6.9 GEOLOGY, SOILS, AND SEISMICITY

6.9.1 Affected Environment

Physiography

DMR is on the Waialua Plain and extends inland to the foot of the Waiʻanae Range. Elevation ranges from near sea level on the northern boundary to 200 feet (61 meters) near the southern boundary.

The proposed Dillingham Trail would connect DMR and SBMR. From DMR to Ranch Camp at Waialua, the proposed trail would use established paved roads on the coastal plain inland of the Farrington Highway. The proposed route would cross several small streams, the largest of which is Makaleha Stream, near Dillingham Ranch. At Ranch Camp, the trail would head south up to an elevation of about 250 feet (15.2 meters), where it would cross a tributary of Kaukonahua Stream. Here it would head east, below the Ito Ditch, which runs approximately along the contour of the hillslope for about one-quarter mile (402 meters). Then the trail would turn upslope and follow a ridge up to an elevation of about 1,800 feet (549 meters). The proposed trail would turn east again and descend gradually along the contour of the mountain to an elevation of about 1,500 feet (457 meters), where it would round the shoulder of a prominence called Māʻili. The trail would continue south along the contour of the mountain at an elevation of about 1,200 feet (366 meters) and then descend steeply to SBMR, crossing both Haleanau Gulch and Mohiākea Gulch.

Geology

DMR is on the north slope of the Waiʻanae Range and is underlain by volcanic rocks of the Waiʻanae volcanic series (Figure 6-11). The Waiʻanae flows ended in the late Tertiary period and were overlain by erosional sediments, followed by volcanic rocks of the Koʻolau series that were erupted during the building of the Koʻolau volcanic dome. These also have been eroded. The exposed rocks on the north slope of the Waiʻanae Range, south of DMR, are remnants of the dike complex belonging to the northwest-trending rift zone of the Waiʻanae dome. Along the coast, the volcanic rocks alternately have been submerged below and have emerged above sea level over recent geologic time. The coastline is underlain by an ancient coral reef, which subsequently has been overlain by dune sand deposits.

Soils

Soils at DMR are developed on beach sand deposits, with various mixtures of finer and coarser sediments. Figure 6-12 shows the distribution of soil types. Most of the area is underlain by Jaucas sand, which has subsequently been disturbed or filled to construct the airstrip, roads, and building sites. The boggy seasonal wetlands are underlain by Lualualei Clay, while the marginal sloping uplands are primarily Kaena very stony clay or other stony or rocky soils. The Jaucas sand is very susceptible to wind erosion (and probably also to liquefaction). The Kaena very stony clay is subject to moderate or severe erosion by water runoff (Foot et. al 1972).

Figure 6-11
Geologic Map of Dillingham Military Reservation

Figure 6-12
Soils Map of Dillingham Military Reservation

Dillingham Trail would use unpaved farm roads over most of the proposed alignment. Some modification to roads would likely be required, such as hardening the roads or improving drainage to prevent damage to the road surface. A fiber optic telecommunications line would be installed underground in a trench alongside the trail. In some areas, such as in the segment that passes near the rim of the channel of Poamoho Stream, east of Waialua, the trail would follow the edge of cultivated farmlands, where the road may be minimally used or non-existent. The trail would use existing stream crossings where suitable, but improvements or modifications to these crossings may be required, to ensure that the trail would be passable, to prevent environmental damage, or both. Because the trail follows existing roads, the characteristics of the soils underlying the trail in these areas are of less relevance to the later discussion of impacts than in areas where the trail requires new construction. The following narrative describes the soils over which the proposed trail passes. The soils along the trail alignment are shown on Figure 6-12.

From the east edge of DMR to just east of Waialua, Dillingham Trail crosses relatively flat lands of the coastal plain, underlain by soils of the Kaena-Waialua association, which includes deep, poorly drained to excessively drained soils with a fine- to coarse-textured subsoil on coastal plains and talus slopes. Initially, the trail follows the 20 to 50 foot (6 to 15 meter) elevation contour near the toe of the alluvium at the base of the Wai‘anae Range, where it is underlain by Pulehu very stony clay loam on 0 to 12 percent slopes (PuB), Pearl Harbor clay (Ph), Kawaihapai stony clay loam on 0 to 12 percent slopes (KlaA), Kaena stony clay on 2 to 6 percent slopes (KaeB), Puleu clay loam on 0 to 3 percent slopes (PsA), Waialua stony silty clay on 3 to 18 percent slopes (WlB), and Waialua silty clay on 0 to 3 percent slopes (Wka). Except for the clay soils, most of the soils make good road fill. The Pearl Harbor clay, Kaena stony clay, and Waialua clays have a moderate to high shrink-swell potential, poor workability, and high water table.

The trail starts upslope along an existing paved road east of Mokule‘ia and continues further upslope to an elevation of about 180 to 200 feet (55 to 61 meters) msl before continuing along the toe of the slope within this elevation range to a point above Ranch Camp at Waialua. This traverse is underlain by Ewa silty clay loam on 6 to 12 percent slopes (EaC), Ewa stony silty clay on 6 to 12 percent slopes (EwC), and Ewa stony silty clay on 2 to 6 percent slopes (EaB). The Ewa soils make good road fill.

The trail rises to the edge of the cultivated farmlands and then starts downslope, picking up a heavier duty farm road, which becomes a paved road near Ranch Camp. The paved road crosses a bridge over a tributary of Ki‘iki‘i Stream east of Ranch Camp and continues along paved roads through Thomson Corner and eastward to a point upstream of the Kaheaka Reservoir. From this point, the trail crosses soils belonging to the Helemano-Wahiawa association. These are deep, well-drained soils on uplands. The trail then continues south, leaving the paved road, and skirts the southern edge of the cultivated farmlands along the north rim of Poamoho Stream. Poamoho Stream is in a deeply-incised channel in a gulch where the stream channel is more than 200 feet (61 meters) below the rim of the gulch. The sideslopes of the downstream portion of the gulch are identified as rock land (rRK), transitioning to Helemano soils (HLMG) further upstream. Rock land is made up of areas where exposed rock covers 25 to 90 percent of the surface. The soil between the rock outcrops tends to be clayey, has a high shrink-swell potential, and is susceptible to sliding. Helemano soils, on steep slopes, have rapid runoff and a severe erosion hazard.

At the rim of the gulch the trail traverses soils of the Wahiawa silty clay (WaB and WaC), then continues gradually upslope across Manana silty clay (MpD and MpC) and Kolekole silty clay loam (KuC and KuD), skirting the Wahiawa silty clay soils that underlie the adjacent farmlands. All three of these soils are suitable for road fill.

Near Poamoho Camp, the trail crosses Poamoho Stream just downstream of the point of convergence of two tributaries of the stream. There is no bridge crossing here. The crossing area is in Helemano soils with 30 to 90 degree slopes (HLMG). The trail then runs along the south bank of the stream, along the margin of the cultivated farmland underlain by Wahiawa silty clay (WaB), then picks up a farm road that traverses the flat ridge between Poamoho Stream and Kaukonahua Stream, across soils of the WaA and WaB series. The trail then follows along the rim of the gulch of Kaukonahua Stream, until it picks up the paved highway (Wilikina Drive) to the gate at SBMR.

Geologic Hazards

Although the installation lies at the foot of the steep slopes of the northern extension of the Wai'anae Range, steep slopes (greater than 30 percent) within DMR are limited to the southern margin of the installation (Figure 6-13). The typical mode of failure in this geologic context is rock falls, since the slopes contain relatively little soil cover.

The northwest part of O'ahu is within an area that has about a 10 percent probability of experiencing ground accelerations of more than 10 percent of gravity during the next 50 years because of an earthquake (Klein et al. 2001).

The combination of loose beach and dune sands and a shallow water table present at DMR make liquefaction a potential hazard. Liquefaction is the sudden loss of strength of saturated soil or sediment that results from increased pore pressure caused by vibration or seismic shaking. Loose sandy sediments with a high water table are particularly susceptible to liquefaction.

6.9.2 Environmental Consequences

This section addresses the environmental consequences of the Proposed Action and No Action on geology.

Summary of Impacts

The Proposed Action and RLA Alternative would result in significant and unmitigable impacts on soil loss from mounted training activities. Significant impacts mitigable to less than significant are expected from soil erosion resulting from wildfires. Less than significant impacts on soil erosion and slope failure are expected from the Proposed Action within DMR and along Dillingham Trail, and less than significant impacts relating to seismicity and liquefaction may result at DMR because of the high water table and sandy sediments. No impacts on soil erosion and slope failure are expected from No Action. A summary of impacts is provided in Table 6-17.

Figure 6-13
Steep Slopes at Dillingham Military Reservation

Table 6-17
Summary of Potential Geologic Resources Impacts at DMR

Impact Issues	Proposed Action	Reduced Land Acquisition	No Action
Soil loss	⊗	⊗	○
Soil erosion and loss from wildland fires	⊘	⊘	⊙
Soil compaction	○	○	○
Exposure to soil contaminants	○	○	○
Slope failure	⊘	⊘	○
Seismic hazards: liquefaction	⊙	⊙	⊙

In cases when there would be both beneficial and adverse impacts, both are shown on this table. Mitigation measures would only apply to adverse impacts.

LEGEND:

⊗ = Significant
⊘ = Significant but mitigable to less than significant
⊙ = Less than significant
○ = No impact
\+ = Beneficial impact
N/A = Not applicable

Proposed Action (Preferred Alternative)

Significant Impacts

Impact 1: Soil loss/erosion in training ranges. Training activities under the Proposed Action are expected to result in a significant increase in soil erosion and soils loss compared to existing conditions in the DMR. The soil loss may be partially but not fully mitigated. Therefore, this is considered to be a significant but not mitigable impact.

The Army developed the ATTACC model, as described in Appendix M and summarized in chapter 5.9, to assess the impacts of mounted maneuver training on land. A land condition curve was developed for DMR.

In DMR, the ATTACC model results indicate that land condition will decline. Maneuver training would be unrestricted over the entire accessible area where slopes are less than 30 percent. Under this assumption, the land condition was determined to decline to a severely degraded condition. However, if the Stryker is restricted to existing training roads, the land damage would be limited to the existing roads instead of distributed over the entire DMR, but the restriction to the roads would mean that damage to the road areas would be increased because the vehicle use would be focused onto a smaller area. The existing roads do not contain vegetation, but intense vehicle use could disturb the soils underlying the roads and cause ruts and gullies to form, which in turn could lead to enhanced soil erosion. These opposing effects do not necessarily cancel each other out, but it is difficult to know what the differences would be. Within the uncertainties of the model, it is expected that, without mitigation, the effects of soil loss from soil erosion caused by the mounted maneuver training would be significant over time.

Land condition is projected by the ATTACC model to decline from acceptable under existing conditions to "severe" under the Proposed Action because mounted maneuver training with the Stryker vehicle would be focused in the relatively small portion of the range having less than 30 percent slopes and because the effect of the Stryker vehicle on vegetation and soils is relatively greater than from existing vehicles. Therefore, without mitigation, the effects on soil loss in DMR are considered to be significant over time. The mitigation measures detailed below could be implemented. Their success cannot be adequately assessed, and because of the expected severity of the effects, the effects likely would not be fully successful in preventing the eventual loss of fertility and sustainability of the soils on the DMR.

Regulatory and Administrative Mitigation 1. Mitigating soil erosion in range areas will draw on land restoration measures described in the INRMP, which were selected using evaluation procedures developed through the Army's ITAM program. Such measures may include placing runoff controls to redirect or intercept runoff and sediment, reducing vehicle use in sensitive areas, mulching, hydroseeding, and revegetating damaged areas with fast growing species. In DMR, mitigation could include hardening the roads, raising the elevation of the roadways to improve drainage, installing drainage ditches adjacent to roads to control runon and runoff, planting grasses to slow overland flow, constructing berms or sediment barriers to intercept runoff and allow sediment to settle or be deposited before being discharged to the adjacent streams with runoff, and recontouring the land to control runoff and direct it to sedimentation ponds. Some of these methods are standard best management practices for controlling erosion at construction sites and could be modified for use in the DMR.

Significant but Mitigable to Less Than Significant

Impact 2: Soil erosion from wildland fires. At each of the installations, wildland fires have the potential for removing vegetation that protects soil from erosion. Fire also could affect the adjacent uplands and the lands bordering Dillingham Trail. Wildland fires can affect large areas of land, removing grasses and larger trees and shrubs that hold the soil. The magnitude of this impact is directly related to the size of the fire. Fires may be initiated by detonation of munitions, or potentially even by vehicle engines, smoking, use of welding torches, by downed power lines, and many other causes. Land management practices can increase or reduce the potential damage caused by fires, through management of the fuel supply (wood, brush, grasses). Although naturally-caused fires are not common in Hawai'i, fires may also be started naturally, by electrical storms. Wildland fires are considered to be a potentially significant impact of all alternatives because of the potential for increased soil erosion.

The potential for fires initiated as a result of Army activities at DMR is expected to be no greater than the potential outside of DMR because activities at DMR would involve mainly transport of personnel and supplies. The potential for a fire to spread, if initiated, is probably somewhat lower than in the surrounding community because the Army maintains fire response equipment and trained personnel at DMR and carries fire suppression equipment during transport and training and thus could respond quickly to a fire. If necessary, Army personnel and civilian fire departments would cooperative to suppress any fires in the vicinity of DMR and to ensure that the response was adequate to address the threat.

Regulatory and Administrative Mitigation 2. Prevention and suppression of wildland fires on training ranges is addressed in the WFMP*,* Pōhakuloa and O'ahu Training Areas (USARHAW and 25th ID [L] 2000a). Post fire land management and rehabilitation is addressed in the LRAM element of the ITAM program, which is discussed in the INRMP, 2002-2006 (USARHAW and 25th ID [L] 2000a) and at the ITAM Web site at http://www.army-itam.com.

Impact 3: Erosion and slope failure in Dillingham Trail alignment. Most of Dillingham Trail would follow existing roads and would be on relatively gentle stable slopes. Parts of the proposed route would be near the rim of the gulches of Poamoho Stream and Kaukonahua Stream. The route could cross areas of unstable slopes, or construction of new roadways or modification of the existing roads could reduce slope stability through creation of new cuts and fills or drainage problems. Some of the clay soils on the coastal plain near DMR are not considered highly suitable for road fills and are subject to shrinking and swelling or soil creep (slow downslope movement in soils with low strength).

Regulatory and Administrative Mitigation 3. These impacts are expected to be reduced to less than significant levels through use of standard engineering techniques, including testing the soils prior to construction to identify problems, modifying or improving the road surface to reduce adverse effects, and constructing appropriate drainage systems to prevent erosion or water logging.

Less than Significant Impacts

Erosion and slope failure within DMR. ATTACC model results indicate that existing levels of maneuver training activities have relatively little impact on land condition. A total of 1,710 MIMs were attributed to mounted maneuver training at DMR in the ATTACC modeling assumptions for existing conditions. Current land condition is considered mildly impacted. However, under the Proposed Action, it is expected that annual MIMs would increase to 4,335. Moderate impacts on land condition (for example, reduction in vegetation and exposure of soils) are expected to occur for a range of about 3,000 to 4,000 MIMs, and land condition is expected to decline more rapidly when MIMs exceed 4,000. DMR itself is mainly on level or gently-sloping terrain. Slopes greater than 30 percent are limited to the southern margin of the installation. Therefore, although vegetation may be affected by training activities (discussed further in the biology section), the threat of erosion within the boundaries of DMR because of damage to vegetative cover would be slight.

Seismicity and liquefaction. Liquefaction potential at DMR has not been characterized, and the potential for injury or property loss in the event that liquefaction occurs is probably small, due to the low potential for significant ground shaking. However, in a strong earthquake DMR may be impacted by liquefaction, because of the high water table and sandy sediments underlying the facility. Liquefaction could cause damage to structures or to the runway, for example. The Proposed Action is not expected to result in any significant new hazards associated with earthquakes or liquefaction relative to existing conditions, and no new structures would be constructed at DMR under the Proposed Action. Therefore, the impact is considered less than significant.

Erosion and slope failure from use of Dillingham Trail. Over the long term, use of Dillingham Trail by heavy vehicles may lead to compaction of the road surface and formation of ruts that interfere with proper drainage and may destabilize slopes in areas underlain by soft saturated soils. In addition, vibrations caused by heavy vehicle use may induce failure of unstable slopes, or loading on unstable steep slopes may induce failure of the roadway. Repair of failed slopes could require additional cutting, filling, or shoring, with the potential to further alter natural land contours and drainage patterns. Landslides themselves may become the locus of future slides since the failed soil may be poorly drained. These potential impacts would be avoided or reduced to less than significant levels through monitoring and early maintenance of the roadway and adjacent slopes.

Reduced Land Acquisition Alternative

The impacts associated with Reduced Land Acquisition are identical to those described for the Proposed Action.

No Action Alternative

Less than Significant/No Impacts

The impacts under the No Action Alternative would generally be the same as described for the Proposed Action. Flood hazards may be qualitatively slightly less, since the installation would be less intensively used.

No impact of slope failure along the Dillingham Trail would occur under the No Action Alternative, because the trail would not be constructed.