4.8 GEOLOGY AND SOILS

4.8.1 Impact Methodology

Geologic impacts include all of the effects that result from the interaction between the project and the geologic environment. For example, project impacts may include changes in erosion rates or changes in the level of exposure of people and structures to earthquakes or unstable slopes.

Identifying project impacts relied heavily on the use of available geologic studies, reports, observations, and engineering judgment to make reasonable inferences about the potential effects of the project, given the interpretation of the geologic setting described in Section 3.8, Geology and Soils. In addition, some geologic impacts were evaluated in the context relative to regulatory requirements or guidelines. Regulatory requirements include state and local building codes, grading ordinances, and restrictions on development in protected areas or in areas subject to specific geologic hazards.

For MMR, the geologic impacts discussion relies in large part on results of the current hydrogeologic investigation being conducted by the Army to characterize the existing surface and shallow subsurface geological conditions at MMR (USACE 2006); the investigation report is included as Appendix G-1.

The objectives of the current hydrogeologic investigation include gaining a better understanding how soils retain, degrade, and transport contaminants resulting from past activities at MMR and the implications for future live-fire training exercises. The investigation provides information about contaminant concentrations and distribution in soils and sediments and also provides information about the physical geologic environment, including stratigraphic relations and physical and chemical properties of soils and sediments. These data have been used to construct a model of the chemical transport pathways and migration rates for chemicals of concern at MMR. The model results are used as a predictive tool in analyzing potential impacts of project alternatives.

The impact analysis compares the effects of MMR alternatives to existing conditions. As discussed in the introduction to Chapter 3, the average number of annual live-fire training days from 1988 to 1998 was 72. The average number of live-fire training days from 1994 to 1998 was about 60 days per year. Each of the historic live-fire days is assumed to be the rough equivalent of a CALFEX. From 1998 to October 2001, no CALFEXs were conducted at MMR. Thirteen CALFEXs were conducted in fiscal year 2002, and eight were conducted in fiscal year 2003. The surface soil data reported in the current hydrogeologic investigation report

(Appendix G-1) reflect the effects of past use and may help predict future effects, but there is no simple correlation between those past effects and future effects.

The Army performed a soil investigation of training ranges at PTA to obtain information about existing concentrations of chemical constituents in the soils, identify potential chemicals of concern, and determine if exposure to these chemicals might impact human health. The Army also evaluated the impacts of training on land condition, including effects such as soil erosion and compaction and damage to vegetation.

The concentrations of chemicals observed or anticipated in soils at MMR and PTA are compared to EPA Region IX PRGs, which are conservative cleanup goals designed to be used as a screening tool for determining whether additional, more detailed site-specific analysis of risk is needed. The assumptions on which the PRGs are based are therefore not intended to be representative of all sites. The EPA has assigned PRGs for two basic scenarios: residential exposures and industrial workplace exposures. Residential exposures are lifetime exposures, beginning from childhood and continuing for 70 years. Industrial soil PRGs are based on standard assumptions about worker exposures to soils over 30 years. Both of these standard scenarios probably overestimate the risks to military personnel, most of whom would be exposed only for brief periods to site contaminants; however, the industrial exposure scenario more closely approximates the exposures of military personnel and has been used as a basis for comparison in the analysis presented in this report.

The impact analysis attempts to reasonably and conservatively account for the effects of the alternatives on future conditions, based on information from a variety of sources, including data on existing conditions. However, a degree of uncertainty is inherent in the analysis. To provide additional assurance that unforeseen impacts do not go undetected, continued monitoring studies have been proposed as part of the mitigation of significant impacts.

4.8.2 Factors Considered for Determining Significance of Impacts

The significance of the project impacts is defined in both relative and absolute terms. Relative criteria are based on context and tend to be subjective, while absolute criteria are defined in terms of objective standards.

Factors considered in determining whether an alternative would have a significant geologic impact include the extent or degree to which its implementation would:

- Result in substantial soil loss (e.g., through increased erosion) or terrain modification (e.g., altering drainage patterns through large-scale excavation, filling, or leveling);
- Result in soil or sediment contamination exceeding regulatory standards or other applicable or relevant human health or environmental effects thresholds; and
- Increase the exposure of people or structures to geologic hazards (e.g., ground shaking, liquefaction, volcanism, slope failure, expansive soils, hazardous constituents of soils) that could result in injury, acute or chronic health problems, loss of life, or major economic loss.
- Adversely alter existing geologic conditions or processes such that the existing or potential benefits of the geologic resource are reduced (e.g., construction of a jetty that would interfere with sand transport processes and beach formation or would increase shore erosion);
- Permanently damage or alter a unique or recognized geologic feature or landmark; or
- Disturb or alter unique, rare, or otherwise important paleontological resources such that the potential to derive benefits from those resources is reduced.

Regulatory standards against which potential soil and sediment contamination impacts have been evaluated include the following:

- EPA Region IX Preliminary Remediation Goals (PRGs) for exposures in industrial settings;
- EPA Generic Soil Screening Levels (included in the Region IX PRG tables);
- EPA Region V Ecological Data Quality Levels for surface soils and sediments (also known as Ecological Screening Levels); and
- Hawai‘i Administrative Rules, Title 11.

In addition to the above factors, public concerns expressed during the scoping process were also considered in the impact analysis.

4.8.3 Summary of Impacts

As shown below in the impact summary table, No Action and Alternatives 1, 2, and 3 are expected to result in significant and unmitigable soil

erosion impacts. Alternative 4 would have less than significant impacts on soil erosion. Potential soil effects would be mitigated through the implementation of standard management practices.

Summary of Potential Geology and Soils Impacts

Impact Issues	No Action Alternative	Alternative 1 MMR (Reduced Capacity Use with Some Weapons Restrictions)	Alternative 2 MMR (Full Capacity Use with Some Weapons Restrictions)	Alternative 3 MMR (Full Capacity Use with Fewer Weapons Restrictions)	Alternative 4 PTA (Full Capacity Use with Fewer Weapons Restrictions)
Soil erosion	⊗	⊗	⊗	⊗	⊙
Soil contamination	○	⊙	⊙	⊙	⊙
Geologic hazards	○	⊙	⊙	⊙	⊙

LEGEND:
⊗ = Significant impact
⊘ = Significant impact mitigable to less than significant
⊙ = Less than significant impact
○ = No impact
+ = Beneficial impact

Under Alternative 1, the impacts would result primarily from ground disturbance from detonation of munitions and from troop activities. The impacts would include potential erosion on the DMR to MMR inland trail. On lands within MMR, these effects would be managed through implementation of the ITAM program, including monitoring the effects on vegetation and implementing measures such as reseeding, mulching, controlling run-on and runoff, and rotating land uses. On lands managed by the State of Hawai‘i (for example, portions of the DMR to MMR inland trail), the state would be responsible for addressing erosion impacts. This would be accomplished by issuing permits to use the trail and through normal trail maintenance procedures. There would also be continued risks of erosion from heavy rainfall in areas that may be affected by wildland fires. These effects would be reduced by continuing to implement the IWFMP.

Alternative 2 would increase the potential for soil disturbance and resulting erosion due to the increased intensity and frequency of live-fire training. In addition, erosion resulting from wildland fires would increase due to the use of tracer ammunition. Use of tracers would increase the potential for fires to be initiated, and nighttime use of tracers would increase the difficulty of responding to fires once initiated. The impacts

would be minimized by implementing the mitigation measures described in Section 4.14, Wildfires.

Alternative 3 would further increase the risk of wildland fires because of the use of inert TOW missiles, 2.75-caliber rockets, and illumination munitions that contain chemical compounds capable of initiating fires when either burning chemicals or hot pieces of the munitions reach the ground. The unburned chemicals in illumination munitions present an additional fire threat because any unburned chemical can be spontaneously ignited by exposure to air after munitions fall to the ground.

Impacts of chemical contaminants in soils on on-site and off-site receptors are not considered significant due to the low concentrations of chemical residues that would result from live-fire training exercises. This conclusion is supported by soil sampling data in the current hydrogeologic investigation being conducted by the Army at MMR and the soil investigation conducted at PTA in 2002, as well as by data on residues of high explosive munitions from tests conducted elsewhere by the Army and discussed in Section 3.8, Geology and Soils.

Geologic hazards, such as slope failure and seismic hazards, are expected to be less than significant at MMR. At PTA, volcanic and seismic hazards, while potentially significant in this area, would not be expected to be significant. Based on distribution of past lava flows, there is a low probability that erupted lava could flow onto PTA. Also, most Hawaiian eruptions would provide some warning and adequate time for evacuation, if necessary. Seismic hazards are not expected to result in significant impacts because seismic energy is not amplified in the geologic materials beneath PTA and because new structures would be designed to resist the lateral forces expected from most earthquakes generated in the region.

No Action Alternative

Significant Impacts

Impact 1: Soil erosion. Under No Action, there may be the potential for removing vegetation cover over a large area of Mākua Valley by both an increase in fuel and by delayed response to a wildfire once initiated. The increase in fuel (vegetation growth) would result from reduced fuel control measures currently being implemented at MMR. Response to a fire would be delayed because the installation would have reduced staffing, fires would not be reported as quickly, and equipment and personnel needed to respond may not be on-site.

The potential for fires to begin might be lower under No Action than under existing conditions because military training activities would be

non-live fire. However, wildfires resulting from other causes, such as arson or accidents, could be more damaging to vegetation once started.

The significance of soil erosion would depend on how much land area was burned and on the amount and timing of rainfall following a fire. Overall, the potential for significant erosion is low because fires and storms are independent, and the likelihood that a major fire would be followed by a large runoff-producing storm before vegetation cover was reestablished is probably very low. However, the impact from such a combination of events is considered significant because it would likely result in a large amount of soil erosion, given the nature of the soils and the steep slopes present in Mākua Valley.

If a major fire were followed by substantial rainfall, the loss of vegetation cover could increase runoff, causing significant erosion and soil loss from hill slopes and increasing sediment deposition on the valley floor or in stream channels. Increased runoff could create gullies and damage roads and trails. Sediment deposition could clog stream channels, divert streams, lead to increased flooding, alter vegetation patterns, and have other indirect impacts. Because the substantial soil erosion effects from a major fire cannot be entirely prevented, even with mitigation measures, this impact would remain significant.

Regulatory and administrative mitigation 1. No regulatory and administrative mitigation measures have been identified for this impact. The existing measures available to address these impacts (for example, fire prevention and control and the ITAM program) would not be implemented under No Action because the Army would not actively maintain the current programs at MMR.

Additional mitigation 1. The Army would implement post-wildfire erosion control measures that may include native plant reseeding and selective planting of burned areas or engineering controls to redirect or control runoff.

No Impacts

Soil contamination. Under No Action, there would be no further deposition of explosives residues or other chemicals associated with live-fire military activities. Over time, the existing residual concentrations of many chemicals would decrease through chemical degradation and dispersion processes.

Geologic hazards. Under No Action, the potential for ground shaking, slope failure, and other geologic events would be the same as that under existing conditions, but because MMR would not be occupied, there

would be no human exposure to these events and therefore no hazard to humans.

Alternative 1 (Reduced Capacity Use with Some Weapons Restrictions)

Significant Impacts

Impact 1: Soil erosion. Alternative 1 is expected to result in disturbance of soils and vegetation, primarily from wildfires, resulting in potential for erosion. Wildfires remove protective vegetation and expose soils to erosion. Although vegetation cover may return within weeks of a burn, erosion can occur during this revegetation period. In some cases, erosion may delay or prohibit portions of the revegetation process in areas. Severe erosion can create gulleys, reduce vegetation growth, and slow land recovery. Erosion also moves sediments from ridges and hill slopes to toes of slopes and channels and can affect drainage or create landslide hazards.

In addition, explosions and troop training (e.g., use of roads, troop movement, digging) disturb soils. The greatest soil disturbance would probably result from detonation of bangalore torpedoes, which contain an equivalent of up to about 80 pounds (36 kilograms) of TNT, and demolition training charges, including cratering charges containing up to 150 pounds (68 kilograms) of ammonium nitrate. Detonating the demolition charges would create craters and would throw soil into the air. Disturbed soils tend to be more easily eroded, and removing protective vegetation exposes soils to wind and water erosion. Wind erosion is not expected to be a major concern because soil moisture is relatively high in the Mākua Valley, the clayey soils on valley side slopes retain moisture well. But wind erosion could become an issue during lengthy dry periods and because windblown dust may disperse chemical residues and therefore increase chemical exposures of military personnel. Most erosion occurs during infrequent, extreme runoff-producing events. Areas particularly susceptible to erosion include moderate to steep slopes traversed by unpaved roads, drainage ditches, and areas with sparse vegetation. Over time, extreme runoff events capable of causing substantial erosion in these areas are expected to occur. This is considered a significant impact, based on observed evidence of soil erosion and susceptibility of soils in range areas to erosion.

In addition, use of the DMR to MMR inland trail for marches by approximately 150 troops several times per month could result in localized enhanced soil erosion on trails both inside MMR and on state-owned lands north of MMR. The principal effects would probably be widening of existing trails, loss of vegetation, enhanced gullying, and slow recovery of affected areas.

Regulatory and administrative mitigation 1. No regulatory and administrative mitigation measures have been identified.

Additional mitigation 1a. Mitigation to address the hazard of wildfires is primarily through prevention and fire suppression. Prevention measures include reducing fuel by mowing grass and maintaining fire breaks, carefully targeting munitions, being alert for signs of fire, scheduling during appropriate weather conditions, and educating staff through awareness training. Fire suppression includes having appropriately trained personnel and adequate and effective fire control equipment and procedures in place so that fires can be identified and put out as soon as possible before they spread. Past experience has demonstrated that fires can quickly burn out of control in Mākua Valley and that weather conditions can change rapidly. No amount of planning can preclude the risk of wildfires, but the risks can be greatly reduced through proper planning; therefore, mitigation may not be fully effective in reducing soil loss to less than significant levels.

Additional mitigation 1b. The Army addresses erosion problems caused by ground disturbance from training activities primarily through the ITAM program (Section 2.5.5). In addition, the Army could prepare and implement an erosion control plan for MMR. This plan would include provisions for periodic monitoring, methods for identifying erosion problems, and management practices for addressing erosion problems. Management practices could include reseeding slopes or planting vegetation buffers, installing/constructing run-on and runoff controls, recontouring or filling damaged areas, or avoiding damaged areas.

Additional mitigation 1c. The Army would obtain a permit from the state prior to using trails within state-owned lands. The state would issue the permit only if it determined that the trail was in good condition. The state would maintain the trail to prevent significant erosion and would improve the trail to address any effects from erosion.

Less than Significant Impacts

Soil contamination. Contaminants in soils can have health effects when humans ingest, inhale, or come into direct contact with contaminated soil. The significance of soil contamination varies, depending on the contaminants present, the potential receptors involved, and the magnitude and duration of exposure. Contaminants in soils can also be transported via wind or water to other media or locations, resulting in additional pathways of exposure. These are discussed in Section 4.7, Water Resources, and Section 4.4, Air Quality.

Evaluation of the results of the current hydrogeologic investigation shows that low concentrations of metals, explosives, pesticides, VOCs, and dioxins are present in surface soils in some of the areas investigated and that some of these concentrations exceed the EPA Region IX industrial PRGs for soils, as described in Section 3.8, Geology and Soils.

Under Alternative 1, explosive chemicals (such as RDX, TNT, and HMX), certain metals (such as lead), and other chemicals (the combustion products of explosives, plastics, and other inert components) would be released to the environment and would be deposited on surface soils. Alternative 1 would involve up to 28 CALFEXs annually. This is more than the number of CALFEXs that were conducted in the last two years (13 CALFEXs in fiscal year 2002 and 8 CALFEXs in fiscal year 2003).

Some of the chemicals would undergo chemical reactions because of contact with moisture, oxygen, and sunlight (chemical degradation), or the chemicals would be degraded by microbes (biodegradation). Therefore, even though there would be an increase in chemical deposition, there would not necessarily be a substantial accumulation of chemicals in soils. Because of dispersion and degradation of explosives compounds, it is likely that concentrations of explosives detected in soils during the current hydrogeologic investigation of MMR reflect the effects of the CALFEXs that were conducted recently, during 2002 and 2003. The residual contaminants from 1998 and before would be less prominent in surface soils, although some accumulation may occur, particularly because the last recorded large runoff-producing storm was in 1996, prior to the period in which the hydrogeologic investigation was performed; thus, the soil sampling results reflect conditions following an extended period of low rainfall and runoff. The recent CALFEXs were similar, in terms of types and quantities of explosives used, to the CALFEXs proposed under Alternative 1.

Chemical residues of high explosives tend to be greatest in ordnance impact areas and to decrease with distance from these areas. As discussed in Section 3.8, Geology and Soils, concentrations of explosives residues are not expected to exceed PRGs, except in highly localized areas, because the amount of unburned chemical residues that result from detonation of high explosives represents a very small percentage of the initial mass of explosive. Under the assumptions described in Section 3.8, Geology and Soils, about 0.15 ounces (4.5 grams) of RDX are expected to be produced per year from 28 CALFEXs. The residue would be distributed unevenly throughout the ordnance impact area. Most of the RDX generated during CALFEXs would result from low-order detonations and the use of C-4 explosive to detonate unexploded ordnance in place, rather than from high-order detonations. Based on the discussion in Section 3.8, Geology

and Soils, the average concentration of RDX in the upper 6 inches (15 centimeters) of soils resulting from detonation of munitions during live-fire exercises for one year over an area of about 35 acres (14 hectares) would be on the order of less than 1.2 micrograms per kilogram (µg/kg).

In addition to the high explosives used in CALFEXs, about 2,640 pounds (1,197 kilograms) of C-4 explosive per year would be used in demolition training in the ordnance impact area, involving detonation of 15-pound (6.8-kilogram) and 40-pound (18-kilogram) shape charges. Assuming that the detonation of the shape charges produces about the same proportion of RDX residues per pound of initial charge as the C-4 charges used for demolition of unexploded ordnance (about 0.013 percent based on work done by the USACE), the 2,640 pounds (1,200 kilograms) of C-4 would produce approximately 5.6 ounces (160 grams) of RDX residue per year, which is about 35 times the amount of RDX residue that would be produced by the CALFEXs.

The concentrations of residue would be highest in the vicinity of the detonations, although it is not known where or how spread out the demolition charges would be placed. The average concentration of RDX in this surface soil would be about 170 µg/kg, which is just under the method detection limit of 200 µg/kg and is less, by a factor of nearly one hundred, than the EPA Region IX industrial soil PRG for RDX of 16,000 µg/kg. This assumes that this training occurred within a relatively small area, that the contamination from the demolition training was contained within an area of about 1 acre (0.4 hectare), and that the RDX was evenly mixed with the upper 6 inches (15 centimeters) of soil in this area (a little less than 1 million kilograms [2.2 million pounds]). Nevertheless, because of the likely uneven distribution of the RDX in surface soils and the potential for accumulation of RDX in the soils over years, it is possible that concentrations above the industrial soil PRG would occur as a result of the demolition training. This is not considered significant because the industrial soil PRGs are based on conservative estimates of long-term exposure that would not occur at MMR.

Metallic lead, in the form of bullets, represents a low environmental hazard because the lead is not in a form that can be ingested, inhaled, or absorbed by the skin. Over time, lead bullets gradually degrade, both mechanically and chemically, enabling the lead to become dispersed in soils in forms that may be more mobile (for example in water-soluble compounds, or as fine particles subject to dispersion with wind-blown dust). The rate at which lead bullets degrade under environmental conditions depends on chemical conditions in the soil and atmosphere and on the amount of surface area exposed to these conditions. This is a relatively slow process, but over time it could result in lead concentrations

in soils in excess of PRGs in areas where lead bullets accumulate, such as near pop-up targets. Other sources of lead include lead-containing chemicals used in the primers of some munitions.

Existing soil contamination from past disposal practices would continue to disperse and would continue to present a low hazard of exposure to military personnel using the range. Comparison to industrial PRGs provides an indication of the risks if personnel were exposed to these concentrations in a typical workplace environment. The exposure assumptions of the PRGs are not representative of the actual exposures expected for military personnel. Although the daily exposures to dust and soil might be greater than assumed in the PRGs, military personnel would be exposed for periods of several days or weeks rather than over the 30-year period assumed in the PRGs, making their total lifetime exposures to these chemicals much lower than assumed in the PRGs.

As discussed in Section 3.8, Geology and Soils, the 95 percent upper confidence limits (UCLs) of the average concentrations of individual chemicals in soils are generally below EPA Region IX industrial soil PRGs. If aluminum, iron, and manganese are ignored, the cumulative noncancer risk level is also below the noncancer risk threshold. The PRGs for aluminum, iron, and manganese are not based entirely on health risk levels (the actual risk levels are much higher than the PRGs) but on the desire of EPA to use PRGs as general indicators of possible waste disposal requirements. However, as discussed in Section 3.8, Geology and Soils, the high concentrations of these metals in soils at MMR are typical of Hawaiian soils generally and so are not the result of human activities; therefore, it is appropriate to ignore the fact that the PRGs for these metals are exceeded in soils at MMR. Individual cancer risk levels for arsenic and chromium exceed EPA's one-in-one-million lower threshold for cancer risk. However, the observed concentrations are likely due to naturally occurring minerals in the volcanic rock from which the soils are derived, rather than being the result of training activities or past disposal practices. Continued training under Alternative 1 is not expected to increase these concentrations. Although existing concentrations of dinitrotoluene (DNT) appear to slightly exceed the one-in-one-million cancer threshold, these concentrations are likely the result of past disposal practices, and therefore, would not increase because of Alternative 1. As discussed in Section 3.8, Geology and Soils, TNT and DNT are present in much lower quantities in explosives used in live-fire exercises at MMR than is RDX, and RDX is not expected to accumulate in concentrations that would be significant to health. Based on the results of the current hydrogeologic investigation, the risks associated with existing DNT concentrations in soils are well within the acceptable cancer risk range of one in one million to one in ten thousand. Therefore, because future live-fire training is not

expected to significantly add to these concentrations, the risks to military personnel associated with future exposures to existing or future concentrations of chemicals in soils is expected to be less than significant.

Geologic hazards. Hazards related to seismicity, including ground shaking, ground rupture, slope failure, and liquefaction, are considered less than significant due to the relatively low probability of large earthquakes at the site. Also, because of the low level of development and occupation of the site, geologic hazards are expected to have minor potential for affecting safety or damaging structures.

Alternative 2 (Full Capacity Use with Some Weapons Restrictions)

Under Alternative 2, the use of MMR would increase, compared to Alternative 1. The types of impacts discussed for Alternative 2 would also occur under Alternative 1, except the magnitude of the impacts would be greater with use of tracer ammunition and up to 50 CALFEXs per year, compared to 28 under Alternative 1.

Significant Impacts

Impact 1: Soil erosion. Under Alternative 2, soil erosion effects would be similar to but greater in magnitude than those described for Alternative 1. Ground disturbance, road use, and vegetation cover disturbance would be greater under Alternative 2 because of more frequent CALFEXs. The more intense training activity under Alternative 2 would probably reduce the effectiveness of some of the available mitigation measures, such as revegetation, resulting in greater vulnerability to erosion from extreme runoff events.

The use of tracer ammunition during nighttime training would greatly increase the risk of wildland fires. Tracer ammunition contains small quantities of materials, such as magnesium metal, that burn to produce intense heat and light. Use of tracers was previously curtailed because it resulted in wildfires, so the high potential for use of this ammunition to result in wildfires in the future would increase the soil erosion potential from loss of vegetative cover.

Regulatory and administrative mitigation 1. No regulatory and administrative mitigation measures have been identified.

Additional mitigation 1a. The mitigation measures for this impact would be similar to those described for Alternative 1.

Additional mitigation 1b. As discussed under Section 4.14, Wildfires, the Army would revise the IWFMP protocols to address fire prevention and

control for the use of tracer ammunition, including addressing the challenges of fighting fires at night, before implementing this alternative. Implementing these protocols would require USFWS approval.

Less than Significant Impacts

Soil contamination. Although the frequency of CALFEX exercises would nearly double under Alternative 2 from the frequency under Alternative 1, the quantity of explosives residue from detonating munitions used in an individual CALFEX is expected to be so low that the potential impacts would be the same as those described under Alternative 1. As discussed for Alternative 1, the highest concentrations of explosives residues would probably result from demolition training. RDX would be the largest component of these explosives residues because C-4 explosive is more than 80 percent RDX, with about 10 percent HMX as an impurity. The amount of RDX residue from demolition training would be the same as described under Alternative 1.

In addition to the munitions used in Alternative 1, tracer ammunition would be used in Alternative 2. Tracer ammunition contains materials that burn to produce different colors of light when exposed to the atmosphere. Among the metals commonly contained in tracer ammunition are barium, calcium, magnesium, and strontium. Except for strontium, these metals are common in background soil samples. Use of tracers containing strontium could measurably increase concentrations of strontium in soils compared to background levels. However, the EPA industrial soil PRG for strontium is very high, similar to that for iron. Therefore, because no toxic effects are expected to result from the use of these tracers, the impact would be less than significant.

Geologic hazards. As described for Alternative 1, seismic hazards and slope failure are not expected to be significant impacts under Alternative 2.

Alternative 3 (Full Capacity Use with Fewer Weapons Restrictions)

Under Alternative 3, range use and training intensity would be comparable to Alternative 2 with the addition of inert TOW missiles, 2.75-caliber rockets, and illumination munitions. Training would also occur over a larger area within the Mākua Valley.

Significant Impacts

Impact 1: Soil erosion. The potential for soil erosion in the training area at MMR would be the same as that described for Alternative 2. However, the overall potential for soil erosion would be greater under Alternative 3 than Alternative 2 because of the increased wildfire threat from illumination

munitions, 2.75-caliber rockets, and inert TOW missiles. Not all wildfires would necessarily result in severe soil erosion. The degree of the effect would depend on the size of the burned areas and on the timing, relative to large storms. Such storms are infrequent, so vegetation in burned areas may be reestablished before an erosion-causing storm occurs.

Regulatory and administrative mitigation 1. No regulatory and administrative mitigation measures have been identified.

Additional mitigation 1. The mitigation measures to address damage to soils and vegetation would be the same as those described for Alternative 2. Measures to prevent and control wildfires would be described in a revised IWFMP that addresses the specific hazards associated with the use of inert TOW missiles, 2.75-caliber rockets, and illumination munitions; the USFWS would approve this plan, as described under Alternative 2.

Less than Significant Impacts

Soil contamination. The quantity of explosives used under Alternative 3 would be about the same as that described under Alternative 2. The use of inert TOW missiles and 2.75-caliber rockets would not significantly increase the total mass of high explosives used. The amount of explosives used in demolition training would also be the same as that described under Alternative 2, so no increase in the rate of deposition of explosive residues in soils is expected. The inert TOW missiles contain propellants and only a small quantity of high explosive sufficient to make a loud noise. The 2.75-caliber rocket contains a small charge, nearly all of which is consumed upon detonation.

The products of the chemical reactions during use of the illumination munitions would mainly be small quantities of metal oxides, phosphates, and other compounds that would have relatively minor environmental impacts.

Geologic hazards. As described for Alternative 1, seismic hazards and slope failure are not expected to be significant impacts under Alternative 3.

Alternative 4 (Full Capacity Use with Fewer Weapons Restrictions), Pōhakuloa Training Area

The SBCT EIS contains a comprehensive discussion and evaluation of geologic and soil contamination impacts at PTA. The discussion in this section focuses on potential impacts from implementation of this alternative at PTA, Keomuku Parcel (WPAA), and PTA Trail.

Less than Significant Impacts

Soil loss. The SBCT EIS evaluated impacts of training and construction activities at PTA, WPAA, and the PTA Trail. Soil impacts from SBCT activities and construction were considered significant or significant but mitigable to less than significant at PTA, WPAA, and the PTA Trail. These significant soil loss, erosion, and compaction impacts are, to a great degree, based on mounted maneuver training with substantial off-road vehicle (Stryker) use.

Under Alternative 4, training at PTA and WPAA would be limited in unit size and be dismounted maneuver training. Vehicle use would be generally limited to existing trails or roads.

Site clearing and grading for construction of the proposed CALFEX range and new facilities would expose soils to enhanced erosion by water or wind. This impact would be expected to be less than significant because the new facilities would be constructed on relatively level land using standard erosion control practices and because the construction impacts would be temporary.

There would be potential dust and surface runoff erosion from use of the PTA Trail. The impacts would not be considered to be significant relative to long term soil loss or erosion because the trail occupies a relatively small amount of acreage. Use of the trail would not significantly alter the rate of erosion. The Army would follow BMPs in maintaining the trail.

The Army would develop and implement a management plan for PTA. The plan would 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 would monitor the impacts of training activities to ensure that fugitive dust emissions stay within the acceptable ranges as predicted and environmental problems do not result from excessive soil erosion or compaction. The plan would also define contingency measures to mitigate the impacts of training activities that exceed the acceptable ranges for dust emissions or soil compaction.

The Army would implement ITAM land management practices and procedures. Currently, these measures include implementing TRI and SRA programs, developing and enforcing range regulations, implementing an Erosion and Sediment Control Management Plan, and continuing to implement land rehabilitation projects, as needed, within the LRAM program.

The Army would fully implement the IWFMP for PTA for all existing and new training areas to reduce the impacts associated with wildland fires.

Soil contamination. Exposure to chemical contaminants in soils at a training area could occur through several pathways, including direct contact with contaminated soils, ingestion of soils, or through inhalation of windblown dust. Exposure estimates are based on assumptions about the amount of soil that might be ingested by a person who works in an area soils. It is a generally accepted principle of risk assessment that not all exposures result in unacceptable health risks and that there are certain thresholds of exposure below which the health risks are so low that they cannot be distinguished from background risks.

The composite soil sampling conducted by the USACE at selected ranges within PTA revealed the presence of metals, explosives, and semi-volatile organic compounds. The observed concentrations were generally less than industrial PRGs. One explosive compound, RDX, was detected in samples from Ranges 5 and 9 at concentrations above the industrial PRG while Training Area 12 was below. The risks from multiple chemical exposures are additive, and similar calculations can be done for each of the contaminants to which people may be exposed at PTA. The risks from HMX, nitroglycerin, and TNT are very small compared to the risk from RDX, and the sum of their risks is less than 0.74×10^{-6}. The risks associated with each of the metals can be calculated similarly, and the results would be similar. The highest risks are associated with the iron and aluminum in the soil, both of which occur naturally at high concentrations.

Overall, the sum of the carcinogenic and non-carcinogenic risks, based on the available soil sampling data and using the PRGs to estimate risk, is less than the EPA threshold for worker exposure. It is unlikely that troop exposures to RDX or other chemicals on the ranges would be similar to worker exposures in an industrial setting. For example, workers are assumed to ingest 100 milligrams of soil per day, 250 days per year for 25 years. This assumption over-estimates troop exposures, because troops are likely to be exposed only temporarily, and only for short durations. No public contact with these soils will occur. Based on the analysis described above, this would represent a less than significant impact.

In general, the risk due to exposure to contaminated soils at PTA would be low. However, the construction of the CALFEX and convoy live-fire ranges would require the conversion of a portion of the range impact area. In this converted training area, Soldiers could be exposed to contaminated soils. However, their exposure would be limited to training for a period of days or weeks. The level of chemical compounds present would be below their respective PRGs. Considered together, the potential duration of

exposure to the chemical concentrations on the training ranges at PTA would represent a low risk to personnel.

Maneuver training conducted in the WPAA would not result in significant exposures to high explosives residues in soils, either from past or proposed activities, because the training there under the Proposed Action would involve simulated rather than live artillery fire

Seismic hazards. Earthquakes are common on the Island of Hawai‘i, but most are relatively small. Some earthquakes are the result of movement of molten rock (magma) deep in the earth's crust as it rises along openings in the crust. Others are the result of shifts in the crust along large fractures. In both cases, either as a result of expansion of the surface or as a result of settling, surface ruptures, cracks, or depressions may appear in the ground surface. These disruptions of the surface could create hazards by damaging roads, utility lines, and buildings.

PTA is in an area that has about a 10 percent chance of experiencing horizontal ground acceleration greater than 40 percent of gravity in the next 50 years. The Island of Hawai‘i is in Zone 4 of the Uniform Building Code.

Implementation of standard procedures and engineering practices would be expected to reduce the volcanic and seismic hazards to acceptable levels, although these measures cannot eliminate the hazards. Most of the measures to address hazards involve implementing timely warning systems, appropriate planning and training, and appropriate engineering design. The proposed structures at PTA would be designed to meet all federal, state, and local building code requirements. The Hawaiian Volcano Observatory provides warnings to local officials and the public of volcanic hazard conditions. The Army prepares and implements volcanic and seismic hazard plans and training, including evacuation plans for personnel and munitions in the event of an emergency.

Slope failure. Although there are many steep slopes within PTA and the WPAA, most slopes are underlain by shallow bedrock or exposed rock outcrops. There would be little potential for slope failure.

Volcanic eruptive hazards. The following discussion focuses on the effects of implementing Alternative 4 in the volcanic and seismic environment that exists at PTA, and the potential for hazards to personnel or structures and facilities because of this environment.

PTA lies on the edge of the northeast rift zone, which last erupted in 1984. At that time, lava flowed northeastward, in the direction of Hilo. Since

lava flows by gravity, its path would be determined by the location of the vent, which cannot be predicted. Eruptions from Mauna Loa tend to be voluminous, and the lava can move quickly (up to about 5 miles [8 kilometers] per hour).

Although PTA is subject to periodic eruptions of lava from the Mauna Loa volcano, the risk of any particular site being inundated by a lava flow is small because flows tend to be narrow and occur relatively infrequently. If a lava flow were initiated an area upslope from PTA, it is likely that PTA would be affected. Quick evacuation would be needed. Potential hazards would include hazards to human safety, loss of property, detonation of stored munitions, and loss of useable land and facilities for training.

As with seismic hazards above, implementation of standard procedures and engineering practices would be expected to reduce the volcanic and seismic hazards to acceptable levels, although these measures would not eliminate the hazards.