of the operations conducted under, or in connection with, the Project, and shall cooperate with the insurance carrier or carriers of the Owner and its affiliates, the subcontractors of any tier in all litigated claims and demands which arise out of said operations which the insurance carrier or carriers are called upon to adjust or resist. Any fines assessed for late claim reporting will be the responsibility of the responsible Contractor.

e. If the Subcontractor or any of its Subcontractors of any tier should fail to comply with their respective obligations under this Addendum, the Owner or its affiliates may withhold any payments due the Subcontractor until such time as the Subcontractor and it Sub-subcontractors of any tier shall have performed their obligations to the Owner or its affiliate's reasonable satisfaction.

f. The Subcontractor hereby warrants to the Owner or its affiliates the accuracy of the information provided on the CIP Insurance Information From and agrees that the Owner or its affiliates, its insurance carriers and/or the CIP Administrator may audit the records of the Subcontractor and its sub-subcontractors to confirm the accuracy of all insurance information provided, including, without limitation, any affect on insurance resulting from changes in the Work. The Subcontractor further warrants and agrees that the Owner or its affiliates is entitled to all credits in CIP insurance premiums which accrue from the audit of Subcontractor's records related to the coverage.

Insurance Provided under the CIP

The coverages provided under the CIP will apply to claims arising out of Project operations at the designated Site and operations necessary or incidental therein. **CIP Coverage is NOT provided for operations at the permanent location(s) of the Subcontractor.** The amount of

insurance coverage purchased by the Owner and its affiliates shall in no way serve as a limitation of the Enrolled Subcontractor's liability for claims in excess of such amounts.

Waiver of Subrogation

To the extent that a loss is covered by insurance in force, and recovery is made for such loss, Owner or its affiliates and Subcontractor hereby mutually release each other from liability and waive all rights of subrogation and all rights of recovery against each other for any loss insured against under their respective policies (including extended coverage), no matter how caused, it being understood that the damaged party will look solely to its insurer for reimbursement. Similarly, the Owner or its affiliates shall require Subcontractor to waive its rights of subrogation in each of their respective sub-subcontracts of any tier with respect to the work.

No Release

The carrying of the above-described insurance shall in no way be interpreted as relieving the Subcontractor of any other responsibility or liability under this agreement or any applicable law, statute, regulation or order.

Other Insurance

Any type of insurance or any increase of limits of liability not described above which a Subcontractor requires for its own protection or on account of any law or statue shall be at its own responsibility and its own expense.

Requirements for Sub tier subcontractors

Should the Subcontractor engage a lower tier subcontractor, the same conditions applicable to the Subcontractor under those Insurance Requirements shall apply to each lower tier subcontractor.

APPENDIX V. MEMORANDUM REGARDING INSTALLATION MANAGEMENT OF PEST CONTROL ACTIVITIES ON RESIDENTIAL COMMUNITIES INITIATIVE (RCI) PROPERTIES AT ARMY INSTALLATIONS

DEPARTMENT OF THE ARMY
ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT
600 ARMY PENTAGON
WASHINGTON DC 20310-0600

DAIM-ZA

OCT 0 3 2003

MEMORANDUM FOR DIRECTOR, INSTALLATION MANAGEMENT AGENCY, ATTN: SFIM-Z, 2511 JEFFERSON DAVIS HIGHWAY, ARLINGTON, VA 22202-3926

SUBJECT: Installation Management of Pest Control Activities on Residential Communities Initiative (RCI) Properties at Army Installations

1. References:

a. Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), Section 136r-1 (Encl 1)

b. Title 40, Code of Federal Regulations (CFR), Part 171, "Certification of Pesticide Applicators" (Encl 2)

c. AR 190-16, Chapter 2, Physical Security, 31 May 1991

d. Department of Defense Armed Forces Pest Management Board (AFPMB) Technical Guide (TG) No. 7, pages 7-8 para 2,9,10, Installation Pesticide Security, March 2003 (Encl 3)

2. This memorandum provides implementation guidance for installation management pest control activities on RCI properties. AR 200-5, "Pest management", does not apply. This guidance derives from FIFRA, 40 CFR part 171, and state-mandated requirements. Installation security places additional requirements, including installation oversight, for the transport of chemical pesticides onto and across installation properties.

3. Effective 1 October, 2003, Garrison Commanders have the responsibility for ensuring RCI partners meet the requirements of the pest management portion of the RCI Community Development and Management Plan (CDMP). For those plans currently in place that do not address the following minimum requirements, the installation will work cooperatively with RCI partners to ensure compliance.

a. The RCI partner will register pesticides scheduled for use with the Installation Pest Management Coordinator (IPMC) and/or the environmental office.

Printed on Recycled Paper

b. The RCI partners will provide the IPMC access to hard, or electronic copies of all pesticide labels and material safety data sheets, as well as records of pesticide usage. These records will include the date, time, specific pesticide application locations, and amount of active ingredient applied. The IPMC will also forward this data to the installation emergency response personnel.

c. The RCI Partners will ensure that vehicles and equipment are clearly identified and used for only pest management activities. The IPMC will provide information on such markings or company logos to the Provost Marshall's office. Vehicles will contain spill and decontamination kits, and the RCI partner will provide documentation of spill prevention and cleanup training to the environmental and safety offices. The installation will provide a copy of the installation Spill Prevention, Control and Countermeasure Plan to the RCI partner.

4. The US Army Staff POC is Mr. Joseph Tarnopol, (703) 614-3637, joseph.tarnopol@hqda.army.mil.

3 Encls

for J C Meis

LARRY J. LUST
Major General, GS
Assistant Chief of Staff
for Installation Management

CF:
DASA P&P, ATTN: MR. ARMBRUSTER, 3D453, 110 ARMY PENTAGON, WASHINGTON D.C. 20310-0110
LITCTR-EL-RSR, ATTN: MR. NIXON, 901 N. STEWART ST, SUITE 700, ARLINGTON, VA 22203
DIRECTOR,
DEPARTMENT OF THE ARMY, INSTALLATION MANAGEMENT AGENCY. ATTN: SFIM-OP, 2511 JEFFERSON DAVIS HIGHWAY, TAYLOR BUILDING, ARLINGTON, VA 22202-3926
DEPARTMENT OF THE ARMY, INSTALLATION MANAGEMENT AGENCY. NORTHEAST REGION, ATTN: SFIM-NE, BUILDING 5A NORTH GATE RD, FORT MONROE, VA 23651-1047
DEPARTMENT OF THE ARMY, INSTALLATION MANAGEMENT AGENCY. NORTHWEST REGION, ATTN: SFIM-NW, 1 ROCK ISLAND ARSENAL, ROCK ISLAND, IL 61299-6200
DEPARTMENT OF THE ARMY, INSTALLATION MANAGEMENT AGENCY. PACIFIC REGION, ATTN: SFIM-PA, 104 H PLACE, FORT SHAFTER, HI 96858-5520
DEPARTMENT OF THE ARMY, INSTALLATION MANAGEMENT AGENCY. SOUTHEAST REGION, ATTN: SFIM-SE, 1593 HARDEE AVE SW, BLDG 171, FORT MCPHERSON, GA 30330-1057
DEPARTMENT OF THE ARMY, INSTALLATION MANAGEMENT AGENCY. SOUTHWEST REGION, ATTN: SFIM-SW, 1204 STANLEY RD, STE 9, FORT SAM HOUSTON, TX 78234-5009
COMMANDER, U S ARMY ENVIRONMENTAL CENTER, ATTN: SFIM-AEC-CO, 179 HOADLEY ROAD, ABERDEEN PROVING GROUND, MD 21010-5401

This page intentionally left blank.

SECTION 6: Pollution Prevention / Good Housekeeping
ECBP APPENDIX

This page intentionally left blank.

ECBP APPENDIX A
Erosion Control BMPs Program Plan

This page intentionally left blank.

REQUIREMENT

In accordance with the US Army Garrison, Hawaii (USAG-HI) Municipal Separate Storm Sewer System (MS4) Permit Number HI S000090, Effective Date of Permit (EDOP) April 7, 2014, Part **D.1.f.(3)(v)**, USAG-HI is required to submit a list of projects and an implementation schedule for permanent erosion control improvements within 1 year of the EDOP.

The list of projects and an implementation schedule shall be prepared in accordance with MS4 permit# HI S000090, Erosion Control BMPs Program Plan, Part **D.1.f.(3)(i):**

The Permittee shall implement permanent erosion control improvements, ensuring that erosion-prone areas with the potential for significant water quality impact, but with limited public safety concerns, are also considered a high priority for remediation. Identification of erosion-prone areas with the potential for significant quality water quality impact shall include areas where there is evidence of rilling, gullying, and/or other evidence of significant sediment transport and areas in close proximity to receiving waters listed as impaired by either sediment, siltation and or turbidity. The Permittee shall include procedures to identify and implement erosion control projects based on water quality concerns while continuing to address high profile public safety concerns.

Correcting areas with soil erosion potential can significantly reduce impacts to water quality by eliminating nutrients, metals and other contaminates that may be attached to sediment. This document will present a prioritized list of erosion-prone areas and an estimated implementation schedule. The areas listed in this document are not related to current or scheduled construction projects. This document does not include erosion areas that are documented and addressed in the outfall or retrofit action plans.

PROCEDURES TO IDENTIFY AND CORRECT PROBLEM AREAS

Erosion prone areas are identified by Directorate of Public Works (DPW) Environmental (ENV) personnel through field survey techniques. Areas of exposed soils with little or no vegetation, signs of gullying and rilling areas are easily identifiable through visual observation during wet or dry periods. Priority areas are determined based on whether soil is mobilizing directly to the storm drain infrastructure or stream. DPW ENV staff observes storm drain inlets during rain events to determine if sediment or other potential contaminates are mobilizing into the storm drainage system. When problem areas are identified DPW ENV personnel trace the discharge to the source. When the area of concern is identified then DPW ENV submits a work request to DPW Business Operations Division (BOD) that describes the area of concern, a general description to correct the problem and justification or consequence if the work is not conducted. BOD enters the request into a tracking database and assigns it a Facilities Engineering Work Request (FEWR) number. BOD forwards the FEWR to DPW Engineering (ENG) where they investigate the area of concern and determine if the project can be executed by DPW staff or if it requires contract support. BOD then ranks the problem against all other installation issues to determine when the project will be executed. ENG will evaluate the areas based on City and County Best Management Practices handbook to determine the preferred method for stabilization. DPW intends to use an existing Rock Quarry contract and existing mulching contract to temporarily stabilize exposed areas until they can be retrofitted will permanent BMP's. This report addresses the exposed soils by

separating them into 3 general categories, Priority Areas, Un-authorized Parking and Range Road Interfaces.

PROJECTS AND IMPLEMENTATION SCHEDULE

Priority Erosion Prone Areas are determined based on whether soil is mobilizing directly to the storm drain infrastructure or stream.

Table 1. Priority Erosion Prone Areas

Site #	Base	Location	Length (ft)	Width (ft)	Implementation Schedule
1	SB	Leadership Development Course Bldg# 1700	250	50	Summer 2017
2	AMR	Near Pump Station #1	150	150	Summer 2017
3	HMR	Vegetated Detention Basin-Paalaa Uka Pupukea Road	1000	35	Summer 2017
4	TAMC	Access road to Bldg 137-Krukowski Rd (both sides)	300	15	Summer 2018

Site 1-Schofield Barracks- The leadership development course adjacent to bldg 1700 has a large area of exposed soils that drains to a storm drain in Bldg 1700 motor pool. The motor pool discharges to a tributary of the Waikele stream. The leadership development course is the only site currently identified that flows directly into the USAG-HI MS4 infrastructure.

Site 2- Aliamanu Military Reservation- An exposed area of soil near the Sewer pump station mobilizes to a large vegetated drainage canal that leads to salt lake. The area seems is used for maintenance vehicle access to the drainage canal.

Site 3-Helemano Military Reservation-A large vegetated retention basin that captures about 80% of the stormwater runoff from HMR area is showing significant rilling and gullying. The basin rarely discharges off site however the slopes should be stabilized to prevent sediment from mobilizing during large storm events.

Site 4-Tripler Army Hospital-The asphalt access road to the Central Plant bldg 137 is lined with un-stabilized area on both sides of the road. Sediment laden stormwater runoff enters an unnamed stream immediately downstream and toward Moanalua. This area will be temporarily stabilized as part of a small construction project. After the construction site is complete the area will be permanently stabilized.

Unauthorized parking has become an issue on USAG-HI properties due to limited asphalt/concrete parking areas. The areas identified in table 2 require stabilization with vegetation and roped off or converted to adequate parking areas.

Table 2. Unauthorized Parking Areas

Site #	Base	Location	Length (ft)	Width (ft)	Implementation Schedule
1	SB	Mellicamp and Trimble	100	50	Summer 2018
2	SB	Area X-Molokini and Beaver	50	30	Summer 2018
3	SB	Area X-Kauai and Maui	20	50	Summer 2018
4	SB	Area X-Beaver	40	50	Summer 2018
5	SB	Water Tank-Trimble road	100	50	Summer 2018
6	SB	Hale Kula Elementary	250	15	Summer 2018
7	SB	SB Bldg 1709-Trimble Road	250	15	Summer 2018

Range road interfaces in the training areas of Schofield Barracks are dirt roads with exposed soils. Although these interfaces are generally outside of the MS4 permit area, sediment laden stormwater does mobilize and enter open vegetated ditches. These ditches eventually tie into the storm drain infrastructure. Essentially every range road interface is a permanent 'construction' entrance and should be stabilized as such.

Table 3. Range Road Interfaces

Site #	Base	Location	Length (ft)	Width (ft)	Implementation Schedule
1	SB	Grenade Range	100	50	Summer 2019
2	SB	Skeet Range	50	40	Summer 2019
3	SB	KR-1	50	20	Summer 2019
4	SB	KR-5	50	40	Summer 2019
5	SB	Engineer Training Area	50	40	Summer 2019
6	SBER	Access Road to Range-Behind Bldg 6027 Higgins Road	250	30	Summer 2019

This page intentionally left blank.

ECBP APPENDIX B
Action Plan to Address Erosional Outfalls

This page intentionally left blank.

ACTION PLAN TO ADDRESS EROSIONAL OUTFALLS

US ARMY GARRISON, HAWAII
SEPTEMBER 2014

TABLE OF CONTENTS

Page

REQUIREMENT.....1

SELECTION OF EROSIONAL OUTFALL REPAIR SITES..... 1

SUMMARY OF EROSIONAL OUTFALL REPAIR SITES..... 2

REFERENCES..... 3

ATTACHMENT 1: EROSIONAL OUTFALL REPAIR SITE DESCRIPTIONS..... A-1

LIST OF TABLES

Number	Title	Page
Table 1	Proposed Erosional Outfall Repair Sites and Implementation Schedule	2

REQUIREMENT

In accordance with the US Army Garrison, Hawaii (USAG-HI) Municipal Separate Storm Sewer System (MS4) Permit Number HI S000090 effective April 7, 2014, Part D.1.f.(3)(iv), USAG-HI is required to developed the following Action Plan to address erosion at storm drain system outlets in their existing MS4. The MS4 Permit requirements are as follows:

> *Erosion Control BMPs Program Plan D.1.f.(3)(iv)*
> *"Provide the DOH with an Action Plan to address erosion at its storm drain system outlets with significant potential for water quality impacts to be completed within one (1) year of the effective date of this permit, which shall identify outfalls to be addressed, explanation on the basis for their selection and an implementation schedule. The implementation schedule shall cover a five (5) year period. A status report on implementation of the plan shall be included in the Annual Report. The Permittee shall install velocity dissipators or other BMPs to reduce erosion at locations identified by periodic required inspections"*

SELECTION OF EROSIONAL OUTFALL REPAIR SITES

The purpose of the Action Plan to Address Erosional Outfalls is to reduce erosion at USAG-HI's MS4 outfalls on the island of Oahu that have the significant potential for water quality impacts by implementing appropriate and cost-effective outfall repairs. Potential erosional outfall repair sites were selected through a combination of two existing reports. The first was the latest (2014) *Illicit Discharge Detection and Elimination Survey* conducted by the Environmental Health Engineering Division, Public Health Command Region-Pacific (PHCR-Pacific). In this survey, PHCR-Pacific identified potential storm water problem areas by surveying and sampling various storm water outfalls throughout USAG-HI's MS4. The second were the *Storm Water Asset Assessment* reports conducted by Colorado State University (CSU) contractors. CSU contractors assessed the conditions of all storm water related infrastructures in USAG-HI's MS4. The following criteria were used to determine the final erosional outfall repair sites and the action plan's five year implementation schedule:

1) Developed initial list of potential erosional outfall repair sites with data from the Illicit Discharge Detection and Elimination Survey.
2) Cross referenced initial list with data from the Storm Water Asset Assessment reports to add or remove potential outfall repair sites.
3) Narrowed list down to focus only on *major* outfalls. Major outfalls are defined by USAG-HI's Storm Water Management Plan (SWMP):

   > *IDE#2- Field Screening of Outfalls Part D.1.c.(2):*
   > *"Major Outfall: Point where storm water discharges off installation boundary, or ultimately to stream or gulch. Major Outfalls do not include points within open conveyances connecting segments of the same MS4 or stream (e.g. culverts under roads or highways). All Major Outfalls are High Priority and will be inspected annually."*

4) Implementation sites were determined by the outfall's construction and maintenance accessibility.

SUMMARY OF EROSIONAL OUTFALL REPAIR SITES

41 erosional outfalls repair sites were identified for proposed remediation and/or reconstruction within the required five-year implementation period. Majority of the outfall's locations are unknown. Initial focus will be on locating them and providing temporary or permanent remediation in this five-year implementation period. **Table 1** provides a summary of proposed outfall repair sites along with their five-year implementation schedule. The implementation year is the year in which the proposed outfall repair is scheduled to be completed; however, this schedule is subject to change due to funding availability, permitting delays, or other unforeseen circumstances. Changes to the implementation schedule will be provided in the Annual Report. A description of each proposed erosional outfall repair site is provided in **Attachment 1**.

Table 1. Proposed Erosional Outfall Repair Sites and Implementation Schedule

Erosional Outfall Site	Outfall PID	Outfall Type	Receiving Waterbody	Watershed	Implementation Year
Wheeler Army Airfield (WAAF)					
1	DP-WAAF-002	Concrete Headwall	Waikele Stream	Waikele	2019
2	DP-WAAF-098	Unknown	Waikele Stream	Waikele	2015
3	DP-WAAF-103	Unknown	Waikele Stream	Waikele	2015
4	DP-WAAF-157	Unknown	Waikele Stream	Waikele	2015
Schofield Barracks (SB)					
5	DP-SB-419	Concrete Headwall	Waikele Stream	Waikele	2016
6	DP-SB-420	Concrete Headwall	Waikele Stream	Waikele	2017
7	DP-SB-424	Concrete Headwall	Waikele Stream	Waikele	2018
8	DP-SB-402	Unknown	Waikele Stream	Waikele	2015
9	DP-SB-481	Unknown	Waikele Stream	Waikele	2015
10	DP-SB-449	Unknown	Waikele Stream	Waikele	2015
11	DP-SB-482	Unknown	Waikele Stream	Waikele	2015
12	DP-SB-483	Unknown	Waikele Stream	Waikele	2015
13	DP-SB-484	Unknown	Waikele Stream	Waikele	2015
14	DP-SB-559	Unknown	Waikele Stream	Waikele	2015
15	DP-SB-542	Unknown	Waikele Stream	Waikele	2016
16	DP-SB-546	Unknown	Waikele Stream	Waikele	2016

Table 1. Proposed Erosional Outfall Repair Sites and Implementation Schedule					
Erosional Outfall Site	Outfall PID	Outfall Type	Receiving Waterbody	Watershed	Implementation Year
17	DP-SB-555	Unknown	Waikele Stream	Waikele	2016
18	DP-SB-452	Unknown	Waikele Stream	Waikele	2016
19	DP-SB-543	Unknown	Waikele Stream	Waikele	2016
20	DP-SB-545	Unknown	Waikele Stream	Waikele	2016
21	DP-SB-550	Unknown	Waikele Stream	Waikele	2016
22	DP-SB-551	Unknown	Waikele Stream	Waikele	2016
23	DP-SB-552	Unknown	Waikele Stream	Waikele	2016
24	DP-SB-560	Unknown	Waikele Stream	Waikele	2016
25	DP-SB-104	Unknown	Waikele Stream	Waikele	2017
26	DP-SB-448	Unknown	Waikele Stream	Waikele	2017
27	DP-SB-464	Unknown	Waikele Stream	Waikele	2017
28	DP-SB-454	Unknown	Waikele Stream	Waikele	2017
29	DP-SB-465	Unknown	Waikele Stream	Waikele	2017
30	DP-SB-469	Unknown	Waikele Stream	Waikele	2017
31	DP-SB-450	Unknown	Waikele Stream	Waikele	2018
32	DP-SB-353	Unknown	Waikele Stream	Waikele	2018
33	DP-SB-428	Unknown	Waikele Stream	Waikele	2018
34	DP-SB-352	Unknown	Waikele Stream	Waikele	2018
35	DP-SB-367	Unknown	Waikele Stream	Waikele	2018
36	DP-SB-512	Unknown	Waikele Stream	Waikele	2018
37	DP-SB-565	Unknown	Waikele Stream	Waikele	2018
38	DP-SB-547	Unknown	Waikele Stream	Waikele	2019
39	DP-SB-489	Unknown	Waikele Stream	Waikele	2019
40	DP-SB-467	Unknown	Waikele Stream	Waikele	2019
41	DP-SB-635	Unknown	Waikele Stream	Waikele	2019

REFERENCES

1. US Army Garrison, Hawaii Municipal Separate Storm Sewer System Permit Number HI S000090, effective April 7, 2014.
2. Illicit Discharge Detection and Elimination Survey, dated July 7-17, 2014.
3. Stormwater Asset Assessment , Wheeler Army Airfield, dated 2013-2014
4. Stormwater Asset Assessment, Schofield Army Airfield, dated 2014 (DRAFT)

ATTACHMENT 1

EROSIONAL OUTFALL REPAIR SITE DESCRIPTIONS

A5
A6
A7
A9
A10
A11
A13
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
C2
C3
C4
C5
C6
C7
D2
D3
D4
D7
E2
E3
E4
E7
F1
F2
F3
F4
F5
F6
F7
G1
G2
G3
G4
G5
G6
G7
G8
H3
H4
H5
H6
H7
H8
I3
I4
I5
I6
I7
I8
J4
J5
J6
J7
J8
K6
K7
L6
L7
M5
M6
N5
N6
Wahiawa State Freshwater Park
Wahiawa Reservoir
Wheeler Army Airfield
Leilehua Golf Course
Launani Valley Park
Kuulako Park
Mililani Ravine Park
Mililani Mauka District Park
Melemanu Park
Waipio Acres
Kipapa Park
Kaomaaiku Neighborhood Park
Maka Unulau Community Park
Mililani Golf Club
Mililani Waena Park
Mililani Town
Kunia
WHEELER ARMY AIRFIELD (WAAF)
Copyright© 2013 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Wheeler Army Airfield
Stormwater System
Assessment

E2

Access Assessment

WAAF_Discharges
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access

WAAF_Manholes
- Accessed_Inspected
- Other
- Unable_To_Access

WAAF_Inlets
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access

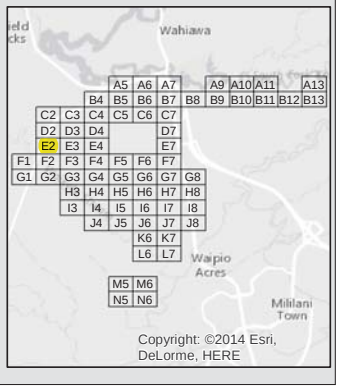
WAAF_Conduits
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access
- REMOVED

WAAF_Open_Drainage

WAAF_LIDs

N

1:1,250



Installation	WAAF
Map_Grid	E2
ObjectID	2
Name	WAAF_Discharges 2
Type	CONC_HEADWALL
Survey_Date	Nov 18, 2013, 5:35 PM
Access	Accessed_Inspected
Access_Note	
Obstruction	No_Obstruction
Obst_Type	-None Selected-
Obst_Notes	
Structural	No_Deficit
Struct_Typ	-None Selected-
Srtruct_Note	
Haz_Materi	No_HazMat
HazMat_Type	-None Selected-
Erosion	Minor_Erosion
Erosion_Note	Erosion is fairly severe, seems to be a result of the long life of outfall, currently seems fairly stable
Other_Note	
Rim_Elv	811.23000000000
Invert_Elv	802.43000000000
STODCRG_ID	D-2-221
ID	DP-WAAF-02

Photo 1	shpimg_329.jpg
Photo 2	shpimg_330.jpg

Next Photo

Displaying	shpimg_329.jpg
Maintenance_Date	
Maintenance_Action	Clear outfall. Provide permanent stabilization remediation.

Copyright© 2013 Esri, DeLorme, NAVTEQ, TomTom, Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Wheeler Army Airfield Stormwater System Assessment

E2

Access Assessment

WAAF_Discharges
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access

WAAF_Manholes
- Accessed_Inspected
- Other
- Unable_To_Access

WAAF_Inlets
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access

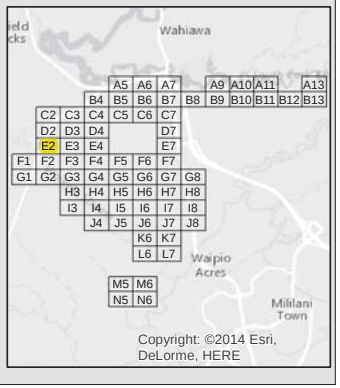
WAAF_Conduits
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access
- REMOVED

WAAF_Open_Drainage

WAAF_LIDs

N

1:1,250



Copyright: ©2014 Esri, DeLorme, HERE

Installation	WAAF
Map_Grid	E2
ObjectID	98
Name	WAAF_Discharges 98
Type	
Survey_Date	Nov 21, 2013, 6:47 PM
Access	Other
Access_Note	Not located, may be covered over
Obstruction	Major_Obstruction
Obst_Type	Sed_Accum
Obst_Notes	Based on conduit inspect
Structural	-None Selected-
Struct_Typ	-None Selected-
Srtruct_Note	
Haz_Materi	-None Selected-
HazMat_Type	-None Selected-
Erosion	-None Selected-
Erosion_Note	
Other_Note	Outfall not found. Research location of outfall.
Rim_Elv	819.25000000000
Invert_Elv	816.25000000000
STODCRG_ID	D-4-384
ID	DP-WAAF-098

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance_Date	
Maintenance_Action	Locate, clear, and temporarily remediate.

Wheeler Army Airfield
Stormwater System
Assessment

H8

Access Assessment

WAAF_Discharges
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access

WAAF_Manholes
- Accessed_Inspected
- Other
- Unable_To_Access

WAAF_Inlets
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access

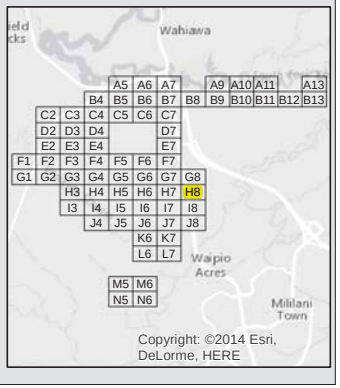
WAAF_Conduits
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access
- REMOVED

WAAF_Open_Drainage

WAAF_LIDs

N

1:1,250



Installation	WAAF
Map_Grid	H8
ObjectID	103
Name	WAAF_Discharges 103
Type	
Survey_Date	Apr 1, 2014, 9:29 AM
Access	Unable_To_Access
Access_Note	Fenced
Obstruction	-None Selected-
Obst_Type	-None Selected-
Obst_Notes	
Structural	-None Selected-
Struct_Typ	-None Selected-
Srtruct_Note	
Haz_Materi	-None Selected-
HazMat_Type	-None Selected-
Erosion	-None Selected-
Erosion_Note	
Other_Note	Outfall not found. Research location of outfall.
Rim_Elv	765.00000000000
Invert_Elv	761.24000000000
STODCRG_ID	D-2-394
ID	DP-WAAF-0103

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance_Date	
Maintenance_Action	Locate, clear, and temporarily remediate.

Wheeler Army Airfield
Stormwater System
Assessment

I4

Access Assessment

WAAF_Discharges
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access

WAAF_Manholes
- Accessed_Inspected
- Other
- Unable_To_Access

WAAF_Inlets
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access

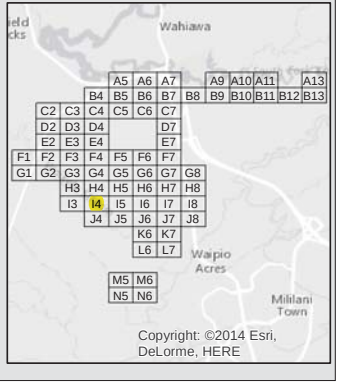
WAAF_Conduits
- Accessed_Inspected
- Not included in assessment
- Other
- Unable_To_Access
- REMOVED

WAAF_Open_Drainage

WAAF_LIDs

N

1:1,250

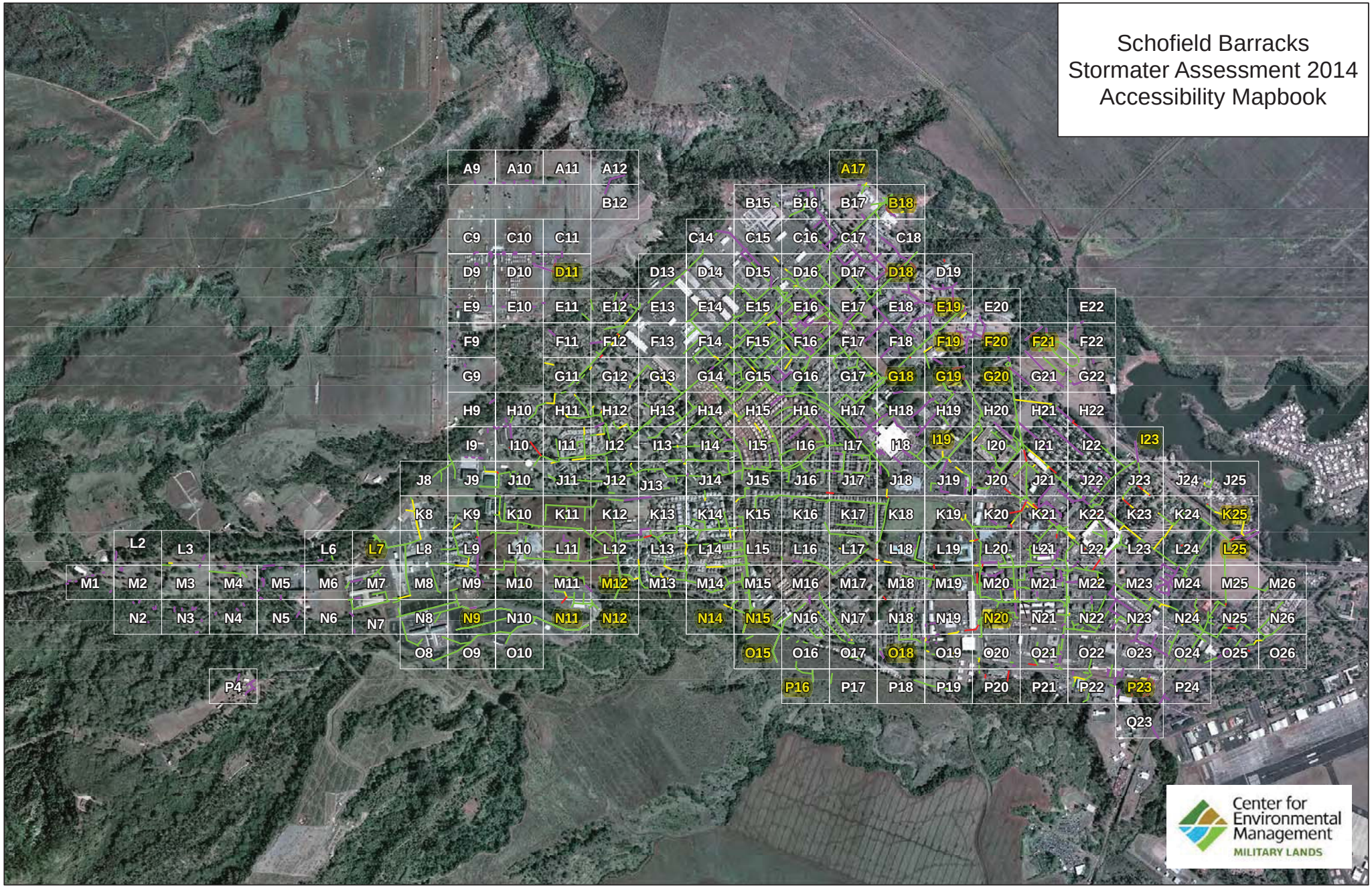


Installation	WAAF
Map_Grid	I4
ObjectID	157
Name	WAAF_Discharges 44
Type	
Survey_Date	Feb 27, 2014, 9:25 AM
Access	Unable_To_Access
Access_Note	Located in jungle
Obstruction	-None Selected-
Obst_Type	-None Selected-
Obst_Notes	
Structural	-None Selected-
Struct_Typ	-None Selected-
Srtruct_Note	
Haz_Materi	-None Selected-
HazMat_Type	-None Selected-
Erosion	-None Selected-
Erosion_Note	
Other_Note	Outfall not found. Research location of outfall.
Rim_Elv	682.50000000000
Invert_Elv	675.00000000000
STODCRG_ID	D-5-296
ID	DP-WAAF-0157

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance_Date	
Maintenance_Action	Locate, clear, and temporarily remediate.

Schofield Barracks Stormater Assessment 2014 Accessibility Mapbook



Schofield Barracks
Stormwater System
Assessment
August 2014

P16

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-419
Map Grid	P16
Type	CONC_HEADWALL
Invert Elv	0.00
Survey Date	Feb 19, 2014, 12:24 PM
Access	Accessed_Inspected
Access Note	
Obstruction	No_Obstruction
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	No_Deficit
Structural Type	-None Selected-
Srtructure Note	
Haz Material	No_HazMat
HazMat Type	-None Selected-
Erosion	No_Erosion
Erosion Note	
Other Note	

Photo 1	shpimg_598.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Clear outfall. Provide permanent stabilization remediation.

Schofield Barracks
Stormwater System
Assessment
August 2014

O15

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-420
Map Grid	O15
Type	CONC_HEADWALL
Invert Elv	0.00
Survey Date	Feb 19, 2014, 12:39 PM
Access	Accessed_Inspected
Access Note	
Obstruction	No_Obstruction
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	Minor_Deficit
Structural Type	Collapsing
Srtructure Note	Rocks eroded at foot
Haz Material	No_HazMat
HazMat Type	-None Selected-
Erosion	Minor_Erosion
Erosion Note	
Other Note	

Photo 1	shpimg_603.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Clear outfall. Provide permanent stabilization remediation.

ID	DP-SB-424
Map Grid	O15
Type	CONC_HEADWALL
Invert Elv	0.00
Survey Date	Feb 19, 2014, 2:46 PM
Access	Accessed_Inspected
Access Note	
Obstruction	No_Obstruction
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	No_Deficit
Structural Type	-None Selected-
Srtructure Note	
Haz Material	No_HazMat
HazMat Type	-None Selected-
Erosion	No_Erosion
Erosion Note	
Other Note	

Photo 1	shpimg_628.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Clear outfall. Provide permanent stabilization remediation.

Schofield Barracks
Stormwater System
Assessment
August 2014

A17

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

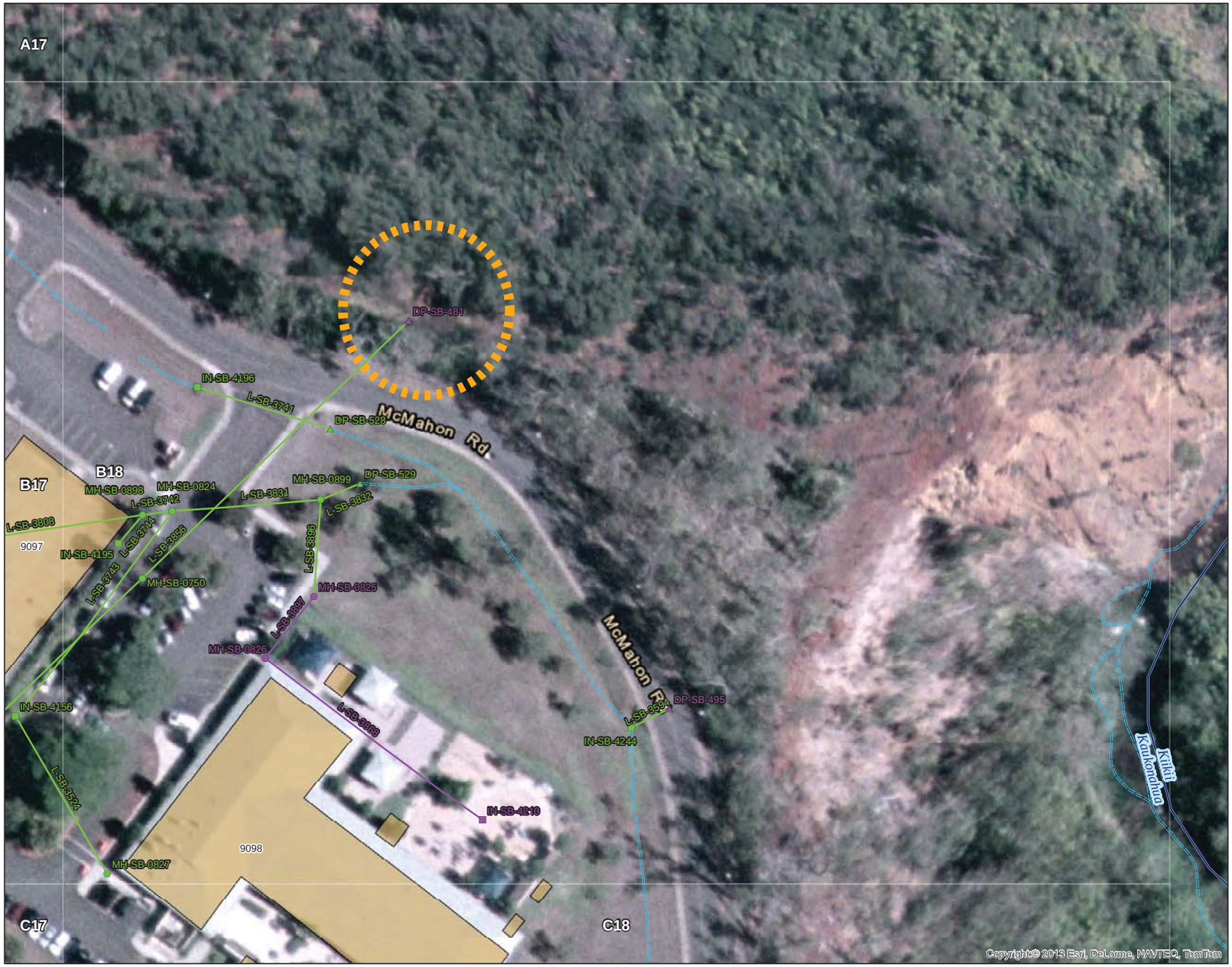
1:750

N

ID	DP-SB-402
Map Grid	A17
Type	
Invert Elv	876.52
Survey Date	Feb 28, 2014, 2:03 PM
Access	Unable_To_Access
Access Note	Fence
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.



Schofield Barracks
Stormwater System
Assessment
August 2014

B18

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

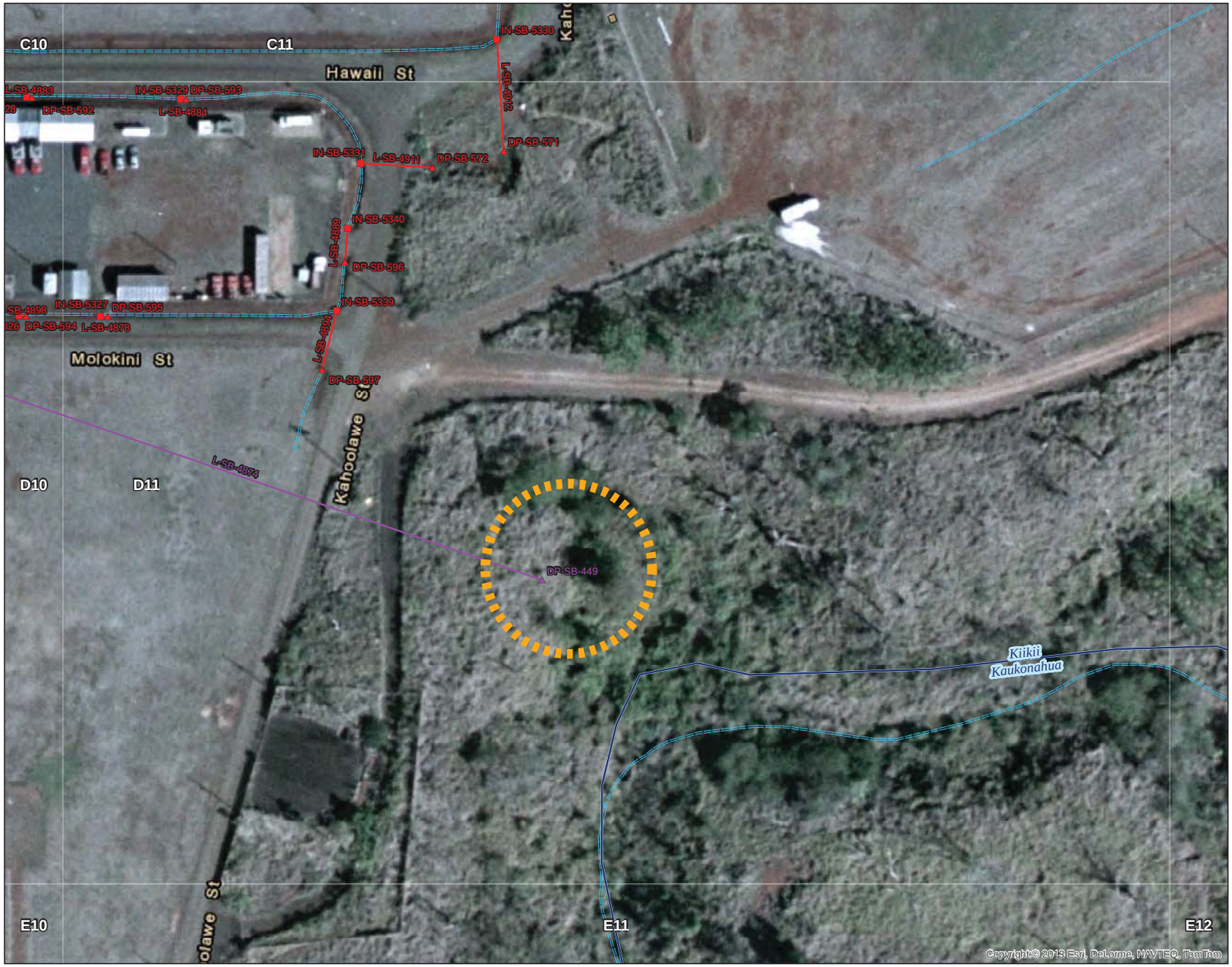
1:750

N

ID	DP-SB-481
Map Grid	B18
Type	
Invert Elv	869.90
Survey Date	Jun 12, 2014, 3:01 PM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.



Schofield Barracks
Stormwater System
Assessment
August 2014

D11

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-449
Map Grid	D11
Type	
Invert Elv	936.00
Survey Date	Jun 16, 2014, 1:32 PM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

D18

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-482
Map Grid	D18
Type	
Invert Elv	864.90
Survey Date	May 6, 2014, 9:57 AM
Access	Unable_To_Access
Access Note	Fence
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

E19

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-483
Map Grid	E19
Type	UNKNOWN
Invert Elv	861.97
Survey Date	Jun 12, 2014, 11:01 AM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

ID	DP-SB-484
Map Grid	E19
Type	UNKNOWN
Invert Elv	860.04
Survey Date	Jun 12, 2014, 11:00 AM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

F19

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-559
Map Grid	F19
Type	
Invert Elv	861.70
Survey Date	June 17, 2014
Access	Unable_To_Access
Access Note	Construction area, unverified features
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

F20

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

Schofield Barracks
Stormwater System
Assessment
August 2014

G20

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-542
Map Grid	F20
Type	
Invert Elv	865.63
Survey Date	Mar 29, 2014, 1:42 PM
Access	Unable_To_Access
Access Note	Construction area, hard hat area
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

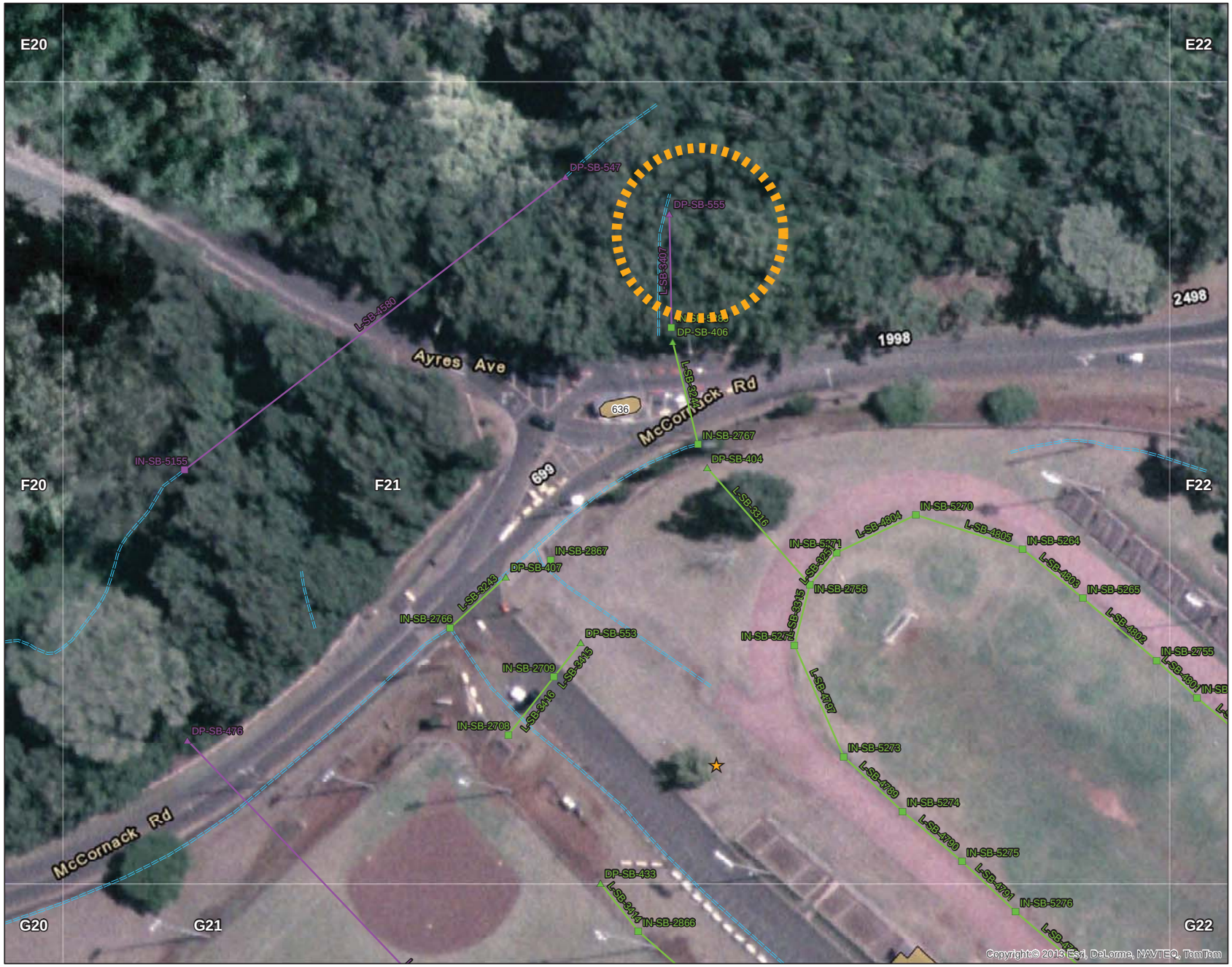
No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

ID	DP-SB-546
Map Grid	F20
Type	
Invert Elv	825.90
Survey Date	Apr 1, 2014, 12:32 PM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.



Schofield Barracks
Stormwater System
Assessment
August 2014

F21

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

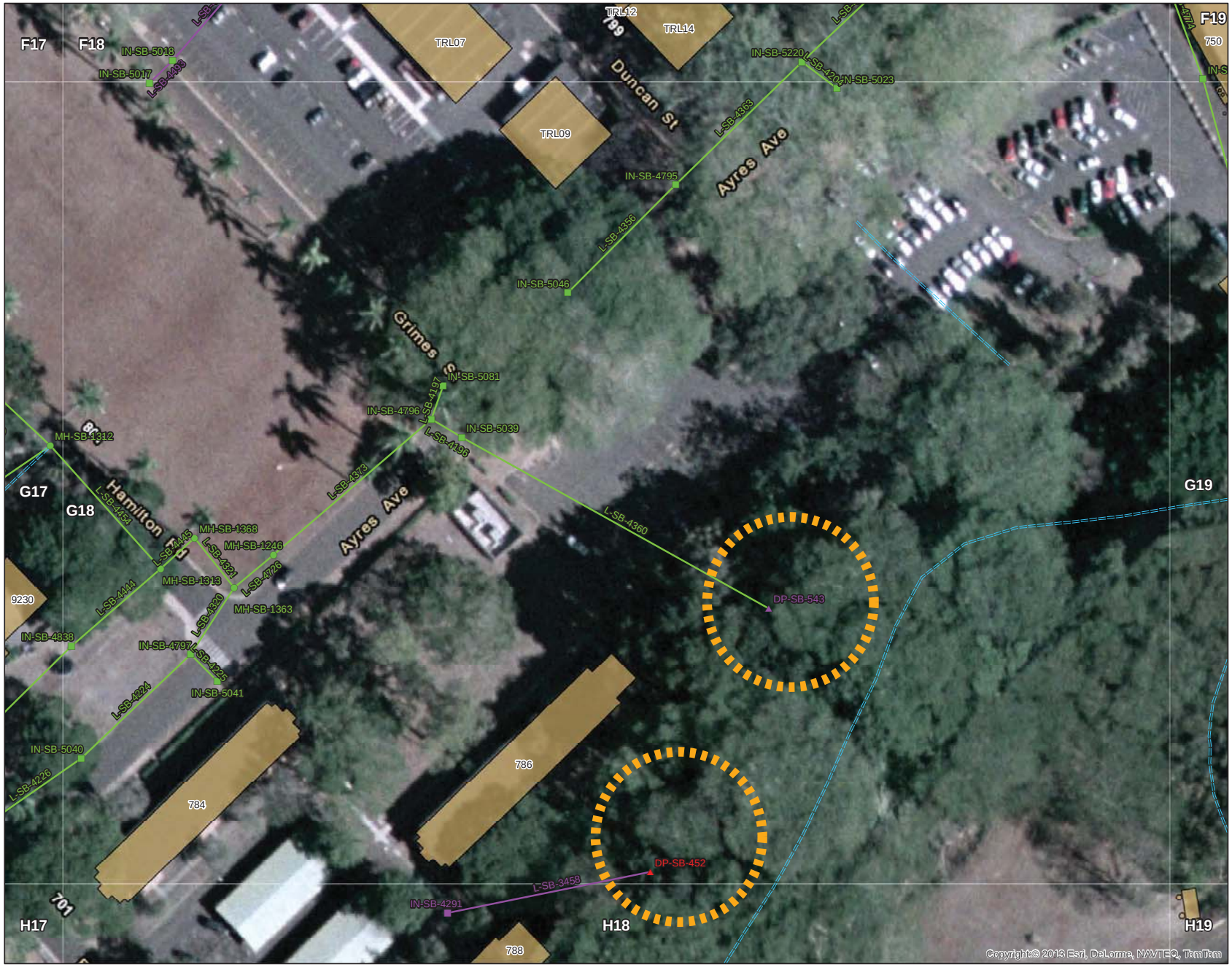
1:750

N

ID	DP-SB-555
Map Grid	F21
Type	CONC_HEADWALL
Invert Elv	0.00
Survey Date	Feb 28, 2014, 2:38 PM
Access	Unable_To_Access
Access Note	Fence, terrain
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.



Schofield Barracks
Stormwater System
Assessment
August 2014

G18

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-452
Map Grid	G18
Type	
Invert Elv	872.23
Survey Date	Jun 17, 2014, 10:02 AM
Access	OTHER
Access Note	Terrain, no access
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

ID	DP-SB-543
Map Grid	G18
Type	
Invert Elv	869.18
Survey Date	Mar 28, 2014, 10:49 AM
Access	Unable_To_Access
Access Note	Overgrown
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

G19

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-545
Map Grid	G19
Type	
Invert Elv	831.50
Survey Date	Mar 30, 2014, 10:08 AM
Access	Unable_To_Access
Access Note	Danger
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

ID	DP-SB-550
Map Grid	G19
Type	
Invert Elv	866.40
Survey Date	May 5, 2014, 9:11 AM
Access	Unable_To_Access
Access Note	Terrain, no access
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

ID	DP-SB-551
Map Grid	G19
Type	
Invert Elv	867.75
Survey Date	May 5, 2014, 9:42 AM
Access	Unable_To_Access
Access Note	Terrain, no access
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

ID	DP-SB-552
Map Grid	G19
Type	
Invert Elv	833.24
Survey Date	Mar 30, 2014, 10:00 AM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

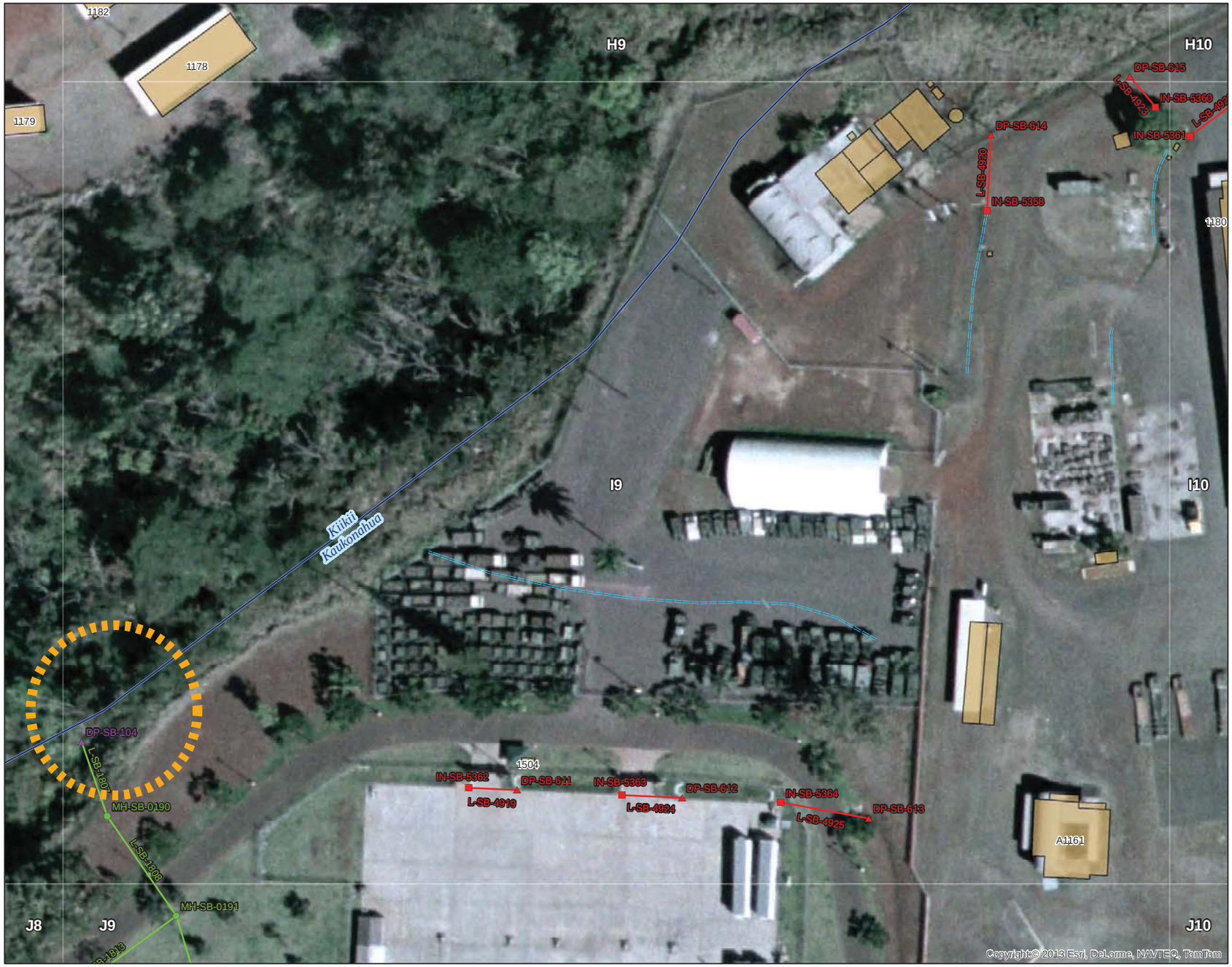
No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

ID	DP-SB-560
Map Grid	G19
Type	
Invert Elv	858.74
Survey Date	Jun 12, 2014, 9:16 AM
Access	Unable_To_Access
Access Note	Fence, terrain
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.



Schofield Barracks
Stormwater System
Assessment
August 2014

I9

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-104
Map Grid	I9
Type	
Invert Elv	984.25
Survey Date	Jan 14, 2014, 9:16 AM
Access	Unable_To_Access
Access Note	Deep veg
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

I23

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-448
Map Grid	I23
Type	
Invert Elv	849.86
Survey Date	Jun 13, 2014, 12:52 PM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

K25

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

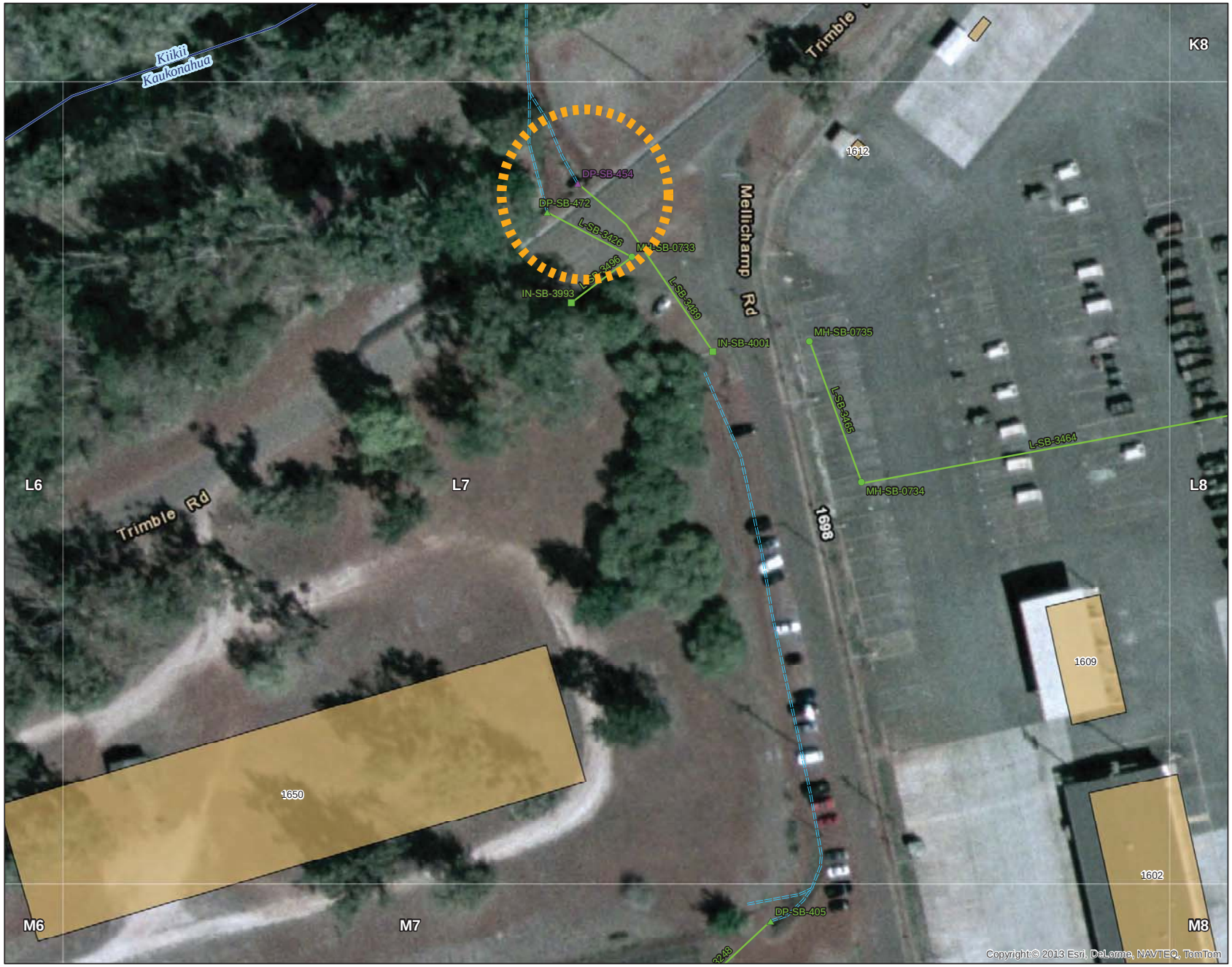
1:750

N

ID	DP-SB-464
Map Grid	K25
Type	
Invert Elv	837.70
Survey Date	Jun 13, 2014, 12:51 PM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.



Schofield Barracks
Stormwater System
Assessment
August 2014

L7

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

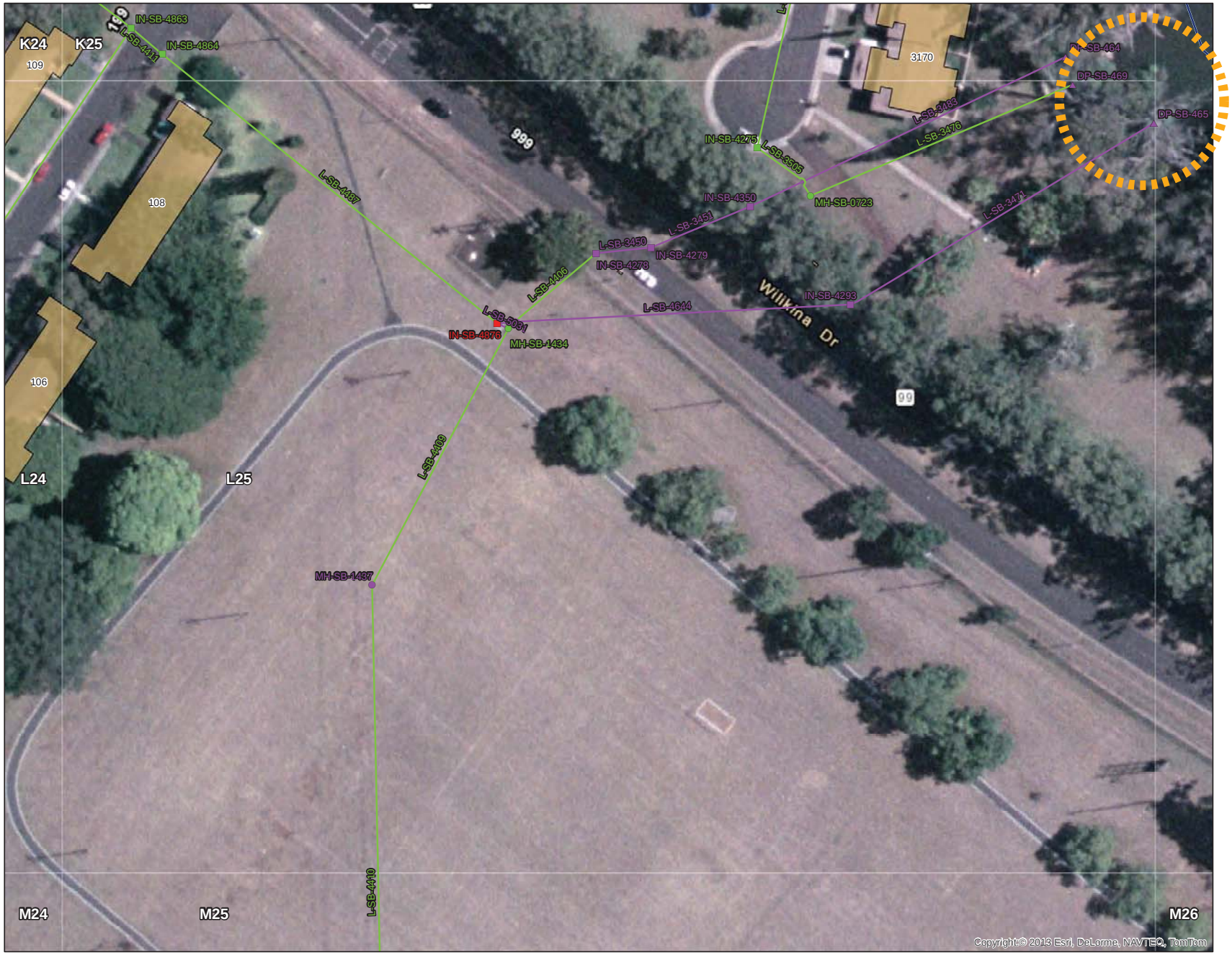
1:750

N

ID	DP-SB-454
Map Grid	L7
Type	
Invert Elv	1019.21
Survey Date	Jun 13, 2014, 9:02 AM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.



Schofield Barracks
Stormwater System
Assessment
August 2014

L25

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-465
Map Grid	L25
Type	
Invert Elv	841.80
Survey Date	Jun 13, 2014, 12:51 PM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

ID	DP-SB-469
Map Grid	L25
Type	
Invert Elv	841.23
Survey Date	Jun 13, 2014, 12:51 PM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

M12

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-450
Map Grid	M12
Type	
Invert Elv	934.18
Survey Date	Jun 13, 2014, 9:56 AM
Access	Unable_To_Access
Access Note	Fenced
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

N9

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

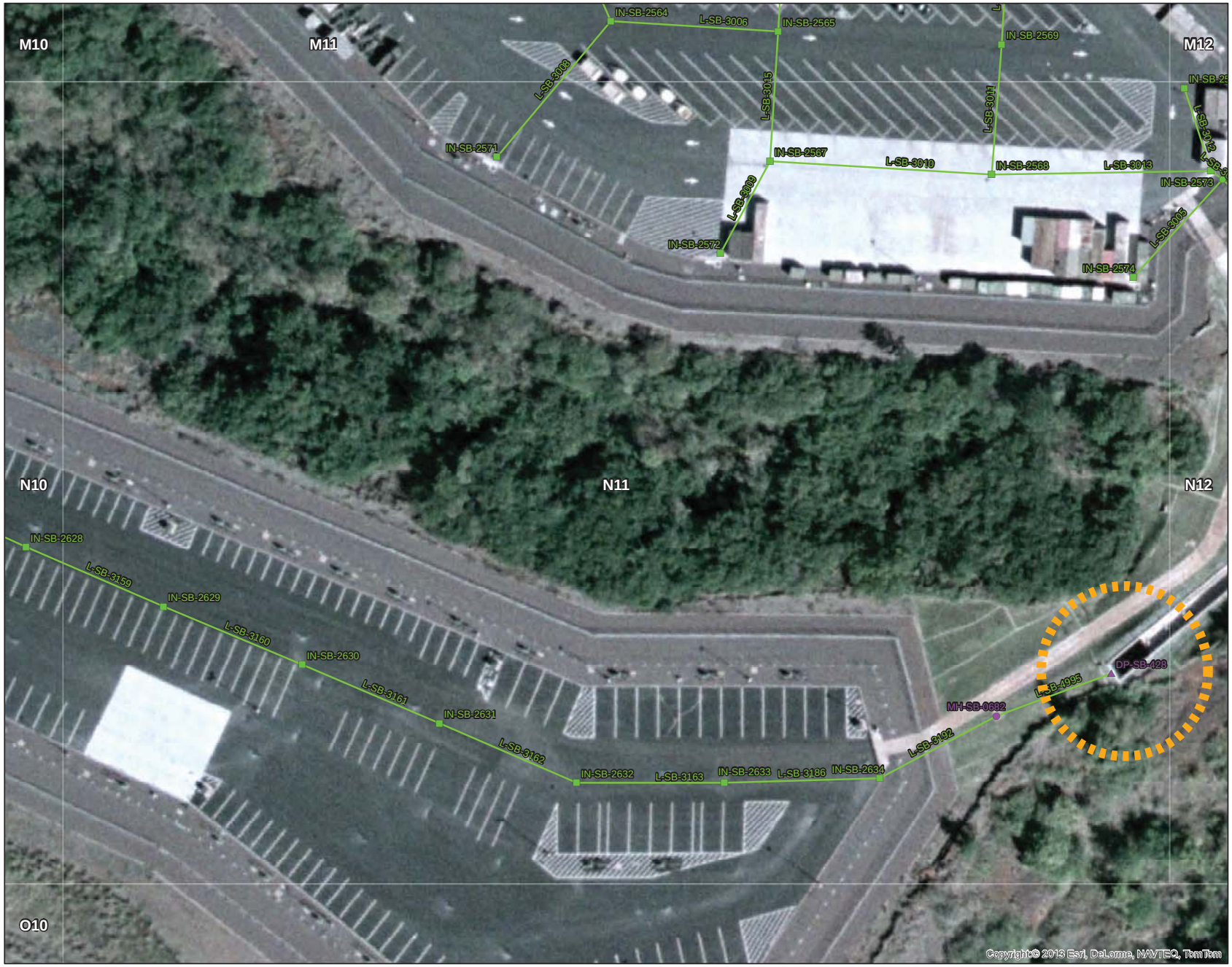
1:750

N

ID	DP-SB-353
Map Grid	N9
Type	
Invert Elv	977.95
Survey Date	Feb 24, 2014, 10:21 AM
Access	Unable_To_Access
Access Note	Fence
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.



Schofield Barracks
Stormwater System
Assessment
August 2014

N11

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-428
Map Grid	N11
Type	
Invert Elv	938.10
Survey Date	Feb 24, 2014, 9:25 AM
Access	Unable_To_Access
Access Note	Fenced, Discharge to OWS system
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

N12

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-352
Map Grid	N12
Type	
Invert Elv	935.04
Survey Date	Feb 24, 2014, 3:47 PM
Access	Accessed_Inspected
Access Note	Viewed from upstream manhole
Obstruction	No_Obstruction
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	No_HazMat
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

N15

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-367
Map Grid	N15
Type	
Invert Elv	889.32
Survey Date	Feb 19, 2014, 12:09 PM
Access	Unable_To_Access
Access Note	Steep bank, thick growth
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

Schofield Barracks
Stormwater System
Assessment
August 2014

O18

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

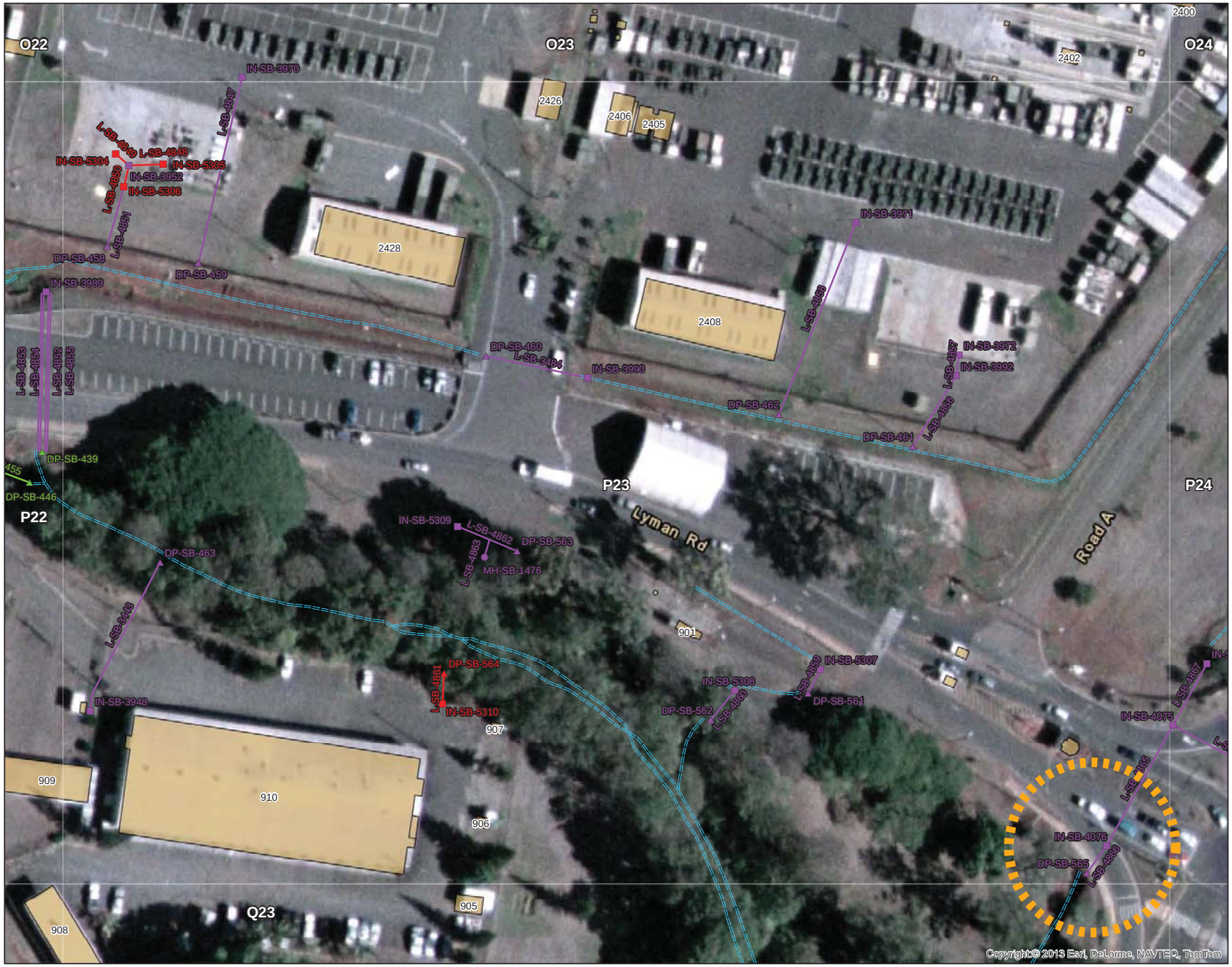
1:750

N

ID	DP-SB-512
Map Grid	O18
Type	
Invert Elv	877.12
Survey Date	May 10, 2014, 8:56 AM
Access	Unable_To_Access
Access Note	Construction
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.



Schofield Barracks
Stormwater System
Assessment
August 2014

P23

Accessibility

Discharge Points

- Unable to Access
- Other
- Accessed Inspected

Manholes

- Unable to Access
- Other
- Accessed Inspected

Inlets

- Unable to Access
- Other
- Accessed Inspected

Conduits

- Unable to Access
- Other
- Accessed Inspected

Additional Features

- LIDs
- Streams
- Open Drainage
- Buildings

1:750

N

ID	DP-SB-565
Map Grid	P23
Type	
Invert Elv	833.46
Survey Date	Jun 17, 2014, 3:00PM
Access	Unable_To_Access
Access Note	Highway, security gate
Obstruction	-None Selected-
Obstruction Type	-None Selected-
Obstruction Notes	
Structural	-None Selected-
Structural Type	-None Selected-
Srtructure Note	
Haz Material	-None Selected-
HazMat Type	-None Selected-
Erosion	-None Selected-
Erosion Note	
Other Note	Outfall not found. Research location of outfall.

No image Available

Photo 1	noimage.jpg
Photo 2	noimage.jpg
Maintenance Date	
Maintenance Action	Locate, clear, and temporarily remediate.

This page intentionally left blank.

SECTION 6: Pollution Prevention / Good Housekeeping
MABP APPENDIX

This page intentionally left blank.

MABP APPENDIX A
Appendix A - Maintenance Interim SOPs

This page intentionally left blank.

DISCLAIMER

The following manuals and guidelines are from existing material that is currently in use in other industries. DPW shall follow these materials as guides on an interim basis until USAG-HI's permanent field manual is complete.

This page intentionally left blank.

CSN TECHNICAL BULLETIN
No. 10

Bioretention Illustrated:

A Visual Guide for Constructing, Inspecting, Maintaining and Verifying the Bioretention Practice

Version 2.0
October 20, 2013

Prepared by:

Ted Scott
Stormwater Maintenance & Consulting
Cecilia Lane & Tom Schueler
Chesapeake Stormwater Network

www.swmaintenance.com | www.mdswm.com

Table of Contents

	Page
Section 1: Basics of Bioretention: What it Does and How it Works	**5**
Section 2: The Construction Sequence for Bioretention	**13**
Section 3: The Visual Indicators Framework	**20**
Section 4: Visual Indicators for Bioretention	**23**
Section 5: Inspections and Maintenance	**27**
5.1 The Establishment Phase and Final Inspection	**27**
5.2 The Bioretention Maintenance Regime	**28**
5.3 Regular Maintenance Checkups and Repair	**30**
5.4 Local Regulatory Inspections	**32**
5.5 BMP Performance Verification	**33**
Section 6: Forensic BMP Investigations	**36**
References Cited	**42**
Appendix A: Visual Indicator Profile Sheets for Bioretention	**43**
Appendix B: Visual Indicators for Other LID Practices	**62**
B.1 Grass Channels	**62**
B.2 Filters Strips and Sheet Flow to Buffers	**71**
B.3 Permeable Pavement	**80**
B.4 Infiltration Practices	**88**

Introduction

The LID Maintenance Challenge

In recent surveys conducted by CSN, local stormwater managers have expressed major concerns about the long term maintenance of low impact development (LID) practices, and the lack of inspection protocols for small-scale practices. Clearly, most communities will have many, many more small practices to report, track, inspect and verify.

The same communities will soon get more prescriptive MS4 permits that will require ongoing maintenance inspection for their entire best management practices (BMPs) inventory in a single permit cycle. In addition, localities may soon have to improve their BMP reporting, tracking and reporting to maintain pollutant reduction credits for the Bay pollution diet or total maximum daily load (TMDL)...And given the state of most local stormwater budgets, they are not likely to get additional staff resources to get the job done.

A New Model for LID Maintenance

The transition to the new LID paradigm requires a new model for efficiently inspecting and maintaining practices over their entire life cycle. This technical bulletin outlines a new visual indicators approach for doing so that is based on the following principles:

- Use simple visual indicators to conduct rapid inspections of individual practices in less than a half hour

- Apply a "triage approach" to focus time and staff resources on fixing the practices in the worst condition

- Use measurable and numeric maintenance "triggers" to develop a punch-list of maintenance tasks and let the owner know how to fix minor, moderate and severe maintenance problems

- Take a proactive approach to maintenance rather than a reactive one so that the maintainer understands the function and design objective for the practice, can immediately fix minor problems and prevent major problems, schedule a follow up visit to address moderate problems, and report severe problems to the owner or local stormwater maintenance authority.

- Confine the efforts of engineers and project estimators to careful construction inspections to ensure they are installed properly and more in-depth "forensic" investigation of failing or non-functional practices and shift inspection responsibilities to inspectors, landscape contractors, and others who may not be trained engineers but could learn to do LID inspection

- In doing all of the above, maximize use of advanced communication, mapping, GPS and data management technology to streamline and integrate maintenance records

Appendix A presents profile sheets that show how each visual indicator is used during bioretention inspection. **Appendix B** provides a list of visual indicators for four other categories of LID practices, as well as numeric maintenance triggers.

Other CSN Initiatives

CSN is working with several partners to craft products and tools to make LID maintenance easier and more cost-effective. A more simplified set of visual indicators are being developed to assess homeowner practices such as on-lot rain gardens, downspout disconnections and rainwater harvesting. CSN also expects to complete Technical Bulletin 11 which will focus on how to build more effective local LID maintenance programs. Finally, CSN aims to develop a tablet or smart phone app to rapidly enter inspection data in the field and develop maintenance punch lists.

Acknowledgements

CSN would like to acknowledge the help of the following people: Ted Scott and William Kopajtic at Stormwater Maintenance & Consulting, Laurel Woodworth, Dave Hirshman, Sadie Drescher and Bryan Seipp at the Center for Watershed Protection, Inc., without whom the production of this technical bulletin would not have been possible.

Support for this technical memo was provided for by the Keith Campbell Foundation and the National Fish and Wildlife Foundation under the Chesapeake Bay Stormwater Training Partnership grant.

CSN would like to thank the following people and organizations for submitting photos for inclusion in this technical bulletin: Ted Scott, Dave Hirshman, Bryan Seipp, Tim Schueler, and the NCSU Stormwater Engineering Group.

Finally, CSN would like to acknowledge the contribution of our reviewers for their careful review of this document: Steve Hubble, Stafford County, VA, Steve Curtis, Luck Stone Corporation, Richard Klein, Community and Environmental Defense Services, Mary Travaglini, Montgomery County DEP, Martin Johnson, Thomas Jefferson Soil & Water Conservation District, Prince William County, VA.

Section 1
Basics of Bioretention: What it Does and How it Works

Bioretention is a stormwater management practice that can achieve both water quantity and water quality goals through runoff reduction and pollutant removal. Pollutant removal is accomplished via processes such as settling, filtering, adsorption, and biological uptake.

Bioretention facilities are known by many different names but they all operate in the same basic way. Table 1 shows some of the different varieties of bioretention facilities.

Table 1. Bioretention Pseudonyms

Bioretention	*Water Quality Swale*
Urban Bioretention	*Residential Rain Garden*

Regardless of the form the bioretention may take, there are several basic design components that are present to ensure the practice's ability to reduce runoff and remove pollutants. These may include: a ponding area, filter bed (or soil media), stone layer (with or without underdrain), an inlet, overflow device or outlet, and vegetative cover (Figure 1).

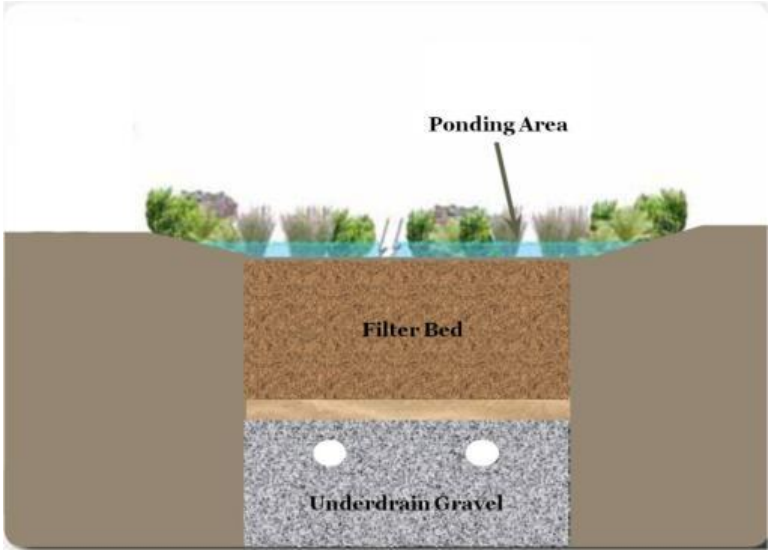


Figure 1. Bioretention Schematic (WVDEP)

The way a bioretention facility works is that stormwater flows into it and temporarily ponds on the surface in the **ponding area**. Water then slowly filters through the **filter bed** (or media layer) where it may be collected by the **underdrain** (a perforated pipe beneath the filter bed) and conveyed to the storm sewer system. Not all bioretention practices are designed to have an underdrain, in areas of "good" soils (soils that meet a specific infiltration capacity) a practice can be designed to allow the water to infiltrate into the underlying soils.

Vegetation is a very important component of a bioretention system. As stormwater makes its way through the practice, it is taken up and utilized by the vegetation along with the corresponding nutrients. Figure 2 demonstrates how runoff makes its way through the bioretention area.

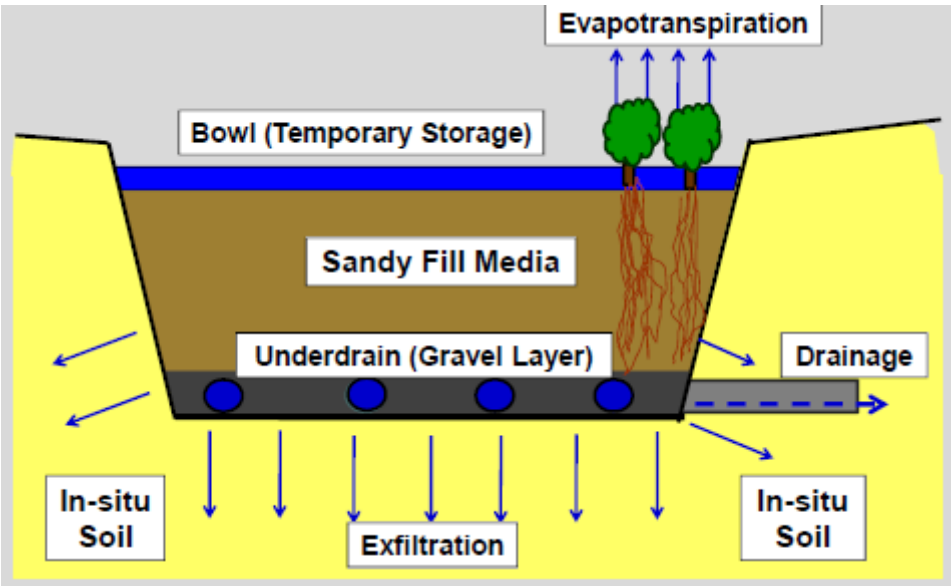


Figure 2. Bioretention Processes (Photo credit: NCSU Stormwater Engineering Group)

Runoff Reduction and Pollutant Removal

Runoff reduction is defined as the total volume of water reduced through canopy interception, soil infiltration, evaporation, rainfall harvesting, engineered infiltration, extended filtration or evapotranspiration. The runoff reduction associated with a bioretention practice ranges anywhere from 40-80% (CWP and CSN, 2008).

Pollutant removal is accomplished via processes such as settling, filtering, adsorption, biological uptake and denitrification. The range of pollutant removal efficiencies for Total Nitrogen (TN), Total Phosphorus (TP) and Total Suspended Solids (TSS) can be seen in Table 2.

Table 2. Pollutant Removal of Bioretention (USWG, 2012)

Pollutant	**% Removal**
Total Nitrogen	56-69%
Total Phosphorus	66-80%
Total Suspended Solids	71-86%

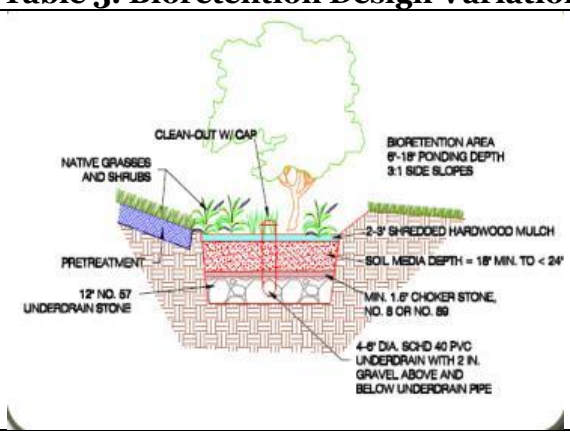
The pollutant removal rate of a particular bioretention area can be increased or decreased based on the design components and what pollutant(s) is being targeted for reduction.

Design variations

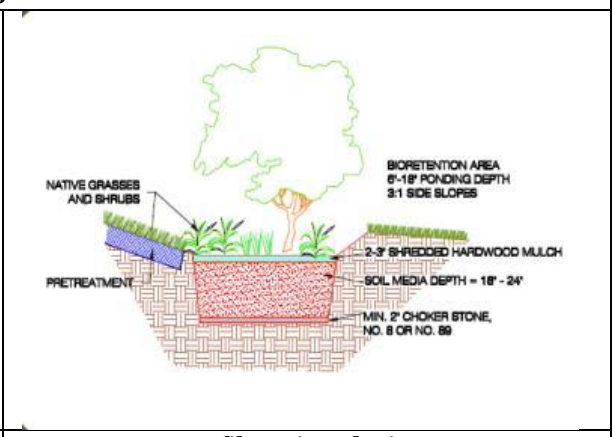
A bioretention area can vary in how it is designed. Some design variations include using an underdrain in the stone layer to slowly dewater the area, sending remaining runoff back to the storm sewer system, or creating a sump at the bottom of the area in the stone layer where water will infiltrate in to the surrounding soils within 48 hours.

In addition, it is also possible to design the bioretention area so as to meet specific pollutant removal needs. For example, by creating a sump in the bottom of the area, one can achieve enhanced nitrogen removal. These different design variations are illustrated in Table 3.

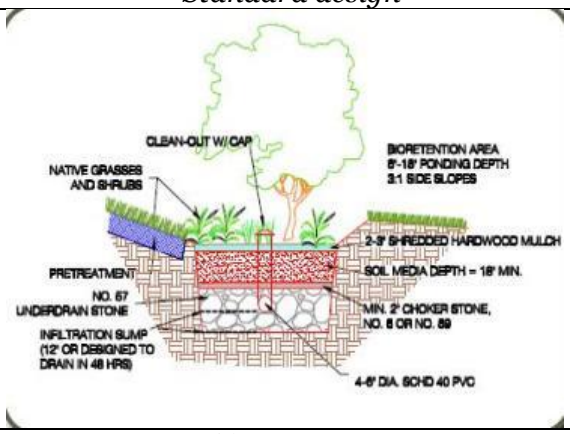
Table 3. Bioretention Design Variations



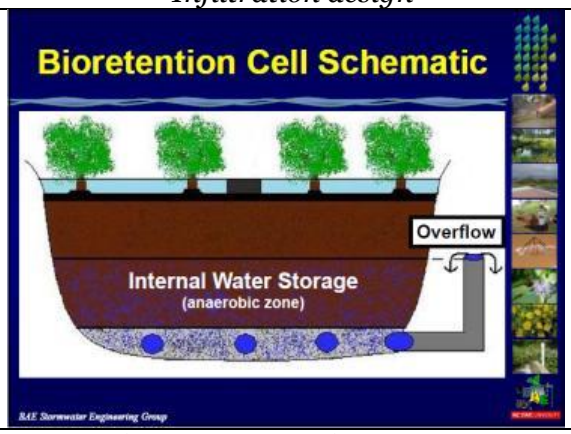
Standard design



Infiltration design



Infiltration sump



Internal water storage layer (Photo credit: NCSU Stormwater Engineering Group)

Runoff enters the bioretention area through the **inlet**. Inlets can vary considerably in the way they are designed to function. Table 4 demonstrates the different types of inlets that are often used with bioretention.

Table 4. Bioretention Inlets	
Curb cut – flow enter through defined place in curb	*Curb cut*
Gravel diaphragm – flow enters as sheetflow and is evenly distributed across length of practice	*Grass filter strip: accepts sheet flow from the parking lot*

Water leaves the bioretention area through several different means. It can evaporate from the ponding area, be taken-up and utilized or evapo-transpired by the vegetation or infiltrated into the surrounding soils. In addition, most bioretention areas are designed to have a designated **outlet** structure of some kind. Outlet structures can take many different forms and oftentimes depend on the design of the facility. One type of outlet or overflow structure that is often used is an inlet structure that is placed at the maximum design ponding depth so as to allow for bypass of larger stormwater volumes out of the facility. Another is a riser structure that accepts water that exceeds the maximum ponding depth and conveys it to the underground storm drain pipes.

Underdrains are another way that runoff can leave the bioretention. Underdrains either convey water to the existing storm drain or daylight into an above ground swale, woodland, or stream. It is important to know where the underdrains connect to, so you can inspect the outlet. They commonly have clean-out and observation well pipes that surface at pipe intersections. Underdrains are used in environments where the soil conditions make it difficult to infiltrate water into the surrounding area. Underdrains are also useful in situations where the runoff entering the practice is contaminated from

the contributing drainage area (called Hotspots) and so cannot be infiltrated into the surrounding soils due to potential groundwater contamination.

Table 5 shows several different types of outlet structures commonly used for bioretention.

Table 5. Bioretention Outlet Structures	
Inlet structure: yard inlet placed at the maximum ponding depth to allow for bypass of larger storms	*Inlet Structure as Overflow Device*
Observation well or clean out: to inspect drainage in the filter media or the condition of the underdrain	*Underdrain outlet: where the water collected by the underdrain is discharged*

Pretreatment is necessary to trap sediment and debris before it reaches and clogs the filter bed. There are several different types of pretreatment measures that are used to protect bioretention. Examples can be found in Table 6.

Table 6. Examples of Different Pretreatment Measures Used in Bioretention

Sediment forebay	*Grass channel*
Level spreader	*Gravel Diaphragm*

Vegetation is an essential component of any bioretention area. As was noted earlier, vegetation is responsible for a significant portion of the pollutant removal and runoff reduction of this stormwater practice. The landscape regime of a bioretention area is often determined by the amount of maintenance it will receive. Often, this is a function of the visibility of the practice.

If the practice will be infrequently maintained, then hardy plant materials should be specified at the various planting zones in the facility. If an owner will have the bioretention area maintained as part of the regular maintenance activities (e.g., grass cutting, weeding, etc) then perhaps a more perennial garden is suitable.

One of the most costly aspects of bioretention maintenance is the cost of supplementing or replacing mulch, if it is specified. Accordingly, careful selection of a diverse plant palette that includes herbaceous material such as ground covers in lieu of widely spaced woody species can result in a reduction in maintenance costs.

Another important factor to consider in designing the landscaping regime of the bioretention is the dynamic nature of vegetation. Typically designers specify material for the immediate conditions. However the systems evolve as the vegetation grows. For example, as trees and shrubs mature, the system might be transformed from a sunny

bioretention to having more shade under trees. Oftentimes, it is beneficial to conduct a plant evaluation specified time increments (i.e., 3 year, 6 year, 9 year and so on) to evaluate the suitability of the plant regime and the appropriateness of the plant material (Gillette, 2013).

Table 7 demonstrates four different typical landscaping regimes for bioretention.

Table 7. Typical Landscaping Regimes for Bioretention

Perennial Garden	*Perennial- Shrub*
Tree-shrub-mulch	*Turf-tree*

Now that we understand the basics behind how bioretention works, we need to learn basic visual indicators to quickly identify and diagnose maintenance problems that prevent it from functioning properly. The rest of this technical bulletin outlines methods for visually inspecting bioretention through all stages of its life cycle

Section 2
Installing it Right the First Time
The Construction Sequence for Bioretention

Construction inspection is an important step to take to ensure that the project is built to its design specifications, and any changes that are made in the field are acceptable.

The construction inspection is performed in order to meet requirements for the local stormwater management review authority, and is typically conducted by an engineer or trained stormwater professional at critical points in the construction process. (Figure 3).

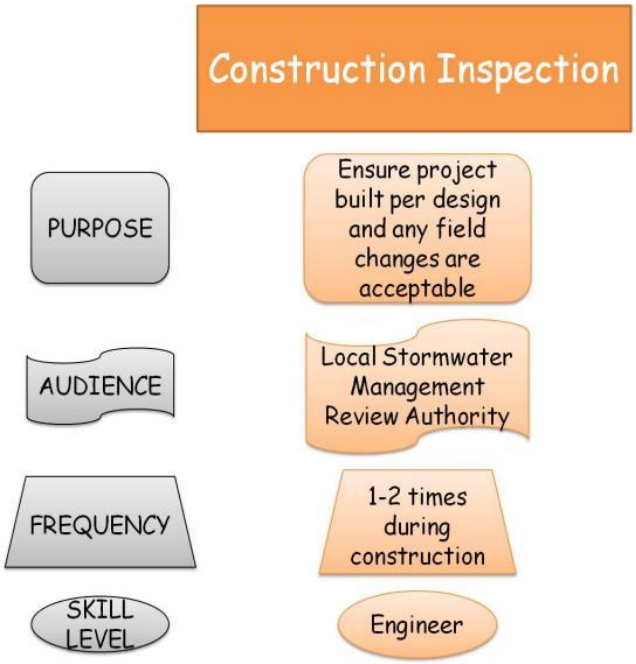


Figure 3. The Construction Inspection Process

Construction Sequence

Table 8 outlines a typical construction sequence for a bioretention area (WV DEP, 2012).

Table 8. A Typical Construction Sequence for a Bioretention Facility	
Step 1. Construction of the bioretention area may only begin after the entire Contributing Drainage Area (CDA) has been stabilized with vegetation. It may be necessary to block certain curb or other inlets while the bioretention area is being constructed. The proposed site should be checked for underground utilities prior to any excavation.	
Step 2. The designer and the installer should have a preconstruction meeting, checking the boundaries of the CDA and the actual inlet elevations to ensure they conform to original design. Since other contractors may be responsible for constructing portions of the site, it is quite common to find subtle differences in site grading, drainage and paving elevations that can produce hydraulically important differences for the proposed bioretention area. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the plan review/inspection authority.	
Step 3. Temporary erosion and sediment controls are needed during construction to divert stormwater and sediments away from the bioretention area until it is completed. Special protection measures such as erosion control fabrics may be needed to protect vulnerable side slopes from erosion during the construction process.	

Step 4. Any pre-treatment cells should be excavated first to trap sediments.	
Step 5. Excavators or backhoes should work from the sides to excavate the bioretention area to its appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the bioretention area. Contractors should use a cell construction approach in larger bioretention basins, whereby the basin is split into 500 to 1,000 sq. ft. temporary cells with a 10-15 foot earth bridge in between, so that cells can be excavated from the side.	
Step 6. It may be necessary to rip (loosen) the bottom soils to a depth of 6 to 12 inches to promote greater infiltration. (Photo credit: NCSU Stormwater Engineering Group)	

Step 7. If using a filter fabric on the sides, place the fabric with a 6-inch overlap where the ends meet. If an underdrain stone storage layer will be used, place the specified depth of No.57 stone on the bottom, install the perforated underdrain pipe, and place No.57 stone to 3 inches above the underdrain pipe. On top of the No.57 stone, add 2 inches of choker stone (No.8 or No.89 stone) as specified and then construction sand to the specified depth (often 2 to 4 inches) as a filter between the underdrain and the soil media layer. If no stone storage layer is used, start with 6 inches of No.57 stone on the bottom, and proceed with the layering as described above.	
Step 8. Deliver the soil media from an approved vendor, and store it on an adjacent impervious area or plastic sheeting. Apply the media in 12-inch lifts until the desired top elevation of the bioretention area is achieved. If heavy machinery is used, make sure the machinery works from the edges to avoid compacting any soils or side slopes. Filter media should be hydraulically compacted to avoid future settling. This process involves flooding the soil media after the initial installation to facilitate settling under natural operation conditions. Wait a few days to check for settlement, and add additional media, as needed, to achieve the design elevation. Plantings and mulch will raise the elevation, so where necessary adjust the design elevation to compensate for the soil volume of new plants.	
Step 9. Prepare planting holes for any trees and shrubs, install the vegetation, and water accordingly. Install any temporary irrigation.	

Step 10. Place the surface cover (double shredded mulch, river stone or turf), depending on the design. If coir or jute matting will be used in lieu of mulch, the matting will need to be installed prior to planting (**Step 9**), and holes or slits will have to be cut in the matting to install the plants. Side slopes should be graded to a preferred maximum slope of 3:1 and capped with at least three inches of topsoil and appropriate much or matting.	
Step 11. Install the remaining plant materials as shown in the landscaping plan, and water them during weeks of no rain for the first two months.	
Step 12. If curb cuts or inlets are blocked during bioretention installation, unblock these after the drainage area and side slopes have good vegetative cover. It is recommended that unblocking curb cuts and inlets take place after two to three storm events if the drainage area includes newly installed asphalt, since new asphalt tends to produce a lot of fines and grit during the first several storms.	
Step 13 Conduct the final inspection, then log the GPS coordinates for each bioretention facility and submit them for entry into the local maintenance tracking database.	

Critical Inspection Points in the Sequence

There are several points during the construction process where inspection is necessary to ensure proper installation that if are not handle properly will result in failure of the bioretention area. The following are key stages in the construction sequence that are important for review:

- Verify the actual contributing drainage area (CDA) boundaries and that the CDA is adequately stabilized and/or secondary erosion control measures installed around perimeter of bioretention or inlet blocked during installation
- Confirm inlet and outlet elevations
- Confirm inflow actually captures runoff
- Check quality of filter media and that it meets specifications
- Make sure stone is washed and not laden with grit and fines
- Check underdrain elevations, slope, pipe connections, perforations and caps
- Confirm final ponding depth and proper grading and stabilization of side slopes
- Conduct full inundation test to inspect underdrain/outflow function (sinking and final grades)

Sometimes it is not possible to get an inspector out to the site for each stage of the construction inspection process. Some communities have developed innovative ways to ensure that the bioretention facilities are being constructed properly. One community in particular requires digital photographs of the bioretention facility during critical points in the construction process to be submitted to the locality in lieu of an inspector's visit. However, this is usually employed on sites where the locality has inspected several facilities during construction and is sure that the contractor and crew have a full understanding of what is required during installation. Otherwise, onsite inspection by either municipal reviewers or certifying engineers is strongly recommended.

Additional Resources

For additional information on the proper construction sequence and sound construction practices for bioretention and other LID practices, please visit the Chesapeake Stormwater Network's website where you can watch the video ***LID Stormwater Construction Practices: A Guide to Proper Construction Techniques for contractors, local governments and involved homeowners.***

The video is available at the link below: http://chesapeakestormwater.net/training-library/design-adaptations/stormwater-bmp-maintenance/

The Center for Watershed Protection has created a BMP Construction Checklist as a supplement to their Post-Construction Guidance Manual. The checklists are designed to be used by stormwater program managers, design consultants, plan reviewers, inspectors, and parties responsible for maintenance and are available for free download from their website: www.cwp.org.

Section 3
Making Sure it Still Works: The Visual Indicators Framework

The framework relies on a series of simple visual indicators to rapidly assess the maintenance condition and hydrologic function of a bioretention area. Each indicator is associated with a series of numeric triggers to classify the maintenance condition of the practice, and used to quickly put together a punch list of actions to restore its original performance.

If the visual indicators thresholds indicate that the practice has severe maintenance problems (or a series of moderate ones), it receives a "failing" grade, and a more in-depth investigation is triggered to diagnose the cause of the maintenance problem and an action plan to fix it (**Section 6**).

The Overall Framework

The visual inspection framework should be employed during every stage of the lifecycle of a bioretention area, including:

- Construction Inspection
- Project Acceptance
- Maintenance Checkups
- Periodic Local Inspection
- BMP Performance Verification
- Forensic BMP Investigations

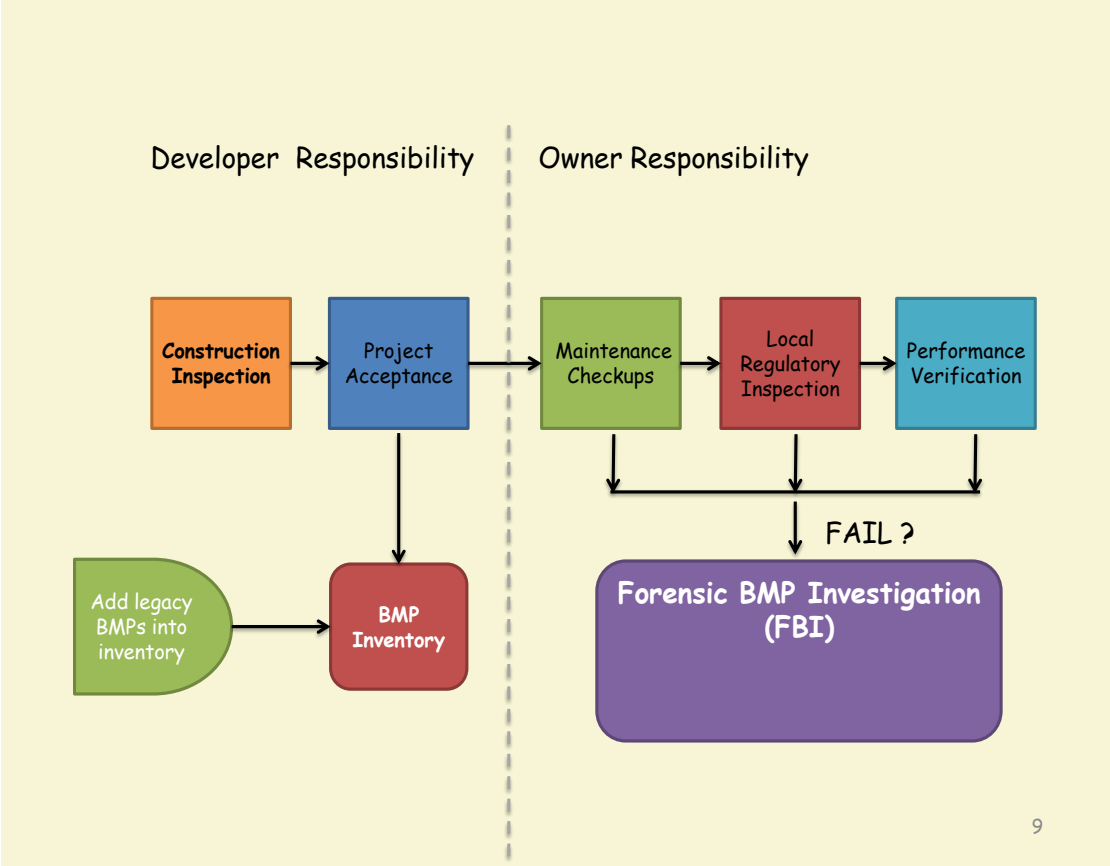


Figure 4. The Visual Inspection Framework

Each kind of inspection assesses the function of the bioretention area for a slightly different purpose. Figure 4 shows how the different types of inspection interconnect with each other to maintain the function of the bioretention area over its design life.

Construction Inspection

Construction inspection takes place during several specific points in the construction sequence of any bioretention area. It is a critical phase to ensure that the project is built to its design specifications, and any changes made in the field are acceptable. The construction inspection is normally performed by a trained professional that works for the local stormwater management review authority.

Project Acceptance

Project acceptance is a visual inspection that takes place about 12 months after the construction phase is over to make sure it is still working and meeting its landscaping objectives. If so, the practice is accepted by the local stormwater management review authority and any remaining performance bond is released and the maintenance responsibility is shifted to the property owner. Many communities may want to extend the duration of the performance bond until the project is finally accepted (or at least

require a care and replacement warranty for the landscaping). For more detail on project acceptance inspections, refer to **Section 5**.

Maintenance Checkups

Routine maintenance checkups occur 2-4 times a year as part of a regular maintenance visits and are used to immediately correct minor maintenance problems. The checkups are also used to provide quality control on maintenance activities, determine whether the landscape contractor needs to schedule a follow up visit to repair moderate maintenance problems and alert owners about any severe maintenance problems that require the attention of a more qualified stormwater professional. The use of visual indicators in routine maintenance checkups is discussed in **Section 5.**

Local Regulatory Inspection

Routine inspections of bioretention area may be required as part of a local MS4 permit and usually occurs once every 3-5 years, as designated by the state permit authority. They are conducted to ensure that the BMP is in regulatory compliance, which is defined as being properly maintained and functioning as designed. A routine inspection is conducted by a trained individual as defined by the local permitting agency. More information can be found in **Section 5**.

Performance Verification

Performance verification inspections occur if the BMP is being used to achieve pollutant reductions needed to help meet load allocations under a local and/or Bay-wide TMDL. This rapid inspection is done in conjunction with the local regulatory inspection to verify that the BMP still exists, is adequately maintained and is operating as designed. Verification inspections will typically occur once every other MS4 permit cycle (or about every 5 to 10 years). More information about verification inspections can also be found in **Section 5**.

Forensic BMP Investigation

A Forensic BMP Investigation, or “FBI”, is employed to diagnose why a practice is failing or has failed, and then come up with a plan to bring it back into compliance. These specialized assessments require a skilled stormwater professional to find and fix any severe maintenance problems discovered at a bioretention area. More details on the different methods to conduct a FBI can be found in **Section 6.**

The remainder of the sections in this technical bulletin walks through a detailed description of the different inspection categories.

Section 4
Visual Indicators for Bioretention

The visual indicators approach allows for a rapid assessment of the bioretention in 10 to 30 minutes by following a prescribed sequence of items to look for. Each of these 'visual indicators' is assessed based on a set of numeric triggers and assigned a grade of Pass, Minor, Moderate or Severe. This assessment results in a punch-list of maintenance tasks to be conducted in order to bring the bioretention area up to speed or in the case of a 'severe' rating, requires a forensic BMP investigation.

Table 9 outlines the 18 visual inspection indicators used for bioretention and identifies which types of inspections they generally apply to.

Table 9. Visual Indicators for a Bioretention Practice

No.	INDICATOR	Construct	Accept	Maintain	Verify	FBI
1	Inlet Obstruction		X	X	X	X
2	Erosion at Inlet		X	X		X
3	Pretreatment	X	X	X		X
4	Structural Integrity, Safety Features		X	X		X
5	Surface Area	X	X	X		
6	Side slope Erosion		X	X		X
7	Ponding Volume	X	X	X	X	X
8	Bed Sinking		X	X	X	X
9	Sediment Caking		X	X	X	X
10	Standing Water		X	X	X	
11	Ponding Depth	X	X	X	X	X
12	Mulch Depth/Condition	X	X	X	X	
13	Trash			X		
14	Bed Erosion		X	X		
15	Vegetative Cover	X	X	X	X	X
16	Vegetative Condition		X	X		X
17	Vegetative Maintenance		X	X		
18	Outlets, Underdrains, Overflows	X	X	X	X	X

Applying the visual indicators during an inspection is best done in a prescribed sequence to systematically evaluate the bioretention area. Each of the indicators has been assigned to a "zone" or area within the bioretention area that corresponds with the sequence that the inspector would follow during assessment:

- Inlet zone
- Side slope zone
- Bed zone

- Vegetation zone
- Outlet zone

Figure 5 shows where the five different inspection zones are located within a typical bioretention area.

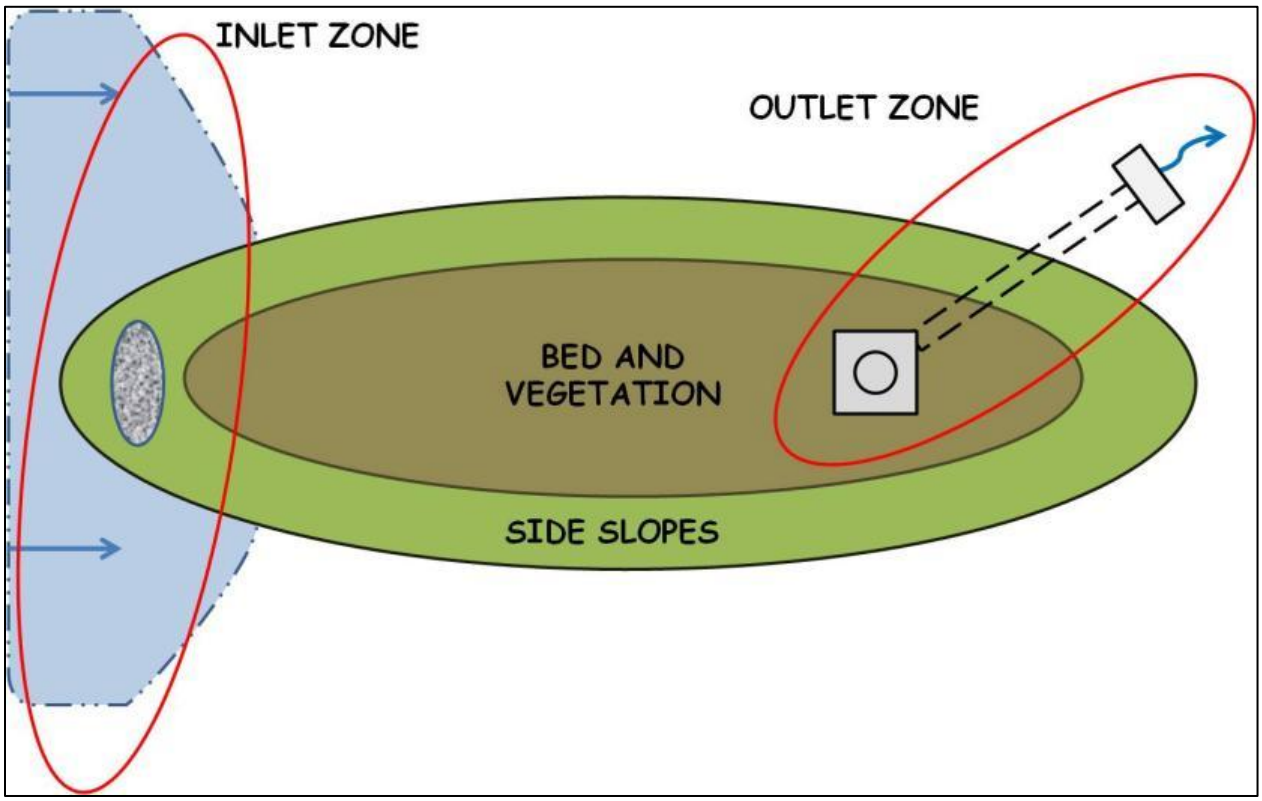


Figure 5. An overhead shot of a typical bioretention area with the inspection zones

Although each of the indicators should be assessed during an inspection, often an inspector will be able to immediately see any key trouble spots occurring with the bioretention. These *primary* or key indicators can inform the inspector instantly whether the bioretention is operating on a most basic level. Once these key indicators have been reviewed the inspection can proceed to assess the remaining indicators. The key indicators for a bioretention area are:

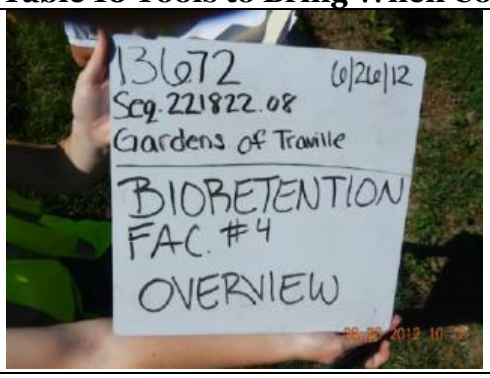
- Erosion within the bioretention
- Standing water anywhere in the basin
- Sediment or debris blocking inlets or outlets and causing
- Lack of or inappropriate vegetation

By assessing the individual components of the facility in this manner, it is possible to comprehensively yet rapidly evaluate the functionality of the entire bioretention area.

Tools for Visual Inspections

For any visual inspection there is a standard process and set of equipment that can help facilitate the process. It is beneficial to have a whiteboard and a digital camera to note observations in the field and document the inspection. For inspecting the facilities from the ground surface, there are many different tools that can be of benefit, the most necessary of which are listed in Table 10.

Table 10 Tools to Bring When Conducting Inspections

	
White board and digital camera: Used to note observations made in the field and rapidly record them	*Manhole lifting device (i.e., pick, hand hook, etc): Used to open manholes or other structures associated with the bioretention area*
Various wrenches (channel lock wrench, socket wrenches): Used to open observation pipes, monitoring wells etc.	*Soil auger: For investigating soil conditions at a site and the soils ability to infiltrate*
Measuring tape & 100' tape: Used to measure the surface area and depth	*Shovel and rake: Used to inspect the mulch and media of the bioretention*

Other tools that may come in handy:

- Dip-sticks (chimney stick): To measure sediment
- Plant ID Sheet: To identify native and invasive species
- As-builts/site plans
- Safety vests
- Bug spray
- Flashlight for inspecting observation wells, cleanout pipes and other dark areas
- Authorization letter

More specialized tools and equipment are needed for routine maintenance checkups and forensic BMP investigations.

Visual Indicators Profile Sheets

Appendix A provides a series of profile sheets outlining each of the each of the visual indicators used to inspect bioretention areas. Each profile sheet describes the visual indicator, its purpose, pictures demonstrating the different grading categories, the maintenance triggers and the corresponding task or investigation needed to maintain or repair the facility. There is also a checkbox on the left hand side of each profile sheet that indicates to which inspection category the visual indicator can be applied.

Punch List Tool

CSN is currently working on the development of a spreadsheet based tablet tool that would create an automatic punch list of immediate and follow up maintenance tasks that need to be performed as a result of the inspection. This tool is under development and is expected to be completed in the summer 2013.

Section 5
Inspections and Maintenance

5.1 The Establishment Phase and Final Inspection

Project acceptance for bioretention is a visual inspection that takes place during the landscape establishment phase, typically 12 months after installation. The inspection is used to determine whether the locality will accept the facility, and release any remaining performance bonds*. The inspection is needed to ensure that the practice and landscaping are acceptable and functioning as designed.

This is a critical phase, since many bioretention areas will encounter some problems in the first year, particularly in establishing vegetation. Certain unforeseen weather events such as severe winters or extreme drought may make it hard for the vegetation to thrive.

The inspection is normally conducted for the local stormwater management review authority by either an engineer or a landscape architect at the culmination of the construction process, at which time the maintenance responsibility is shifted over to the property owner or responsible maintenance entity (Figure 6).

Figure 6. The Project Acceptance Process

The landscape establishment phase extends through the first growing season, and is usually covered by a landscape care and replacement warranty therefore this inspection should be completed before the plant warranty ends.

Inspectors use the full range of the 18 visual indicators discussed in **Section 4** to decide whether to accept the facility. The bioretention area should be inspected after a decent

sized storm to ensure it is operating correctly for the design storm and bypassing larger events.

Some typical tasks to accomplish during the establishment phase include:

- Regular watering if it has not rained in two weeks
- Spot re-seeding and removal/replacement of dead plants
- Remove any sediment accumulation at inlets or the bed
- Repair erosion on side-slopes
- Perform any minor or moderate maintenance tasks, as triggered by any visual indicator.
- Correct any severe maintenance problems in response to a forensic BMP investigation.

The inspector should certify that the desired vegetative cover has been achieved, confirm that the ponding depth and volume meet the design specs, and determine whether a practical overflow exists. Based on the results, the inspector may also recommend changes to the frequency of future inspections in the landscape maintenance contract to achieve the desired "level of service" for the facility.

Once a facility passes the final inspection, the designer should submit an “as-built” construction plan and local program staff should enter the GPS coordinates into the local stormwater maintenance tracking system. As-builts for a bioretention area should include taking digital photos and recording GPS coordinates for future verification. At this time, the local review authority can release the performance bond.

The final step is to hand off the facility to the owner, ensure a landscape maintenance contract or agreement is executed, and that its key provisions are understood by both the owner and the contractor.

*Please note some localities may not have the legal authority to hold a performance bond for a full twelve months after the bioretention facility has been constructed. But localities should be cognizant of the importance of the vegetation in the pollutant reduction capabilities of a bioretention system and thus should wait as long as legally possible before final approval to ensure a good vegetative cover of the facility.

5.2 Bioretention Maintenance Regime

It can be tempting to prescribe a specific list of maintenance tasks and a fixed schedule to perform them, but in reality most maintenance tasks are performed on demand based on what the inspector/maintainer actually sees. The maintenance regime for an individual practice depends on the desired level of service or amenity, visibility, development intensity and owner preferences. Other factors, such as extreme rainfall events, hard winters and extended droughts, can strongly influence maintenance needs from year to year.

At a minimum, visit the bioretention area at least twice during the growing season to see what needs to be done immediately during the inspection (with hand tools), or schedule a follow up visit to fix any moderate maintenance problems. Table 11 shows a general summary of common maintenance tasks that should be anticipated with any facility, with the proviso that the frequency that they will need to be performed will differ for each facility.

Table 11. Common Bioretention Maintenance Tasks [1]

Maintenance Tasks	Frequency
• Mow grass filter strips and any intended turf cover in bioretention area • Check curb cuts and inlets for any accumulated sediment, leaves, and debris that may block inflow • Remove sediment in pre-treatment cells and inflow points	Mowing: Approximately 6 times a year
• Spot weeding, trash removal, and mulch raking	Twice during growing season
• Add reinforcement planting to maintain desired the vegetation density and/or split out perennials to increase plant cover. • Remove invasive plants using recommended control methods • Remove any dead or diseased plants • Stabilize the contributing drainage area to prevent erosion • Prune trees and shrubs to reduce "bushiness"	As needed
• Conduct a maintenance inspection	Annually
• Perform facility "make-over" to maintain intended landscaping regime and address any moderate or severe maintenance problems detected during routine inspections	Once every 5 to 7 years

[1] loosely adapted from WVDEP Stormwater Design Manual (2012).

Additional Resources

For additional information on how to conduct routine maintenance of LID practices including bioretention and what critical factors need to be checked to make sure they are operating as designed please visit the Chesapeake Stormwater Network's website where you can watch the video ***Stormwater BMP and LID Maintenance: A Guide to Proper Maintenance Practices for Local Government Staff and Landscapers*** available at the link below: http://chesapeakestormwater.net/training-library/design-adaptations/stormwater-bmp-maintenance/

Montgomery County Department of Environmental Protection has also created a series of fact sheets on maintenance of LID practices which are free for download and can be accessed here:
http://www6.montgomerycountymd.gov/dectmpl.asp?url=/content/dep/water/stormwaterfacility_new.asp#ESDLIDfactsheets

5.3 Regular Maintenance Checkups and Repair

Routine maintenance checkups occur 2-4 times a year as part of a regularly scheduled maintenance visit and are necessary in order to provide quality control on maintenance activities and/or to alert owners of any major problems that may be developing. The purpose of a routine maintenance checkup is to "catch" minor problems before they turn into more serious problems. The checkup is usually conducted by the same landscape contracting company that provides ongoing maintenance or the property manager (Figure 7).

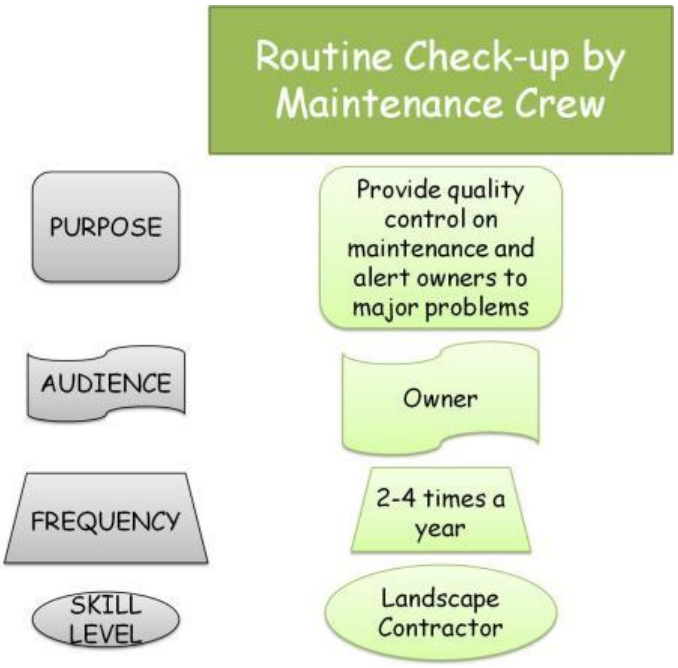


Figure 7: Key Elements of Routine Check Up by the Maintenance Crew

The other key purpose of the checkup is to train the crew so they can figure out what immediate maintenance tasks to perform during their visit, and whether a follow-up visit needs to be scheduled to correct any moderate maintenance problems that are encountered (i.e., that may require re-mulching, media replacement, spot repairs). If a follow-up visit is warranted, the crew should take notes on the materials and equipment needed to perform the repairs.

If the crew discovers a severe maintenance problem during their visit, they should flag it in their notes, and make sure to notify the owner or local stormwater authority that a more skilled inspector needs to perform a forensic BMP investigation (**Section 6**).

Additional Resources

For additional information on how to conduct routine maintenance of LID-type stormwater management practices including bioretention and commonly encountered maintenance problems with potential solutions for remediating them please visit the Chesapeake Stormwater Network's website where you can watch the video ***Stormwater BMP and LID Maintenance: A Guide to Proper Maintenance Practices for Local Government Staff and Landscapers*** available at the link below: http://chesapeakestormwater.net/training-library/design-adaptations/stormwater-bmp-maintenance/

5.4 Local Regulatory Inspections

Local regulatory inspections are conducted to ensure the practice is properly maintained and functioning as originally designed. Most regulatory inspections are done by the local governments to satisfy their MS4 permit requirement to inspect all the practices in their local BMP inventory to make sure they are still in regulatory compliance.

The required interval for performing regulatory inspections differs among the Bay states, but typically ranges from 1 to 5 years. The inspections are typically performed by local government inspectors, although it is increasingly common to hire private contractors to perform the service (Figure 8).

The basic technique is to assess the facility using the visual indicators, but the inspector will also look more closely at construction drawings and ensure that other connected stormwater practices, both above and underground, are functioning properly. If the inspector finds that facility has no or only minor maintenance problems, the facility passes, and is considered in compliance. The inspector enters the data into the local BMP tracking database, and moves on to assess the next practice.

On the other hand, if the inspection reveals more than two moderate maintenance problems or a single severe maintenance problem, the facility is deemed to fail. The inspector then sends the owner a letter indicating that their facility is non-compliant (and the reasons why), and gives them a specified interval to make the needed repairs. In some cases, they may also provide a list of qualified/certified maintenance contractors that can assess the problem and actually perform the repairs.

If the owner fails to make the repairs by the deadline, there may be enforcement actions. The nature and severity of the enforcement actions differ in many Bay communities, but may include fines, liens on property, loss of stormwater utility discounts, or direct billing to the owner for third party repairs.

Several local maintenance enforcement options are outlined in Technical Bulletin 11, most start with a heavy dose of education as to why the practice is needed to protect the Bay, and how it is supposed to work.

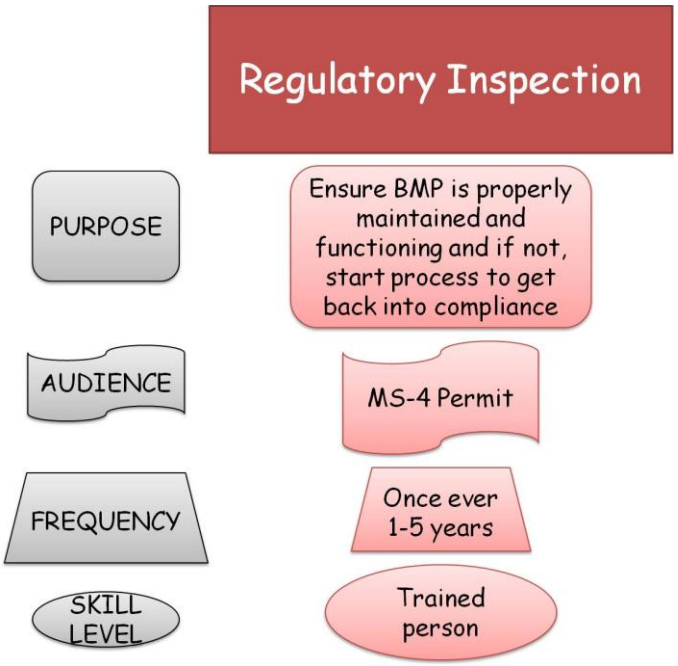


Figure 8. Key Components of Local Regulatory Inspections

5.5 BMP Performance Verification

Another kind of regulatory inspection is needed to verify that the bioretention area still exists, is adequately maintained and is operating as designed, and therefore can continue to earn its pollutant reduction credits, in the context of either a local or Bay-wide TMDL.

The performance verification as seen in Figure 9 is conducted at the same time as the required local regulatory inspection using the same visual indicators but is only needed once every other permit cycle, as mandated in the local MS4 permit (typically every 9-10 years). Since the performance verification is "piggybacked" onto regularly scheduled regulatory inspections, it requires little or no additional work, just a different level of reporting.

In the Chesapeake Bay Watershed, BMP performance verification is required to continue to receive pollutant reduction credits that help meet the Chesapeake Bay Total Maximum Daily Load (TMDL).

For more information on verification protocols, visit our website and download the CBP Urban Stormwater Workgoup's Final Recommended Principles and Protocols for Urban Stormwater BMP Verification here: http://chesapeakestormwater.net/bay-stormwater/baywide-stormwater-policy/urban-stormwater-workgroup/. Individual states will be rolling out their specific BMP verification requirements in the next year or so, so make sure to consult with your state stormwater agency.

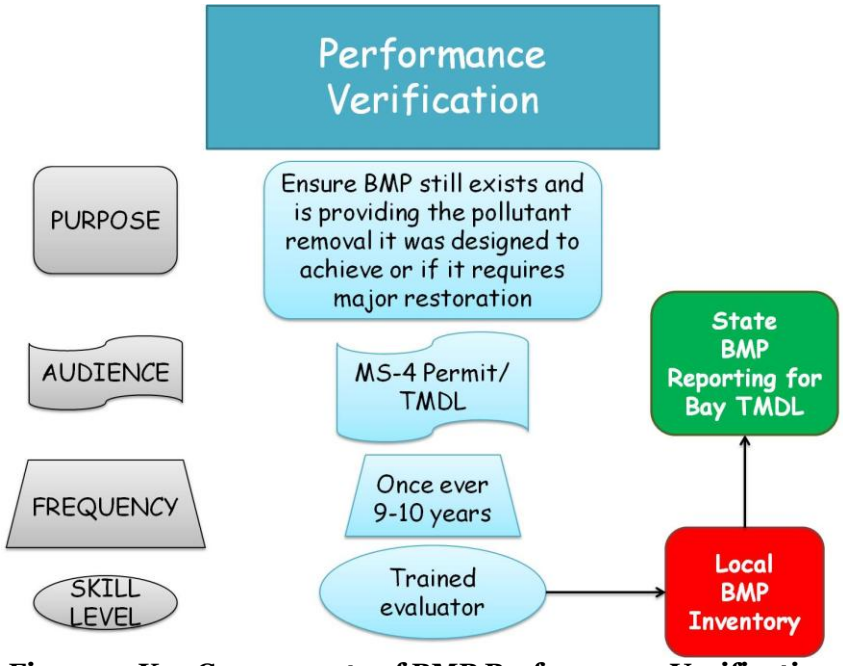


Figure 9. Key Components of BMP Performance Verification

Performance verification uses a subset of the list of visual indicators that assess the hydrologic function and pollutant removal capability of the bioretention area, by answering three simple questions:

1. Does it still physically exist? i.e., can you find it and are the conditions and cover in the contributing drainage area still the same?

2. Is it still operating to treat and reduce runoff as it was originally designed?

3. Is the maintenance condition sufficient to still support its pollutant reduction functions?

Table 12 indicates the 9 specific visual indicators that are used to answer the questions above. A "severe" maintenance problem detected for one or more of these indicators, means that the facility fails and will lose pollutant removal credits unless it is brought back into compliance.

Table 12. Key Visual Indicators for Performance Verification

Hydrologic Condition	Severe Bed Sinking	Runoff moves too quickly through the bioretention
	Severe Inlet Obstruction	Runoff is not able to get into the bioretention
	Standing Water	Runoff is not fully being treated
	Loss of Surface Ponding Capacity	Runoff is not fully being treated
	Severe Erosion at Outlet	Runoff is bypassing the bioretention

Maintenance Condition	Inadequate Vegetative Cover	Runoff is not fully being treated
	Severe Pretreatment Failure	Reduced longevity of the bioretention
	Severe Inlet or Side Slope Erosion	Sediment delivery to filter bed

Section 6
Forensic BMP Investigations

When a bioretention area cannot meet the minimum performance thresholds (i.e., classified as having severe maintenance problems), it is time for a more in-depth assessment to diagnose the causes of failure and prescribe an effective repair, which is known as a Forensic BMP Investigation, or "FBI".

The party responsible for conducting the FBI will often be the same one that has legal responsibility for maintenance and repairs of the facility. Therefore, it may not be appropriate for a FBI to be performed by the same party that performs the routine inspections.

The purpose of the FBI is to diagnose why the bioretention is not working and how it can be fixed. If a bioretention is considered to be "failing" due to one or more severe indicators then most likely a follow-up visit by an engineer, landscape architect, or contractor with relevant project experience will be required. Several indicators can trigger an FBI, as shown in Table 13.

Table 13. Key Visual Indicators that Trigger an FBI for Bioretention

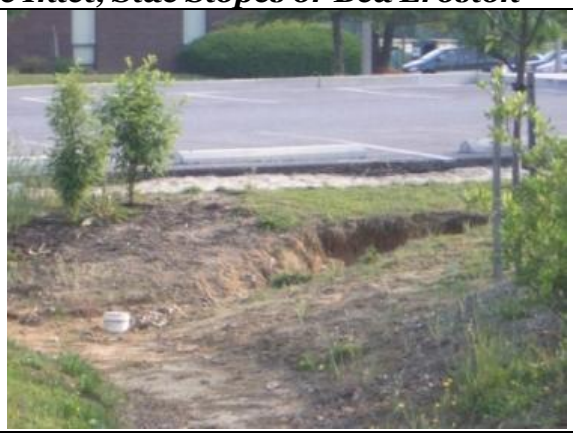
No.	INDICATOR	Status
1	Severe Inlet Obstruction	Most runoff cannot enter the facility
3	Inadequate or Lack of Pretreatment	Severe accumulation of sediment in facility
4	Structural Integrity	Facility or adjacent infrastructure at risk of failure
2, 6, 14	Severe Inlet Erosion, Sideslope or Bed	A foot or more of gully erosion
5, 7, 11	Severe Design Departures	More than 25% departure from design assumptions for surface area, ponding depth and/or contributing drainage area
8	Severe Bed Sinking	A foot or more of localized bed sinking and/or sediments observed in underdrain
9	Severe Sediment Caking	More than two inches of deposition in the facility
10	Severe Standing Water	More than 3 inches of ponding 72 hours after rain
15	Severe Vegetative Cover	35% or less vegetative cover

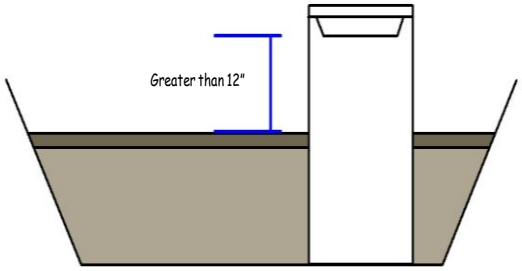
The goal behind the FBI approach to bioretention problems and repairs is to quickly identify why the bioretention facility is not working and how it can be fixed instead of turning the failed facility into an expensive engineering project. FBIs only occur when a field inspection shows that the bioretention facility is not functioning as designed.

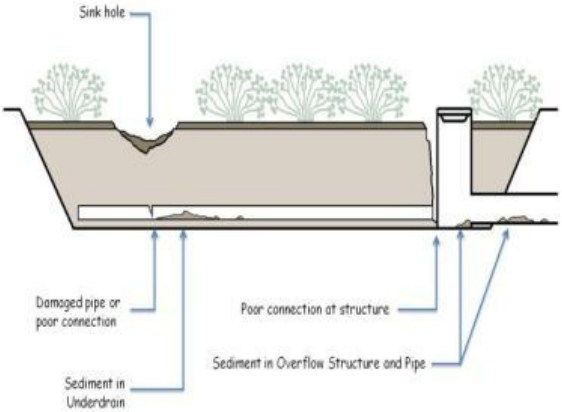
Indicator #1: Severe Inlet Obstruction	
Problem: Severe accumulation (greater than 3") of sediment or debris at the inlet so that most of the runoff cannot enter the bioretention facility. Photo on the left shows sever sediment build-up in the crevices between the stones.	
Solution: Locate source of the sediment, mitigate and evaluate the need for enhanced pretreatment. Remove riprap, stone, or mulch contaminated with sediment. Clean all sediment from the inflow area. If riprap is used, clean off and replace with original stone, supplemented as needed. If stone or mulch is used, add new material to attain appropriate elevations and flow characteristics. Check inlet elevations and adequate drops from pavement edge to inlet channel. Inlet may need to be reshaped to have adequate drop or slope to filter bed surface so it is not prone to routine clogging. Arrange for more frequent cleaning of sediment from inlet.	

Indicator #3: Inadequate or Lack of Pretreatment	
Problem: Severe accumulation of sand or sediment within the bioretention facility or the pretreatment area. Evidence of standing water in the pretreatment area or bypass of the bioretention facility altogether.	
Solution: Locate the source of the sediment, mitigate and evaluate the need for enhanced pretreatment, corrected or more frequent maintenance, and/or design remediation. In many cases, ensuring that maintenance personnel are removing minor amounts of sediment while performing routine maintenance can help correct the lack of pretreatment.	

Indicator #4: Structural Integrity
Problem: Curbs, pavement, or drainage structures are damaged to the point where it impairs the function of the bioretention.
Solution: Schedule a visit by a project estimator with relevant project experience to develop a solution and conduct repairs. Depending upon the type of structure involved, such as with a retaining wall, an engineer may need to be consulted to design a solution.

Indicators #2, #6, #14: Severe Inlet, Side Slopes or Bed Erosion	
	
Problem: A foot or more of gully erosion at the inlet or in the bed of the bioretention facility. Greater than 3" of erosion in the side slopes.	
Solution: In general, the solution is to determine the cause of the erosion and repair it. This differs depending on where the erosion is occurring. At the inlet, it may be necessary to implement protection measures to ensure that runoff is being dissipated and prevented from entering the facility in a concentrated flow or to extend the protection onto the flat bed area. On the side slopes of the bioretention, it may be necessary to re-grade and evaluate the topsoil and vegetation to determine if there is sufficient vegetative cover to stabilize the slopes. When erosion occurs within the bed of the facility, it is necessary to evaluate the flow patterns and the condition of the bed materials to determine if they are appropriate for the runoff volume. Supplemental protection may be required to match the flow conditions. Soil media should be utilized for any bed repairs to ensure the intended flow characteristics are preserved.	

Indicators #5, #7, #11: Severe Design Departures	
	
Problem: A greater than 25% departure from the design assumptions for surface area, storage, ponding depth or contributing drainage area.	
Solution: Conduct a topographic survey and consult site plans to determine the cause and degree of the deviation. In the case of ponding depth, adjust grade by removal or addition of mulch and/or media. In the case of surface area and storage, re-grade the facility to meet design areas and volumes. If increasing the surface area, evaluate the dewatering capabilities of the existing soil media area and adjust accordingly. In the case of changes to the drainage area, delineate the actual CDA, re-compute the facility performance, and modify as needed to meet minimum design criteria.	

Indicator #8: Severe Bed Sinking	
	
Problem: Greater than 1' of localized bed sinking and/or sediment is observed in the underdrain or overflow. The discovery of sediment in the underdrain or overflow structures indicates the movement of sediment through the facility.	
Solution: Severe bed sinking is often a result of breached material layers, poor connections, or damaged pipes within the bioretention facility. Conduct a test pit excavation to provide detailed visual examination of subsurface conditions. Test pitting should occur by hand to minimize compaction of the bed. Make sure dissimilar materials are kept separate and not cross contaminated during the test pitting operation. Be prepared to repair the system (i.e., with new filter cloth or choker stone) to full functionality at test pit completion. Remove mulch, and evaluate the soil media for sediment and/or discoloration throughout the profile. Once through the soil media, cut filter cloth or hardware cloth or, if choker stone is used, remove the next level of stone to gain access to the underdrain stone. Look for voids, loss of material, staining or failure of any of the layers. There should be no evidence of soil media at the underdrain stone layer. If needed, excavate to the underdrain pipe and check pipe and joint condition. All materials should be replaced in appropriate layers to ensure full intended functionality without cross contamination of the individual material layers.	

Indicator #9: Severe Sediment Caking
Problem: Greater than 2" of sediment deposition within the bioretention facility or a hard-pan surface due to sediment sealing the surface of the mulch or soil media.
Solution: Sedimentation in the bioretention facility can result from a variety of causes. It can be from a sediment source in the contributing drainage area or from erosion within the facility itself. Conduct a full cleanout of sediment, mulch and soil media in the affected area to depth of 6" within the bed surface or to the point where sediment is no longer observed in the soil media. Identify source of sediment and work to remediate it.

Indicator #10: Severe Standing Water

Problem: Standing water in the bioretention facility 24-48 hours after a design storm indicates the facility is not functioning as designed.

Solution: Confirm that the underdrain pipe is perforated and not blocked. Pump down the water and conduct a test pit excavation (as described in Indicator #8) to investigate the mulch, soil media and possible presence of filter cloth (which should NOT be used a separation barrier between the soil media and underlying underdrain stone layer). All pumping should be discharged through a geotextile bag. Evaluate the condition of the materials and look for signs of sediment and saturation in the soil media profile. First, determine if sediment is clogging the surface of the mulch or soil media. Then determine if the soil media contains too many fines with either a simple field test or laboratory analysis. If filter cloth is present, determine if it is functional and of the correct specification (non-woven geotextile fabric with a flow rate of > 110 gal./min./sq. ft.). If choker stone is present, determine if the in-place stone matches the specification (typically #8 or #89 washed gravel).

Indicator #15: Severe Vegetative Cover

Problem: When the bioretention facility suffers from less than 35% vegetative coverage, dead or diseased plants or overgrown with invasive species.

Solution: Evaluate the cause of the plant failure (soils, species, disease, design) and create a new planting plan based on the outcomes of those findings. The analysis of the plant material should include a soil test to determine if critical parameters, such as pH, organic matter, and moisture are a match for the intended species. For invasive species control, design and implement an eradication plan. Following the remediation, ensure that appropriate plant maintenance, such as mulching, fertilizing, weeding, disease intervention, etc. occurs to avoid a re-occurrence of the failure.

References Cited

CWP and Chesapeake Stormwater Network (CSN). 2008. *Technical Support for the Baywide Runoff Reduction Method*. Baltimore, MD www.chesapeakestormwater.net

Gillette, A. 2013. Personal communication. Landscape Architect. Low Impact Design Studio. January, 2013.

Urban Stormwater Workgroup (USWG). 2012. Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards. 4.30.2012. Chesapeake Bay Program. Annapolis, MD.

West Virginia Department of Environmental Protection (WVDEP). November 2012. West Virginia Stormwater Management and Design Guidance Manual.

Appendix A
Visual Indicator Profile Sheets for Bioretention Inspections

#1

INLET OBSTRUCTION

INLET ZONE

Construction Inspection

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification ✓

Description: Investigate the inlet for sediment, debris or turf that obstructs runoff from getting into the bioretention area.

PASS

This inlet is clean and in good condition.

MINOR

There is a minor amount of sediment and/or debris build up at the inlet.

MODERATE

The moderate amount of sediment accumulation at this inlet indicates an entry problem that could lead to a risk of blockage.

SEVERE

Sediment build-up or staining indicates that water is ponding and a significant amount of runoff is not getting into the facility.

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Free of sediment/debris	None
MINOR	Less than 1” of sediment potentially blocking inlet	Immediately clear inlet of accumulated sediment
MODERATE	1-3” of sediment blocking the inlet	Schedule next visit to remove sediment
SEVERE	3 or more inches of blockage preventing most storms from getting into the bioretention area	Schedule next visit to remove sediment and conduct an investigation of source CDA

#2

INLET EROSION

INLET ZONE

- Construction Inspection
- Project Acceptance ✓
- Routine Maintenance ✓
- Routine Inspection ✓
- Performance Verification

Description: Investigate the inlet for evidence of channelized erosion or scour. This indicator determines if upland erosion is delivering sediment to the bioretention area, and may also indicate improper elevations or a preferential flow path within the facility.

PASS	MINOR
Inlet (stone channel) in good condition, no evidence of erosion.	*Surface runoff from parking lot causing minor erosion of mulch at inlet.*
MODERATE	**SEVERE**
Concentrated flow results in moderate erosion at inlet. Investigation into cause is necessary as could result in more severe condition.	*Scour is occurring at the inlet indicates a possible design flaw.*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	No evidence of erosion at inlet.	None
MINOR	3”– 6” of gully erosion	Rake, mulch and replace media
MODERATE	6”– 12” of gully erosion	Schedule visit to stabilize inlet with fabric or stone
SEVERE	More than 1’ of gully erosion	Do above, but investigate CDA for sediment sources

#3

PRETREATMENT

INLET ZONE

Construction Inspection ✓

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification

Description: This indicator evaluates whether pretreatment exists at the facility and whether it needs to be cleaned out. Pretreatment is necessary to trap sediment and debris before it reaches and clogs the filter bed. Pretreatment methods vary by bioretention design but the visual indicators approach would be similar for all.

PASS	MINOR
This pretreatment measure is free and clear of sediment/debris.	*Slight accumulation of sediment in the pretreatment cell.*
MODERATE	**SEVERE**
Pretreatment measures needed at this facility. Sediment deposition has almost entirely clogged the inlet.	*Lack of pretreatment or inadequate pretreatment has led to facility failure.*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Free and clear of sediment or debris	None
MINOR	Pretreatment capacity is within 10% of design	Remove and dispose sediment from pretreatment cell
MODERATE	As much as 50% pretreatment capacity has been lost or no pretreatment provided	Schedule visit to restore /create pretreatment capacity
SEVERE	Loss of pretreatment capacity (or absence of pretreatment) is compromising facility .....Conduct FBI (**Section 6**)	

#4

STRUCTURAL INTEGRITY

INLET ZONE

Construction Inspection

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification

Description: This indicator assesses whether the facility is causing damage to adjacent pavement and curbs. Flows, scour or water seepage are usually the cause of the damage.

PASS	MINOR
Surrounding curbs and pavement are in good condition.	*Some pavement cracking occurring in surrounding pavement.*
MODERATE	**SEVERE**
Inlet elevation drop too steep leading to erosion within the facility. Reinforcement needed immediately to preventt collapse.	*Major problems with adjacent curbs and/or pavement. Design repair needed.*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Surrounding curbs and pavement in good condition	None
MINOR	A few cracks or isolated deterioration but does not impair facility or infrastructure function	Note in project file
MODERATE	Moderate flaws in structural integrity that are resulting in the facility not functioning properly	Schedule visit to assess and develop repair strategy
SEVERE	Curbs or pavement are damaged and impairing function.	Schedule a visit by project estimator or contractor to conduct repairs

#5

SURFACE AREA

PERIMETER ZONE

Construction Inspection ✓

Project Acceptance ✓

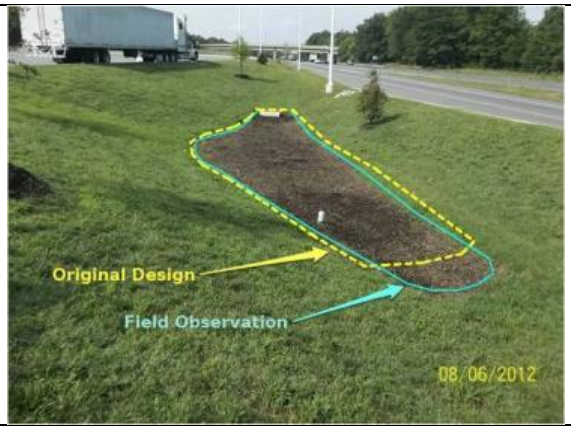
Routine Maintenance ✓

Routine Inspection ✓

Performance Verification

Description: This indicator determines whether the bioretention facility still matches the original surface area of the design. Bioretention facilities that are undersized can lead to the need for more frequent maintenance and repairs.

PASS



The surface area of this bioretention facility slightly deviates from the original design but not significantly to impact the pollutant reduction functions of the facility.

SEVERE

Inspectors measure the surface area of a bioretention facility.

The surface area of this bioretention facility significantly deviates from the original design.

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Surface area matches design	None
MINOR	Surface area 5-10% different from design	Note in project file.
MODERATE	Surface area 10-25% different from design	Check to see if easement exists
SEVERE	Surface area >25% different from design	Conduct analysis to see if surface area can be increased, if performance bond is still active, and if facility is within limits of easement

#6

SIDE SLOPE EROSION

PERIMETER ZONE

Construction Inspection

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification

Description: This indicator evaluates the stability of the side slopes of the bioretention area which should be 3:1 or flatter. Erosion of the side slopes can indicate a problem with grading or incoming runoff velocities and may require better inflow protection measures.

PASS	MINOR
There is no evidence of side slope erosion occurring in this bioretention.	*There is minor side slope erosion occurring as a result of overland flow of water into the bioretention facility.*
MODERATE	**SEVERE**
The side slopes in this bioretention are too steep which is causing moderate erosion.	*Severe side slope erosion is occurring.*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	No evidence of side slope erosion.	None
MINOR	Isolated rill erosion, less than 1”	Spot soil replacement and reseeding.
MODERATE	Gully erosion of 3” or less at several points on the slope	Schedule visit to fill gullies (and replant, stabilize), add inflow protection measures.
SEVERE	Gully erosion greater than 3” at any point	Investigate whether the gullies are formed by too much runoff.

#7

PONDING VOLUME

PERIMETER ZONE

Construction Inspection ✓

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification ✓

Description: This indicator determines whether the facility is fully utilizing its design ponding capacity or is short-circuiting or not using full ponding depth for some other reason.

PASS	MINOR
Runoff spreads evenly through the entire facility and uses the entire ponding depth	*Water leaves the facility through the gap at the bottom of the outlet structure before having a chance to fill up the basin.*
MODERATE	**SEVERE**
Water that enters the facility leaves before infiltrating into the filter bed.	*Water is unable to enter the facility due to incorrect elevations.*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Runoff fully utilizes entire ponding depth across the facility	None.
MINOR	Effective ponding volume within 10% of original design assumption	Note in project files.
MODERATE	Effective ponding volume is 25% less than design assumption	Schedule a visit to modify facility to increase ponding volume.
SEVERE	Effective ponding volume is >50% less than design assumption	Compare to original design to see if facility still conforms to ponding volume or CDA design assumption.

#8

BED SINKING

BED ZONE

Construction Inspection

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification ✓

Description: This indicator determines whether any localized depressions or sink holes are present within the bed of the bioretention facility. This could indicate potential underground problems with the soil media, filter cloth, the stone layer and/or underdrain.

PASS	MINOR
Even, flat bed, with no evidence of sinking	*Minor, localized sinking occurring*
MODERATE	**SEVERE**
Moderate, localized sinking occurring	*Severe sinking occurring at overflow structure.*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Bed is even with no depressions	None
MINOR	3-6” of localized bed sinking and/ or sediments observed in underdrain	Provide spot mulch and/or media refills, rake level
MODERATE	6”-12” of localized bed sinking and/ or sediments observed in underdrain	Schedule second visit to fill in depressions with mulch and/or media, and replant
SEVERE	>12” of localized bed sinking and/ or sediments observed in underdrain	Check underdrain/overflow for media/soil, and/or conduct test pit near the holes

#9

SEDIMENT CAKING

BED ZONE

Construction Inspection

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification ✓

Description: This indicator determines if sediment caking or deposits exist in the bed that could impair the performance of the facility. This could indicate a source of sediment in the CDA or problems with the pretreatment measures.

PASS	MINOR
Bioretention in good condition. Free of sediment and caking.	*Caking occurring on the bioretention bed surface.*
MODERATE	**SEVERE**
Moderate sedimentation occurring.	*Severe sedimentation occurring; bioretention most likely clogged*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	No evidence of sediment or caking on the bioretention bed	None.
MINOR	<1" of sedimentation or caking occurring within the facility	Rake and remove surface caking.
MODERATE	1-2" of sediment deposition occurring within the facility	Schedule a second visit to remove sediments and check pretreatment and CDA.
SEVERE	More than two inches of deposition in the facility	Conduct full cleanout to depth of 6" within bed surface. Identify and fix sediment delivery problem.

#10

STANDING WATER

BED ZONE

Construction Inspection

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification ✓

Description: This indicator determines if the bioretention facility is functioning properly. Bioretention facilities are designed to fully dewater in 48 hours, and should be free of standing water after as few as 12 hours after most storms. Standing water or evidence thereof indicates a problem within the facility.

PASS

Bioretention in good condition, no evidence of standing water.

MINOR

Saturated soils indicate presence of standing water.

MODERATE

1-3" of standing water after 72 hours

SEVERE

Standing water for more than 72 hours indicates facility failure

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	No evidence of standing water	None.
MINOR	Saturated soils or evidence of obligate wetland plant species	Make a note, and check for at next maintenance visit.
MODERATE	1-3" of standing water after 48 hrs	Note as a potential risk for failure and schedule for more frequent inspection.
SEVERE	>3" of standing water after 48 hrs	Pump down, dig test pit, check fabrics.

#11

PONDING DEPTH

BED ZONE

Construction Inspection ✓

Project Acceptance ✓

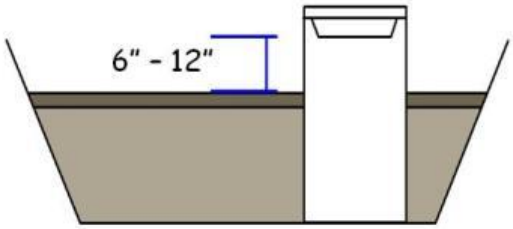
Routine Maintenance ✓

Routine Inspection ✓

Performance Verification ✓

Description: This indicator determines whether the current ponding volume of the bioretention facility matches the design. Ponding areas that are too shallow are an indication that the bioretention does not provide the correct amount of storage whereas ponding areas that are too deep cause a safety and performance problem.

PASS



Ponding depth should be measured and compared to the original design. 6-12" is standard for most bioretention facilities (however ponding depth limits vary by state, check your state stormwater manual for guidance).

SEVERE

The ponding depth of this facility is significantly shallower than originally designed

The ponding depth of this facility is significantly deeper than as originally designed

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Ponding depth matches design	None.
MINOR	Less than 10% departure from design ponding depth of X inches (i.e., 12")	Note in project file.
MODERATE	Plus or minus 4" departure from design ponding depth	Remove mulch/media if too shallow; Add mulch/media if too deep.
SEVERE	More than 25% departure from design	FBI (**Section 6**)

#12

MULCH DEPTH/CONDITION

BED ZONE

Construction Inspection ✓

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification ✓

Description: This indicator assesses the mulch depth and condition in the bioretention area which should be 2-3" deep unless the bed has significant ground cover (>75%). This visual indicator also assesses that there isn't too much mulch in the facility which could lead to nutrient leaching or the loss of ponding depth.

PASS	MINOR
Bioretention in good condition. Good mulch depth and/or ground cover.	*Slight displacement occurring. Replace mulch and/or add ground cover.*
MODERATE	**SEVERE**
Level of mulch is blocking curb inlet.	*10" of mulch indicates maintenance crew not aware of function of facility.*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	2-3" of mulch and more than 75% vegetative cover	None.
MINOR	1" or less of mulch or 65% ground cover	Schedule mulching for next visit
MODERATE	4-5" of mulch or no mulch and less than 50% vegetative cover	Add or remove mulch to design depth (2"-3"). And add more ground cover to meet passing grade
SEVERE	More than 6" of mulch or no mulch and < 35% vegetative cover	Add or remove mulch to design depth (2"-3"). And add more ground cover to meet passing grade

#13

TRASH

BED ZONE

Construction Inspection

Project Acceptance

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification

Description: This indicator determines if the bioretention is filled with trash and needs to be cleaned out. Trash can block important parts of the bioretention like the inlets and outlets as well as take up valuable storage area.

PASS

Bioretention in good condition, no evidence of trash.

FAIL

Bioretention full of trash and needs to be cleaned out.

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Free of trash	None.
FAIL	Significant amount of trash	Remove trash and debris and dispose of appropriately.
CHRONIC FAIL	More than three major cleanouts a year	Evaluate drainage and surrounding area to see if there are any prevention opportunities (trash cans etc.)

#14

BED EROSION

BED ZONE

Construction Inspection

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification

Description: This indicator determines whether erosion is occurring in what should be a flat bed facility. Bed erosion can be a sign of an undersized facility either due to poor design or changes in its drainage area.

PASS	MINOR
Bioretention in good condition – no bed erosion occurring.	*Minor bed erosion or displacement occurring as a result of a larger storm event.*
MODERATE	**SEVERE**
Significant bed erosion occurring leading to a preferential flow path.	*Severe bed erosion demonstrates that the bioretention may be undersized for the amount of volume it is receiving or pretreatment is needed*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Bed is flat and even	None.
MINOR	3-6” of rill erosion	Backfill with soil and cover, add mulch and rake.
MODERATE	6”-12” of gully erosion	Schedule visit to install measures to disperse flows more evenly, rake, backfill and mulch.
SEVERE	>12” of gully erosion	FBI (**Section 6**)

#15

VEGETATIVE COVER

VEGETATION ZONE

Construction Inspection

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification ✓

Description: This indicator determines whether the facility is achieving the desired percentage of vegetative cover. Adequate vegetative cover is critical to reduce runoff and pollutants in a facility. Lack of vegetation can impair the pollutant uptake function of a bioretention area. This indicator can only be assessed during the growing season.

PASS	MINOR
This bioretention has good vegetative cover.	*This bioretention has a few bare spots and could use either spot planting or the addition of mulch.*
MODERATE	**SEVERE**
This bioretention has less than 75% vegetative coverage and is probably not functioning to its full potential	*Vegetation is not growing in this bioretention as a result of it not being an environment conducive to vegetation or poor maintenance is occurring.*

	TRIGGER	TASK/INVESTIGATION
PASS	Good vegetative cover, > 75%	None.
MINOR	Isolated bare spots (< 65% vegetative cover)	Split herbaceous materials, reseed, and add reinforcement plantings.
MODERATE	< 50% vegetative cover	Replant, schedule visit to do a major replanting.
SEVERE	< 35% vegetative cover	Investigate cause of plant mortality. Based on findings, design a revised planting plan for facility.

#16

VEGETATIVE CONDITION

VEGETATION ZONE

- **Construction Inspection**
- **Project Acceptance** ✓
- **Routine Maintenance** ✓
- **Routine Inspection** ✓
- **Performance Verification**

Description: This indicator assesses the health of the vegetation planted in the bioretention facility and checks for the spread of invasive plants. Plants should be healthy and alive and match the original planting plan.

PASS	MINOR
Plants alive and in good condition	*Spot weeding needed.*
MODERATE	**SEVERE**
Plants are dead or diseased in this bioretention facility.	*This bioretention is overrun with invasive plants.*

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Plants alive and in good condition	None.
MINOR	Considerable weeding needed	Weed, replant
MODERATE	Some plants are dead or diseased or some invasive plants.	Determine the cause of plant mortality, replant
SEVERE	Significant plant mortality and/or takeover by invasive species. The objectives of the original planting plan are no longer being met.	FBI (**Section 6**)

#17

VEGETATIVE MAINTENANCE

VEGETATION ZONE

Construction Inspection

Project Acceptance ✓

Routine Maintenance ✓

Routine Inspection ✓

Performance Verification

Description: This indicator assesses what level of vegetative maintenance is occurring at the bioretention area to maintain its function and appearance. The level of maintenance a bioretention facility receives depends largely upon its landscaping regime and landscaping regimes should be considered when contemplating maintenance (**Section 1**).

PASS	MODERATE
Well-maintained	*Tree and/or shrubs overgrown in facility; removal is needed*
MODERATE	**SEVERE**
Major tree and/or shrub removal needed	

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Vegetation is being maintained per its landscaping objective	None.
MINOR	Bioretention is getting a bit bushy, needs some weeding or thinning.	Cosmetic weeding and pruning.
MODERATE	Too bushy, needs harvest of trees, shrubs, or herbaceous material to meet its landscaping objectives.	Schedule a second visit for mowing, tree thinning, and/or reinforcement plantings
SEVERE	Needs major tree/shrub removal	Bush hog the entire facility and replace vegetation.

#18

OUTLETS, UNDERDRAINS, OVERFLOWS

VEGETATION ZONE

- Construction Inspection ✓
- Project Acceptance ✓
- Routine Maintenance ✓
- Routine Inspection ✓
- Performance Verification ✓

Description: This indicator assesses whether the outlets, underdrains and/or overflows are clean, free of obstructions and are working properly. If the outflow device has sediment or debris in it, this is a sign of a more serious problem occurring within the facility.

PASS

This underdrain is mainly free of sediment and debris.

SEVERE

This underdrain is clogged with sediment. Further investigation is needed to determine the cause of the problem.

	MAINTENANCE TRIGGER	TASK/INVESTIGATION
PASS	Outflow device is free of sediment and debris	None.
MINOR	Nominal loss of pipe capacity	Pipe cleanout, flag to investigate during next inspection cycle
MODERATE	Significant loss of pipe capacity	Cleanout pipe and investigate cause.
SEVERE	Outflow device is completely clogged with sediment or debris	FBI (**Section 6**)

Appendix B
Visual Indicators for Other LID Practices

This appendix outlines proposed visual indicators for four additional LID practices that have a maximum contributing drainage area of 10,000 square feet:

- Grass Channels
- Filter Strips/Sheet flow to Buffer
- Permeable Pavement
- Subsurface Infiltration

Simpler visual indicators are being developed separately for smaller LID practices, such as on-lot residential disconnections and rain gardens.

B.1. Grass Channels

Grass Channels are vegetated open channels that are used as part of the stormwater conveyance system. Grass channels reduce runoff and manage pollutants by slowing the flow of stormwater through the channel and providing the opportunity for infiltration. Figure B-1 shows a schematic of a grass channel (WVDEP). Figure B-2 is a photo of a Grass Channel in "good condition".

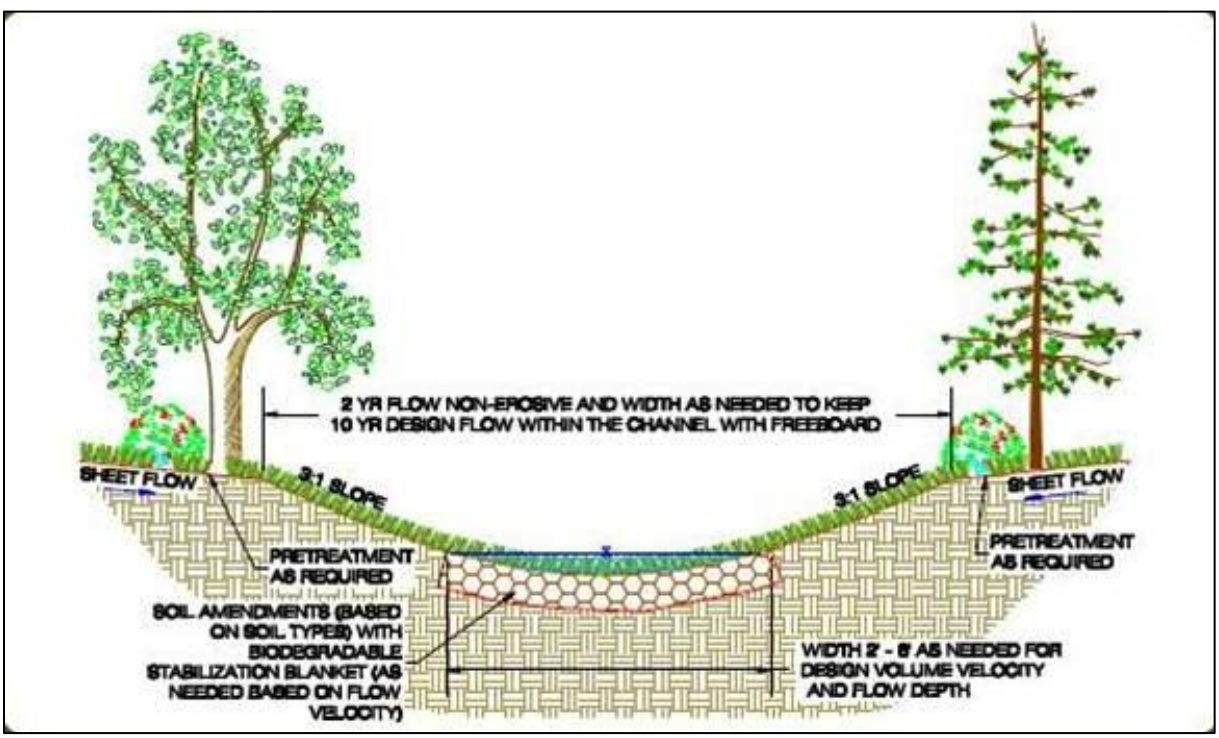
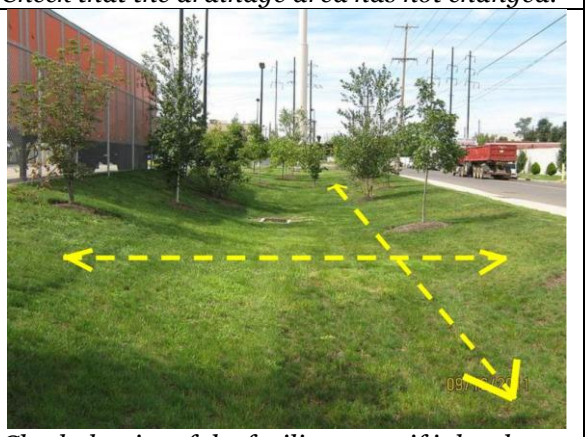


Figure B-1. Schematic of a Grass Channel (WVDEP, 2012)

Figure B-2. Photo of a Grass Channel in Good Condition

Table B-1 outlines the key visual indicators to assess the maintenance condition of grass channels and bioswales, and Table B-2 indicates which indicators are utilized during each of the four different kinds of inspection. Lastly, Table B-3 defines the numeric triggers to classify the maintenance condition of the practice (e.g., pass, minor, moderate or severe problems).

Table B-1 Visual Indicators for Grass Channels and Bioswales[2,3]			
#	**INDICATOR**	**Description & Rationale**	**Picture**
1	CDA Condition	Has the area or land cover in the CDA materially changed from original design assumptions?	 *Check that the drainage area has not changed.*
2	Surface Dimensions	Has the width and length of the swale remained the same?	 *Check the size of the facility to see if it has been altered.*
3	Flow Distribution	Are flows effectively distributed over the width of the swale or is their visual evidence of gully or channel formation?	 *Uneven or concentrated flow causes erosion.*

4	Sediment Deposition	Is there evidence of deposition or caking on the swale bed?	*Severe caking on the channel bed.*
5	Standing Water or Saturated Soils	Any evidence of standing water, ponding, and/or saturation of surface soils w/in the swale 24 hours after storm?	*Standing water in grass channel*
6	Trash/Dumping	Any evidence of excessive trash/dumping that affects aesthetics or interferes with basic mowing operation?	*Styrofoam pieces in facility.*

7	Inlet Obstruction[1]	Any evidence that runoff cannot enter the top or lateral sides of the swale due to sediment/turf build up?	*Sediment accumulation at curb cut inflow.*
8	Inlet Erosion	Any erosion occurring at storm drain pipe or inflow to head of swale?	*Erosion at pavement edge where stormwater enters facility.*
9	Swale Erosion	Any evidence of concentrated overland flow, and/or rill or gully erosion within the swale?	*Severe erosion in the bed of the channel.*

10	Side Slope Erosion	Do swale side slopes show evidence of gully or rill erosion?	*Erosion of side slope.*
11	Vegetative Cover	Does the swale meet numerical targets for turf cover density?	*Bare area in bottom of facility.*
12	Vegetative Condition	Is the facility's vegetation in good condition, and is free of weeds?	*Grass in poor condition.*

13	Check Dams (if applicable)	Are structures intact and providing intended design function? (i.e., no evidence of sediment buildup, hydraulic jump, down-gradient erosion or outflanking).	*Sediment build-up behind check dams.*
14	Outflow Obstruction	If swale discharges to a storm drain or catch basin, is there evidence of clogging, sediment deposition or erosion?	*Inlet in a grass swale covered by debris.*
15	Pavement Edge Integrity	Any evidence that the pavement edge is deteriorating or that utilities or other infrastructure are at risk?	*Erosion at pavement edge.*

[1] Both pipe inflow and lateral inflow from road
[2] Does not include wet swales
[3] Dry swales are inspected using the bioretention VI protocol

Table B-2
Which Visual Indicators Are Used in Each Swale Inspection[1]

#	INDICATOR	Accept	Maintain	Verify	FBI
1	CDA Condition	X		X	X
2	Surface Dimensions	X		X	X
3	Flow Distribution	X	X	X	X
4	Sediment Deposition	X	X		X
5	Standing Water/ Saturated Soil	X	X	X	X
6	Trash/Illegal Dumping		X		
7	Inlet Obstruction	X	X	X	X
8	Inlet Erosion	X	X	X	X
9	Swale Erosion	X	X	X	X
10	Side Slope Erosion	X	X		
11	Vegetative Cover	X	X		X
12	Vegetative Condition	X	X	X	X
13	Check Dams	X	X		X
14	Outflow Obstruction	X	X		X
15	Pavement Edge Integrity		X		X

[1] Swales should be installed per construction sequence, and confirmed using the appropriate state and/or CWP construction inspection checklist which can be accessed at www.chesapeakestormwater.net.
Some limited survey work may need to be done to confirm swale dimensions and acceptable longitudinal and side slopes.

Table B-3:
Defining Numeric Triggers to Classify Swale Maintenance Condition

#	INDICATOR	PASS	MINOR	MODERATE	SEVERE
1	CDA Condition	No increase in CDA or change in surface cover	Within 5% of design assumption	Departs by as much as 15% from design assumption	Departs by more than 15% from design assumption
2	Surface Dimensions	Width and length meet design	Within 5% of design assumption	Departs by up to 15% from design assumption	Departs by more than 15% from design assumption
3	Flow Distribution	100% of width is utilized	75% of width is utilized	Less than 50% of width is utilized	Less than 25% of width is utilized, evidence of channelization for majority of swale length
4	Sediment Deposition	None	A few isolated caking areas	Deposits up to 3 inches deep	Deposits more than 3 inches deep
5	Standing Water or Saturated Soil	None	Soggy soils 48 hours after rain event	Surface ponding of an inch or less, after 48 hours	Surface ponding of an inch or more after 48 hours for at least 10% of swale surface area
6	Trash	None	Some Litter	Very trashy	Dumping
7	Inlet Obstruction [1]	None, all runoff enters facility	Future risk of bypass	Evidence that some runoff may bypass	Most runoff cannot enter facility
8	Inlet Erosion	None	Some rill erosion	Gully erosion of 6 inches or less	Gully erosion more than 6 inches
9	Swale Erosion	None	Some rill erosion	Gully erosion of 6 inches or less	Gully erosion more than 6 inches
10	Side Slope Erosion	None	Some rill erosion	Gully erosion of 6 inches or less	Gully erosion more than 6 inches
11	Vegetative Cover	>90% turf cover	75-90% turf cover	50-75% turf cover	Less than 50% turf cover
12	Vegetative Maintenance	Well-maintained, few weeds	Isolated areas need re-seeding or weeding	Needs major mowing and weed eradication	Needs major mowing or shrub/tree removal or replanting
13	Check Dams	Good Condition	Minor sediment deposits, out-flanking or down-gradient erosion	Some sediment deposits, out-flanking or down-gradient erosion	Problems are so severe that structure function is compromised
14	Outflow Obstruction	None	Nominal loss of pipe or inlet capacity	Needs to be cleaned out	Clogging. No pipe capacity
15	Pavement Edge	Good condition	Minor deterioration	Edge at risk, longitudinal cracking	Edge is broken and is compromised

Note: based on the numerical trigger, specific maintenance tasks or forensic investigations would be recommended (for minor, moderate and severe problems)

B.2. Filter Strips and Sheet Flow to Buffer

Sheet Flow to Vegetated Filter Strips and Sheet Flow to Buffers represent the practice of using adjacent vegetated areas to manage stormwater runoff by slowing runoff velocities and allowing sediment and attached pollutants to settle and be filtered by the vegetation.

Vegetated Filter Strips are an engineered practice designed to receive runoff from adjacent land areas. Buffers are areas of conserved open space, conserved or restored riparian buffers. Figure B-3 is an overhead schematic of how runoff is treated by a filter strip or buffer. Figure B-4 is a photo of a filter strip in good condition.

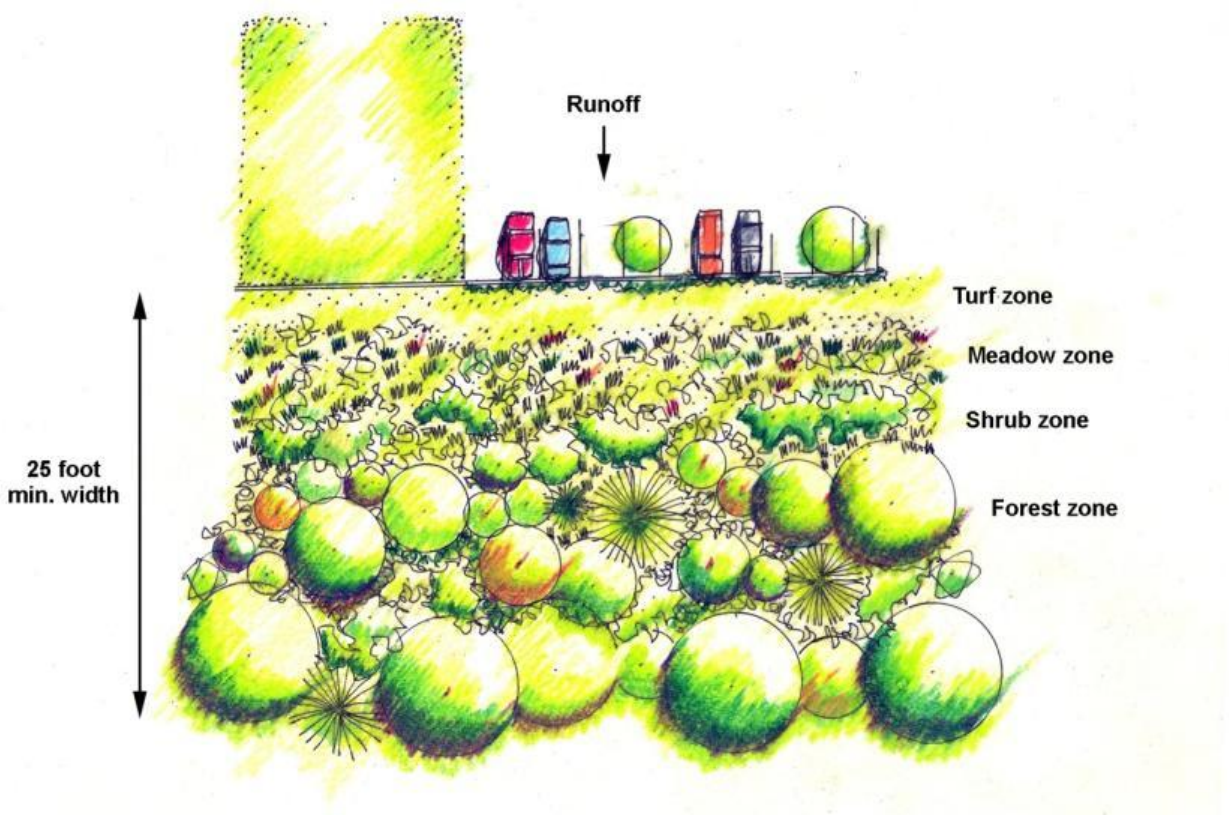


Figure B-3. Schematic of a Filter Strip

Figure B-4. Picture of a Filter Strip in Good Condition

Table B-4 outlines the key visual indicators to assess the maintenance condition of filter strips and sheet flow to buffers, and Table B-5 indicates which indicators are utilized during each of the four different kinds of inspection. Lastly, Table B-6 defines the numeric triggers to classify the maintenance condition of the practice (e.g., pass, minor, moderate or severe problems).

Table B-4
List of Visual Indicators for Filter Strips/Sheet Flow to Buffer

#	INDICATOR	Description & Rationale	Picture
1	CDA Condition	Has the area or land cover in the CDA materially changed from original design assumptions?	*A change in drainage area means a change in the volume of water entering a facility.*
2	Surface Dimensions	Has the width and length of the filter remained the same?	*Measure the length and width of the facility.*
3	Flow Distribution	Are flows effectively distributed over the filter width, or is there visual evidence of channel formation?	*Concentrated flows can cause erosion.*

4	Sediment Deposition	Is there evidence of deposition or caking within the filter?	*Sediment deposition in a facility.*
5	Saturated Soils	Any evidence of saturation of surface soil days after a storm?	*Saturated soil days after a storm indicates poor drainage.*
6	Trash/Dumping	Any evidence of excessive trash/dumping that affects aesthetics or interferes with basic mowing operations?	*Litter in a facility.*

7	Inlet Obstruction	Any evidence that runoff cannot enter the filter strip or level spreader due to sediment/turf buildup?	*Sediment accumulation at a curb cut inflow.*
8	Inlet Erosion	Any evidence of outflanking or erosion below the level spreader?	*Erosion at facility inlet below riprap protection.*
9	Filter Strip Erosion	Any evidence of concentrated overland flow, and/or rill or gully erosion along the filter strip gradient?	*Erosion of a slope.*

10	Vegetative Cover	Does the filter meet its numerical targets for turf or riparian cover?	*Erosion can occur wherever there is a lack of vegetative cover.*
11	Vegetative Condition	Is the filter in good grass or meadow condition and weed- free?	*Vegetation in poor condition.*
12	Level Spreaders	Is the structure intact and providing its intended design function? (i.e., no evidence of sediment buildup, hydraulic jump or out-flanking)	*Accumulation of sediment along a level spreader. Vegetation is growing in the sediment at the edge of the pavement.*

13	Outflow Condition	Does the grass filter effectively transition to a stream buffer or forest?	*Stormwater first flows through the grass filter strip, and then a strip of forest before reaching the stream.*
14	Pavement Edge Integrity	Any evidence that the pavement edge is deteriorating or that utilities or other infrastructure are at risk?	*Erosion at pavement edge.*

Table B-5
Which Visual Indicators Are Used in Each Filter Strip Inspection

#	INDICATOR	Accept	Maintain	Verify	FBI
1	CDA Condition	X		X	X
2	Surface Dimensions	X		X	X
3	Flow Distribution	X	X	X	X
4	Sediment Deposition	X	X		X
5	Saturated Soils	X	X	X	X
6	Trash/Illegal Dumping		X		
7	Inlet Obstruction [1]	X	X	X	X
8	Inlet Erosion	X	X	X	X
9	Filter Erosion	X	X	X	X
10	Vegetative Cover	X	X		X
11	Vegetative Condition	X	X	X	X
12	Spreaders	X	X	X	X
13	Outflow Condition	X	X		X
14	Pavement Edge Integrity	X			X

[1] Filter strips should be installed per construction sequence, and confirmed using the CWP construction inspection checklist which can be accessed at www.chesapeakestormwater.net. Some limited survey work may need to be done to confirm filter strip dimensions and longitudinal slopes.

Table B-6:
Defining Numeric Triggers to Classify Filter Strip Maintenance Condition

#	INDICATOR	PASS	MINOR	MODERATE	SEVERE
1	CDA Condition	No increase in CDA or change in surface cover	Within 5% of design assumption	Departs up to 15% from design assumption	Departs more than 15% from design assumption
2	Surface Dimensions	Width and length meet design	Within 5% of design assumption	Departs up to 15% from design assumption	Departs more than 15% from design assumption
3	Flow Distribution	100% of filter width is utilized	75% of filter width is utilized	Less than 50% of filter width is utilized	Less than 25% of filter width utilized and evidence of short-circuiting
4	Sediment Deposition	None	A few isolated caking areas	Deposits up to 3 inches deep	Deposits more than 3 inches deep
5	Saturated Soil	Soils are dry 48 hours after storm	Soggy soils 12 hours after rain event	Soggy soils 24 hours after rain event	Soggy soils 48 hours after rain event
6	Trash	None	Some Litter	Very trashy	Dumping
7	Inlet Obstruction	None, all runoff enters filter	Future risk of bypass	Evidence that some runoff may bypass	Most runoff cannot enter filter
8	Inlet Erosion	None	Some rill erosion	Gully erosion of 6 inches or less	Gully erosion of more than 6 inches
9	Filter Erosion	None	Some rill erosion	Gully erosion of 6 inches or less	Gully erosion of more than 6 inches
10	Vegetative Cover	Dense turf cover (90%)	Isolated bare spots	Turf cover of 75% or more	Turf cover less than 75%
11	Vegetative Maintenance	Well-maintained	Isolated areas need re-seeding or weeding	Needs major mowing and weed eradication	Needs major moving, shrub/tree removal and/or re-planting
12	Level Spreaders	Good Condition	Minor sediment deposits or down-gradient erosion	Some undercutting or deposits above and/or down-gradient erosion	Problems are so severe that structure function is compromised
13	Outflow Condition	Good, remains as sheet flow	Some isolated flow channelization	Risk of short-circuiting and erosion	Evidence of short-circuiting and erosion
14	Pavement Edge Integrity	Good edge condition	Minor deterioration	Risk of significant deterioration	Pavement or curb stops are compromised

Note: based on the numerical trigger, specific maintenance tasks or forensic investigations would be recommended (for minor, moderate and severe problems)

B.3. Permeable Pavement

Permeable pavements are alternative paving surfaces that allow stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated. Figure B-5 is a schematic of permeable pavement; Figure B-6 is a photo of permeable pavement in good condition.

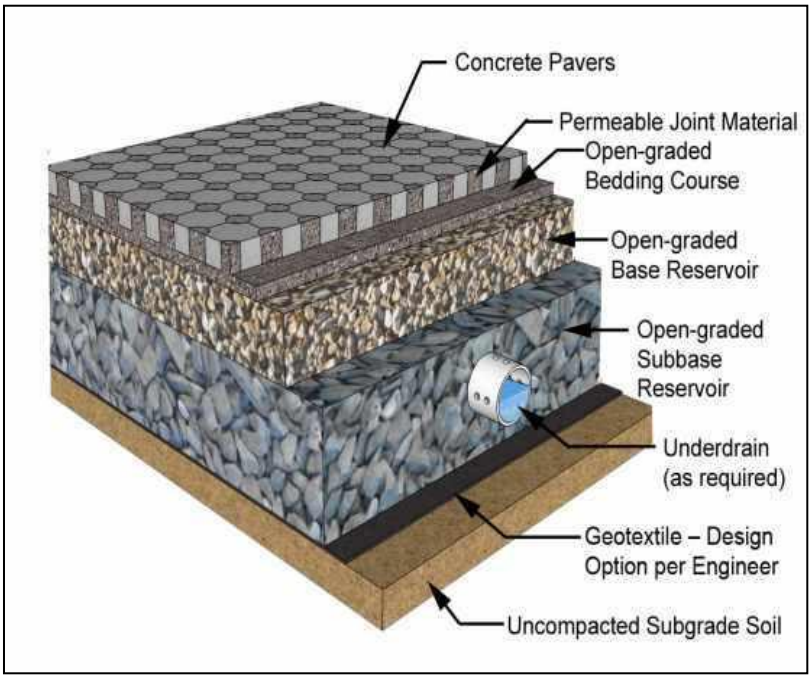


Figure B-5. Schematic Profile for Typical Permeable Pavement Section (Source: David Smith, ICPI).

Figure B-6. Photo of Permeable Pavement in Good Condition

Table B-7 presents the 12 visual indicators that are used to assess the maintenance condition of permeable pavement, and Table B-8 indicates which ones are utilized during each of the four different kinds of inspection. Table B-9 defines the numeric triggers to classify the maintenance condition of permeable pavement (pass, minor, moderate or severe problems).

Table B-7
Permeable Pavement Visual Indicators[1]

#	INDICATOR	Description and Rationale	Picture
1	CDA Run-on	For facilities with a CDA: stable, no exposed soils, no increase in CDA, no mulch or grass clippings discharging to pavement. Upgradient asphalt CDA should be free and clear of grit and fines.	*Contributing drainage area should be clear of materials that might clog porous/permeable pavement.*
2	Pavement Surface Area	Surface area of permeable pavement matches design, and has not been sealed or re-paved with non-permeable materials	*Compare the size of the facility with the plans.*

3	Pavement Sinking	Surface should mach design slope, with no low points or depressions that promote concentrated inflow or indicate stone reservoir is settling	*Sunken area in permeable pavement parking lot.*
4	Surface Clogging	Evidence of sediment or vegetative accumulation on pavement surface or within pavement voids	*Sediment clogging permeable pavement.*
5	Standing Water	Evidence that stormwater is not getting thru the pavement in all or part of the facility	*There should be no standing water on permeable pavement after a rain event.*

6	Pavement Staining	Evidence of hydrocarbons or other pavement staining that could impair performance	*Oil stains on permeable pavement.*
7	Surface Deterioration	Evidence of spalling, cracking or breakup of pavement or paver blocks, in all or part of the facility	*Loose gravel on permeable pavement.*
8	Flow Test	Rapid test to determine whether pavement flow thru is compromised in "at risk" sections of facility	*A flow test checks for clogging on the surface.*

9	Overflow Obstruction	Evidence that runoff from larger storms safely conveys from the facility	*Flooding due to obstruction of overflow.*
10	Underdrain or Observation Well	Evidence of sediment or blockage or poor stormwater clearance after a storm	*Underdrain cleanouts and observation wells should be clear of water after a rain event.*
11	Structural Integrity	Evidence of water-based damage to pavement edge, curbs, sidewalks or infrastructure	*Erosion at pavement edge.*

12	Parking Lot Management Practices	Good practices on parking lot and adjacent CDA (no over-size vehicles, no outdoor material storage, leaky dumpsters, proper winter maintenance (no sand or salt), healthy landscaping, leaking dumpsters, etc)	*Sediment accumulation after snow removal.*
[1] Applies to pervious concrete, porous asphalt and interlocking pavers			

Table B-8
Which Visual Indicators are Used in Permeable Pavement Assessment[1]

#	INDICATOR	Accept	Maintain	Verify	FBI
1	CDA Run-on	X	X	X	X
2	Pavement Area	X		X	
3	Pavement Sinking	X	X		X
4	Surface or Void Clogging	X	X	X	X
5	Standing Water	X	X	X	X
6	Pavement Staining		X	X	X
7	Surface Deterioration	X	X		X
8	Flow Test	X		X	X
9	Overflow Condition	X	X		
10	Underdrain/Observation Wells	X	X	X	X
11	Structural Integrity	X	X		X
12	Parking Mgmt. Practices	X		X	

[1] Permeable pavement should be installed per approved construction sequence, and confirmed using the CWP construction inspection checklist which can be accessed at www.chesapeakestormwater.net.

A simple flow through test should be conducted in at-risk pavement sections

Table B-9
Defining Numeric Triggers to Classify Permeable Pavement Maintenance Condition

#	INDICATOR	PASS	MINOR	MODERATE	SEVERE
1	CDA Run-on	No CDA, or CDA in good condition	CDA, has some isolated spots that generate sediment, grit or fines	CDA in fair to poor condition, and appears to have a risk for sediment, grass clipping or mulch delivery or grit/fines from upgradient non-permeable pavement	Exposed soils, erosion or stored materials in CDA are clearly delivering sediment to pavement
2	Pavement Areas	Matches design	Within 5% of design area	Departs by up to 10% of design area	Departs by more than 10% of design area
3	Pavement Sinking	Surface is flat	A few depressions, less than an inch deep	Localized depressions are up to three inches deep	Widespread sinking or localized depressions more than 6 inches deep
4	Surface or Void clogging	Surface is clean and voids are particle free	Enough particles are present to warrant increased vacuuming	Significant sediment accumulation on surface and or in pavement void spaces	Sediment particles prevent flow through pavement, or vegetative growth observed
5	Standing Water	None	Isolated surface moisture	Ponding on up to 10% of surface	Ponding on more than 10% of surface
6	Surface Staining	No Staining	Isolated water stains	Stains on up to 10% of surface	Stains on more than 10% of surface
7	Surface Deterioration	Good Condition	Deterioration of less than 5% of surface, cracks less than half inch	Problems found on less than 10% of surface, cracks deeper than ½ in	Problems found on more than 10% of surface. Major cracking/separation
8	Flow Test	Not needed	Flow-thru occurs within test period	Testing of all high risk areas (VI 2 to 7)	Flow-thru does not occur within test period
9	Overflow Condition	Good	Minor problems	Partially obstructed	Totally obstructed
10	Underdrain/ Observation Well	Clean	Minor deposits, no dry weather flow	Dry weather flow and/or sediment/gravel accumulation	Evidence that stone reservoir is not draining or is obstructed
11	Structural Integrity	Good	Some water entry where it is not desired	Early signs of failure	Failure
12	Parking Management Practice	No Risk	Minor Risk for Clogging	Strong Risk of Clogging	Practices causing failure

Note: based on the numerical trigger, specific maintenance tasks or forensic investigations would be recommended (for minor, moderate and severe problems).

B.4. Subsurface Infiltration Practices

Infiltration practices capture and temporarily store runoff before allowing it to infiltrate into the underlying soil over a period of approximately two days. Figure B-7 is a schematic of an infiltration practice; Figure B-8 is a picture of an infiltration basin in good condition.

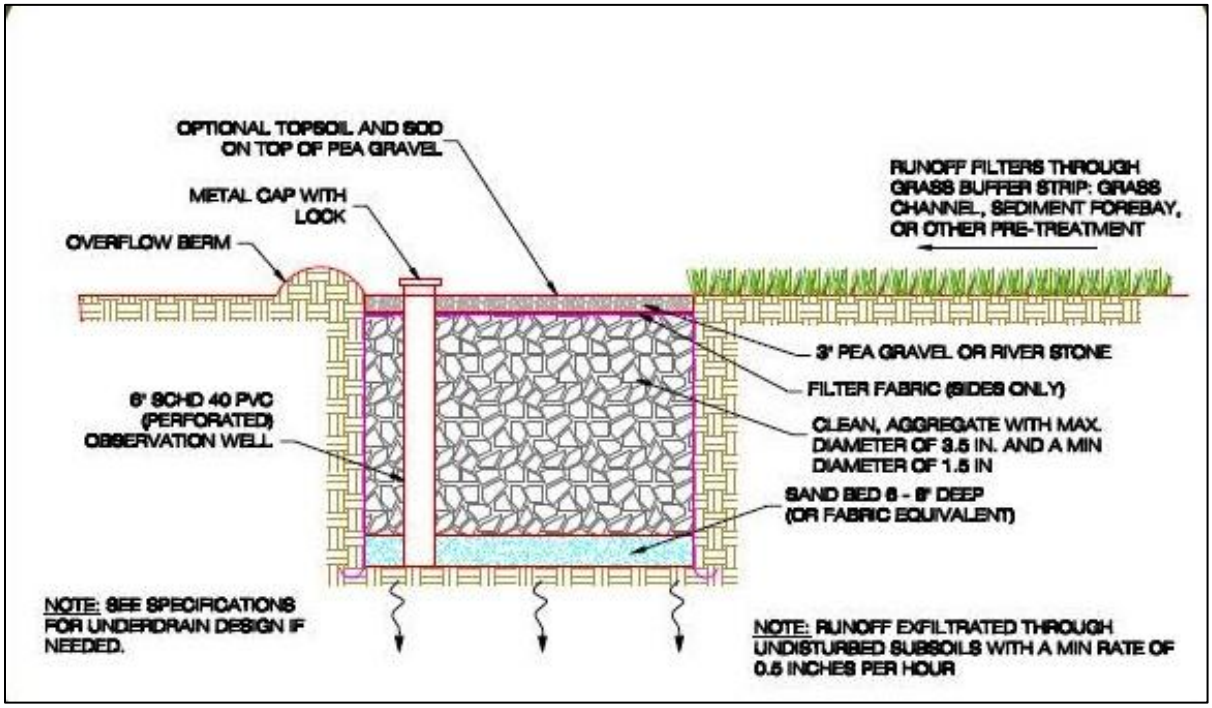


Figure B-7. Schematic of Infiltration Practice

Figure B-8. Photo of Infiltration in Good Condition

The following visual indicators apply to most sub-surface infiltration trenches and dry wells, but they should not be used to assess larger infiltration basins with surface ponding.

Table B-10 presents the 12 visual indicators that are used to assess the maintenance condition of infiltration practices, and Table B-11 indicates which ones are utilized during each of the four different kinds of inspection. Table B-12 defines the numeric triggers to classify the maintenance condition of infiltration practices (e.g., pass, minor, moderate or severe problems).

Table B-10
Visual Indicators for Infiltration Practices

#	INDICATOR	Description and Rationale	Picture
1	Surface Area	Surface dimensions agree with design	*Check the dimensions of the facility.*
2	CDA Condition	Stable, no exposed soils, no increase in CDA from design assumptions	*The contributing drainage area should be clear of sediment and debris that will compromise the facility.*

3	Surface Sinking	Surface is not flat, or has low points or depressions, particularly near perimeter edges	*Sinkhole in a facility.*
4	Sedimentation or Plant Growth	Sediment or plant growth observed on the surface of the infiltration bed	*Test pit showing sediment accumulation in gravel layer.*
5	Standing Water	Standing water on surface within 6 hours after a storm	*Standing water should infiltrate into a facility immediately.*

6	Surface Staining	Evidence of hydrocarbon or other staining on surface	*Stain on surface of a facility.*
7	Poor Observation Well Measurement	Standing water observed in observation well (OW) after 72 hours of a storm	*Water inside an observation well might indicate poor drainage from a facility.*
8	Observation Well & Cap	Well and cap are not intact, cannot be opened or allow for measurement of water clearance rate	*Damaged observation well.*

9	Pretreatment Condition	Pretreatment not in working condition and has insufficient capacity to trap sediment/debris	*Strong flows are dispersing the stone and eroding the pretreatment.*
10	Inlet Conditions	Runoff cannot enter the bed and/or erosion observed at the inlet boundary	*Erosion at a curb cut inflow.*
11	Underdrain	Evidence of stone or sediment, blockage or dry weather flows well after a storm	*Sediment inside underdrain.*

12	Overflow Condition	The outlet or overflow does not have full capacity to convey flow events that exceed the water quality storm design event	*A clogged outflow structure.*

Table B-11
Which Visual Indicators Are Used for Each Infiltration Assessment

#	INDICATOR	Accept	Maintain	Verify	FBI
1	Surface Area	X		X	X
2	CDA Condition	X	X		X
3	Surface Sinking	X	X	X	X
4	Sedimentation or Plant Growth	X	X	X	X
5	Standing Water	X	X	X	X
6	Surface Staining	X		X	X
7	Observation Well Measurement	X	X	X	X
8	Observation Well and Cap	X	X		
9	Pretreatment Condition	X	X	X	X
10	Inlet Condition	X	X		X
11	Underdrain	X	X		X
12	Overflow Condition	X	X		

[1] Subsurface infiltration should be installed per approved construction sequence, and confirmed using the CWP inspection checklist to deal with below and above ground construction elements of infiltration construction, which can be accessed at www.chesapeakestormwater.net.

A quick check of the depth of water in the observation well should be done in every inspection

Table B-12
Maintenance Triggers for Infiltration Practices

#	INDICATOR	PASS	MINOR	MODERATE	SEVERE
1	Surface Area	Matches design	Within 5% of design area	Departs by up to 10% of design area	Departs by more than 10% of design area
2	CDA Condition	CDA in good condition	CDA has some isolated spots that generate sediment	CDA in fair to poor condition, and has a risk for sediment, grass clipping or much delivery	Exposed soils or erosion in CDA is clearly delivering sediment to practice
3	Surface Sinking	Flat and at grade	A few depressions, less than 3 inches deep	Sinking of up to 6 inches from grade	Widespread sinking more than 6 inches deep
4	Sediment/ Plant Growth	No deposits or plant growth	Minor deposits of particles on surface	Sediment and organics found to a depth of 6 inches in practice	Sediment particles prevent flow into or distribution across practice and vegetative growth observed
5	Standing Water	None	Some moisture in first foot	Ponding on up to 10% of surface 6 hours after storm	Ponding on up to 10% of surface 12 hours after storm
6	Surface Staining	None	Isolated minor stains	Stains on up to 10% surface	Stains on more than 10% of surface
7	Observation Well (OW) Measurement	No water present in OW	Less than 3 inches of water in well 72 hours after storm	Up to a foot of water in OW 72 hours after storm	More than a foot of water in well 72 hours after a storm
8	Observation Well & Cap	Intact, clean and dry	Minor deposits of sediment or gravel (< 3 in)	3 to 6 inches of sediment or gravel in the well	OW is broken, missing, obstructed or not accessible
9	Pretreatment Condition	Good	Minor sediment accumulation to remove.	More than 50% of pretreatment capacity lost, need cleanout or renovation	Pretreatment is missing, or no longer functioning to trap sediment
10	Inlet Obstruction	None, all runoff enters filter	Future risk of bypass	Evidence that some portion of runoff is bypassing practice	Most runoff cannot enter the infiltration practice
11	Underdrain	Good	Minor deposits, no dry weather flow	Dry weather flow and/or sediment/gravel accumulation	Evidence that stone reservoir is not draining or is obstructed
12	Overflow Condition	Good	Minor problems	Partially obstructed	Totally obstructed

This page intentionally left blank.

SECTION 7:
Industrial and Commercial Activities Discharge Management Program
ICA APPENDIX

This page intentionally left blank.

ICA APPENDIX A
Storm Water Pollution Control Plan Enforcement Program Memo

This page intentionally left blank.

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND, PACIFIC REGION
HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
745 WRIGHT AVENUE, BUILDING 107, WHEELER ARMY AIRFIELD
SCHOFIELD BARRACKS, HAWAII 96857-5000

REPLY TO ATTENTION OF:

IMHW-ZA

MEMORANDUM FOR ALL Military Personnel and Department of Defense Civilian Employees within United States Army Garrison, Hawaii (USAG-HI) Installations

SUBJECT: Policy Memorandum USAG-HI-62, Storm Water Pollution Control Plan Enforcement Program

1. References.

a. Army Regulation (AR) 200-1, Environmental Protection and Enhancement, 13 Dec 07.

b. USAG-HI National Pollutant Discharge Elimination System Permit Number HI S000090, 7 Apr 14.

c. Policy Memorandum USAG-HI-4, Environmental Compliance and Protection Program, 5 Nov 14.

2. Purpose. To provide a formal, written Storm Water Pollution Control Plan (SWPCP) enforcement policy statement to ensure that garrison facilities and activities are in compliance with the requirements of the USAG-HI National Pollutant Discharge Elimination System (NPDES) permit to prevent or reduce pollutant runoff.

3. Background. The State Department of Health (SDOH), Clean Water Branch (CWB) issued USAG-HI an NPDES permit effective 7 Apr 14. This policy is prepared in compliance with Part D.1.g. of the permit which requires USAG-HI to perform the following:

"*The Permittee shall develop and implement an industrial and commercial discharge management program to reduce to the Maximum Extent Practicable the discharge of pollutants from all industrial and commercial facilities and activities which initially discharge into the Permittee's Municipal Separate Storm Sewer System*."

4. Applicability. This policy applies to all Soldiers, Civilians, Family members, contractors, and other personnel who work on, reside on, or visit any US Army installation, facility, or work site in the State of Hawaii.

5. General.

a. Inspections. In accordance with the USAG-HI NPDES permit, annual inspections for compliance with the SWPCP, including its site-specific plans and Best Management Practices (BMPs), will be performed by the Directorate of Public Works (DPW), Environmental Division.

(1) The majority of facilities are inspected under the Environmental Compliance Officer (ECO) Program per Policy Memorandum USAG-HI-4, Environmental Compliance and Protection Program, 15 May 14. Enforcement and penalties shall be carried out by the ECO Program.

(2) For facilities that do not fall under the ECO Program, annual inspections are conducted by the DPW Clean Water Program. For each inspection, a checklist will be completed and follow-up actions identified.

b. Enforcement for facilities that do not fall under the ECO Program. At facilities that do not fall under the ECO Program, the tenant is responsible for implementing the recommended BMPs. If the inspection finds that BMPs are not being implemented, the following enforcement procedure will be initiated:

(1) The tenant will be notified of the deficiency on the spot, and the tenant shall immediately correct the deficiency.

(2) If the deficiency cannot be corrected immediately, the DPW Clean Water Program will issue a written finding including copies of the inspection checklist, photographs, and sampling results, if applicable, to the tenant point of contact within five (5) working days. The tenant shall correct the deficiency and provide a written response to the DPW Environmental Division within ten (10) calendar days from the date of notification. The response should address what actions were taken to correct the deficiency and when they were completed and include photos of the corrections made.

(3) As needed, the DPW Clean Water Program will conduct a re-inspection to ensure that the deficiency has been corrected.

c. Penalties for facilities that do not fall under the ECO Program. For facilities that do not fall under the ECO Program, the tenant is responsible for penalties if the identified deficiencies are not corrected within ten (10) calendar days from the date of notification. If the issues are not addressed then DPW will contact the HDOH as described below.

(1) In the event USAG-HI has exhausted all available sanctions and cannot bring a facility or activity into compliance, or otherwise deems the facility or activity an immediate and significant threat to water quality, the Permittee shall provide email notification to cleanwaterbranch@doh.hawaii.gov, Attn: Enforcement Section Supervisor within one (1) week of such determination. Email notification shall be followed by written notification and include a copy of all inspection checklists, notes, photographs, and related correspondence within two (2) weeks of the determination. All resulting cost, fines, and penalties shall be the responsibility of the inspected tenant/activity.

d. Record Keeping. Inspection reports shall be kept on file with the DPW Environmental Division. Records shall be kept for five (5) years in accordance with the permit.

6. This policy supersedes Policy Memorandum USAG-HI-62, SAB, dated 4 Jun 14 and remains in effect until superseded or cancelled in writing.

7. The SWPCP Enforcement Program policy shall be given widest dissemination. This policy memorandum will be available for download at: www.garrison.hawaii.army.mil/sites/policies/policies.asp and available to the public upon request.

8. Proponent. The proponent for administration of the USAG-HI SWPCP is the DPW Environmental Division, at 656-5790.

RICHARD A. FROMM
COL, AD
Commanding

DISTRIBUTION
Electronic Media

This page intentionally left blank.

ICA APPENDIX B
Industrial Facilities Inventory

This page intentionally left blank.

INDUSTRIAL FACILITIES INVENTORY

Base	Bldg #	Facility Description	TMK	Additional Permit Coverage	SIC Code	SIC Description	Comments
FS	405	Motor Pool		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
FS	420	DPW Organizational Maintenance		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
FS	1507	Motor Pool		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
FS	1507	Motor Pool		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
FS	1507	Motor Pool		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
FS	1528	Car Care Center		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Indoors
FS	1535	Auto Skills Center		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Industrial
FS	1575	Motor Pool		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
FS	1585	Motor Pool		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
FS	T-205	Motor Pool		110080050000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
HMR	220	Motor Pool		640040030000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	940	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	955	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	968	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	986	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)

Base	Bldg #	Facility Description	TMK	Additional Permit Coverage	SIC Code	SIC Description	Comments
SB	990	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	1059	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	1080	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	1087	Recycling Center		770010010000	5093	Scrap and Waste Materials*	Covered facility
SB	1180	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	1611	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	1626	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	1670	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	1700	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	1709	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	2400	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	2420	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	2440	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	2460	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	2510	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	2600	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)

Base	Bldg #	Facility Description	TMK	Additional Permit Coverage	SIC Code	SIC Description	Comments
SB	2624	DPW Maintenance		770010010000	4173	Facilities Support Management Services	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	3030	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
SB	6017	BAE Maintenance Shops		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Indoors
SB	6037	DOL Storage Warehouse		770010010000	4225	4225 General Warehousing and Storage*	Indoors
SB	A3005	Quartermasters Warehouse		770010010000	4225	General Warehousing and Storage*	
SB		MP Impound Lot		770010010000	5093	Scrap and Waste Materials*	
WAAF	110	URS Paint Booth		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Indoors
WAAF	111	Aircraft Maintenance		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Occcasional outdoor maintance conducted-topping off fluids, bleeding hydraulic pump, fuel sampling and unscheduled events (ex: ruptured hoses)
WAAF	114	Aircraft Maintenance		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Occcasional outdoor maintance conducted-topping off fluids, bleeding hydraulic pump, fuel sampling and unscheduled events (ex: ruptured hoses)
WAAF	205	Aircraft Maintenance		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Occcasional outdoor maintance conducted-topping off fluids, bleeding hydraulic pump, fuel sampling and unscheduled events (ex: ruptured hoses)
WAAF	206	Aircraft Maintenance		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Occcasional outdoor maintance conducted-topping off fluids, bleeding hydraulic pump, fuel sampling and unscheduled events (ex: ruptured hoses)
WAAF	256	Aircraft Maintenance		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Occcasional outdoor maintance conducted-topping off fluids, bleeding hydraulic pump, fuel sampling and unscheduled events (ex: ruptured hoses)
WAAF	1012	Aircraft Maintenance		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Occcasional outdoor maintance conducted-topping off fluids, bleeding hydraulic pump, fuel sampling and unscheduled events (ex: ruptured hoses)
WAAF	1020	Aircraft Maintenance		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Occcasional outdoor maintance conducted-topping off fluids, bleeding hydraulic pump, fuel sampling and unscheduled events (ex: ruptured hoses)
WAAF	1026	FEDS Engine Testing		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Covered facility
WAAF	1100	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
WAAF	1109	Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)
WAAF	1138	UAV Hangar		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Refuleling Outdoors
WAAF	1421	Hot Fuel Point		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Refueling
WAAF		Bird Bath (helicopter washing)		770010010000	4581	Airports, Flying Fields, and Airport Terminal Services*	Helicopter Wash Rack

Base	Bldg #	Facility Description	TMK	Additional Permit Coverage	SIC Code	SIC Description	Comments
WAAF		Sprung Motor Pool		770010010000	4173	Terminal and Service Facilities for Motor Vehicle Passenger Transportation*	Fleet Parking. Occcasional outdoor maintance conducted-topping off fluids, replacing filters, and unscheduled events (ex: ruptured hoses)

*** EPA's 2008 MultiSection General Permit (for storm water discharges from various industrial activities)-Appendix D**

Industrial activity defined by 40 CFR 122.26 (b)(14)(i) -122.26(b)(14)(ix) and 122.26(b)(14)(xi)

ICA APPENDIX C
Commercial Facilities Inventory

This page intentionally left blank.

Commercial Facilities Inventory

Base	Bldg #	Facility Description	TMK	SIC Code	SIC Description
AMR	14	Island Palm South Maintenance Yard	110110010000	8744	Facilities Support Management Services
AMR	880	AAFES Gas Station	110110010000	5541	Gasoline Service Stations
AMR	888	Burger King	110110010000	5812	Eating Places
FS	347	DPW Grounds Maintenance	110080050000	8744	Facilities Support Management Services
FS	355	DPW Pest Management	110080050000	8744	Facilities Support Management Services
FS	536	AAFES Gas Station	110080050000	5541	Gasoline Service Stations
FS	660	Bowling Alley	110080050000	5812	Eating Places
FS	711	Hale Ikena	110080050000	5812	Eating Places
FS	723	Golf Course Maintenance	110080050000	O782	Lawn and Garden Services
FS	1507	DPW Storage Yard	110080050000	8744	Facilities Support Management Services
FS	1578	Wash Rack	110080050000	7542	Carwashes
SB	80	80 Car Care Center	770010010000	7538	General Automotive Repair Shops
SB	357	C-Quad Dining Facility	770010010000	5812	Eating Places
SB	557	Bowling Alley	770010010000	5812	Eating Places
SB	589	Tropics	770010010000	5812	Eating Places
SB	694	PX Food Court	770010010000	5812	Eating Places
SB	780	K-Quad Dining Facility	770010010000	5812	Eating Places
SB	909	Commercial Car Wash	770010010000	7542	Carwashes
SB	910	Auto Skills Center	770010010000	7538	General Automotive Repair Shops
SB	1086	Island Palm North Maintenance Yard	770010010000	8744	Facilities Support Management Services
SB	1123	Natural Resources	770010010000	9512	Land, Mineral, Wildlife, and Forest Conservation
SB	1124	Range Maintenance	770010010000	8744	Facilities Support Management Services
SB	1167	AAFES Gas Station	770010010000	5541	Gasoline Service Stations
SB	1580	Water Treatment Plant	770010010000	4941	Water Supply
SB	1595	Natural Resources	770010010000	9512	Land, Mineral, Wildlife, and Forest Conservation
SB	2060	Kolekole Bar & Grill / Nehelani	770010010000	5812	Eating Places
SB	2085	Warrior Inn Dining Facility	770010010000	5812	Eating Places
SB	2606	Burger King / Popeye's	770010010000	5812	Eating Places
SB	2640	Power Generation	770010010000	4911	Electric Services
SB	2802	Boiler Plant	770010010000	4961	Steam and Air-Conditioning Supply
SB	2805	Superstation	770010010000	5541	Gasoline Service Stations
SB	6014	East Range Wash Rack	770010010000	7542	Carwashes
SB	6028	Golf Course Maintenance	770010010000	782	Lawn and Garden Services
SB	6056	NCO Academy Dining Facility	770010010000	5812	Eating Places
SB	6065	BAE Shop 4	770010010000	7629	Electrical and Electronic Repair Shops, Not Elsewhere Classified
SB	6505	Leilehua Golf Course Clubhouse	770010010000	5812	Eating Places
SB	6506	Golf Cart Barns	770010010000	7992	Public Golf Courses
SB	80X	AAFES Gas Station	770010010000	7538	Gasoline Service Stations
SB		KR-8 Burn Pans	770010010000	4953	4953 Refuse Systems
SB		Charity Car Wash Area	770010010000	7542	Carwashes
TAMC	25	Boiler Plant	UNK	4961	Steam and Air-Conditioning Supply
TAMC	122	Grounds Maintenance / Greenhouse	UNK	8744	Facilities Support Management Services
TAMC	137	Central Plant	UNK	4961	Steam and Air-Conditioning Supply

Base	Bldg #	Facility Description	TMK	SIC Code	SIC Description
TAMC	152	Grounds Maintenance	UNK	8744	Facilities Support Management Services
TAMC	160	Environmental Services Ltd	UNK	7349	Building Cleaning and Maintenance Services
TAMC	1B-WING	Dining Facility	UNK	5812	Eating Places
WAAF	102	25th CAB Dining Facility	770010010000	5812	Eating Places
WAAF	203	25th ASOS	770010010000	4212	Local Trucking without Storage
WAAF	835	Bowling Alley	770010010000	5812	Eating Places
WAAF	1054	Vehicle Inspection / Alert Holding Area	770010010000	7549	Automotive Services, Except Repair and Carwashes

ICA APPENDIX D
Prioritized List for Industrial and Commercial Facilities

This page intentionally left blank.

Prioritized List for Industrial and Commercial Facilities

Facility Type	Description	Priority	Total Number	Frequency Inspection	Number of Inspection (permit term)
Industrial	Automotive	High	39	Quarterly	156
Industrial	Aircraft	High	12	Quarterly	48
Industrial	Warehouse	High	3	Quarterly	12
Commercial	Gas Station	High	9	Quarterly	36
Commercial	Restaurant	Low	16	Minimum once permit term	16
Commercial	Other	Low	26	Minimum once permit term	52

ICA APPENDIX E
Environmental Compliance Inspection Checklist

This page intentionally left blank.

Environmental Compliance Inspection Checklist

All printed copies are uncontrolled documents. For latest version,please consult the Environmental Division's electronic library.

Unit/Activity Name: Inspector: Date:

A. Environmental Program Management

			YES	NO	N/A	Comments	Citation
1	★	Is the U.S. Army Hawaii Environmental Policy posted in a visible location?	☐	☐	☐		**USAG-HI-10, 6.** *Copies of the Environmental Policy will be posted in shops, work areas, unit bulletins, and on all official bulletin boards as appropriate.*
2	★	Are current copies of the Primary and Alternate ECO's appointment orders, initial ECO training certificate and annual ECO refresher training certificate available for inspection?	☐	☐	☐		**USAG-HI-4, 3.b.** *Subordinate Commanders, Directors, and tenant activities will appoint one primary and one alternate ECO from brigade level down to the company level or equivalent. It is essential that "key" personnel are appointed and sent to the ECO Course.*
3		Have the unit/activity senior leaders attended the Senior Leaders Environmental Compliance Training (SLECT) course within 120 days of Assignment to their position?	☐	☐	☐		**USAG-HI-4, 3.c.** *Each senior leader with environmental compliance responsibilities in platoon level and above leadership positions, brigade/battalion/company executive officers, S-4s, logistics officers and civilians in supervisory positions will attend SLECT within 120 days of assuming these positions.*
4	★	Have the primary and/or the alternate ECO conducted and documented quarterly internal environmental compliance training ?	☐	☐	☐		**29 CFR 1910.1200 (e), USAG-HI-200-4.** *The ECO and alternate must conduct and document quarterly internal training in the following areas: Hazard Communication Program, HM/HW Management, HW Minimization, Spill Contingency Procedures, AST/UST, OWS.*
5		Does the unit maintain historic HW documentation for a period of 3 years for the following:					**USAG-HI-200-4,3.8.a.** All waste turn-in documentation must be kept on file for three years.
5.a.	★	HW Manifest(EPA 8700-22 rev)	☐	☐	☐		**40 CFR 262.40(a), USAG-HI-200-4,3.8.a.(1).** The HW Manifest is required only for units/activities located on installations that do not have a DPW TAP (e.g. AMR, MMR, KMC, etc.)
5.b.	★	DRMS Form 1851 (LDR)	☐	☐	☐		**40 CFR 268.7(a)(8).USAG-HI-200-4,3.8.b.** The LDR is required only for units/activities located on installations that do not have a DPW TAP (e.g. AMR, MMR, KMC, etc.)
5.c.	★	The DTID (DD Form 1348-1) (IHWMP)	☐	☐	☐		**USAG-HI-200-4,3.8.a.(2)**
5.d.	★	HW Profile Sheet(DRMS Form 1930)	☐	☐	☐		**USAG-HI-200-4,3.8.a.(3)**
5.e.	★	Laboratory analyses and MSDSs	☐	☐	☐		**USAG-HI-200-4,3.8.a.(4)**
5.f.	★	USAG-HI Form 33, SSP/TAP/90-day ASF Hazardous Waste Collection Log, Oct 08	☐	☐	☐		**USAG-HI-200-4,3.8.a.(5)**

A. Environmental Program Management			YES	NO	N/A	Comments	Citation
5.g.		Non-Hazardous Waste Manifests/contractor receipts (for RMSSP/OWS)	☐	☐	☐		**USAG-HI-200-4,3.8.c.**
6	★	Has the unit/activity or its higher headquarters sent an ECO update memorandum to the DPW Environmental Division each month since the last inspection?	☐	☐	☐		**USAG-HI-200-4, 1.6.f.(6).** *The Brigade ECO will forward a consolidated list of ECOs to the DPW Environmental Division...Chief Inspector no later than the 15th of each month. A copy of this update must be kept in the unit/activity's records.*
7	★	Does the unit have a current (updated annually or as changes occur) HM/HW standing operating procedure (SOP) and Spill Contingency Plan (SCP)?	☐	☐	☐		**USAG-HI-200-4,1.6.f.(6).**The ECO must develop a site-specific HM/HW SOP. (A sample SOP is available on the ECO website.)
8		Have the Primary and Alternate ECOs signed a certification statement that they have read and understand the unit/activity HM/HW SOP and SCP?	☐	☐	☐		**USAG-HI-200-4,1.6.f.(7).** A sample certification statement is available on the ECO website.
9		Does the unit/activity have readily available current (printed or electronic) copies of the following environmental documents and have the old, obsolete documents been removed?					
9.a.		AR 200-1, Environmental Protection and Enhancement?	☐	☐	☐		**USAG-HI-200-4, 1.6.g.(20)(a)-(e).** Copies of these documents must be maintained on the ECO CD in the ECP Book. The most current copies of these documents are available on the ECO website. The ECP Book is furnished by the DPW Environmental Division and maintained by the unit/activity ECOs. The ECP Book should be turned in to the DPW Inspectors before deployment and picked up when the unit returns.
9.b.		AR 420-1, Army Facilities Management?	☐	☐	☐		
9.c.		The USAG-HI, Spill Prevention, Control and Countermeasures (SPCC) Plan?	☐	☐	☐		
9.d.		The Installation Hazardous Waste Management Plan (IHWMP)?	☐	☐	☐		
9.e.		The Environmental Compliance Program Book?	☐	☐	☐		
10		Does the unit/activity have a current diagram of the area(s) where HMs/HWs are stored?	☐	☐	☐		**USAG-HI-200-4, 1.6.f.(14).** The diagram will show the following locations: the Hazardous Material Storage Points, RMSSP, HWSSP (must include an HWSSP evacuation route which must be posted at the HWSSP), and Universal Waste Storage Point.
11	★	Are monthly and weekly inspections conducted (and documented) using all applicable sections of the Environmental Compliance Inspection Checklist?	☐	☐	☐		**USAG-HI-200-4, 1.6.g.(8).** *Conduct and document monthly (and weekly HWSSP) internal compliance inspections using all applicable sections of the ECIC.*
12	★	Is the use of "listed" solvents, such as acetone, MEK, toluene or 1,1,1-trichloroethane justified by a technical manual or other authorized documentation?	☐	☐	☐		**USAG-HI-200-4 ,1.1.b.(2)-(3).** *For degreasing/cleaning operations, units/activities must use the Government solvent recycling service as a substitute for solvents regulated as HWs. If this is not possible, then the Technical Manual that calls for the HM or other authorized documentation shall be provided by the unit commander indicating that there is no substitute.*
13	★	Is the unit/activity free of all serious deficiencies other than those listed on this checklist? (if "No", describe in detail in the Comments section)	☐	☐	☐		**USAG-HI-200-4, 4.1.a.**

B. Hazardous Material Management

			YES	NO	N/A	Comments	Citation
1	★	Does the unit/activity have an approved Authorized Use List (AUL)?	☐	☐	☐		**USAG-HI-19, 3.a.** *All units down to the company level, are required to identify all HM necessary to meet daily mission requirements through their AUL. The AUL, which reflects a 30-day HM supply, shall be based upon the unit's basic load (UBL) and shall be approved by the Company Cmdr's signature.*
2	★	Are all Hazardous Materials (HM) authorized and documented on the unit/activity AUL?	☐	☐	☐		
3		Are all HMs bar-coded in accordance with HMCP guidelines? (HMCP SOP)	☐	☐	☐		**USAG-HI -19, 3.d.** *All HM stored on USAG-HI installations must be labeled with the HMMS bar code.*
4		Has the annual HM inventory been submitted to the DPW Environmental Division EPCRA Manager NLT 31 January?	☐	☐	☐		**USAG-HI -19, 3.a.** *AULs, along with a current on-hand inventory, must be submitted to the DPW Env Div…NLT 31 Jan of each year.*
5		Are inventories of HMs within the quantities of the unit/activity AUL?	☐	☐	☐		**USAG-HI-19 ,3.a.** *Units are permitted to store only up to the amount of HM designated on their AUL at their facilities.*
6		Do MSDSs cover all materials being stored and are they available in a visible location inside all HM storage areas ?	☐	☐	☐		**29 CFR 1910.1200(b)(4)(ii), USAG-HI 200-4,1.6.f(21).** *The ECO and alternate will maintain Material Safety Data Sheets (MSDS) on-site for all HM utilized, stored, received, or shipped.*
7		Are incompatible HMs properly segregated (e.g. oxidizers segregated from flammables and acids segregated from bases)?	☐	☐	☐		**NFPA-1, UFC 80.301(n), 29 CFR 1910.106, USAG-HI SPCCP 2.3.2.8.** *All materials shall be stored neatly, and segregation storage requirements for incompatible and flammable products shall be followed. ECOs should contact the installation Safety Office or DPW-ED for any questions about storage incompatibilities.*
8		Are all "flammable" HMs stored in approved "flammable" storage cabinets?	☐	☐	☐		
9	★	Are all HM containers properly marked/labeled for identification?	☐	☐	☐		**29 CFR 1910.1200(f)(5).** *...the employer shall ensure that each container of hazardous chemicals in the workplace is labeled, tagged or marked with the following information…Identity of the hazardous chemical(s) contained therein; and,...Appropriate hazard warnings...*
10		Are all hazardous material product containers in good condition?	☐	☐	☐		**29 CFR 1910, Subpart H.**
11		Are damaged/leaking HMs over-packed or transferred to a good container?	☐	☐	☐		
12		Are expired/excess HMs promptly turned-in to the HMCP or TAP?	☐	☐	☐		**USAG-HI-200-4,1.6.f(13)h.** Ensure products are absolutely required; promptly and properly turn-in excess hazardous materials.
13		Are containers of new material that are stored outside covered to prevent accumulation of rainwater on the containers or in containment pallets?	☐	☐	☐		**USAG-HI SWPPP, BMP 16.** *the ECO shall verify that POL and other significant liquid materials are not stored in areas or containers exposed to storm water.*

B. Hazardous Material Management					N/A	Comments	Citation
14		Do all HM storage areas have secondary containment capable of preventing spills into the environment?	☐	☐	☐		**USAG-HI-SPCCP, 2.2.3.1.** *USAG-HI policy is that all containers of POL and hazardous substances will be provided secondary containment, capable of containing the entire contents of the largest container or 10% of the total volume of all containers, whichever is greater.*
15		Is a spill kit available and contain adequate supplies to respond to a spill or release of the HM stored at the facility?	☐	☐	☐		**USAG-HI-200-4,1.6.f(13)d.** Spill kits should contain, at a minimum: (1) Granular absorbent (50 pounds) (2) Absorbent pillows (5 ea) or pads (bundle of 100) (3) Straight edge, non-sparking shovel or dustpan (1 ea) (4) Broom (1 ea) (5) Used dry sweep container with lid (1 ea) (6) Rubber gloves (2 pair) (7) Rubber boots (2 pair) (8) Absorbent booms, 8 or 10 feet long (2 ea)
16	★	Has all HW been properly identified and managed IAW the IHWMP?	☐	☐	☐		**USAG-HI-200-4,4.1.a**

Unit/Activity Name: Inspector: Date

C1. Hazardous Waste Shop Storage Point (HWSSP) Management (Weekly Requirement)

			YES	NO	N/A	Comments	Citation
1		Is the HWSSP free of severe structural deterioration?	☐	☐	☐		**USAG-HI-200-4,4.2.b**
2		Is there a warning sign designating the area as a HWSSP?	☐	☐	☐		**USAG-HI-200-4,4.2.c.** HWSSP signs are provided by the DPW Environmental Division.
3		Are signs stating "No Smoking Within 50 Feet" posted in locations where they are visible from all approachables sides?	☐	☐	☐		
4		Does the structure have secondary containment capable of preventing spills into the environment?	☐	☐	☐		**USAG-HI-200-4,4.1.a**
5		Is there a telephone (or other authorized communication device) in working order and easily accessible?	☐	☐	☐		**40 CFR 265.32(b)**
6		Are the emergency notification personnel and activity phone numbers posted in a visible location at the HWSSP?	☐	☐	☐		**40 CFR 262.40(a), USAG-HI-200-4,4.2.c.** *The following emergency points of contact will have phone numbers posted: ECO and alternate, fire department, Military Police/DOD Police, DPW. Design these signs large enough to read from 50 feet away (1-inch letters).*
7		Is a fire extinguisher readily accessible that is fully charged, sealed and compatible for the waste being stored?	☐	☐	☐		**40 CFR 265.32(c)**
8		Is a spill kit available and does it contain adequate supplies to respond to a spill or release of the waste being stored at the HWSSP?	☐	☐	☐		**USAG-HI-200-4,4.2.e.** Spill kits should contain, at a minimum: Granular absorbent (50 pounds), Absorbent pillows (5 ea) or pads (bundle of 100), Straight edge, non-sparking shovel or dustpan (1 ea), Empty over-pack drum to accommodate largest container(e.g., 30 gal over-pack for 15 gal drum) (1), Broom (1), Rubber gloves (2 pair), Rubber apron (2), Rubber boots (2 pair), Goggles (2 pair), Absorbent booms, 8 or 10 feet long (2)
9	★	Is there no unauthorized waste stored inside the HWSSP?	☐	☐	☐		**40 CFR 262.34(c)(1), USAG-HI-200-4,4.2.a.** The HWSSP must be established at or near the point of generation and must be under the control of the unit/activity generating the waste to ensure that no unauthorized waste is placed inside.
10	★	Does the Primary/Alternate ECO maintain security and accessibility to the HWSSP?	☐	☐	☐		
11		Is the HWSSP evacuation route posted in a visible location?	☐	☐	☐		**USAG-HI-200-4,1.6.f(14)c.**

NOTE: If HW is present inside the HWSSP, proceed with section C2. If there is no HW currently stored inside the HWSSP, the following section C2 questions do not apply.

MARK THIS BLOCK IF THERE IS NO HW CURRENTLY STORED INSIDE THE HWSSP: ☐

C2. Hazardous Waste Management

			YES	NO	N/A	Comments	Citation
1		Are copies of MSDSs/laboratory analyses for all HW present kept inside the HWSSP and in an alternate location other than the HWSSP for spill response (i.e., an office in the motorpool)?	☐	☐	☐		**USAG-HI-200-4,4.4.d.** The ECO/alternate must maintain MSDSs for all HWs stored. A laboratory analysis must accompany any waste that is a process generated waste or an unknown material.
2	★	Are HWs properly segregated?	☐	☐	☐		**40 CFR 265.177 (c), USAG-HI-200-4(4.5.a).** *Collect different types of HW in separate drums/containers……Properly segregate incompatible waste.*
3		Are HWs stored away from new and in-use material?	☐	☐	☐		**40 CFR 262.34(c)(1)**
4	★	Are the words "HAZARDOUS WASTE" marked on container(s) holding HW?	☐	☐	☐		**40 CFR 262.34(c)(1)(ii)**
5	★	Are all containers free of deficiencies, such as leaks, rust, corrosion, dents, and/or bulges?	☐	☐	☐		**40 CFR 265.171**
6	★	Are containers compatible with the wastes they hold?	☐	☐	☐		**40 CFR 265.172.** Consult the EPA'S Chemical Compatibility Chart, EPA-600/2-80-076 for compatibility information. Contact the DPW Environmental Inspections for assistance.
7	★	Are containers holding ignitable or reactive waste located at least 15 meters (50 feet) from the facility's property line?	☐	☐	☐		**40 CFR 265.176**
8	★	Is one copy of the SSP/TAP Hazardous Waste Collection Log for each container accumulating HW accurately maintained and kept inside the HWSSP and an identical copy kept in a location away from the HWSSP for spill response (i.e., an office inside the motorpool)?	☐	☐	☐		**USAG-HI-200-4,4.4.c.** *Maintain a separate collection log that accounts for the contents of all items placed into each drum or container. In addition to maintaining a separate collection log for each container inside the HWSSP, the ECO will have an additional copy of the collection logs kept in an area other than the HWSSP for spill response actions .*
9	★	Are all container(s) properly marked and labeled, to reflect the name and DOT hazard class of the waste?	☐	☐	☐		**40 CFR 262.31, USAG-HI-200-4,4.6.f.** *Place DOT hazard labels on each drum according to the hazard (e.g.flammable liquid).*
10	★	Are drum bungs/bolts wrench tightened after every use?	☐	☐	☐		**40 CFR 265.173(a).** *A container holding hazardous waste must always be closed during storage, except when it is necessary to add or remove waste.*
11	★	Does the HWSSP contain less than 55 gallons of HW or 1 quart of acutely HW?	☐	☐	☐		**40 CFR 262.34(c)(1)**
12	★	Is the accumulation start date annotated on the HW label for containers in excess of 55 gallons of HW or 1 quart of acute HW at the HWSSP?	☐	☐	☐		**40 CFR 262.34(c)(2).** As soon as the amount of HW at the HWSSP/facility exceeds 55 gallons or 1 quart of acute waste, the generator must annotate the date on the HW label affixed to the container and the generator must contact the installation TAP immediately to ensure that the HW is transferred there within 72 hours.
13	★	Has all HW in excess of 55 gallons or 1 quart of acutely HW been transferred to the TAP within three calendar days of 55 gallon limit?	☐	☐	☐		

D. Operational Area

			YES	NO	N/A	Comments	Citation
1		Are spills/leaks in work areas, maintenance bays, and vehicle parking areas promptly cleaned up to the extent that only a dry stain remains?	☐	☐	☐		**USAG-HI SWPPP BMP28.** *Minor spills are cleaned by the organization that caused the spill or the organization with operational control where the spill occurred.* All spills should be reported to DPW (656-1111) by the ECO.
2		Are shop floors cleaned with dry sweep only?	☐	☐	☐		**USAG-HI SWPPP BMP04.** *Dry sweep, along with brooms and receptacles, should be placed in clearly marked locations at the complex.*
3	★	Are trash containers free of Hazardous Waste?	☐	☐	☐		**40 CFR 262.11.** Disposal of Hazardous/Non-Regulated Waste and/or Recyclable Material in the general refuse is strictly prohibited.
4		Are trash containers free of Non-RCRA Regulated Waste/Recyclable Material?	☐	☐	☐		
5		Is dry sweep or dry absorbent peat available for the cleanup of spills?	☐	☐	☐		**USAG-HI SWPPP BMP04.** *Dry sweep, along with brooms and receptacles, should be placed in clearly marked locations at the complex.*
6		Are containers of used dry sweep or dry absorbent peat available for the clean up of spills and are the containers marked “USED DRY SWEEP”?	☐	☐	☐		
7		Are solvent parts washer lids locked when not in use and kept free of dry sweep, rags, and other foreign matter?	☐	☐	☐		**USAG-HI-200-4, 4.13.m.(3).**
8		Are solvent parts washers used for cleaning parts only?	☐	☐	☐		**USAG-HI-200-4, 4.13.m.(1).** *Cleaning vehicle parts should be done by using the DPW contractor provided solvents parts washers only. Conversely, the DPW provided solvent parts washers should be used only for cleaning vehicle parts.*
9		Is there a process for recycling/disposing of used solvent?	☐	☐	☐		**USAG-HI-200-4, 4.13.m.(2).** *Only the DPW-provided solvent parts washer should be used for cleaning vehicle parts. Any other solvent parts washer (e.g. used for cleaning vehicle parts or weapons) must be approved by the DPW Environmental Division. Approval will be contingent upon the prior establishment of a process for the recycling or disposal of the used solvent.*

D. Operational Area					N/A	Comments	Citation
10		Are all contaminated rags kept in closable metal containers and properly marked/labeled for identification? (e.g. USED POL RAGS, USED ACETONE RAGS)	☐	☐	☐		**USAG-HI 200-4, 1.6.f.(17).** *Ensure that hazard warnings are posted and that containers of HM/HW are properly marked for identification and kept closed.*
11		Are daily accumulation containers for used aerosol paint cans marked/labeled "Used Aerosol Paints?"	☐	☐	☐		
12	★	Are all containers used to collect used oil products marked "USED OIL"?	☐	☐	☐		**40 CFR 279.22(c)(1).** *Containers and aboveground tanks used to store used oil at generator facilities must be labeled or marked clearly with the words "Used Oil".*
13		If temporary storage containers are used for used POL and antifreeze, are they marked/labeled for identification and with the words "EMPTY DAILY" and transferred into the proper accumulation drums at the RMSSP daily?	☐	☐	☐		Temporary storage containers should only be used when access to the RMSSP throughout the work day is limited. The temporary storage containers must be properly marked labeled (e.g. "USED OIL") in addition to being marked "EMPTY DAILY" and must be stored on secondary containment. These containers must be transferred to the RMSSP at the end of the day and the amount transferred must be annotated on the RMSSP Collection Logs.
14		Are maintenance and other work activities that could cause water contamination conducted away from storm/sewer drains?	☐	☐	☐		**USAG-HI SWPPP BMP32.** *Whenever practical, equipment maintenance shall be performed indoors or in an area that is isolated from the rain and has adequate facilities for the containment of spills.*
15		Are items that can be a source of contamination, such as hazardous materials, containment pallets, engines, parts, tools, or loose equipment that are outdoors, kept under cover to avoid contaminated runoff?	☐	☐	☐		**USAG-HI SWPPP BMP31.** *Mechanical equipment, chemical storage containers, wrecked or salvaged vehicles, parts, scrap metals, batteries, and other items that have been in contact with oil or chemicals shall be stored under cover.*
16		Is there a hazard communication station available in a visible location that contains the MSDSs for all materials being used in the operational area?	☐	☐	☐		**29 CFR 1910.1200 (g)(8).** *The employer shall maintain in the workplace copies of the required material safety data sheets for each hazardous chemical, and shall ensure that they are readily accessible during each work shift to employees when they are in their work area(s).*

E. Recyclable Material Shop Storage Point (RMSSP)

			YES	NO	N/A	Comments	Citation
1		Is the Recyclable Material Shop Storage Point (RMSSP) clean,orderly and free of severe structural deterioration?	☐	☐	☐		**USAG-HI SWPPP BMP18.** *Complex buildings, paving, and outdoor sites such as wash racks, fueling stations, and storage sheds should be maintained in good operational condition with regular cleaning to prevent the accumulation of trash, scrap material, and debris.*
2		Is there a warning sign designating the area as an RMSSP and are signs stating "No Smoking Within 50 Feet" posted in locations where they are visible from all approachable sides?	☐	☐	☐		**USAG-HI-200-4, 4.13.e.**
3	★	Does the RMSSP have adequate secondary containment?	☐	☐	☐		**USAG-HI SWPPP BMP18.** *Drums with a capacity of 15 gallons or greater should be stored inside areas having permanent containment features to prevent contamination of storm water and soil in event of a spill.*
4		Are the current emergency notification personnel and phone numbers posted?	☐	☐	☐		**USAG-HI-200-4, 4.13.e.**
5		Is a spill kit containing adequate supplies for spill response available?	☐	☐	☐		**USAG-HI-200-4, 4.13.l.** *A spill kit containing the following items must be kept on-site: (1) Granular absorbent in new dry-sweep cont. w/lid (50 lbs)* *(2) Absorbent pillows (5) or pads (Bundle of 100)* *(3) Straight edge, non-sparking shovel or dustpan (1)* *(4) Broom (1)* *(5) Used dry sweep container with lid (1)* *(6) Rubber gloves (2 pair)* *(7) Rubber boots (2 pair)* *(8) Absorbent booms, 8 or 10 feet long (2)* *(9) Empty overpack drum, for largest container*
6		Is adequate aisle space (1 foot) present between drums?	☐	☐	☐		**USAG-HI-200-4, 4.13.c.** *Recyclable materials will be stored in DOT/POP approved 55 gallon steel drums. The containers must be compatible for the material they are holding and in good condition. There should be at least 12 inches of aisle space between drums. The containers must have the following proper air spaces between the top of the contents and the lid: for 55-gallon drums/containers, 3 to 4 inches; for 15-gallon drums/containers, 2 to 3 inches; for 5-gallon containers, 1.5 to 2 inches; for 1-gallon containers, 1 inch.*
7		Are all containers free of deficiencies, such as leaks, rust, corrosion,unserviceable bungs, dents, bulges, and/or grooves?	☐	☐	☐		
8		Are containers compatible for the material they are holding?	☐	☐	☐		
9		Do containers have the proper air spaces between the contents and the lid?	☐	☐	☐		

E. Recyclable Material Shop Storage Point (RMSSP)			YES	NO	N/A	Comments	Citation
10		Are drum bungs and bolts wrench tightened after every use?	☐	☐	☐		**USAG-HI-200-4, 4.13.d.** *Drum bungs or rings will be wrench tightened and the RMSSP will be locked at all times when recyclable material is not being added to the drums.*
11		Are "Non-regulated Waste" labels affixed on the container(s) holding non-regulated waste(s)?	☐	☐	☐		**USAG-HI-200-4, 4.14.b.1.** *Mark/Label the container holding the waste "Non-Regulated Waste" and indicate the name of the waste on the container or the label. Drums should be positioned so the markings/labels are easily read.*
12		Are drums positioned so labels are easily read?	☐	☐	☐		
13	★	Are all containers properly marked to reflect their contents (e.g. USED OIL) and are all other non-applicable markings and labels removed?	☐	☐	☐		**USAG-HI 200-4, 4.13.f, k.**
14		Are all drums in the RMSSP color-coded and labeled appropriately as stated below?					
14.a.	★	"USED OIL" (USED OIL includes engine oil, gear oil, all synthetic oil and transmission, hydraulic and brake fluid): RED	☐	☐	☐		**USAG-HI 200-4, 4.13.f.** *The color band will be painted around the middle third of the drum and the lettering will be stenciled on this band. Drums containing materials meeting the definition of any of the DOT hazard classes will be labeled with the appropriate DOT hazard label (e.g., MOGAS will be labeled with the "Flammable Liquid" label). Consult MSDSs to determine whether materials meet the definition of any of the hazard classes. All drums will be numbered to correspond with the accumulation log.*
14.b.		"USED ANTIFREEZE ONLY": GREEN	☐	☐	☐		
14.c.		"USED JP-8/DIESEL ONLY": YELLOW	☐	☐	☐		
14.d.		"USED MOGAS": FLUORESCENT ORANGE	☐	☐	☐		
14.e.		"ASBESTOS-DANGER INHALATION HAZARD": WHITE	☐	☐	☐		
14.f.		USED AEROSOL PAINT	☐	☐	☐		
15		Are RMSSP Collection Logs accurately maintained for each container used for the accumulation of recyclable materials/non-regulated waste and are identical copies kept in the RMSSP and at an alternate location for spill response?	☐	☐	☐		**USAG-HI 200-4, 4.13.g.** *The RMSSP/NRW Collection Log, USAG-HI Form 31 provided at Appendix X will be used to document the type and amount of recyclable material added to a drum in the RMSSP. One form should be used for each accumulation drum. One copy of the accumulation log will be kept inside the RMSSP and one copy will be kept in another readily available location (i.e., an office at the motorpool, etc.).*

F. Universal Waste Management

			YES	NO	N/A	Comments	Citation
1	★	Are containers holding UW properly marked to identify the waste being stored? ex: "UNIVERSAL WASTE – BATTERIES, UNIVERSAL WASTE - LAMPS"	☐	☐	☐		**40 CFR 273.34**
2	★	Is each container holding Universal Waste (UW) marked with the Accumulation Start Date (the earliest date that the UW became a waste)?	☐	☐	☐		**40 CFR 273.35**
3	★	Has the UW been stored no longer than six months from the Accumulation Start Date?	☐	☐	☐		**40CFR 273.35**
4		Is a spill kit with the appropriate spill response materials to contain a release of the UW available?	☐	☐	☐		**40 CFR 273.37**
5		Is a UW Collection Log accurately maintained?	☐	☐	☐		**40 CFR 273.35.** The ECO must maintain an inventory that identifies the earliest date that the UW being accumulated became a waste.
6		Are MSDSs for all UW present in a visible location within the storage area?	☐	☐	☐		**29 CFR 1910.1200, USAG-HI 200-4,1.6.f(21)**

G. Storm Water Pollution Prevention Plan/ Best Management Practices (BMP)

			YES	NO	N/A	Comments	Citation
1		Is the complex clean, neat and in good repair and are proper signs displayed?	☐	☐	☐		**USAG-HI SWPPP BMP01.** *Neat work areas reduce pollution by reducing potential for spills and storm water exposure to contaminants.*
2		Is equipment clean and in good condition or labeled for repair and are maintenance records current?	☐	☐	☐		**USAG-HI SWPPP BMP02.** *Regular cleaning maintains a neat appearance and is needed to inspect for leaks and drips.*
3		Are trash bins closed?	☐	☐	☐		**USAG-HI SWPPP BMP01.** *Trash bins should be closed and there should be no excess rubbish in the work areas.*
4		Are parts, supplies, scrap metal, wood, and other materials stored on pallets and in a manner to minimize exposure to storm water run-off?	☐	☐	☐		**USAG-HI SWPPP BMP05.** *Materials such as parts, supplies, scrap metal and wood should be stored on pallets if kept outside to minimize exposure to storm water runoff.*
5	★	Are liquids, POLs, parts, supplies, and other materials located away from storm drains and stored on covered secondary containment?	☐	☐	☐		
6		Are chemicals stored in the secured areas?	☐	☐	☐		**USAG-HI SWPPP BMP03.** *Security features include fences with locked gates, industrial chemicals stored in secured areas, and locks on fuel pumps when not in use.*
7	★	Are drums, hazardous materials, hazardous and non-regulated wastes properly labeled and stored to prevent discharge to storm drains/State waters?	☐	☐	☐		**USAG-HI SWPPP BMP01,16, 17, 18.** *Drums should be stored inside areas with permanent containment features to prevent contamination of storm water and soil in event of a spill.*
8	★	Are fuel transfer operations authorized by DPW Env Div and are they properly conducted to prevent discharge into the storm water system?	☐	☐	☐		**USAG-HI SWPPP BMP21.** *Spill-response materials shall be placed at readily accessible locations in fueling areas so that spills can be immediately cleaned.*
9	★	Are fuel trucks properly emptied/contained, inspected and maintained and are fuel pumps secured when not in use?	☐	☐	☐		**USAG-HI SWPPP BMP22, 23.** *Fuel-hauling trucks and portable POL tanks should be stored empty or in areas with containment curbs or trench drains to intercept spills.*
10		Are spill response materials and neutralizing compounds for chemicals present?	☐	☐	☐		**USAG-HI SWPPP BMP04.** *Areas used to store corrosive chemicals should have appropriate neutralizing compounds and containment materials.*
11	★	Are spills/leaks cleaned up to prevent storm water contamination?	☐	☐	☐		**USAG-HI SWPPP BMP28.** *Minor spills are cleaned by the organization that caused the spill and must be reported by the ECO to the DPW Environmental Division.*
12		Are vehicles parked on paved surfaces with drip pans?	☐	☐	☐		**USAG-HI SWPPP BMP06, 07.** *Vehicles should be parked on an impermeable surface. Drip pans should be placed below engines and other potential areas of leakage on vehicles and equipment that are parked or stored outside and exposed to storm water. Water in drip pans should be visually inspected for oil or other contaminants and properly cleaned as needed.*
13	★	Are drip pans located beneath leaking vehicles and are they maintained and replaced regularly?	☐	☐	☐		

G. Storm Water Pollution Prevention Plan/ BMPs			YES	NO	N/A	Comments	Citation
14		Is there no discoloration/no oil sheen or visible illicit discharges in storm water basins or storm drains?	☐	☐	☐		**USAG-HI SWPPP BMP08, 11.** *Drains should be inspected monthly by the ECO to see if sediment is clogging the storm water system. The inspection should also check for possible contaminants in the storm water system such as oil stains on sediment, an odor of fuel or other chemicals coming from the storm water system, or a discoloration of water or oily sheen on water. Discharge of non-storm water to storm water conveyance features is prohibited.*
15		Is the wash rack/trench drain cleaned regularly?	☐	☐	☐		**USAG-HI SWPPP BMP15.** *Weekly inspections by the ECO shall check for debris in trench and floor drains, verify that pipes are not blocked, and note the amount of sediment in grit chambers and settling basins. If necessary, the ECO shall contact DPW to arrange for cleaning or repair of drains and washracks.*
16		Are trench drains adequate to intercept spills?	☐	☐	☐		**USAG-HI SWPPP BMP19.** *Weekly inspections by the ECO shall verify that work involving the handling, disbursement, or transfer of significant liquids is done only in areas with containment features or that material spills in areas without containment features can be quickly controlled with spill-response equipment on site.*
17		Is the oil water separator serviced and maintained quarterly and are contractor servicing records maintained at the facility?	☐	☐	☐		**USAG-HI SWPPP BMP10, 11,14.** *The ECO shall verify that oil-water separators and other facilities to treat industrial wastewater are cleaned and inspected according to maintenance contracts administered by DPW.*
18		Are storm drains stenciled and cleaned regularly?	☐	☐	☐		**USAG-HI SWPPP BMP08, 13.** *Inlets to the storm water system should have signs stenciled or posted nearby stating that the storm water inlets lead to the ocean (contact DPW Env Div for storm drain markers).*
19	★	Is only storm water going to storm system?	☐	☐	☐		**USAG-HI SWPPP BMP09.** *Storm water outside of contained process areas such as wash racks, maintenance platforms, and fueling areas should not flow to oil-water separators or enter the sanitary sewer system. Monthly visual inspections by the ECO should verify that, as far as can be determined and except for designated areas, storm water will only flow to the storm water system and not enter the sanitary-sewer system.*

Unit/Activity Name:	Inspector:	Date:

H. Transfer and Accumulation Point (TAP)/90-Day ASF Management

			YES	NO	N/A	Comments	Citation
1	★	Is a job title and description (or appointment orders), with the name of the person filling the job, available for the position of TAP/90-day ASF manager/alternate?	☐	☐	☐		USAG-HI 200-4, 5.1.d(1), 40 CFR 265.16(d)(2)
2	★	Has the TAP/90-day ASF manager/alternate attended the resident initial ECO class and are copies of the certificates on file?	☐	☐	☐		USAG-HI 200-4, 5.1.d(5), 40 CFR 265.16(a)(1))
3	★	Has the TAP/90-day ASF manager/alternate attended the resident ECO refresher training within 1 year of most recent training?	☐	☐	☐		USAG-HI 200-4, 5.1.d(6), 40 CFR 265.16(c)
4	★	Has the TAP/90-day ASF manager/alternate attended a DOD approved "Transportation of Hazardous Materials" course and refresher training every 2 years and are the certificates on file?	☐	☐	☐		USAG-HI 200-4, 5.1.d(7), DOD 4500.9-R
5		Has the TAP/90-day ASF manager/alternate been delegated by the HW Program Manager the authority to sign the Uniform Hazardous Waste Manifest (UHWM EPA 8700-22 (rev 3-05)) for the commander and is the delegation memo on file?	☐	☐	☐		USAG-HI 200-4, 1.6(19)(j), AR 200-1 10-1.d (6), 49 CFR 172.700–704 (Subpart H); DOD 4500.9–R, chapter 204
6	★	Has the TAP/90-day ASF manager/alternate completed an initial 40-hour course in "Hazardous Waste Operations and Emergency Response (HAZWOPER)"and is a certificate on file?	☐	☐	☐		USAG-HI 200-4, 5.1.d.(8), 29 CFR 1910.120(e)(2)
7	★	Has the TAP/90-day ASF manager/alternate completed an 8-hour refresher course in HAZWOPER within 1 year of most recent training and is a certificate on file?	☐	☐	☐		USAG-HI 200-4, 1.6(19)(k), 29 CFR 1910.120(e)(8)
8		Does the TAP/90-day ASF maintain historic documentation for a period of 3 years for the following :					
8.a.	★	The HW Manifest ?	☐	☐	☐		40 CFR 262.40(c), USAG-HI 200-4, 5.9.c.(2)(e)
8.b.	★	The DD Form 1348-1a and HW Profile Sheet, DRMS Form 1930?	☐	☐	☐		USAG-HI 200-4, 5.9.c(2)(f)
8.c.	★	Laboratory Analyses ?	☐	☐	☐		40 CFR 262.40(c), USAG-HI 200-4, 5.9.c.(2)(c)
8.d.	★	Exception Reports ?	☐	☐	☐		40 CFR 262.40(b), USAG-HI 200-4, 5.9.c.(2)(h)
8.e.	★	Land Disposal Restriction Forms ?	☐	☐	☐		40 CFR 268.7(a)(7), USAG-HI 200-4, 5.9.c.(2)(i)
9	★	Are the weekly TAP/90-day ASF Inspection Logs completed correctly (i.e., dates, times, and results entered accordingly)?	☐	☐	☐		40 CFR 265.174, USAG-HI 200-4, 5.9.c.(3)

H. Transfer and Accumulation Point (TAP)/90-Day ASF Management

			YES	NO	N/A	Comments	Citation
10	★	Are the TAP/90-day ASF container(s) inspection logs completed correctly on a weekly basis (i.e., inspection date, total number of drums inspected, ID numbers, and comments)?	☐	☐	☐		USAG-HI 200-4, 5.9.b.(1)
11		Are the TAP/90-day ASF inventory logs completed?	☐	☐	☐		USAG-HI 200-4, 5.7.b.
12	★	Has the TAP/90-day ASF manager/alternate followed up on UHWMs not returned in 35-days of date accepted by the transporter?	☐	☐	☐		40 CFR 262.42(a)(1), USAG-HI 200-4, 5.8.c.(e)
13	★	Has the TAP/90-day ASF manager/alternate submitted an exception report for UHWMs not returned within 45-days of date accepted by the transporter?	☐	☐	☐		40 CFR 262.42(a)(2), USAG-HI 200-4, 5.8.c.(f)
14	★	Does the TAP/90-day ASF have an updated SOP?	☐	☐	☐		USAG-HI 200-4, 5.1.d (12)
15		Does the TAP/90-day ASF have an updated Site Safety and Health Plan (SSHP)?	☐	☐	☐		USAG-HI 200-4, 5.1.d (11)
16	★	Have all TAP personnel signed a statement that they have read and understood the SSHP?	☐	☐	☐		
17		Does the TAP/90-day ASF have readily available copies of the USAG-HI, Spill Prevention, Control and Countermeasures (SPCC) Plan?	☐	☐	☐		USAG-HI 200-4, 5.1.d (14)
18	★	Does the facility have current "TAP Emergency Procedures"/ Spill Contingency Plan (SCP) in place with information on "Notifications and Arrangements" with local authorities and signed a certification statement that they have read and understood the SCP?	☐	☐	☐		40 CFR 265.37, 40 CFR 265.51(a), 40CFR 265.54, USAG-HI 200-4, 5.2.d, USAG-HI 200-4, 5.1.d (13)
19		Does TAP "Notifications and Arrangements" familiarize local authorities with the following information:					40 CFR 265.37(a)
19.a		Layout of the TAP Facility?	☐	☐	☐		
19.b.		Properties of HW handled and associated hazards?	☐	☐	☐		
19.c.		Places personnel will be normally working?	☐	☐	☐		
19.d.		Entrances to roads inside the facility?	☐	☐	☐		
19.e.		Evacuation routes?	☐	☐	☐		
19.f.		Types of injuries that could result from fires, explosions or releases from the TAP Facility?	☐	☐	☐		

H. Transfer and Accumulation Point (TAP)/90-Day ASF Management

			YES	NO	N/A	Comments	Citation
20		Were arrangements made with the following local authorities:					40 CFR 265.37
20.a.		Federal and Local Police?	☐	☐	☐		
20.b.		Federal and Local Fire Departments?	☐	☐	☐		
20.c.		State and Contractor Emergency Response Teams?	☐	☐	☐		
20.d.		Government and Local Hospitals?	☐	☐	☐		
21		Have the local authorities signed that they have received a copy of the "Notification and Arrangements" and Spill Contingency Plan and is a copy of the notification letter of arrangements with local authorities on file?	☐	☐	☐		40 CFR 265.37
22		Where State or Local authorities decline to accept such arrangements, is such refusal documented and kept on file?	☐	☐	☐		40 CFR 265.37(b)
23		Is the TAP/90-day ASF secured to prevent unauthorized access, free of severe structural deterioration and does the structure have secondary containment capable of preventing spills into the environment?	☐	☐	☐		40 CFR 265.31, USAG-HI 200-4, 5.2.a.
24		Are "Danger - Flammable Materials, No Smoking Within 50 Feet, Hazardous Waste Transfer and Accumulation Point (TAP)/90-day Accumulation and Storage Facility, Unauthorized Personnel Keep Out" signs posted on all visible sides?	☐	☐	☐		SWCP BMP 03, 29 CFR 1910.106(d)(6)(iv), 29 CFR1910.106(d)(7)(iii), 29 CFR 1910.106(e)(6), USAG-HI 200-4, 5.2.b.
25		Is there a telephone working, available and accessible?	☐	☐	☐		40 CFR 265.32(b), USAG-HI 200-4, 5.2.b.(4)
26	★	Is there, at all times, a designated emergency coordinator for the TAP/90-day ASF that has the responsibility and authority to commit the resources needed to carry out the contingency plan?	☐	☐	☐		40 CFR 265.55
27	★	Does the emergency coordinator know what responses are required in cases of fire, explosions, minor spills and major spills?	☐	☐	☐		
28	★	Is the facility equipped with a fire extinguisher that is charged, accessible, seal intact and compatible for the waste being stored?	☐	☐	☐		40 CFR 265.32(c), USAG-HI 200-4, 5.2.b.(2)
29	★	Is there an adequate supply of water via hose or sprinkler system?	☐	☐	☐		40 CFR 265.32(d), USAG-HI 200-4, 5.2.b.(5)

H. Transfer and Accumulation Point (TAP)/90-Day ASF Management

			YES	NO	N/A	Comments	Citation
30		Are the following emergency notification personnel and activity phone numbers posted in a visible location on the outside of the structure:					40 CFR 265.52(d), USAG-HI 200-4, 5.2.c.
30.a.	★	The TAP/90-day ASF Manager?	☐	☐	☐		40 CFR 265.55
30.b.		The TAP/90-day ASF Alternate?	☐	☐	☐		
30.c.		Fire Department?	☐	☐	☐		40 CFR 265.37
30.d.		Military/DOD Police?	☐	☐	☐		
30.e.		Directorate of Public Works?	☐	☐	☐		
31		Are spill control equipment (spill kits)/decontamination equipment (PPE) available and compatible/sufficient for wastes stored in the facility?	☐	☐	☐		40 CFR 265.32(c), USAG-HI 200-4, 5.3.f.
32		Does the TAP/90-day ASF have a current diagram of the area(s) where it stores HWs and an evacuation route posted in a visible location?	☐	☐	☐		40 CFR 265.37(a)(1)
33	★	Does the TAP personnel have copies of MSDSs/ laboratory analyses for all HW located on-site?	☐	☐	☐		29 CFR 1910.1200
34	★	Is adequate aisle space present between drums to allow unobstructed movement for emergency response equipment and inspections?	☐	☐	☐		40 CFR 265.35, USAG-HI 200-4, 5.7.e.
35	★	Are HWs properly segregated (i.e. acids and bases)?	☐	☐	☐		40 CFR 265.177(c)
36		Are SSP/TAP/90-day ASF Hazardous Waste Collection Logs maintained for containers used for the accumulation of HW?	☐	☐	☐		USAG-HI 200-4, 5.9.c.(2)(b)
37	★	Are all containers free of leaks (per 40 CFR 265.171), rust (more than surface rust) (per 40 CFR 265.171), corrosion (per 40 CFR 265.171),unserviceable bungs?	☐	☐	☐		40 CFR 265.171, 40 CFR 265.173
38	★	Are containers compatible with the wastes they are holding?	☐	☐	☐		40 CFR 265.172, USAG-HI 200-4, 5.7.g.
39	★	Are the words "Hazardous Waste" marked on container(s) holding HW?	☐	☐	☐		40 CFR 262.34(a)(3)
40	★	Are all container(s) properly marked, to reflect the name of the waste stored inside?	☐	☐	☐		40 CFR 262.32
41	★	Are all container(s) properly labeled?	☐	☐	☐		40 CFR 262.31, USAG-HI 200-4, 5.7.h.
42	★	Are containers positioned so labels can be easily read?	☐	☐	☐		
43	★	Are all containers kept closed except when adding or removing wastes or stored in a manner to prevent leakage?	☐	☐	☐		40 CFR 265.173(a)

H. Transfer and Accumulation Point (TAP)/90-Day ASF Management

			YES	NO	N/A	Comments	Citation
44	★	Is the accumulation start date annotated on the HW label on containers stored at the TAP/90-day ASF ?	☐	☐	☐		40 CFR 262.34(a)(2), USAG-HI 200-4, 5.7.a.
45	★	If holding ignitable or reactive wastes, is the TAP/90-day ASF located 50 feet from the post property line?	☐	☐	☐		40 CFR 265.176
46		Are drums used for the accumulation of flammable liquids properly grounded with the following:					29 CFR1910.106(e)(6)(ii)
46.a.	★	Is the cable constructed of stranded wire?	☐	☐	☐		
46.b.	★	Is cable free of visible signs of corrosion?	☐	☐	☐		
46.c.	★	Is the cable copper or carbon-steel?	☐	☐	☐		

Unit/Activity Name:	Inspector:	Date:

H1. Conditionally Exempt Small Quantity Generator (CESQG) Transfer and Accumulation Point (TAP) Management

			YES	NO	N/A	Comments	Citation
1	★	Is a job title and description (or appointment orders), with the name of the person filling the job, available for the position of TAP manager/alternate?	☐	☐	☐		USAG-HI 200-4, 5.1.d(1), 40 CFR 265.16(d)(2)
2	★	Has the TAP manager/alternate attended the resident initial ECO class and are copies of the certificates on file?	☐	☐	☐		USAG-HI 200-4, 5.1.d(5), 40 CFR 265.16(a)(1))
3	★	Has the TAP manager/alternate attended the resident ECO refresher training within 1 year of most recent training?	☐	☐	☐		USAG-HI 200-4, 5.1.d(6), 40 CFR 265.16(c)
4	★	Has the TAP/90-day ASF manager/alternate attended a DOD approved "Transportation of Hazardous Materials" course and refresher training every 2 years and are the certificates on file?	☐	☐	☐		USAG-HI 200-4, 5.1.d(7), DOD 4500.9-R
5		Has the TAP/90-day ASF manager/alternate been delegated by the HW Program Manager the authority to sign the Uniform Hazardous Waste Manifest (UHWM EPA 8700-22 (rev 3-05)) for the commander and is the delegation memo on file?	☐	☐	☐		USAG-HI 200-4, 1.6(19)(j), AR 200-1 10-1.d (6), 49 CFR 172.700–704 (Subpart H); DOD 4500.9–R, chapter 204
6	★	Has the TAP/90-day ASF manager/alternate/ completed an initial 40-hour course in "Hazardous Waste Operations and Emergency Response (HAZWOPER)" and is a certificate on file?	☐	☐	☐		USAG-HI 200-4, 5.1.d(8), 29 CFR 1910.120(e)(2)
7	★	Has the TAP/90-day ASF manager/alternate completed an 8-hour refresher course in HAZWOPER within 1 year of most recent training and is a certificate on file?	☐	☐	☐		USAG-HI 200-4, 1.6(19)(k), 29 CFR 1910.120(e)(8)
8		Does the TAP/90-day ASF maintain historic documentation for a period of 3 years for the following :					
8.a.	★	The HW Manifest ?	☐	☐	☐		40 CFR 262.40(c), USAG-HI 200-4, 5.9.c.(2)(e)
8.b.	★	The DD Form 1348-1a and HW Profile Sheet, DRMS Form 1930?	☐	☐	☐		USAG-HI 200-4, 5.9.c(2)(f)
8.c.	★	Laboratory Analyses ?	☐	☐	☐		40 CFR 262.40(c), USAG-HI 200-4, 5.9.c.(2)(c)
8.d.	★	Exception Reports ?	☐	☐	☐		40 CFR 262.40(b), USAG-HI 200-4, 5.9.c.(2)(h)
8.e.	★	Land Disposal Restriction Forms ?	☐	☐	☐		40 CFR 268.7(a)(7), USAG-HI 200-4, 5.9.c.(2)(i)
9	★	Are the weekly TAP Inspection Logs completed correctly (i.e., dates, times, and results entered accordingly)?	☐	☐	☐		40 CFR 265.174, USAG-HI 200-4, 5.9.c.(3)

H1. CESQG Transfer and Accumulation Point (TAP) Management

			YES	NO	N/A	Comments	Citation
10	★	Are the TAP container(s) inspection logs completed correctly on a weekly basis (i.e., inspection date, total number of drums inspected, ID numbers, and comments)?	☐	☐	☐		USAG-HI 200-4, 5.9.b.(1)
11		Are the TAP inventory logs completed?	☐	☐	☐		USAG-HI 200-4, 5.7.b.
12	★	Does the TAP have installation monthly HW generation logs that accurately document reflect the unit/activity, location, ECO, weight and date of the HW generated on the installation?	☐	☐	☐		USAG-HI 200-4
13	★	Do the installation HW generation logs show that there is no more than 220 lbs. (100 kg) per month of HW and no more than 2.2 lbs. (1 kg) of acute HW generated on the installation?	☐	☐	☐		40 CFR 261.5, USAG-HI 200-4
14	★	Do the installation HW generation logs show that no more than 2200 lbs. (1000 kgs) aggregate of HW has been stored on the installation at any one time?	☐	☐	☐		
15	★	If the installation HW generation logs show that the CESG limits have been exceeded, has the TAP been operating as a Small or Large Quantity Generator based on the amount of HW generated?	☐	☐	☐		40 CFR 261.5(g)(2), USAG-HI 200-4
16	★	Does the TAP have a current and updated SOP?	☐	☐	☐		USAG-HI 200-4, 5.1.d (12)
17		Does the TAP have readily available copies of the USAG-HI, Spill Prevention, Control and Countermeasures (SPCC) Plan?	☐	☐	☐		USAG-HI 200-4, 5.1.d (14)
18		Is the TAP secured to prevent unauthorized access, free of severe structural deterioration and does the structure have secondary containment capable of preventing spills into the environment?	☐	☐	☐		40 CFR 265.31, USAG-HI 200-4, 5.2.a.
19		Are “Danger - Flammable Materials, No Smoking Within 50 Feet, Hazardous Waste Transfer and Accumulation Point (TAP)/90-day Accumulation and Storage Facility, Unauthorized Personnel Keep Out” signs posted on all visible sides?	☐	☐	☐		SWCP BMP 03, 29 CFR 1910.106(d)(6)(iv), 29 CFR1910.106(d)(7)(iii), 29 CFR 1910.106(e)(6)
20		Is there a telephone working, available and accessible?	☐	☐	☐		40 CFR 265.32(b), USAG-HI 200-4, 5.2.b.(4)
21		Is the facility equipped with a fire extinguisher that is charged, accessible, seal intact and compatible for the waste being stored?	☐	☐	☐		40 CFR 265.32(c), USAG-HI 200-4, 5.2.b.(2)
22		Is there an adequate supply of water via hose or sprinkler system?	☐	☐	☐		40 CFR 265.32(d), USAG-HI 200-4, 5.2.b.(5)

H1. CESQG Transfer and Accumulation Point (TAP) Management

			YES	NO	N/A	Comments	Citation
23		Are the following emergency notification personnel and activity phone numbers posted in a visible location on the outside of the structure:					40 CFR 265.52(d), USAG-HI 200-4, 5.2.c.
23.a.	★	The TAP Manager?	☐	☐	☐		40 CFR 265.55
23.b.		The TAP Alternate?	☐	☐	☐		
23.c.		Fire Department?	☐	☐	☐		40 CFR 265.37
23.d.		Military/DOD Police?	☐	☐	☐		
23.e.		Directorate of Public Works?	☐	☐	☐		
24		Are spill control equipment (spill kits)/decontamination equipment (PPE) available and compatible/sufficient for wastes stored in the facility?	☐	☐	☐		40 CFR 265.32(c)
25		Does the TAP/90-day ASF have a current diagram of the area(s) where it stores HWs and an evacuation route posted in a visible location?	☐	☐	☐		40 CFR 265.37(a)(1)
26	★	Is adequate aisle space present between drums to allow unobstructed movement for emergency response equipment and inspections?	☐	☐	☐		40 CFR 265.35
27	★	Are HWs properly segregated (i.e. acids and bases)?	☐	☐	☐		40 CFR 265.177(c)
28		Are SSP/TAP Hazardous Waste Collection Logs maintained for containers used for the accumulation of HW?	☐	☐	☐		USAG-HI 200-4, 5.9.c.(2)(b)
29	★	Are all containers free of leaks (per 40 CFR 265.171), rust (more than surface rust) (per 40 CFR 265.171), corrosion (per 40 CFR 265.171),unserviceable bungs?	☐	☐	☐		40 CFR 265.171, 40 CFR 265.173
30	★	Are containers compatible with the wastes they are holding?	☐	☐	☐		40 CFR 265.172
31	★	Are the words "Hazardous Waste" marked on container(s) holding HW?	☐	☐	☐		40 CFR 262.34(a)(3)
32	★	Are all container(s) properly marked, to reflect the name of the waste stored inside?	☐	☐	☐		40 CFR 262.32
33	★	Are all container(s) properly labeled?	☐	☐	☐		40 CFR 262.31
34	★	Are containers positioned so labels can be easily read?	☐	☐	☐		
35	★	Are all containers kept closed except when adding or removing wastes or stored in a manner to prevent leakage?	☐	☐	☐		40 CFR 265.173(a)
36	★	Is the accumulation start date annotated on the HW label on containers stored at the TAP?	☐	☐	☐		40 CFR 262.34(a)(2)

H1. CESQG Transfer and Accumulation Point (TAP) Management

			YES	NO	N/A	Comments	Citation
37	★	If holding ignitable or reactive wastes, is the TAPlocated 50 feet from the post property line?	☐	☐	☐		40 CFR 265.176
38		Are drums used for the accumulation of flammable liquids properly grounded with the following:					29 CFR1910.106(e)(6)(ii)
38.a.	★	Is the cable constructed of stranded wire?	☐	☐	☐		
38.b.	★	Is cable free of visible signs of corrosion?	☐	☐	☐		
38.c.	★	Is the cable copper or carbon-steel?	☐	☐	☐		

Unit/Activity Name:	Inspector:	Date:

H2. Small Quantity Generator (SQG) Transfer and Accumulation Point (TAP) Management

			YES	NO	N/A	Comments	Citation
1	★	Is a job title and description (or appointment orders), with the name of the person filling the job, available for the position of TAP/180-day ASF manager/alternate?	☐	☐	☐		USAG-HI 200-4, 5.1.d(1), 40 CFR 265.16(d)(2)
2	★	Has the TAP/180-day ASF manager/alternate attended the resident initial ECO class and are copies of the certificates on file?	☐	☐	☐		USAG-HI 200-4, 5.1.d(5), 40 CFR 265.16(a)(1))
3	★	Has the TAP/180-day ASF manager/alternate attended the resident ECO refresher training within 1 year of most recent training?	☐	☐	☐		USAG-HI 200-4, 5.1.d(6), 40 CFR 265.16(c)
4	★	Has the TAP/180-day ASF manager/alternate attended a DOD approved "Transportation of Hazardous Materials" course and refresher training every 2 years and are the certificates on file?	☐	☐	☐		USAG-HI 200-4, 5.1.d(7), DOD 4500.9-R
5		Has the TAP/180-day ASF manager/alternate been delegated by the HW Program Manager the authority to sign the Uniform Hazardous Waste Manifest (UHWM EPA 8700-22 (rev 3-05)) for the commander and is the delegation memo on file?	☐	☐	☐		USAG-HI 200-4, 1.6(19)(j), AR 200-1 10-1.d (6), 49 CFR 172.700–704 (Subpart H); DOD 4500.9–R, chapter 204
6	★	Has the TAP/180-day ASF manager/alternate completed an initial 40-hour course in "Hazardous Waste Operations and Emergency Response (HAZWOPER)" and is a certificate on file?	☐	☐	☐		USAG-HI 200-4, 5.1.d.(8), 29 CFR 1910.120(e)(2)
7	★	Has the TAP/180-day ASF manager/alternate completed an 8-hour refresher course in HAZWOPER within 1 year of most recent training and is a certificate on file?	☐	☐	☐		USAG-HI 200-4, 1.6(19)(k), 29 CFR 1910.120(e)(8)
8	★	Does the TAP/180-day ASF maintain historic documentation for a period of 3 years for the following:					
8.a.	★	The HW Manifest ?	☐	☐	☐		40 CFR 262.40(c), USAG-HI 200-4, 5.9.c.(2)(e)
8.b.	★	The DD Form 1348-1a and HW Profile Sheet, DRMS Form 1930?	☐	☐	☐		USAG-HI 200-4, 5.9.c(2)(f)
8.c.	★	Laboratory Analyses ?	☐	☐	☐		40 CFR 262.40(c), USAG-HI 200-4, 5.9.c.(2)(c)
8.d.	★	Exception Reports ?	☐	☐	☐		40 CFR 262.40(b), USAG-HI 200-4, 5.9.c.(2)(h)
8.e.	★	Land Disposal Restriction Forms ?	☐	☐	☐		40 CFR 268.7(a)(7), USAG-HI 200-4, 5.9.c.(2)(i)
9	★	Are the weekly TAP/180-day ASF Inspection Logs completed correctly (i.e., dates, times, and results entered accordingly)?	☐	☐	☐		40 CFR 265.174, USAG-HI 200-4, 5.9.c.(3)

H2. SQG Transfer and Accumulation Point (TAP) Management

			YES	NO	N/A	Comments	Citation
10	★	Are the TAP/180-day ASF container(s) inspection logs completed correctly on a weekly basis (i.e., inspection date, total number of drums inspected, ID numbers, and comments)?	☐	☐	☐		USAG-HI 200-4, 5.9.b.(1)
11		Are the TAP/90-day ASF inventory logs completed?	☐	☐	☐		USAG-HI 200-4, 5.7.b.
12	★	Does the TAP have installation monthly HW generation logs that accurately document reflect the unit/activity, location, ECO, weight and date of the HW generated on the installation?	☐	☐	☐		USAG-HI 200-4
13	★	Do the installation HW generation logs show that there is no more than 2200 lbs. (1000 kg) per month of HW generated on the installation?	☐	☐	☐		40 CFR 262.34(d), USAG-HI 200-4
14	★	Do the installation HW generation logs show that no more than 6000 kgs aggregate of HW has been stored on the installation at any one time?	☐	☐	☐		40 CFR 262.34(d)(1) ,USAG-HI 200-4
15	★	If the installation HW generation logs show that the SGG limits have been exceeded, has the TAP been operating as a Large Quantity Generator?	☐	☐	☐		
16	★	Has the TAP/180-day ASF manager/alternate followed up on UHWMs not returned in 50-days of date accepted by the transporter?	☐	☐	☐		40 CFR 262.42(b), USAG-HI 200-4, 5.8.c.(e)
17	★	Has the TAP/180-day ASF manager/alternate submitted an exception report for UHWMs not returned within 60-days of date accepted by the transporter?	☐	☐	☐		40 CFR 262.42(b), USAG-HI 200-4, 5.8.c.(f)
18	★	Does the TAP/180-day ASF have an updated SOP?	☐	☐	☐		USAG-HI 200-4, 5.1.d (12)
19		Does the TAP/180-day ASF have an updated Site Safety and Health Plan (SSHP)?	☐	☐	☐		USAG-HI 200-4, 5.1.d (11)
20		Have all TAP personnel signed a statement that they have read and understood the SSHP?	☐	☐	☐		
21		Does the TAP/180-day ASF have readily available copies of the USAG-HI, Spill Prevention, Control and Countermeasures (SPCC) Plan?	☐	☐	☐		USAG-HI 200-4, 5.1.d (14)
22		Does the facility have current “TAP Emergency Procedures”/ Spill Contingency Plan (SCP) in place with information on “Notifications and Arrangements” with local authorities and signed a certification statement that they have read and understood the SCP?	☐	☐	☐		40 CFR 265.37, 40 CFR 265.51(a), 40CFR 265.54, USAG-HI 200-4, 5.2.d, USAG-HI 200-4, 5.1.d (13)

H2. SQG Transfer and Accumulation Point (TAP) Management

			YES	NO	N/A	Comments	Citation
23		Does TAP "Notifications and Arrangements" familiarize local authorities with the following information:					40 CFR 265.37(a)
23.a.		Layout of the TAP Facility?	☐	☐	☐		
23.b.		Properties of HW handled and associated hazards?	☐	☐	☐		
23.c.		Places personnel will be normally working?	☐	☐	☐		
23.d.		Entrances to roads inside the facility?	☐	☐	☐		
23.e.		Evacuation routes?	☐	☐	☐		
23.f.		Types of injuries that could result from fires, explosions or releases from the TAP Facility?	☐	☐	☐		
24		Were arrangements made with the following local authorities:					40 CFR 265.37
24.a.		Federal and Local Police?	☐	☐	☐		
24.b.		Federal and Local Fire Departments?	☐	☐	☐		
24.c.		State and Contractor Emergency Response Teams?	☐	☐	☐		
24.d.		Government and Local Hospitals?	☐	☐	☐		
25		Have the local authorities signed that they have received a copy of the "Notification and Arrangements" and Spill Contingency Plan and is a copy of the notification letter of arrangements with local authorities on file?	☐	☐	☐		40 CFR 265.37
26		Where State or Local authorities decline to accept such arrangements, is such refusal documented and kept on file?	☐	☐	☐		40 CFR 265.37(b)
27		Is the TAP/180-day ASF secured to prevent unauthorized access, free of severe structural deterioration and does the structure have secondary containment capable of preventing spills into the environment?	☐	☐	☐		40 CFR 265.31, USAG-HI 200-4, 5.2.a.
28		Are "Danger - Flammable Materials, No Smoking Within 50 Feet, Hazardous Waste Transfer and Accumulation Point (TAP)/180-day Accumulation and Storage Facility, Unauthorized Personnel Keep Out" signs posted on all visible sides?	☐	☐	☐		SWCP BMP 03, 29 CFR 1910.106(d)(6)(iv), 29 CFR1910.106(d)(7)(iii), 29 CFR 1910.106(e)(6), USAG-HI 200-4, 5.2.b.
29		Is there a telephone working, available and accessible?	☐	☐	☐		40 CFR 265.32(b), USAG-HI 200-4, 5.2.b.(4)
30	★	Is there, at all times, a designated emergency coordinator for the TAP/180-day ASF that has the responsibility and authority to commit the resources needed to carry out the contingency plan?	☐	☐	☐		40 CFR 265.55

H2. SQG Transfer and Accumulation Point (TAP) Management

			YES	NO	N/A	Comments	Citation
31	★	Does the emergency coordinator know what responses are required in cases of fire, explosions, minor spills and major spills?	☐	☐	☐		40 CFR 265.55
32	★	Is the facility equipped with a fire extinguisher that is charged, accessible, seal intact and compatible for the waste being stored?	☐	☐	☐		40 CFR 265.32(c), USAG-HI 200-4, 5.2.b.(2)
33	★	Is there an adequate supply of water via hose or sprinkler system?	☐	☐	☐		40 CFR 265.32(d), USAG-HI 200-4, 5.2.b.(5)
34		Are the following emergency notification personnel and activity phone numbers posted in a visible location on the outside of the structure:					40 CFR 265.52(d), USAG-HI 200-4, 5.2.c.
34.a.	★	The TAP/180-day ASF Manager?	☐	☐	☐		40 CFR 265.55
34.b.		The TAP/180-day ASF Alternate?	☐	☐	☐		
34.c.		Fire Department?	☐	☐	☐		40 CFR 265.37
34.d.		Military/DOD Police?	☐	☐	☐		
34.e.		Directorate of Public Works?	☐	☐	☐		
35		Are spill control equipment (spill kits)/decontamination equipment (PPE) available and compatible/sufficient for wastes stored in the facility?	☐	☐	☐		40 CFR 265.32(c), USAG-HI 200-4, 5.3.f.
36		Does the TAP/180-day ASF have a current diagram of the area(s) where it stores HWs and an evacuation route posted in a visible location?	☐	☐	☐		40 CFR 265.37(a)(1)
37	★	Does the TAP personnel have copies of MSDSs/ laboratory analyses for all HW located on-site?	☐	☐	☐		29 CFR 1910.1200
38	★	Is adequate aisle space present between drums to allow unobstructed movement for emergency response equipment and inspections?	☐	☐	☐		40 CFR 265.35, USAG-HI 200-4, 5.7.e.
39	★	Are HWs properly segregated (i.e. acids and bases)?	☐	☐	☐		40 CFR 265.177(c)
40		Are SSP/TAP/180-day ASF Hazardous Waste Collection Logs maintained for containers used for the accumulation of HW?	☐	☐	☐		USAG-HI 200-4, 5.9.c.(2)(b)
41	★	Are all containers free of leaks rust (more than surface rust), corrosion,unserviceable bungs?	☐	☐	☐		40 CFR 265.171, 40 CFR 265.173
42	★	Are containers compatible with the wastes they are holding?	☐	☐	☐		40 CFR 265.172, USAG-HI 200-4, 5.7.g.
43	★	Are the words "Hazardous Waste" marked on container(s) holding HW?	☐	☐	☐		40 CFR 262.34(a)(3)

H2. SQG Transfer and Accumulation Point (TAP) Management

			YES	NO	N/A	Comments	Citation
44	★	Are all container(s) properly marked, to reflect the name of the waste stored inside?	☐	☐	☐		40 CFR 262.32
45	★	Are all container(s) properly labeled?	☐	☐	☐		40 CFR 262.31, USAG-HI 200-4, 5.7.h.
46	★	Are containers positioned so labels can be easily read?	☐	☐	☐		
47	★	Are all containers kept closed except when adding or removing wastes or stored in a manner to prevent leakage?	☐	☐	☐		40 CFR 265.173(a)
48	★	Is the accumulation start date annotated on the HW label on containers stored at the TAP/90-day ASF ?	☐	☐	☐		40 CFR 262.34(a)(2), USAG-HI 200-4, 5.7.a.
49	★	If holding ignitable or reactive wastes, is the TAP/180-day ASF located 50 feet from the post property line?	☐	☐	☐		40 CFR 265.176
50		Are drums used for the accumulation of flammable liquids properly grounded with the following:					29 CFR1910.106(e)(6)(ii)
50.a.	★	Is the cable constructed of stranded wire?	☐	☐	☐		
50.b.	★	Is cable free of visible signs of corrosion?	☐	☐	☐		
50.c.	★	Is the cable copper or carbon-steel?	☐	☐	☐		

ICA APPENDIX F
Storm Water Pollution Control Plan

This page intentionally left blank.

U.S. ARMY GARRISON, HAWAII

STORM WATER POLLUTION CONTROL PLAN

JANUARY 2013

Prepared by:

U.S. Army Public Health Command Region – Pacific
Environmental Health Engineering Division
Camp Zama, Japan 96343-5006

This page intentionally blank

Certification

Reviewed by:

SHANE BOURKE
Clean Water Program

Reviewed by:

TESSA BURGE
Clean Water Program

Reviewed by:

PETER YUH
Chief, Environmental Division
Directorate of Public Works

Submitted by:

ROBERT EASTWOOD
Director of Public Works

Approved by:

DANIEL W. WHITNEY
COL, SF
Commanding

This page intentionally blank

List of Updates / Changes

Date	Author	Summary of Changes

This page intentionally blank

Table of Contents

Certification ..... **iii**
List of Updates / Changes ..... **v**
List of Acronyms ..... **ix**
1. Introduction **1**
Plan Objectives 1
Plan Organization 1
2. Storm Water Pollution Control Team **1**
3. Storm Water Systems **2**
Schofield Barracks 2
Wheeler Army Airfield 2
Fort Shafter 2
Tripler Army Medical Center 2
Aliamanu Military Reservation 3
Helemano Military Reservation 3
4. Industrial Activities **3**
Schofield Barracks 4
Table 4-1. Schofield Barracks Facilities and their Standard Industrial Classification Codes 4
Wheeler Army Airfield 7
Table 4-2. Wheeler Army Airfield Facilities and their Standard Industrial Classification Codes 7
Fort Shafter 8
Table 4-3. Fort Shafter Facilities and their Standard Industrial Classification Codes 8
Tripler Army Medical Center 9
Table 4-4. Tripler Army Medical Center Facilities and their Standard Industrial Classification Codes 9
Aliamanu Military Reservation 9
Table 4-5. Aliamanu Military Reservation Facilities and their Standard Industrial Classification Codes 9
Helemano Military Reservation 9
5. Potential Pollutants **10**
Table 5-1. Potential Pollutants Associated with Different Activities 10
Hazardous Material Management 10
Vehicle Maintenance 10

Vehicle Parking/Storage 11
Vehicle/Equipment Washing 11
Vehicle Fueling 11
Waste/Recyclable Material Management (Hazardous) 11
Waste/Recyclable Material Management (Non-Hazardous) 12

6. Best Management Practices 13
7. Spill Prevention and Response Procedures 16
8. Pesticide, Herbicide, and Fertilizer Application Procedures 16
9. Inspection Procedures 16
10. Training Requirements 16

APPENDICES

APPENDIX A – References A-1
APPENDIX B – Storm Water System Maps B-1
APPENDIX C* – Schofield Barracks Facility Specific Storm Water Pollution Control Plans C-1
APPENDIX D* – Wheeler Army Airfield Facility Specific Storm Water Pollution Control Plans D-1
APPENDIX E* – Fort Shafter Facility Specific Storm Water Pollution Control Plans E-1
APPENDIX F* – Tripler Army Medical Center Facility Specific Storm Water Pollution Control Plans F-1
APPENDIX G* - Aliamanu Military Reservation Facility Specific Storm Water Pollution Control Plans G-1
APPENDIX H – Facility Specific Storm Water Pollution Control Plans Frequently Asked Questions H-1
APPENDIX I – National Pollutant Discharge Elimination System Permit I-1

* Pages within these appendices are ordered by building number

List of Acronyms

AAFES	Army and Air Force Exchange Service
AAMDC	Army Air Missile Defense Command
AHA	Alert Holding Area
AMR	Aliamanu Military Reservation
ASOS	Air Support Operations Squadron
AVGAS	Aviation Gasoline
BCT	Brigade Combat Team
BDE	Brigade
Bldg	Building
BMP	Best Management Practice
BN	Battalion
BSB	Brigade Support Battalion
CAB	Combat Aviation Brigade
CAV	Cavalry
CFR	Code of Federal Regulations
CO	Company
CSSB	Combat Sustainment Support Battalion
DFAC	Dining Facility
DOL	Directorate of Logistics
DPW	Directorate of Public Works
ECO	Environmental Compliance Officer
EN	Engineer
ER	East Range
ESB	Engineer Support Battalion
FEDS	Flexible Engine Diagnostic Systems
FS	Fort Shafter
GOV	Government Owned Vehicle
HEMTT	Heavy Expanded Mobility Tactical Truck
HHB	Headquarters and Headquarters Battalion
HHC	Headquarters and Headquarters Company
HI	Hawaii
HMR	Helemano Military Reservation
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HWSSP	Hazardous Waste Shop Storage Point
ID	Infantry Division
IPC	Island Palm Communities
LMTV	Light Medium Tactical Vehicle
Ltd.	Limited
MI	Military Intelligence
MOUT	Military Operations on Urban Terrain
MP	Military Police
MS4	Municipal Separate Storm Sewer System
MWR	Directorate of Family and Morale, Welfare and Recreation

List of Acronyms (continued)

NCO	Non-Commissioned Officer
NO	Number
NPDES	National Pollution Discharge Elimination System
Org.	Organizational
PHCR-Pacific	Public Health Command Region – Pacific
POL	Petroleum, Oil and Lubricants
POV	Privately Owned Vehicle
PX	Post Exchange
QM	Quartermaster
RMSSP	Recyclable Material Shop Storage Point
SB	Schofield Barracks
SCHB	Schofield Barracks
SIC	Standard Industrial Classification
SWPCP	Storm Water Pollution Control Plan
SWPCT	Storm Water Pollution Control Team
TAMC	Tripler Army Medical Center
TAP	Transfer Accumulation Point
TSC	Theater Sustainment Command
UAV	Unmanned Aerial Vehicle
USAG-HI	U. S. Army Garrison, Hawaii
WAAF	Wheeler Army Airfield

1. Introduction

This Storm Water Pollution Control Plan (SWPCP) has been developed to satisfy the requirements of the National Pollution Discharge Elimination System (NPDES) permit HI S000090 [Reference 1] issued in accordance with the Clean Water Act, Hawaii Revised Statutes, Chapter 342D, and Hawaii Administrative Rules, Chapters 11-54 and 11-55. The current permit is dated February 7, 2007.

Plan Objectives

Water is one of the focus areas of the U.S. Army Garrison Hawaii (USAG-HI) sustainability program. Water quality, especially surface water quality, is directly related to storm water quality. Storm water runoff can transport sediment, trash, oil, and other pollutants into streams and the ocean. USAG-HI conducts numerous activities that can pose a threat to water quality if practices and procedures are not in place to prevent pollutants from entering the storm sewer system. The SWPCP has two objectives: first, to identify facilities and activities within USAG-HI with the potential to contribute pollutants to storm water; second, to identify simple and inexpensive practices that can limit the impact of garrison activities on storm water quality.

Plan Organization

This document is divided into three primary components. The first portion, consisting of Section 2 through Section 10, addresses the elements required by the permit including potential pollutants, industrial activities, and best management practices (BMPs). The second portion, Appendix B, provides storm water system maps for each of the installations included in the permit. These maps show the relative location of each installation on Oahu and identify the water bodies that receive storm water from each installation. The final and most important parts of this plan are the facility-specific storm water pollution control plans in Appendix C through Appendix G. These plans identify BMPs for each facility to prevent storm water pollution.

2. Storm Water Pollution Control Team

The Storm Water Pollution Control Team (SWPCT) is primarily responsible for overseeing the implementation of this plan. The SWPCT consists of the Directorate of Public Works (DPW), Environmental Division, Compliance Branch, Clean Water Program staff and Hazardous Waste Program staff. Clean Water Program personnel are primarily responsible for updating the plan and providing technical assistance to facility personnel. Hazardous Waste Program staff are primarily responsible for inspection and enforcement.

The SWPCT will:

- Review the SWPCP at least annually and update the SWPCP when changes occur in the types of activities at any facility;

- Assist facility managers and Environmental Compliance Officers (ECOs) with implementing BMPs identified in facility management plans;
- Develop personnel training related to the SWPCP (see Section 10); and
- Conduct inspections and maintain records of inspections related to the SWPCP.

3. Storm Water Systems

This section provides a brief description of the storm water systems on each installation including the names of any State waters that could potentially receive storm water runoff from these installations. Appendix B contains maps that show discharge points from storm water systems on each installation. These maps also identify the State receiving waters for any discharges.

Schofield Barracks

Storm water from Schofield Barracks (SB) discharges into two streams: Waikele Stream to the south and Kiikii Stream to the north. Waikele Stream flows from the crest of the Waianae Volcano into the west loch of Pearl Harbor. Storm water from industrial facilities on East Range discharges north into Kiikii Stream. Kiikii Stream flows northwest into Kaiaka Bay. A storm water system map for SB can be found in Appendix B.

Wheeler Army Airfield

Storm water flow on Wheeler Army Airfield is (WAAF) generally to the southwest. Storm water from installation facilities discharges into Waikele Stream. Waikele Stream flows from the crest of the Waianae Volcano into the west loch of Pearl Harbor. A storm water system map for WAAF can be found in Appendix B.

Fort Shafter

Most storm water on Fort Shafter (FS) flows into a central storm channel that follows a tributary of Moanalua Stream known as Kahauiki stream. Kahauiki Stream discharges into Moanalua Stream/Canal at FS Flats. A small portion of the storm sewer system on the southeast side of the installation connects to off-base city storm sewer. This storm water most likely discharges into either Kalihi stream or Moanalua Stream. Both Moanalua Stream and Kalihi Stream drain into the ocean at Ke'ehi Lagoon. A storm water system map for FS can be found in Appendix B.

Tripler Army Medical Center

Storm water on Tripler Army Medical Center (TAMC) flows outward in all directions (except northeast) toward the perimeter of the installation and into surrounding natural areas and city storm sewer systems. Storm water from TAMC most likely enters Moanalua Stream discharging into the ocean at Ke'ehi Lagoon. A storm water system map for TAMC can be found in Appendix B.

Aliamanu Military Reservation

Aliamanu Military Reservation (AMR) is divided into two areas separated by the H201 Freeway. The storm system for the area northeast of H201 connects to surrounding municipal storm sewers. These storm sewers likely flow into North Halawa Stream which flows into the east loch of Pearl Harbor. Storm water within the portion of AMR southwest of H201 discharges into a central storm water channel. This channel flows southeast into Salt Lake. A storm water system map for AMR can be found in Appendix B.

Helemano Military Reservation

Storm water on Helemano Military Reservation (HMR) generally flows southwest into a large detention pond. During periods of high flow, storm water discharges from this pond into a tributary of Kiikii Stream. Kiikii Stream flows northwest into Kaiaka Bay. A small amount of storm water on HMR flows north to Helemano Stream (also known as Paukauila Stream). Like Kiikii Stream, this stream also flows northwest into Kaiaka Bay. A storm water system map for HMR can be found in Appendix B.

4. Industrial Activities

The following sections identify the facilities included in this plan for each installation. Please note that while over 100 facilities are included in this SWPCP, only those defined in 40 CFR Sections 122.26(b)(14)(i) through 122.26(b)(14)(ix) and 122.26(b)(14)(xi) are considered "industrial activities." This includes facilities with Standard Industrial Classification (SIC) codes 4173, 4225, 4226, 4581, and 5093. However, regardless of their SIC code all facilities listed in the plan are required to comply with this plan.

Schofield Barracks

SB has a wide variety of facilities in the Storm Water Pollution Control Plan. However, the majority are either food service facilities (SIC 5812) or motor pools (SIC 4173). Table 4-1 identifies all the SB facilities included in this plan and their SIC codes.

Table 4-1. Schofield Barracks Facilities and their Standard Industrial Classification Codes

Bldg. Number and Facility	SIC Code
KR-8 Burn Pans	4953 Refuse Systems
Charity Car Wash Area	7542 Carwashes
MP Impound Lot	4226 Special Warehousing and Storage* (or 5093 Scrap and Waste Materials*)
80 Car Care Center	7538 General Automotive Repair Shops
80X AAFES Gas Station	5541 Gasoline Service Stations
357 C-Quad Dining Facility	5812 Eating Places
557 Bowling Alley	5812 Eating Places
589 Tropics	5812 Eating Places
694 PX Food Court	5812 Eating Places
780 K-Quad Dining Facility	5812 Eating Places
909 Commercial Car Wash	7542 Carwashes
910 Auto Skills Center	7538 General Automotive Repair Shops
940 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
955 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
968 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
986 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
990 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1059 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1080 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1086 Island Palm North Maintenance Yard	8744 Facilities Support Management Services
B1087 Recycling Center	5093 Scrap and Waste Materials*
1123 Natural Resources	9512 Land, Mineral, Wildlife, and Forest Conservation
1124 Range Maintenance	8744 Facilities Support Management Services
1167 AAFES Gas Station	5541 Gasoline Service Stations
1180 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1580 Water Treatment Plant	4941 Water Supply

Bldg. Number and Facility	SIC Code
1595 Natural Resources	9512 Land, Mineral, Wildlife, and Forest Conservation
1611 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1626 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1670 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1700 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
2060 Kolekole Bar & Grill / Nehelani	5812 Eating Places
2085 Warrior Inn Dining Facility	5812 Eating Places
2400 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
2420 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
2440 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
2460 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
2510 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
2600 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
2606 Burger King / Popeye's	5812 Eating Places
2624 DPW Maintenance	8744 Facilities Support Management Services
2640 Power Generation	4911 Electric Services
2802 Boiler Plant	4961 Steam and Air-Conditioning Supply
2805 Superstation	5541 Gasoline Service Stations
A3005 Quartermasters Warehouse	4225 General Warehousing and Storage*
3030 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
6014 East Range Wash Rack	7542 Carwashes
6017 BAE Maintenance Shops	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
6028 Golf Course Maintenance	0782 Lawn and Garden Services
6037 DOL Storage Warehouse	4225 General Warehousing and Storage*
6040 Transfer Accumulation Point	Included under 40 CFR 122.26(b)(14)(iv) Hazardous waste treatment, storage, or disposal facilities*

Bldg. Number and Facility	SIC Code
6056 NCO Academy Dining Facility	5812 Eating Places
6065 BAE Shop 4	7629 Electrical and Electronic Repair Shops, Not Elsewhere Classified
6505 Leilehua Golf Course Clubhouse	5812 Eating Places
6506 Golf Cart Barns	7992 Public Golf Courses

* Denotes an “Industrial Activity as defined in 40CFR Sections 122.26(b)(14)(i) through 122.26(b)(14)(ix) and 122.26(b)(14)(xi)

Wheeler Army Airfield

Operations on WAAF center on the airfield. WAAF facilities in this SWPCP include 11 dedicated to maintenance and service of aircraft (SIC 4581), three motor pools (SIC 4173), two food service facilities (SIC 5812), and a vehicle inspection area (SIC 7549). Table 4-2 identifies the facilities on WAAF and their SIC codes.

Table 4-2. Wheeler Army Airfield Facilities and their Standard Industrial Classification Codes

Bldg. Number and Facility	SIC Code
102 25th CAB Dining Facility	5812 Eating Places
110 URS Paint Booth	4581 Airports, Flying Fields, and Airport Terminal Services*
111 Aircraft Maintenance	4581 Airports, Flying Fields, and Airport Terminal Services*
114 Aircraft Maintenance	4581 Airports, Flying Fields, and Airport Terminal Services*
203 25th ASOS	4212 Local Trucking without Storage
205 Aircraft Maintenance	4581 Airports, Flying Fields, and Airport Terminal Services*
206 Aircraft Maintenance	4581 Airports, Flying Fields, and Airport Terminal Services*
256 Aircraft Maintenance	4581 Airports, Flying Fields, and Airport Terminal Services*
Sprung Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
835 Bowling Alley	5812 Eating Places
1012 Aircraft Maintenance	4581 Airports, Flying Fields, and Airport Terminal Services*
1020 Aircraft Maintenance	4581 Airports, Flying Fields, and Airport Terminal Services*
1026 FEDS Engine Testing	4581 Airports, Flying Fields, and Airport Terminal Services*
1054 Vehicle Inspection / Alert Holding Area	7549 Automotive Services, Except Repair and Carwashes
1100 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1109 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1138 UAV Hangar	4581 Airports, Flying Fields, and Airport Terminal Services*
1421 Hot Fuel Point	4581 Airports, Flying Fields, and Airport Terminal Services*
Bird Bath (helicopter washing)	4581 Airports, Flying Fields, and Airport Terminal Services*

* Denotes an “Industrial Activity as defined in 40CFR Sections 122.26(b)(14)(i) through 122.26(b)(14)(ix) and 122.26(b)(14)(xi)

Fort Shafter

FS has a wide variety of facilities in the SWPCP. These include multiple motor pools (SIC 4173), DPW maintenance / storage areas (SIC 8744), a gas station (SIC 5541) and a car wash (SIC 7542). Table 4-3 identifies all the FS facilities included in this plan and their SIC codes.

Table 4-3. Fort Shafter Facilities and their Standard Industrial Classification Codes

Bldg. Number and Facility	SIC Code
T-205A Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
347 DPW Grounds Maintenance	8744 Facilities Support Management Services
355 DPW Pest Management	8744 Facilities Support Management Services
405 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
420 DPW Organizational Maintenance	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
424 Transfer Accumulation Point	Included under 40 CFR 122.26(b)(14)(iv) Hazardous waste treatment, storage, or disposal facilities*
536 AAFES Gas Station	5541 Gasoline Service Stations
660 Bowling Alley	5812 Eating Places
711 Hale Ikena	5812 Eating Places
723 Golf Course Maintenance	0782 Lawn and Garden Services
1507 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1507 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1507 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1507 DPW Storage Yard	8744 Facilities Support Management Services
1528 Car Care Center	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1535 Auto Skills Center	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1575 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*
1578 Wash Rack	7542 Carwashes
1585 Motor Pool	4173 Terminal and Service Facilities for Motor Vehicle Passenger Transportation*

* Denotes an “Industrial Activity as defined in 40CFR Sections 122.26(b)(14)(i) through 122.26(b)(14)(ix) and 122.26(b)(14)(xi)

Tripler Army Medical Center

TAMC has seven facilities in the SWPCP including a boiler plant (SIC 4961) and a power plant (Bldg 137, also SIC 4961). Table 4-4 identifies all the TAMC facilities included in this plan and their SIC codes.

Table 4-4. Tripler Army Medical Center Facilities and their Standard Industrial Classification Codes

Bldg. Number and Facility	SIC Code
1 B-Wing Dining Facility	5812 Eating Places
25 Boiler Plant	4961 Steam and Air-Conditioning Supply
122 Grounds Maintenance / Greenhouse	8744 Facilities Support Management Services
137 Central Plant	4961 Steam and Air-Conditioning Supply
143 Transfer Accumulation Point	Included under 40 CFR 122.26(b)(14)(iv) Hazardous waste treatment, storage, or disposal facilities*
152 Grounds Maintenance	8744 Facilities Support Management Services
160 Environmental Services Ltd	7349 Building Cleaning and Maintenance Services

* Denotes an "Industrial Activity as defined in 40CFR Sections 122.26(b)(14)(i) through 122.26(b)(14)(ix) and 122.26(b)(14)(xi)

Aliamanu Military Reservation

AMR is primarily a housing area for military families. However, AMR has three facilities included in the SWPCP. These are a commercial gas station, Burger King, and the Island Palm Communities LLC South Maintenance facility. Table 4-5 contains a summary of AMR facilities and their SIC codes.

Table 4-5. Aliamanu Military Reservation Facilities and their Standard Industrial Classification Codes

Bldg. Number and Facility	SIC Code
14 Island Palm South Maintenance Yard	8744 Facilities Support Management Services
880 AAFES Gas Station	5541 Gasoline Service Stations
888 Burger King	5812 Eating Places

Helemano Military Reservation

Helemano Military Reservation (HMR) does not have any facilities included in the SWPCP. A motor pool is currently under construction.

5. Potential Pollutants

There are seven (7) broadly categorized activities within USAG-HI with the potential to pollute storm water. These activities are: hazardous material management, vehicle maintenance, vehicle parking/storage, vehicle/equipment washing, vehicle fueling, waste/recyclable material management (hazardous), and waste/recyclable material management (non-hazardous). Table 5-1 identifies the potential pollutants associated with each of these activities.

Table 5-1. Potential Pollutants Associated with Different Activities

Activity	Potential Pollutants
Hazardous Material Management	Oil and grease, fuel, antifreeze, solvents, corrosives, toxics
Vehicle Maintenance	Oil and grease, fuel, antifreeze, heavy metals, solvents, corrosives, toxics
Vehicle Parking/Storage	Sediment, oil and grease
Vehicle/Equipment Washing	Sediment, oil and grease, detergents, heavy metals, suspended solids
Vehicle Fueling	Fuel (gasoline, diesel, aviation gas, and JP-8)
Waste/Recyclable Material Management (hazardous)	Oil and grease, antifreeze, fuel
Waste/Recyclable Material Management (non-hazardous)	Oil and grease, nutrients and organic material, suspended solids,

Hazardous Material Management

Hazardous material management is the storage, handling, and on-post transport of petroleum, oils, and lubricants (POL); flammable, toxic, reactive, or corrosive materials; and health hazards as defined in 29CFR1910.1200. Excepting the food service facilities, most of the facilities identified within this plan manage hazardous materials.

Potential pollutants from hazardous material management include oil, antifreeze, fuel, solvents, pesticides, herbicides and a variety of other materials. More specific details on potential pollutants can be found in the facility specific plans in Appendices C through G. Pollution of storm water from hazardous materials can result from improper storage or from leaks and spills while transporting from a storage location to a point of use.

Vehicle Maintenance

Vehicle maintenance occurs at many facilities within USAG-HI including motor pools, aircraft maintenance hangars, commercial car care establishments, and within DPW shops. Vehicle maintenance can involve anything from a routine oil change to complex overhauls of entire aircraft.

Vehicle maintenance can contribute many of the same pollutants found in hazardous material management including oil and grease, fuel, antifreeze, solvents, corrosives and assorted toxics.

Pollution of storm water can result from leaks and spills, and from leaving engine components exposed to storm water.

Vehicle Parking/Storage

Motor pools, motor vehicle maintenance facilities, aircraft maintenance facilities, and DPW maintenance yards are the most common areas where vehicle parking occurs.

Sediment is the primary pollutant resulting from vehicle parking and storage. Dirt and debris collected on the exterior of the vehicle during normal operation can be washed off the vehicle during rain events. Oil and grease can also result from vehicle parking when leaks occur.

Vehicle/Equipment Washing

Vehicle washing is conducted at motor pools, aircraft maintenance hangars, commercial car wash facilities, and designated charity car wash locations. Equipment washing also occurs at centralized wash racks within motor pools. Soldiers returning to the cantonment area have soiled gear and equipment that must be cleaned prior to returning to storage. Food service facilities also clean their equipment regularly including waste storage containers.

Potential pollutants from vehicle and equipment washing include sediment, oil and grease, detergents, heavy metals, and suspended solids. These pollutants are most likely to enter the storm water system when washing is performed outside of a designated area or if engineering controls (e.g. oil/water separators or water recycling systems) are not functioning properly.

Vehicle Fueling

Vehicle fueling occurs most often at the Army and Air Force Exchange Service (AAFES) commercial gas stations on AMR, FS, and SB; the hot fueling point on WAAF; and the "Superstation" on SB. However, vehicle fueling is also conducted at select motor pools and on the aircraft parking ramp of WAAF.

Fuel is the sole pollutant associated with vehicle fueling. Fuel can enter storm water from spills that occur during vehicle fueling.

Waste/Recyclable Material Management (Hazardous)

Recyclable hazardous material management is conducted at most activities engaged in vehicle maintenance such as motor pools and aircraft maintenance hangars. Recyclable materials include used oil, used fuels, used antifreeze, and a variety of used rags and absorbent material.

Potential pollutants from recyclable hazardous material management include oil and grease, antifreeze, and fuel. These pollutants can enter the storm water system through improper handling (e.g. leaving a container open), or through leaks and spills.

Waste/Recyclable Material Management (Non-Hazardous)

Non-hazardous waste and recyclable material management are essentially the collection and storage or trash and assorted recyclables including aluminum, cardboard, and glass. Motor pools and food service facilities are the primary facilities that engage in waste/recyclable material management.

Potential pollutants from waste management include used cooking oil and grease, organic material and nutrients, and suspended solids. These pollutants can enter the storm water system through improper storage (e.g. storing uncovered), or through leaks and spills.

6. Best Management Practices

BMPs are schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants to waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage

For the purposes of this plan, the BMPs have been divided into two major categories. One set of BMPs, identified as "shop/facility level best management practices," are intended for implementation at the shop/facility level. These practices are easily initiated, shop level tasks that will reduce the potential for pollutants entering storm water. See Table 6-1 for a list and description of all shop/facility level BMPs. The other BMPs, identified as "Directorate of Public Works Best Management Practices," are intended for implementation by DPW. These include tasks requiring specialized equipment or training (e.g. maintaining oil/water separators). See Table 6-2 for a complete list of DPW BMPs.

Site specific BMPs for each industrial facility can be found in Appendices C through G.

Table 6-1. Shop/Facility Best Management Practices

BMP #	BMP	BMP Specifics
BMP 1	Monthly Inspections	ECOs or facility managers will conduct monthly inspections of their facilities to ensure storm water best management practices are implemented properly.
BMP 2	Communication and Signage	Post spill response procedures where hazardous materials are stored and used. Label spill kits and dry sweep. Label all hazardous materials, hazardous wastes and recyclable materials.
BMP 3	Security	Facilities should have proper security features to prevent unauthorized access and use of equipment and material. Security features include fences with locked gates. Hazardous materials, recyclable hazardous materials, and hazardous wastes will be stored in secured areas.
BMP 4	Spill Kits	Clearly identified spill kits should be located near areas where hazardous material/fuel spills might occur.
BMP 5	Dry Clean Up	Spills will be captured using dry cleanup methods including dry sweep, absorbent pads, booms, or rags. Do not rinse off or hose down outside areas.
BMP 6	Spill Response	Minor spills are promptly cleaned by the organization that caused the spill or the organization with operational control where the spill occurred to the extent that only a dry stain remains. Spills should be reported to DPW (656-1111) by the ECO.
BMP 7	Clean Vehicles / Equipment	Vehicles and equipment will be clean if stored/parked outside within the motor pool. Clean means free from dirt and mud that can fall off the vehicle/equipment in the course of moving it within the yard. Stored/parked means left in one location for more than 24 hours. Engines will not be left exposed when vehicles are parked.
BMP 8	Vehicle Washing	Vehicles will be washed at designated wash racks or authorized car washes only.

Table 6-1. Shop/Facility Best Management Practices

BMP #	BMP	BMP Specifics
BMP 9	Equipment Washing	Equipment will be washed at designated wash racks or at interior locations that discharge to the sanitary sewer (e.g. mop sink).
BMP 10	Drip Pans	Drip pans will be used under all tactical vehicles, under all heavy equipment (i.e. bulldozers, backhoes, dump trucks, etc.), and under any vehicle with an observable leak. Drip pans should be inspected/emptied following heavy rain, and prior to large anticipated storm events (to prevent overflowing).
BMP 11	Vehicle Parking	Vehicles will be parked on a paved surface.
BMP 12	Paved Area Sweeping	Sweep paved areas to remove accumulated sediment. Sweeping will be conducted as needed.
BMP 13	Storm Drain Labeling	Label storm drains/inlets. ECO should confirm during monthly inspections that all storm sewer inlets are identified. DPW Environmental office can provide additional labels.
BMP 14	Discharge Point Inspection	ECO will inspect around storm sewer inlets and other locations where storm water leaves the facility. These areas should be free from excessive sediment, trash or other debris, staining, discoloration, and signs of spills or illicit discharges. Any observed deficiencies should be traced back to the source for correction/elimination.
BMP 15	HAZMAT and POL Storage (Cover)	All hazardous materials, recyclable materials, hazardous waste and POL will be stored in a covered or enclosed area that reduces or eliminates exposure to storm water. Note: POL includes used cooking oil.
BMP 16	HAZMAT and POL Storage (Contain)	All liquid hazardous materials, liquid recyclable materials, hazardous waste, and POL will be stored within secondary containment capable of holding 110% of the largest full container. Note: POL includes used cooking oil.
BMP 17	HAZMAT Inventory	The ECO or facility manager will maintain and update an inventory of POL and other hazardous materials.
BMP 18	Trash / Recyclables Storage	Trash bins will be kept closed. Other containers for storing waste or recyclable materials should be stored inside or kept covered to prevent exposure to rain water. Excess garbage, debris, or scrap will not be stored outside uncovered.
BMP 19	Outdoor Material Storage	Materials stored outside will be on pallets to facilitate movement and reduce exposure to storm water flows. Materials stored outside will be covered to prevent exposure to storm water. Examples of materials that must be covered include: materials that can rust (e.g. a box of nails, reusable scrap metal), materials that can degrade in water (e.g. bags of cement), oily materials (e.g. used vehicle parts, "empty" cans of POL, drip pans), and dirty or dusty materials. Examples of excluded materials: concertina wire, and wooden pallets.
BMP 20	Wastewater Disposal	Dispose of mop water and other water used for facility cleaning in interior janitorial sinks or other interior drains that discharge to the sanitary sewer system.
BMP 21	Maintenance	Whenever practical, maintenance activities involving the use of hazardous materials or POL shall be performed indoors or in an area that is isolated from the rain and has adequate facilities for the containment of spills.
BMP 22	Training	ECO will conduct quarterly hazardous material and spill response training for facility personnel.

Table 6-1. Shop/Facility Best Management Practices

BMP #	BMP	BMP Specifics
For units with an authorized fuel operations waiver		
BMP 23	Vehicle Fueling	When fueling tactical vehicles drip pans will be placed under the fueling connection to capture any drips or spills.
BMP 24	Fuel Storage Inspection	Fuel trucks and portable POL tanks should be routinely inspected for proper functioning and leaks and faulty equipment should be repaired or replaced.
BMP 25	Fuel Storage Containment	Fuel trucks and portable POL tanks should be stored empty or in areas with containment curbs or trench drains to intercept spills.

Table 6-2. Directorate of Public Works Best Management Practices

BMP #	BMP	BMP Specifics
BMP 26	Wash Water to Oil/Water Separators	Vehicle wash racks will be provided with a functional an oil/water separator to treat wash water prior to discharge to the sanitary sewer.
BMP 27	Maintain Oil / Water Separators	Oil/water separators will be maintained in proper working condition and cleaned regularly to remove accumulated oil and sediment.
BMP 28	Maintain Storm Sewer System	Storm sewer inlets, swales and culverts will be inspected, maintained, and cleaned as necessary to ensure proper function.
BMP 29	Maintain Paved Surfaces	Paved surfaces will be appropriately graded and maintained.
BMP 30	Erosion Control	Disturbed and damaged soils will be stabilized to prevent erosion.
BMP 31	ECO Training	ECO receives storm water pollution prevention training including hazardous material handling and spill response.
BMP 32	Storm Water to Storm Sewer	In general only storm water will be allowed to enter the storm sewer system. See complete USAG-HI SWPCP for exceptions.
BMP 33	Waste Water to Sanitary Sewer	As much as possible, storm water will not be allowed to enter the sanitary sewer system.
BMP 34	Trench Drains	Facility trench drains will be cleaned and maintained to ensure proper functioning.
BMP 35	Trash Containers	Facilities will be provided with receptacles for the temporary storage of refuse. Containers should be covered and have leak proof bottoms.
BMP 36	Fuel Waivers	Authorize fuel operations waivers.

7. Spill Prevention and Response Procedures

Spill prevention and response will be conducted in accordance with USAG-HI Spill Prevention, Control and Countermeasures (SPCC) Plan dated October 9, 2009 [Reference 2].

8. Pesticide, Herbicide, and Fertilizer Application Procedures

All applications of pesticides, herbicides and fertilizers will be done in accordance with the USAG-HI Pest Management Plan, dated April 2008 [Reference 3].

9. Inspection Procedures

Per Policy Memorandum USAG-HI-4 [Reference 4], facilities with hazardous waste and recyclable materials (hazardous) are subject to quarterly inspections by USAG-HI DPW Compliance Branch personnel. In addition to quarterly external inspections, ECOs will perform monthly inspections of their facility using the existing Environmental Compliance Inspection Checklist (USAG-HI Form 30 Jun10).

Facilities without ECOs (e.g. food service facilities) will be inspected at least annually by DPW Environmental Clean Water Branch Personnel and regularly by facility managers. The facility specific SWPCPs (Appendices C through G) provide a list of BMPs. Inspections will confirm that these practices are in place and are properly implemented.

10.Training Requirements

Employee training is essential to the implementation of the SWPCP. Training is needed to educate facility personnel in understanding the goals of the SWPCP and proper implementation of BMPs. When properly trained, facility personnel can recognize situations that could lead to storm water contamination and respond safely and effectively to an accident. A regular employee-training program ensures that all individuals understand the rationale for environmental regulations and procedures required for compliance.

Per Policy Memorandum USAG-HI-4 [Reference 4], Subordinate Commanders, Directors and heads of tenant activities, both military and civilian, will appoint one primary and one alternate ECO from brigade-level down to the company-level or equivalent organizational element. Per USAG-HI Regulation 200-4 [Reference 5], ECOs attend 24 hours of training to familiarize them with their duties and responsibilities. ECO training includes the following subjects relevant to storm water management:

- Hazardous material and waste storage
- Used oil management
- Oil-water separator usage guidelines
- Good housekeeping
- Facility inspections
- Spill prevention and response

- Solid waste disposal
- Storm water pollution prevention

Once trained, ECOs are expected to provide environmental training and guidance to the personnel in their unit.

For facilities without ECOs, training will be provided by the SWPCT to facility managers and personnel as needed. This training will address understanding, implementing, and inspecting site-specific BMPs as determined in each facility's site-specific SWPCP (Appendices C through G).

This page intentionally blank

APPENDIX A – References

Cited References

1. Permit Number HI S000090 Authorization to Discharge under the National Pollution Discharge Elimination System, 7 February 2007.

2. "U.S. Army Garrison, Hawaii Spill Prevention Control and Countermeasures Plan, 2009."

3. "U.S. Army Garrison, Hawaii Pest Management Plan, April 2008."

4. Policy Memorandum USAG-HI-4, Environmental Compliance and Protection Program, dated 12 Sep 12

5. USAG-HI Regulation 200-4, Installation Hazardous Waste Management Plan, 21 October 2010.

Other references

6. Federal Water Pollution Control Act (Amended Through P.L. 107–303), 33 U.S.C 1251 et seq., 27 November 2002 (Also known as the Clean Water Act).

7. "U.S. Army Garrison, Hawaii Storm Water Pollution Control Plan, May 2008."

8. United States Department of Labor, Occupational Safety and Health Administration Website, http://www.osha.gov/pls/imis/sicsearch.html.

This page intentionally blank

APPENDIX B – Storm Water System Maps

This page intentionally blank

APPENDIX C – Schofield Barracks Facility Specific Storm Water Pollution Control Plans

This page intentionally blank

APPENDIX D – Wheeler Army Airfield Facility Specific Storm Water Pollution Control Plans

This page intentionally blank

APPENDIX E – Fort Shafter Facility Specific Storm Water Pollution Control Plans

This page intentionally blank

APPENDIX F – Tripler Army Medical Center Facility Specific Storm Water Pollution Control Plans

This page intentionally blank

APPENDIX G - Aliamanu Military Reservation Facility Specific Storm Water Pollution Control Plans

This page intentionally blank

APPENDIX H – Facility Specific Storm Water Pollution Control Plans Frequently Asked Questions

This page intentionally blank

APPENDIX I – National Pollutant Discharge Elimination System Permit

This page intentionally left blank.