Table 2-2
Muliwai Sediment Type Data *(continued)*

		Visual Classification (ASTM 2488)		Sieve Analysis Classification (ASTM D422/D4464M)	
Sample Number	**Depth (inches)**	**Soil Symbol**	**Soil Type**	**Soil Symbol**	**Soil Type**
NMM-21-MX-3	38 to 42	SP[1]	Poorly-graded sand		
NMM-22-MX-1	At 12	CL	Clay		
SMM-01-MX-1	6 to 9	CL	Clay		
SMM-02-FL-1	0 to 6	SM	Silty sand	SM	Silty sand
SMM-03-MX-1	0 to 4	GM	Gravel-sand-silt		
SMM-04-MX-1	9 to 14	GW	Gravel-sand		
SMM-05-MX-1	0 to 4	OL	Organic silt		
SMM-06-FL-1	6 to 12	CL	Sandy clay	SC	Clayey sand
SMM-07-MX-1	8 to 12	CL	Sandy clay		
SMM-08-MX-1	22 to 24	SW	Well-graded sand		
SMM-09-MX-1	0 to 3	CL	Clay		
SMM-11-MX-1	0 to 2	CL	Clay		
SMM-12-MX-1	0 to 4	CL	Sandy clay		
SMM-13-FL-3	37 to 40	SP[1]	Poorly-graded sand	SP	Poorly-graded sand
SMM-14-FL-1	0 to 4	SM	Silty sand	SW	Well-graded sand
SMM-15-MX-1	0 to 4	SM	Silty sand		
SMM-16-MX-2	24 to 26	SP[1]	Poorly-graded sand		
SMM-17-MX-1	0 to 4	SM	Silty sand		
SMM-18-MX-2	24 to 26	SP[1]	Poorly-graded sand		
SMM-19-MX-3	34 to 38	SP[1]	Poorly-graded sand		

NOTES: [1]Sediment appeared to be aeolian beach sand.

For the 49 primary sediment samples listed in Table 2-2, a variety of sediment or soil types were collected. Sixteen of the samples were poorly graded sand (SP), twelve of the samples were clay (CL), nine of the samples were silty sand (SM), seven of the samples were well graded sand (SW), three of the samples were either well graded gravel (GW) or silt-sand-gravel (GM), and two of the samples were either organic clay (OL) or organic silt (OH). Therefore, the analytical data represent a variety of depositional conditions.

As another indicator of sediment type and depositional setting, TOC analyses were performed on the "full suite" samples. Table 2-3 presents the TOC concentrations and the respective soil types. Based on this small data set, the soil type and TOC

concentrations appear to be poorly correlated. Furthermore, the TOC concentrations do not correlate well with the existing pond footprint. Samples collected inside the pond outline (Figures 2-2 and 2-3) contain both the highest TOC concentration and non-detect concentrations, while samples collected outside of the existing pond footprint also contained a range of detectable and also some non-detect concentrations of TOC.

All of the samples listed in Table 2-3 contained detectable concentrations of nitrate. These concentrations ranged from 3.9 to 19.5 mg/kg. As with the TOC concentrations, there does not appear to be any obvious correlation between the nitrate concentrations and the sediment type or location from which the sample was collected.

Table 2-3
Muliwai Total Organic Carbon (TOC) and Nitrate Data

Sample Number	Depth (inches)	Soil Symbol	Soil Type	TOC (Walkley Black) (mg/kg)	Nitrate (mg/kg)
DMM-01-FL-3	24 to 30	SP	Gravelly sand /Poorly-graded sand	<170	10.1
NMM-04-FL-1	12 to 18	SM/SW	Silty sand/Well-graded sand	<170	19.5
NMM-10-FL-1	0 to 4	SW	Well-graded sand	1,990	12.6
NMM-12-FL-3	19 to 33	SW	Gravelly sand	510	12.9
NMM-16-FL-3	38 to 44	SP[1]	Poorly-graded sand	<170	3.9
NMM-20-FL-1	0 to 12	SP	Poorly-graded sand	1,200	11
SMM-02-FL-1	0 to 6	SM	Silty sand	3,270	13
SMM-06-FL-1	6 to 12	CL/SC	Sandy clay /Clayey sand	<170	12.1
SMM-13-FL-3	37 to 40	SP[1]	Poorly-graded sand	620	4.1
SMM-14-FL-1	0 to 4	SM/SW	Silty sand /Well-graded sand	720	12

NOTES: [1]Sediment appeared to be aeolian beach sand.

2.2.2 Background Sampling

To assess the ambient concentrations of the analytes of concern near MMR, two areas were selected for background sediment sampling ("north stream" and "south stream"). No other muliwai ponds were identified near Mākua Valley. These two background areas were selected as locations where sediments are derived from similar source rocks, but are not likely to have been affected by military activities. The north stream location is at the mouth of the Kaluakauila Stream, approximately 1.3 miles north of the MMR main gate. This streambed was the site used for background sampling during the 1999 USEPA muliwai sampling (USEPA 1999a). The south stream is an unnamed streambed approximately 1.6 miles south of the MMR main gate (Figure 2-1). Both streams were dry at the time of sampling.

Sampling locations at the background sites were selected where the streambeds appear to be relatively flat and the sediments are likely the thickest. Three sediment samples were collected at each of the two background sampling sites, comprising the composited upper one foot of streambed sediment. Table 2-1 lists the background samples that were collected and their associated laboratory analyses.

2.3 ANALYTICAL PROCEDURES

Chemical parameters and analytes of interest included in this sampling project were selected based on the following sources and references and in accordance with the approved SAP for this project:

- Previous investigation results;
- Third-party technical expert review comments;
- Interviews with MMR range personnel;
- Hydrogeologic data from MMR (WES 2004);
- Final Report, RCRA Facility Assessment for MMR (SAIC 1992);
- Federal Facility Preliminary Assessment/Site Inspection Review for MMR (University of Hawai'i, undated);
- Critique of the "Halliburton Study" dated Feb 17, 1999 (Masters 2001); and
- Heavy Metals Survey in Mākua (Char 1977).

Table 2-4 lists the analytes included in each of the analytical methods used in this study. Table 2-5 lists the analytical methods performed for each of the samples submitted. All samples were shipped to the APCL Laboratory in Chino, California. Note that the analysis for dioxins (Method 8280A) was performed by Triangle Laboratories in Triangle Park, New Jersey, and that the particle size analysis (ASTMD1140) was performed by PTS Laboratories in Santa Fe Springs, California.

Table 2-4
Muliwai Analytical Procedures

No.	Parameter	Method	Analyte(s)
1.	**Metals**	USEPA 6010B[1]	Aluminum, Antimony, Arsenic, Barium, Cadmium, Chromium, Cobalt, Copper, Lead, Selenium, Silver, Vanadium, and Zinc
2.	**Mercury**	USEPA 7471A[1]	Mercury
3.	**Cyanide**	USEPA 335.2[2]	Cyanide
4.	**Nitrite**	USEPA 354.1[2]	Nitrite
5.	**Nitrate**	SM 4500D[3]	Nitrate
6.	**TOC**	Walkley Black[4]	Total Organic Carbon
7.	**Perchlorate**	USEPA 314.0[5]	Perchlorate
8.	**Explosives & Energetics**	USEPA 8330[1]	Includes full suite of nitroaromatic and nitramine explosive compounds (e.g., TNT, RDX and HMX), as well as relevant breakdown compounds.
9.	**Nitroglycerine**	USEPA 8332[1]	Nitroglycerine
10.	**BTEX**	USEPA 8021B[1]	Benzene, toluene, ethylbenzene, and xylenes.
11.	**OC Pesticides**	USEPA 8081A[1]	Includes full suite of organochlorine pesticides (e.g., DDT, chlordane, aldrin and dieldrin) as well as relevant breakdown isomers.
12.	**SVOCs**	USEPA 8270C[1]	Includes full suite of semivolatile compounds, including polycyclic aromatic hydrocarbons (PAHs), phthalates, and phenolic compounds.
13.	**Chlorinated herbicides**	USEPA 8151A[1]	Includes full suite of chlorinated herbicides, including phenoxy-acid herbicides (e.g., 2,4-D and 2,4,5-T).
14.	**Dioxins/Furans**	USEPA 8280A[1]	Includes 17 isomers and congeners of tetra through octa chlorine-substituted dibenzo-p-dioxins and dibenzofurans (PCDDs and PCDFs)
15.	**Particle Size**	ASTM D-1140[6]	Particle size/sieve analysis: amount of material in soils finer than the #200 sieve.

NOTES:
[1]Test Methods for Evaluating Solid Waste (SW-846), Final Update IIIB (USEPA 1998).
[2]Methods for Chemical Analysis of Waters and Wastes (USEPA 1983).
[3]Standard Methods for the Examination of Water and Wastewater (APHA/AWWA 1998).
[4]Walkley Black (Soil Science 37:29-37, 1934).
[5]Methods for the Determination of Organic and Inorganic Compounds in Drinking Water (USEPA 2000b).
[6]Standard Test Methods – Book of Standards (Volume 04.08, ASTM).

Table 2-5
Muliwai Sample Location and Analyses Matrix

Sample ID		Sample Date	Depth (feet)	314.0 APCL	335.2 APCL	354.1 APCL	6010B APCL	7471A APCL	8021B APCL	8081A APCL	8151A APCL	8270C APCL	8280A Triangle	8330 APCL	8332 APCL	9045C APCL	D2216 APCL	SM4500 APCL	WBLACK APCL
BMN-01-MX-1	BMN-01	5/22/2003	1				X	X						X			X		
BMN-02-MX-1	BMN-02	5/22/2003	1				X	X						X			X		
BMN-02-MX-1-D	BMN-02	5/22/2003	1				X	X						X			X		
BMN-03-MX-1	BMN-03	5/22/2003	1				X	X						X			X		
BMS-01-MX-2	BMS-01	5/22/2003	2				X	X						X			X		
BMS-02-MX-2	BMS-02	5/22/2003	2				X	X						X			X		
BMS-03-MX-1	BMS-03	5/22/2003	1				X	X						X			X		
BMS-03-MX-1-D	BMS-03	5/22/2003	1				X	X						X			X		
DMM-01-FL-3	DMM-01	5/20/2003	3	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
DMM-02-MX-3	DMM-02	5/20/2003	3				X	X						X			X		
DMM-02-MX-3-D	DMM-02	5/20/2003	3				X	X						X			X		
DMM-03-MX-1	DMM-03	5/20/2003	1				X	X						X			X		
NMM-01-MX-1	NMM-01	5/19/2003	1				X	X						X			X		
NMM-02-MX-1	NMM-02	5/20/2003	1				X	X						X			X		
NMM-03-MX-1	NMM-03	5/20/2003	1				X	X						X			X		
NMM-04-FL-1	NMM-04	5/22/2003	1	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
NMM-05-MX-1	NMM-05	5/22/2003	1				X	X						X			X		
NMM-06-MX-1	NMM-06	5/19/2003	1				X	X						X			X		
NMM-07-MX-3	NMM-07	5/20/2003	3				X	X						X			X		
NMM-08-MX-1	NMM-08	5/20/2003	1				X	X						X			X		
NMM-09-MX-1	NMM-09	5/22/2003	1				X	X						X			X		
NMM-10-FL-1	NMM-10	5/22/2003	1	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
NMM-11-MX-2	NMM-11	5/19/2003	2				X	X						X			X		
NMM-12-FL-3	NMM-12	5/19/2003	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NMM-13-MX-3	NMM-13	5/19/2003	3				X	X						X			X		
NMM-14-MX-1	NMM-14	5/20/2003	1				X	X						X			X		
NMM-15-MX-1	NMM-15	5/19/2003	1				X	X						X			X		
NMM-16-FL-3	NMM-16	5/20/2003	3	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
NMM-16-FL-3-D	NMM-16	5/20/2003	3	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
NMM-17-MX-2	NMM-17	5/19/2003	2				X	X						X			X		
NMM-18-MX-3	NMM-18	5/20/2003	3				X	X						X			X		
NMM-19-MX-3	NMM-19	5/19/2003	3				X	X						X			X		
NMM-20-FL-1	NMM-20	5/19/2003	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NMM-21-MX-3	NMM-21	5/20/2003	3				X	X						X			X		
NMM-22-MX-1	NMM-22	5/19/2003	1				X	X						X			X		
SMM-01-MX-1	SMM-01	5/20/2003	1				X	X						X			X		
SMM-02-FL-1	SMM-02	5/21/2003	1	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SMM-03-MX-1	SMM-03	5/21/2003	1				X	X						X			X		
SMM-04-MX-1	SMM-04	5/21/2003	1				X	X						X			X		
SMM-05-MX-1	SMM-05	5/21/2003	1				X	X						X			X		
SMM-06-FL-1	SMM-06	5/20/2003	1	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SMM-07-MX-1	SMM-07	5/20/2003	1				X	X						X			X		
SMM-08-MX-1	SMM-08	5/21/2003	1				X	X						X			X		
SMM-09-MX-1	SMM-09	5/21/2003	1				X	X						X			X		
SMM-11-MX-1	SMM-11	5/21/2003	1				X	X						X			X		
SMM-12-MX-1	SMM-12	5/21/2003	1				X	X						X			X		
SMM-13-FL-3	SMM-13	5/21/2003	3	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SMM-13-FL-3-D	SMM-13	5/21/2003	3	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SMM-14-FL-1	SMM-14	5/21/2003	1	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SMM-15-MX-1	SMM-15	5/21/2003	1				X	X						X			X		
SMM-16-MX-2	SMM-16	5/21/2003	2				X	X						X			X		
SMM-17-MX-1	SMM-17	5/21/2003	1				X	X						X			X		
SMM-18-MX-2	SMM-18	5/21/2003	2				X	X						X			X		
SMM-19-MX-3	SMM-19	5/21/2003	3				X	X						X			X		