5.9 GEOLOGY, SOILS, AND SEISMICITY

5.9.1 Affected Environment

The discussion of SBMR is divided between the Main Post, which is west of the town of Wahiawā and WAAF, and SBER, which is east of Highway 99.

Physiography

Main Post

Most of the Main Post of SBMR is in the Schofield Plateau geomorphic province, which is a broad interior highland that lies between the Wai‘anae Range and the Ko‘olau Range. The western side of the Main Post lies within the Wai‘anae Range geomorphic province. Figure 5-29 shows the location of SBMR and some of the other major features discussed in this section.

The Main Post is bounded on the east by Kaukonahua Stream, Wahiawā Reservoir, the town of Wahiawā, and Route 750, and it extends westward to the ridgeline of the Wai‘anae Range. Elevations in the Main Post of SBMR range from about 660 feet (less than 201 meters) along the eastern boundary to about 3,000 feet (greater than 915 meters) on the ridgeline of the Wai‘anae Range.

Wheeler Army Airfield

WAAF is near the southern edge of the Schofield Plateau, between Schofield Barracks Main Post and the East Range. It is bounded by Waikele Stream on the south and by Wahiawa Reservoir on the north. The land is relatively flat, with a gentle southward slope over most of the installation, from an elevation of about 860 feet near Wahiawa Reservoir, to about 790 feet on the south edge of the plateau. Along the southern boundary of the installation the slope breaks sharply in steep gullies that drain to the channel of Waikele Stream, about 80 to 100 feet below the level of the runways.

South Range Acquisition Area

Most of the SRAA is south of Waikele Stream, and consists of a generally east-sloping upland that slopes from an elevation of about 1,200 feet msl in the southwest to about 850 feet msl near Wheeler Army Airfield on the east. The upland surface is deeply dissected by Waikele Gulch and gulches of several north-draining tributaries to Waikele Stream. The channel of Waikele Stream is more than 100 feet below the rim in some areas. The upper surface of the SRAA is planted with non-irrigated pineapples, in long rows that run generally along the contour of the land.

Schofield Barracks East Range

SBER is on the east side of the Schofield Plateau geomorphic province, an area created by the lapping of basalt flows from the Ko‘olau Volcano against the remnants of the older Wai‘anae Volcano to the west. The eastern side of SBER lies within the Ko‘olau Range geomorphic province.

Figure 5-29
Geologic Map of Schofield Barracks Main Post

The southern boundary of SBER is the boundary between the Kaukonahua watershed and the Waikele watershed. The northern boundary of SBER, east of Wahiawā, corresponds to the boundary between the Kaukonahua watershed and the Poamoho watershed.

SBER is on the leeward slope of the Koʻolau Range. The landscape is geologically young and undergoing rapid erosion. Streams cut deep V-shaped valleys in volcanic flow deposits that have deeply weathered in place, leaving the remnant structure of the volcanic flows but reducing their original permeability.

The upper surface of SBER slopes at an average rate of about 10 percent, dropping from an elevation of about 2,681 feet (817 meters) msl on the Koʻolau Ridge at Puʻu Kaʻaumakua to about 850 feet (259 meters) msl at Highway 99. The slope increases to the east. The western third of the range slopes at about half that rate, while the eastern third slopes at nearly twice that rate. The terrain is very rugged; the walls of the stream valleys in the eastern two-thirds of the range typically have slopes of 30 to over 100 percent.

Geology

Main Post

SBMR is underlain by the Koʻolau Basalt member of the Koʻolau Volcanics series, which butts up against the older eroded surface of the Kamaileʻunu and Lualualei (lower and middle) members of the Waiʻanae Volcanics series (Figure 5-29). The Koʻolau Basalt flowed in thin nearly horizontal layers, on which soils developed and alluvial sediments were deposited between flows during the eruptive history of the Koʻolau Volcano. The Koʻolau volcanics are overlain by recent alluvial sediments eroded from the Waiʻanae Range, which accounts for the surficial deposits that cover most of the Main Post (Oki 1998).

The thickness of the alluvial sediments generally increases toward the center of the Schofield Plateau. Beneath that is soil that developed in place on the surface of the Koʻolau volcanics. This soil surface is underlain by saprolite (basalt that has been intensely weathered in place but retains many of the features of the original rock). Saprolite is exposed in some stream channels at SBMR (HLA 1992). The saprolite grades with depth into less weathered basalt. Thus, relatively soft materials are found to depths of 100 to 200 feet (30.5 to 61 meters) below the ground surface (HLA 1992).

Wheeler Army Airfield

WAAF is adjacent to the east side of the Main Post and is underlain by a thick 100-foot or greater sequence of saprolite, as described above, over which has developed an approximately 10-foot (3-meter) thick layer of clay-rich soil.

South Range Acquisition Area

As illustrated in Figure 5-29, the geology underlying the SRAA is dominated by lava flows of the lower and middle members of the Waiʻanae Volcanic Series, which crops out along the uplands on the east side of the Main Post, and underlies WAAF. The channel of Waikele Stream is incised 80 to 120 feet (24 to 37 meters) below the surface of the plateau, meaning that the stream channel has eroded through softer alluvium, soil, and saprolite deposits and rests near the depth of the underlying weathered basalt. The stream channels are covered by sediments eroded from the uplands and from the side slopes of the channels.

Schofield Barracks East Range

The geology of SBER is similar to that described above for the Main Post. Stearns and Vaksvik estimated the thickness of the Koʻolau deposits (depth to the underlying Waiʻanae volcanic deposits) to be about 1,500 feet (457 meters) under the east side of SBMR. The thickness increases to the east.

The eastern side of SBER is part of the Northwest Rift Zone of the Koʻolau Volcano. This is an area of greater dike intensity. The eruptive center of the Koʻolau Volcano was probably to the east of the ridge of the Koʻolau Range, near Kāneʻohe Bay.

Soils

Main Post

Figure 5-30 is a map of the soil series found within the Main Post. Four of the seven soil associations found on Oʻahu occur within SBMR. Each of these is derived from volcanic parent material. Soils on the steep east-facing slopes above an elevation of about 1,500 feet (457 meters) belong to the Tropohumults-Dystrandepts association (Foote et. al 1972). These are thin light soils derived from volcanic ash; they are high in organic matter and when saturated can contain more water than soil. Deep V-shaped drainages and narrow ridges dominate the areas in which these soils occur. The soils are strongly to extremely acid. Tropohumults have a surface layer of reddish-brown silty clay. The subsoil has a strong blocky structure and is underlain by saprolite. Dystrandepts are dark-colored friable soils with a silty clay surface layer. The subsoil is generally massive. These soils may contain thick accumulations of organic material.

Lower on the flanks of the range, the two major soil groups are Kolekole silty clay loam and Manana silty clay loam. Kolekole soils are developed in gravelly alluvium mixed with volcanic ash. They are found on gently to moderately steep slopes at elevations ranging from 500 to 1,200 feet (152 to 366 meters). These soils are used for sugarcane, pineapple, and pasture. Permeability is moderately rapid to the depth of a hardpan layer at about 2 to 3 feet (0.6 to 0.9 meters). Runoff is slow, and erosion hazard is slight.

The principal soil type on the flatter lands at lower elevations is Kunia silty clay. Kunia soils are well-drained soils found on nearly level ground in upland terraces and fans at elevations of 700 to 1,000 feet (213 to 305 meters). Permeability is moderate, runoff is slow, and erosion hazard is slight. The surface layer is a dark reddish-brown silty clay about 2 feet (0.61 meters) thick, grading to a blocky silty clay loam to a depth of about 6 feet (1.83 meters), and underlain by gravelly silty clay (Foote et al. 1972).

In gulches, the principal soils are Helemano and Kawaihapai series. Helemano soils are well-drained silty clays that occur in V-shaped gulches. Erosion hazard is severe to very severe. Kawaihapai soils occur in drainageways on alluvial fans. These soils are well drained, and the erosion hazard is slight.

Figure 5-30
Soils Map Schofield Barracks Main Post

A study conducted for the Army in 1979 (WLA 1979) identified soil erosion problems in the Central and South Ranges of SBMR. The study concluded that erosion of the walls of gulches in heavy rainfall/runoff was primarily a natural phenomenon, mainly affecting Helemano soils. The study also identified soil erosion problems associated with unstable or poorly drained road cuts, mainly at gulch crossings and in areas with steep slopes, and associated with bare ground surfaces where vegetation loss was caused by vehicle traffic and other military activities. The study found that in the 3,600-acre (1,457 hectare) study area, about 48 acres (19.4 hectares) (1.3 percent of the total study area) were undergoing high rates of erosion due to natural conditions, while about 126 acres (51 hectares) (3.5 percent) were undergoing a high rate of erosion due to military activities. Erosion rates in denuded upland soil areas were estimated at between 28 and 80 tons per acre per year, compared to erosion on vegetated surfaces of 1.7 tons per acre per year. The erosion rate from soils at the tops of gulches in denuded areas was estimated at over 400 tons per acre per year, versus a rate of 8.1 tons per acre per year in areas where the tops of gulches were vegetated. Most of the erosion was caused by precipitation and runoff, but wind erosion was also a factor in bare soil areas. Revegetation, along with improving drainage at road cuts, was the principal management measure identified to address the erosion problems.

Wheeler Army Airfield

Most of the flat lands on WAAF are underlain by Waihiawa silty clay soils, as described above. The gully slopes adjacent to Waikele Stream are underlain by Helemanō soils. As described above, Helemanō soils have a high erosion hazard.

South Range Acquisition Area

Most of the SRAA is underlain by Kunia Silty Clay. Uplands on the east side of the South Range are underlain by soils similar to those at the same elevations on the Main Post, including Kolekole Silty Clay Loam and Mahana Silty Clay Loam. Soils in the SRAA are classified by the State of Hawai'i as "important farmland" because they support unirrigated pineapple culture.

Schofield Barracks East Range

Figure 5-31 shows the soils within SBER. The eastern half of SBER, above about 1,200 feet (366 meters) msl, contains thin soils classified as "rough mountainous land." The soils range from one to ten inches (2.54 to 25.4 centimeters) thick over saprolite. The saprolite is typically soft enough for roots to penetrate. Annual rainfall ranges from 70 to more than 400 inches (178 to more than 1,016 centimeters). On the narrow ridge tops, the soils are similar to Olokui and Amalu soils of Maui and Moloka'i. Amalu soils are poorly drained, peaty silty clays on slopes up to 20 percent. Olokui soils are shallow poorly drained soils that are high in organic matter content and found on slopes of up to 30 percent. A thin impermeable iron-cemented layer (ironstone) is found just above weathered rock at depths of 6 to 20 inches (15 to 51 centimeters). Roots and infiltration of rainwater are limited by the ironstone, so vegetation must have a flat shallow rooting system. These soils are always wet.

Figure 5-31
Soils Map Schofield Barracks East Range

Farther downslope, at elevations below about 1,200 feet (366 meters) msl, the predominant soil is Helemano silty clay on 30 to 90 percent slopes. These are well-drained soils formed on alluvial fans or on the colluvium deposited along the walls of gulches. Colluvium is a loose deposit of rock debris accumulated through the action of gravity at the base of a cliff or slope. The surface soil is dark reddish-brown silty clay, about 10 inches (25.4 centimeters) thick, which is underlain by about 50 inches (127 centimeters) of similar soil with a blocky structure. The soil is developed on soft highly weathered basalt. Runoff is medium to very rapid, and the erosion hazard is severe to very severe. On the gentler slopes of ridge tops below an elevation of about 1,200 feet (366 meters) msl are silty clay soils of the Leilehua and Paaloa series. Leilehua soils are about 48 inches (122 centimeters) thick over gravelly parent material weathered from basalt. Permeability is moderately rapid, runoff is slow to moderate, and the erosion hazard is slight to moderate, depending on slope. Paaloa soils are silty clays or clays. Permeability is moderately rapid, runoff is slow to medium, and the erosion hazard is slight to moderate.

At the lowest elevations of SBER, near Wahiawā, the predominant soil is Wahiawa silty clay. Slopes range from 0 to 8 percent. These soils are well drained, about four feet (1.2 meters) thick, and developed on alluvium underlain by weathered basalt. Runoff is slow, and the erosion hazard is slight.

Helemanō Trail

Helemanō Trail extends from HMR to SBMR and is the southern segment of the route connecting SBMR and KTA. The northern segment of that route is Drum Road, and soils along that segment are discussed in Section 7.9. Dillingham Trail, which connects DMR and SBMR, uses the portion of Helemanō Trail south of the Poamoho Stream crossing, near Poamoho Camp. Soils along Dillingham Trail are discussed in Section 6.9.

The soils along Helemanō Trail are shown in Figure 7-15 (provided in Chapter 7, Section 7.9 with the soils map for Drum Road). Beginning at HMR, the trail follows the Pa‘ala‘a Uka Pūpūkea Road, which is a paved road. The trail continues south from the junction of Pa‘ala‘a Uka Pūpūkea Road and the Kamehameha Highway, about one mile to near the head of small gulch tributary to Poamoho Stream, and continues south for less than a mile along the west rim of the gulch, to the crossing point on the main stem of Poamoho Stream. At this point, the route to SBMR is the same as for Dillingham Trail. (For a description of the soils along the trail alignment south of the Poamoho Stream, please refer to Section 6.9.)

The only portion of Helemanō Trail north of the Poamoho Stream crossing that would be over unpaved road is along the rim of the short tributary gulch. The trail skirts the margin of cultivated farmlands underlain by Wahiawa silty clay soils (WaA and WaC). Wahiawa soils are described as having good suitability for road fill. The banks of the gulch are composed of Helemano silty clay soil on 30 to 60 percent slopes.

Chemical Constituents in Soils

Main Post

USACE conducted a surface soil investigation at SMBR from November 8 to November 10, 2002. The objective of the investigation was to get a snapshot of the current condition of soils on the active training ranges. Comparison tables of detected compounds are included in Appendix M.

The results of the investigation as they relate to concentrations of natural and introduced substances in soils are summarized and briefly discussed in this section. The data from the investigation are intended to support the description of current conditions based on past use of the ranges and naturally occurring factors. The investigation was not intended to be a comprehensive study of the distribution of contaminants on the ranges.

Appendix M contains the complete list of detected constituents. The concentrations are compared to the USEPA's preliminary remediation guidelines (PRGs) for industrial soils. Information about the use of PRGs is provided by the USEPA at: http://www.epa.gov/region09/waste/sfund/prg/files/02userguide.pdf.

PRGs are not regulatory standards. Since risk assessment methods are fairly well standardized, the USEPA has developed PRGs for certain common scenarios that provide a rapid means of screening the results of site investigations to identify areas of potential concern. PRGs have been developed for many chemicals, for residential and industrial soil exposure scenarios, based on conservative assumptions about exposure. The PRGs are goals and are designed to be protective of health under a wide range of conditions.

The guidelines for the use of PRGs allow users to adjust the exposure assumptions to better reflect site-specific conditions. This has not been done for the analysis presented in this report. The Army used the industrial soil PRGs in order to establish a basis of comparison for the concentrations of contaminants observed on the training ranges. However, these PRGs are based on exposure assumptions that are substantially higher than could be expected for military personnel using the proposed range areas. Industrial soil PRGs assume adult outdoor worker exposures for a period of 25 years. In fact, most military personnel use the training ranges only for brief periods, totaling days or weeks, so that actual exposures are far lower than assumed in the industrial soil PRGs. No public exposure can be expected at the proposed range areas.

Three general classes of compounds were detected: metals, explosives, and semivolatile organic compounds. Metals occur naturally in Hawaiian soils, as a result of the weathering of minerals contained in the volcanic rock from which the soils were derived. Training activities may contribute additional metals concentrations to the natural background concentrations present in soils. For example, bullets are composed of an alloy of lead and antimony, which hardens the lead, and lead is present in some explosives.

Explosives. The sampling detected four explosives: TNT (2,4,6-TNT), HMX (Octahydro-1357-tetranitro-1357-tetrazocine), RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine), and nitroglycerin. The reporting limit for TNT, HMX, and RDX was 0.4 mg/kg and for nitroglycerin was 2.2 mg/kg. It is one of these four explosives; two samples of RDX and one sample of nitroglycerin exceeded their respective industrial PRGs. Whether the levels of arsenic detected occur naturally or because of human activity is unclear.

Based on these results, it appears that traces of explosives compounds are present in areas where high explosives have been used or where munitions demolition occurred: the Engineering Demolition Range, the MAC, and the KR8 Anti-Armor Range. Explosives were not detected in samples collected from the North Firebreak Road Impact Area or from the firing point area for 105mm and 155mm mortars in the South Range.

Metals. High concentrations of a number of metals, including aluminum, manganese, iron, chromium, and others, occur naturally in Hawaiian soils. These concentrations are not related to human activities. Activities on the ranges have nothing to do with these concentrations, even though the concentrations exceed industrial soil PRGs. These metals are major constituents of the minerals in the basalt lavas found in Hawai'i. As can be seen in the frequency distribution diagrams, the concentrations of most of the metals, including these, show a normal distribution. In other words, most of the concentrations are near the average, with a decreasing number of samples containing concentrations much higher or lower than the average.

The concentrations of some metals exceeded the average in some samples. Where this occurs, it may indicate a contribution from human-made sources. For example, one sample, MAC-04, from the MOUT Assault Course in the South Range, contained an arsenic concentration of 45 milligrams per kilogram (mg/kg). Arsenic is one of several metals that occurs naturally in Hawaiian soils, at ranges from 1 to 5 mg/kg. Arsenic is one of several metals that occur naturally in Hawaiian soils, at ranges from 1 to 5 mg/kg. Arsenic is one of several metals that is known or suspected to cause cancer in humans, and both the cancer and the noncancer risk must be taken into account. Arsenic was detected in 36 of the 44 samples analyzed, and the average arsenic concentration was 3.9 mg/kg, well below the noncancer industrial soil PRG for arsenic of 260 mg/kg but above the cancer industrial soil PRG of 1.59 mg/kg, The carcinogenic risk from arsenic is about 4×10^{-5} and is the largest contributor to the total carcinogenic risk among the metals and explosives detected. Arsenic was detected in all four samples from the MAC, at concentrations representative of the full range of concentrations observed at SBMR.

Only a few metals seem to be present sporadically at concentrations attributable to human activities. These may include arsenic, lead, cadmium, and vanadium. With the exception of the discussion of arsenic above, all of the concentrations of these metals detected in samples from the ranges were below industrial soil PRGs. Whether the levels of arsenic detected occur naturally or because of human activity is unclear.

Semi-volatile Organic Compounds. No semivolatile organic compounds were detected above industrial soil PRGs. Most of the semivolatile organics that were detected (22 of 27 detections in a total of nine separate samples) were found in the five samples from the Infantry Demolition Area.

Geologic Hazards and Seismicity

Main Post

Steep slopes, slopes weakened by road cuts, and slopes supported by poorly consolidated materials are subject to failure. Slope failure may be initiated by a number of factors, including seismic shaking, high water content, and excessive loading relative to soil strength. Failure also can occur on gentle slopes for similar reasons. Figure 5-32 shows areas of steep slopes that may be particularly vulnerable to landslides or slope failure.

The risk of strong ground shaking at SBMR is relatively low due to its distance from the south coast of the island of Hawai'i, where most earthquakes are centered. The US Geological Survey's National Seismic Hazard Mapping Project estimates that there is about a 10 percent chance that ground accelerations of more than 12 percent of gravity would occur in firm rock areas within the southeastern three quarters of O'ahu over the next 50 years.

Wheeler Army Airfield

Geologic hazards at WAAF are similar to those described above for the Main Post, and the potential for earthquakes and ground motion is the same. The steep slopes of Waikele Gulch are underlain by erodible soils and soft saprolite deposits, which are vulnerable to slope failure.

South Range Acquisition Area

The SRAA is dissected by the channels of Waikele Stream and its tributaries. The streams have incised steep-sided gullies, 80 to 120 feet (24 to 37 meters) deep, into the relatively gently northeast-sloping surface of the plateau. The floors of the gullies are relatively wide and flat, and the Waikele Stream meanders within this incised channel. The slopes of the plateau surface are stable, while the walls of the gullies are subject to collapse due to erosion at the base of the slopes from migration of the streams within their channels. This situation is similar to what occurs in stream channels on the Main Post. Seismic hazards are the same as those described above for the Main Post.

Schofield Barracks East Range

SBER contains many areas of steep slopes and deeply weathered rock (Figure 5-33). Erosion tends to prevent the accumulation of alluvium and colluvium, but slope failure remains a potential hazard in many areas.

Similar to the Main Post, there is little risk of strong ground shaking in areas underlain by firm rock in SBER. However, site-specific conditions, such as the thickness of loose geologic deposits and the depth of the water table, may increase ground shaking. Earthquakes also may trigger landslides in areas of unstable slopes.

Figure 5-32
Steep Slopes at Schofield Barracks Main Post

Figure 5-33
Steep Slopes at Schofield Barracks East Range

5.9.2 Environmental Consequences

Summary of Impacts

Table 5-22 summarizes the levels of significance of the various categories of impacts expected for geology and soils resources. Enhanced soil erosion from maneuver training activities, which has already resulted in gullying and other damage in some areas of SBMR, is expected to continue under the Proposed Action, probably at significantly increased rates. This is considered a significant <u>but not mitigable to less than significant impact</u>.

Additional contributions to soil erosion and soil loss could occur because of wildland fires, and soil compaction, both of which would affect vegetation cover. Soil contamination is present on the live fire ranges at SBMR. Based on the results of the soil investigation of SBMR, there are indications that the cumulative health risks from exposure of military personnel to both natural metals concentrations and human-introduced metals and explosives concentrations are less than significant under current conditions. Note, however, that the investigation was designed to selectively sample areas in which higher than average contaminant concentrations would occur and that the PRGs to which these concentrations are compared are conservative values that may overestimate the risk to the exposed population at SBMR. Concentrations in soils on the ranges, and therefore the health risks associated with these concentrations are not expected to increase substantially under the Proposed Action.

Table 5-22
Summary of Potential Geologic Resources Impacts at SBMR/WAAF

Impact Issues	Proposed Action	Reduced Land Acquisition	No Action
Soil erosion and loss	⊗	⃠	⃠
Soil erosion and loss from wildland fires	⃠	⃠	⃠
Soil compaction	⃠	⊙	⊙
Exposure to Contaminated Soils	⊙	⊙	⊙
Slope failure	⃠	⃠	○
Volcanic and seismic hazards	○	○	○

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.

<u>LEGEND:</u>

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

The potential for slope failure is considered significant in the SRAA, SBER, and along portions of Helemanō Trail. Mitigation would reduce most of these impacts to less than significant levels. Seismic hazards would remain less than significant under the Proposed Action.

Proposed Action (Preferred Alternative)

Significant Impacts

Impact 1: Soil 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 SRAA and in SBER. The soil loss may be partially but not fully mitigated. Therefore, this is considered to be a significant but not mitigable to less than significant impact.

The Army developed the ATTACC model, which is described in more detail in Appendix M-2, to assess the impacts of mounted maneuver training on land. The first step in using the model is to estimate the training load placed on the land by the vehicles that would be used to transport and accompany troops on maneuvers on the ranges. This training load is measured in terms of a standard based on the impact of an Abrams tank per mile of travel during maneuver training. The standard unit is called a maneuver impact mile (MIM). Other vehicles have different impacts on land condition due to their weight, wheel or track configuration, and how they are operated. The effect of mounted maneuver training on a particular plot of land can be generally described by a curve that relates the land condition to the training load. As the training load increases, the condition of the land would generally decrease because the training load damages vegetation cover and disturbs soils, and these effects can persist over time. Once initiated, damage to vegetation cover and soils can accelerate, as eroded areas widen, for example, and soil loss prevents vegetation from becoming reestablished. Mounted maneuver training is generally not restricted to roads but is restricted by terrain factors (slope and vegetation) and can be further restricted by the need to avoid sensitive habitat or cultural sites. Curves that relate land condition to training load can be developed for small areas based on detailed information about the susceptibility of the land to the effects of maneuver training, or they can be developed for larger areas, where the effects are not known in as much detail, but are averaged. ATTACC modeling was performed at this broader level of analysis for this EIS to estimate the overall effects of the Proposed Action relative to existing conditions for entire ranges.

In modeling the effects on the Schofield ranges, the existing annual training load at SBMR was estimated at 16,740 MIMs, and the existing training load in SBER was estimated at 11,680 MIMs. The training load at SBMR is confined to a small portion of the South Range that is accessible to vehicles. This includes unpaved roads and off-road areas. For the Proposed Action, the annual training load at SBMR would increase to 25,855 MIMs and the load at SBER would increase to 19,145 MIMs per year. The increase results from a combination of increased training intensity and the increased effects on land condition per mile of training with the Stryker vehicle. Land condition curves were developed for both SBER and SBMR. For SBMR, future training was assumed to be on the SRAA.

In both the SRAA and SBER, the ATTACC model results indicate that land condition would decline. In the SRAA, the land is currently used for pineapple cultivation. The pineapple fields would be left in place, and the Stryker vehicle would be restricted to existing farm roads. These roads are oriented in a grid pattern that allows access to the pineapple rows. In modeling the effects on the SRAA, the pineapple crop was assumed to be removed, so that 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, the modeling conflicted with the Proposed Action, which restricts Strykers to existing farm roads. This would have two opposing effects relative to the assumption used in the modeling: the land damage would be limited to the existing roads instead of distributed over the entire SRAA, 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.

Similarly, for SBER, land condition is projected by the ATTACC model to decline from "moderate" 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 SBER 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 SRAA.

Regulatory and Administrative Mitigation 1. The Army will develop and implement a DuSMMoP for the training area. In the plan the Army will address measures such as, but not limited to, restrictions on the timing or type of training during high risk conditions, vegetation monitoring, soil monitoring, and buffer zones to minimize dust emissions in populated areas. The Army will use the plan to determine how training will occur in order to keep fugitive dust emissions below CAA standards for PM_{10} and soil erosion and compaction to a minimum. The Army will monitor the impacts of training activities to ensure that emissions stay within the acceptable ranges as predicted and environmental problems do not result from excessive soil erosion or compaction. The plan will also define contingency measures to mitigate the impacts of training activities that exceed the acceptable ranges for dust emissions or soil compaction.

The Army will implement land management practices and procedures described in the ITAM annual work plan to reduce erosion impacts (US Army Hawai'i 2001a). Currently these measures include implementing a TRI program; implementing an ITAM program and an SRA program; developing and enforcing range regulations; implementing an Erosion and Sediment Control Management Plan; coordinating with other participants in the Ko'olau Mountains Watershed Partnership (KMWP); and continuing to implement land rehabilitation projects, as needed, within the LRAM program. Examples of current LRAM activities at KTA include revegetation projects involving site preparation, liming, fertilization, seeding or hydroseeding, tree planting, irrigation, and mulching; a combat trail maintenance program (CTP); coordination through the Troop Construction Coordination Committee (TCCC) on road maintenance projects; and developing mapping and GIS tools for identifying and tracking the progress of mitigation measures.

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. 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.

Regulatory and Administrative Mitigation 2. The IWFMP for Pōhakuloa and O'ahu Training Areas was updated in October 2003. The Army will fully implement this plan for all existing and new training areas to reduce the impacts associated with wildland fires. The plan is available upon request.

Impact 3: Soil compaction. Soils may be compacted by tracked or wheeled off-road vehicles during maneuver training. Soils on the SRAA may be susceptible to compaction. Compaction can reduce soil moisture holding capacity, and harden silty-clay soils, making it harder to restore damaged vegetation. Since vegetation cover is one of the primary means of preventing soil erosion, widespread compaction could indirectly increase soil loss. Compacted wheel tracks may create surface drainage conduits, resulting in faster runoff, formation of ruts, and enhanced erosion.

Regulatory and Administrative Mitigation 3. Mitigation for compaction is the same as described for mitigation of soil erosion above.

Impact 4: Slope failure. Slope failure involves the collapse of soils on a steep slope when the internal friction of the materials supporting the slope is exceeded by the weight of the materials. Slope failure can be initiated by the presence of water in the pore spaces of the materials which reduces the internal frictional forces, by a change in the angle of repose of the materials through undercutting the slope, by increasing the loading at the top of the slope, by deeper weathering of the materials in the slope, and by vibration, among other causes. The combination of steep slopes, easily erodible soils, and the damage or modification to land cover or surface drainage that would occur in construction of the road or use of the ranges for maneuver training, has the potential to increase rates of slope failure. Although many slopes are prone to localized failure, the principal effect would be to increase rates of erosion, and to move sediment into stream channels. These processes are continuous and naturally occurring, but the potential for substantially enhanced rates of failure is considered a potentially significant impact of construction and use of Helemanō Road, and of maneuver training on the SRAA and at SBER.

Regulatory and Administrative Mitigation 4. Enhanced slope failure rates would be observed through monitoring land condition under the ITAM Program. Many slope failures would be small, and might not be noticed. But if slope failures occur in areas associated with training activities or roads, they would be more likely to be noticed and may require response. The Army proposes to minimize and avoid cut slopes, where practicable. Cut slopes would be blended into the landscape by rounding the edges of the slope, differentially orienting the slope and the roadbed alignments where practicable. Use of these techniques would be varied based on the specific conditions, including depth of the cut, orientation of the slope, and type of material (e.g., dirt slope and rock slope). In accordance with Army design standards, potential mitigation measures for this impact also include, where practicable, selecting the least failure-prone route, testing soils where necessary along the route to identify problems, designing the roadbed, slope, and surface to avoid slope failure, properly sizing drainage systems, designing storm drainage outfalls for efficient performance, and properly monitoring and maintaining the road.

Less than Significant Impacts

Exposure to contaminated soils. An important factor in evaluating risk due to exposure to contaminated is soils is the fact that munitions are fired from firing points down range and into the range impact areas. These areas are not accessible to or entered by Soldiers or members of the public because of the safety explosive risk they represent. Therefore, it is unlikely that human beings, either military personnel or off-post residents, would come into contact with the constituents of these munitions in the downrange or impact area soils. Taken together, the chemical concentrations on the training ranges represent a low risk to personnel who use the ranges. There is no threat to the general public from munitions constituents related to range use because there would be no public access to these areas.

Based on the analysis described above, this represents a less than significant impact.

Although a relatively small number of samples were collected to represent the ranges, the samples were specifically collected from locations that were considered to have a high probability of representing the most contaminated sites. Therefore, the sample results represent above average concentrations on the ranges overall. RDX was found in the highest relative levels among the chemicals detected on the ranges, exceeding the PRG for RDX in two composite samples of 39 composite samples taken. The soil concentrations used for comparison to the PRGs in this report are not randomly distributed, but represent the highest concentrations on the ranges (USACE 2002a). The actual exposures would be lower than has been assumed in this analysis. Arsenic was detected in levels far below its non-cancer industrial PRG, but slightly above its cancer industrial PRG.

The Proposed Action is not expected to cause increased exposures to these chemicals because it would not place personnel in additional contact with contaminated soils. Instead, by moving mounted maneuver training to the SRAA, it would reduce some of the opportunities for exposure. In addition, it is unlikely that troops would be exposed to these compounds while training, since Soldiers are not exposed to conditions on a training range for the long periods of time (25 years) assumed in the industrial soil PRGs. For the reasons described above, the actual risk to human receptors from the low level compounds in the range soils is not significant.

With regard to the presence of pesticides in land within the SRAA, the USEPA has investigated pesticide use in the Del Monte plantation lands surrounding Kunia, and did not find unusual concentrations of farm chemicals in the SRAA (the Kunia Plantation Superfund Site investigations are discussed further in Section 5.11).

Impacts on soil loss from training activities - construction sites. Excavation, grading, trenching, and other earth-disturbing activities can expose soils to runoff and erosion. The impacts of localized soil loss related to development of construction sites are not expected to be geologically significant. Also, implementing standard construction BMPs to control stormwater runoff would reduce the potential for soil loss at construction sites to less than significant levels.

No Impacts

Volcanic and seismic hazards. At SBMR, as with all of the island of Oʻahu, the expected intensity of a reasonably probable earthquake would be moderate to low because of its distance from the center of most seismic activity on the island of Hawaiʻi. There is little risk of renewed volcanic activity on Oʻahu, so the impacts from this issue at SBMR are considered less than significant.

Reduced Land Acquisition Alternative

Significant Impacts Mitigable to Less than Significant

Impact 1: Impacts on Soil loss from training activities. The impact of soil erosion on SBER would be similar to that described under the Proposed Action, and the mitigation measures described above would also apply. The impact in the SRAA would not occur; instead, maneuver training would be moved to PTA under this alternative, and the training load there would be increased. This impact is discussed in Section 8.9.

Regulatory and Administrative Mitigation 1. Because training intensity would be at levels similar to existing conditions, the impacts are expected to be mitigable to less than significant levels with implementation of the ITAM program.

Additional Mitigation 1. The same mitigations would be implemented under the RLA as under the Proposed Action, including implementing a DuSMMoP.

Less than Significant Impacts

Exposure to contaminated soils. The impacts under this alternative would be the same as or similar to those described under the Proposed Action alternative, and would less than significant for the same reasons.

Soil compaction from loss of important farmland. Under RLA, only about 100 acres (40.5 hectares) of land in the SRAA would be transferred. This land is on the north side of Waikele Stream and is not currently in cultivation, although the soils are of the type that can be considered important farmland. Therefore, there would be no conversion of important farmland under this alternative, and no impact would occur.

With regard to the presence of pesticides in land within the SRAA, the USEPA has investigated pesticide use in the Del Monte plantation lands surrounding Kunia, and did not find unusual concentrations of farm chemicals in the SRAA (the Kunia Plantation Superfund Site investigations are discussed further in Section 5.11).

Impacts on soil loss from training activities - construction sites. The impacts of construction on soil erosion would be the same as those described for the Proposed Action and would be less than significant for the same reason described above.

No Action Alternative

The current baseline of existing conditions would continue under No Action. Under the status quo of No Action, impacts on geology resources would continue at their current levels; they are summarized below.

Significant but Mitigable to Less than Significant Impacts

Impact 1: Impacts on soil loss from training activities. Current training activities, including use of vehicles on unimproved roads and off roads, have resulted in localized severe soil erosion, particularly in areas underlain by Helemanō soils on steep slopes adjacent to streams or gulches. The training activities impair vegetation growth, resulting in gully erosion, which increases in severity as the gullies broaden. This erosion can remove large volumes of soil, which are ultimately redeposited downslope or downstream. Although ATTACC modeling identifies the current effects of maneuver training overall on SBMR ranges as moderate, current conditions are not sustainable and land condition has continued to decline. Under the No Action Alternative, no additional lands would be available to enable training to be rotated to other areas while the damaged land recovers. Therefore, continued damage to the land is considered a significant impact under No Action.

Regulatory and Administrative Mitigation 1. As described above for the Proposed Action, the ITAM program and DuSMMoP would be implemented to evaluate land condition, to identify mitigation measures for land restoration appropriate to specific local problems and conditions, and to monitor the success of the restoration measures.

Impact 2: Soil erosion and loss from wildland fires. The impact from soil erosion and loss from wildland fires would be the same as for the Proposed Action, and the mitigation measures described above would also apply.

Less than Significant Impacts

Exposure to Contaminated Soils. The impact from exposure to contaminated soils would be the same as for the Proposed Action, and would be less than significant for the same reasons described above.

Soil compaction. The impact from soil compaction would be the same as for the Reduced Land Acquisition alternative described above.

No Impacts

Slope failure. Because Helemanō Trail would not be constructed, no off-road maneuvers would take place at SBER. There would be no impacts under the No Action Alternative.