CHAPTER 5. GEOLOGICAL AND SOIL RESOURCES

5.1 INTRODUCTION

This chapter discusses the potential environmental impacts to geological and soil resources associated with implementing the proposed action within the region of influence (ROI) as they relate to utilities. The geology and soils ROI includes all the geologic resources on Guam that are subject to construction and operation activities. Because geology and soils relate to the physical foundation of Guam, the proposed land uses would affect characteristics of erosion and surface changes, such as land clearing and slope cuts, but not the overall geologic and soil conditions. Instead, geology and soils are more likely to affect the placement or location of land use.

For a description of the affected environment for all resources, refer to the respective chapter of Volume 2. The chapters are presented in the same order as the resource areas contained in Volume 6. The locations described in Volume 2 include the ROI for the utilities and roadway projects. Analysis of long-term alternatives was not done because those alternatives are not yet adequately developed for project-specific analysis.

5.2 ENVIRONMENTAL CONSEQUENCES

5.2.1 Approach to Analysis

5.2.1.1 Methodology

Utilities

The methodology for identifying, evaluating, and mitigating impacts to geology and soil resources was established through review of geological and soil studies and reports, federal laws and regulations, state and local building codes, and grading ordinances. The assessment of geologic and soils impacts was conducted, in part, by reviewing available literature, such as previously published National Environmental Policy Act documents for actions in the Mariana Islands Range Complex and surrounding area. A site-specific geotechnical investigation was not undertaken for this Environmental Impact Statement.

Light Detection and Ranging Contour Data was used to identify potential sinkholes on proposed sites. Analysis of topography, soil, and vegetation was completed during site characterization using Light Detection and Ranging Contour Data, geotechnical reports, and site visits to ensure minimal impacts to geological and soil resources.

Geologic and soil impacts include any resulting effects that the proposed action would have on the geological and soil resources of each geographic area as described in the affected environment section. Effects can occur during construction or operations, and may include:

- Cut and fill activities leading to soil erosion
- Removal of vegetation and landscaping leading to soil erosion
- Use of heavy equipment resulting in soil compaction
- Impacts to karst topography (surface collapse)
- Impervious surface increase resulting in increased runoff and soil erosion
- Vehicle movements on unpaved surfaces resulting in increased soil erosion and compaction

- Fires resulting in reduced vegetation and increased soil erosion
- Increased vulnerability to a geologic hazard (e.g., seismic activity, tsunami, liquefaction), and the probability that such an event could result in injury

The potential effects of these activities and their significance within the areas of occurrence under the alternative actions are described below. The analysis of potential impacts to geological and soil resources consider both direct and indirect impacts. Such disturbance may cause increased erosion and loss of productive soil. Direct impacts result from physical soil disturbances or topographic alterations. Indirect impacts include risks to individuals from geologic hazards, as well as impacts to water or marine biological resources occurring away from the construction/operation site or at a later time, after construction or operations. Factors considered in determining whether an impact would be significant include the potential for substantial changes in soil or slope stability. An impact to geological resources would be considered significant if the action could disrupt geologic features, or if actions were to be affected by potential geologic hazards.

Increases in runoff due to the removal of ground cover may increase sedimentation into surface waters.

Indirect groundwater impacts associated with the construction and operational activities include direct contamination of groundwater resources through percolation for surface runoff. Stormwater runoff can contribute to groundwater contamination. Water impacts are addressed in Volume 6, Chapter 6.

Construction activities are major sources of karst collapse, which can occur as a result of excavation, change of drainage patterns, or lowering the groundwater table (Islam 2005). Soil disturbance from construction can cause deposits to form in openings near the bedrock surface, which get heavier when saturated, causing the underlying structure to collapse.

Potential geology and soil impacts addressed in this chapter are limited to elements of the proposed actions that could affect onshore land forms or that could be affected by geologic hazards. Potential soil contamination issues are addressed in Volume 6, Chapter 18. Increased soil erosion also may indirectly impact water quality and aquatic ecosystems. Potential impacts to these resources are described in Volume 6, Chapter 6 and Chapter 13.

Applicable Regulatory Standards

The United States Environmental Protection Agency (USEPA) Region 9 gives the Guam Environmental Protection Agency (GEPA) the authority to enforce portions of federal statutes via a Memorandum of Agreement. Under this Memorandum of Agreement, the Safe Drinking Water Program, Water Resources Management Program, and the Water Pollution Control Program are administered by GEPA. The GEPA Water Pollution Control Program is responsible for protecting Guam's resources from point and non-point source pollution, including administration of the National Pollutant Discharge Elimination System (NPDES) program. NPDES permits are required for large and small construction activities. Requirements include a Notice of Intent, a Notice of Termination, and a construction site Stormwater Pollution Prevention Plan (SWPPP). Permits are required for projects that disturb greater than 1 acre (ac) of soil, including lay-down, ingress, and egress areas. Phase I regulates construction activity disturbing 5 ac (2 hectares [ha]) or more of total land area and Phase II regulates "small" construction activity disturbing between 1 and 5 ac (0.4 and 2 ha) of total land area. Erosion and sediment control would be covered under the stormwater general permit included in NPDES permits for construction projects greater than 1 ac (0.4 ha).

An Environmental Protection Plan (EPP) is required for projects at the discretion of the GEPA Administrator**.** EPPs are specifically identified in 22 Guam Annotated Regulations, Division II,

Chapter 10, Section (§) 10103.C.5(d). EPPs would include nonpoint source control management measures including erosion and sedimentation control, vegetation, wildlife resource protection measures, fugitive dust control, solid and hazardous waste management and disposal procedures, nutrient management plan, integrated pest management strategy/plan, confined animal facilities management plan, irrigation water management plan, personnel safety procedures, work site maintenance, and typhoon contingency plans, as necessary, depending on the work, project, activity and facility function.

Military construction projects are required to follow Unified Facilities Criteria (UFC) 3-310-04 Seismic Design for Buildings, which contains specifications for limiting seismic, liquefaction and ground shaking effects (U.S. Army Corps of Engineers [USACE] 2007). Government of Guam (GovGuam) has established a Soils and Water Conservation Program as defined in Chapter 26 of Title 17 of the Guam Code Annotated, as authorized by Public Law 28-179. The program is administered by the University of Guam. This regulation promotes the Territory of Guam's soil and water conservation policy in an effort to prevent erosion and water management problems; conserves and improves the use of the Territory's land and water resources; establishes Soil and Water Conservation Districts; and affirms the University of Guam's role as the Territory's lead soil conservation agency. Conservation programs are also administered by the Public Utility Agency of Guam and GEPA (Commander Navy Region Marianas 2008).

Effects of seismic, liquefaction, and ground shaking are reduced by following UFC 3-31-04, that provides the Department of Defense (DoD) requirements for:

- Creating earthquake-resistant design for new buildings.
- Evaluating and rehabilitating existing buildings for earthquake resistance.
- Applying seismic design principles to specialized structural and non-structural elements.

The new UFC adopts the seismic design provisions of the 2003 International Building Code for use in DoD building design. GovGuam regulations regarding solid waste landfills adhere to Rules and Regulations for the GEPA Solid Waste Disposal (Guam Code Annotated Title 22, Div. 4, Chapter 23). These regulations are no less stringent than the U.S. Environmental Protection Agency standards. These requirements are common to all sites:

- Access Control
- Office and Maintenance Facilities
- Base Liner System
- Leachate Collection
- Stormwater Control
- Landfill Operation
- Landfill Closure/Post-Closure
- Landfill Gas Collection and Monitoring

In addition, soil at all municipal landfills must cover disposed solid waste with six inches (15 centimeters) of earthen material at the end of the work day (Guam Department of Public Works 2005).

Off Base Roadways

The affected environment for geological and soil resources for the proposed roadway improvement projects on Guam is described in the Volume 2, Chapter 3.

Each of the action alternatives would result in construction and operation of a set of individual roadway improvement projects on the island of Guam, as defined in Volume 6, Chapter 2. Implementation of each

alternative would result in construction activities in each of the four geographic regions shown in that chapter.

Construction activities would consist of intersection improvements, bridge/culvert replacements, pavement strengthening, road relocation, road widening, and construction of a new road. Typical activities associated with each of these types of projects are described in Table 5.2-1. While many projects would involve construction work in developed and paved areas, some roadway projects could result in alteration of topography and disturbance to soils. A preliminary screening of project types and potential effects on geologic resources is provided in Table 5.2-1.

Table 5.2-1. Typical Effects of Guam Road Network Roadway Project Construction Activities on Geological and Soil Resources

Item	*Project Type*	*Description*	*Potential Effect on Geological and Soil Resources*
1	Intersection Improvement (including military access points)	Installation of new traffic loop sensors, extending lanes through the intersection, striping and paving to include new approach or turn lanes, reconfiguring intersection shapes (i.e., from Y-intersection to T-intersections), combining lanes, creating shared lanes, restriping, signalization modifications or upgrades, and grade separations.	Generally, intersection improvement work would not result in contact with subsurface soils or any changes in topography. Geological resources would be affected only when reconfiguration or grade separations include excavation, trenching, or grading into the subsoil.
2	Bridge/Culvert Replacement	Bridge/culvert replacement would be conducted in phases. The new bridge/culvert structure would be lengthened or widened to adequately accommodate the hydraulic flow of the river. The width of the new structure would accommodate more or wider lanes and a median, with sidewalks and barriers on each side.	Bridge/culvert replacement can include excavation, trenching, or grading into the subsoil. Geological resources would be affected when foundation work requires excavation beneath the existing bridge/culvert structure, utility work requires new trenching, or when new structures require expansion of the footprint of the existing bridge/culvert.
3	Pavement Strengthening	Existing asphalt pavement sections would be strengthened by rehabilitating the existing pavement materials in place and placing an asphalt overlay or by reconstructing with new materials. Pavement strengthening may include widening or adding impervious surface. The widened pavement section would be constructed of residual material from the existing pavement rehabilitation, new material, or a combination thereof, and an asphalt overlay. Pavement strengthening would also include matching existing access connections, pavement striping, signing, intelligent traffic systems, and safety lighting. The project would match existing horizontal and vertical alignment as required. Minor realignment of the road may be necessary to accommodate design elements.	Physical disturbance to soils from pavement strengthening would only occur when pavements are widened, new traffic systems or devices are installed, or minor road realignment occurs in previously undisturbed ground. Most activities associated with pavement strengthening would not require soil intrusion.

Item	*Project Type*	*Description*	*Potential Effect on Geological and Soil Resources*
4	Road Relocation (Route 15 only)	Route 15 would be realigned to accommodate the location of military firing ranges. New asphalt pavement would be constructed on the new alignment. The roadway cross section would consist of one lane in each direction, outside shoulders and inside shoulders, with an unpaved median that would accommodate future widening. Bicycles would be accommodated in the outside shoulders of the shared roadway. Alternatively, future widening would be accommodated to the outside, and the roadway cross section would consist of two lanes and outside shoulders with a paved median. Realignment would also include construction of new bridges to grade separate Route 15 and the frontage roads, obliterating existing Route 15 pavement, building removal, connecting to existing roadways or other access roads, utility relocation, pavement striping, signing, property fence, and guardrail installation.	Realignment into previously undisturbed soils may be required to accommodate design of the roadway. This activity would require building removal and relocation of existing utilities.
5	Road Widening	New lanes would be added to an existing roadway to accommodate predicted increased traffic volumes and to relieve congestion caused by increase in traffic volumes due to relocation activities. Widening would result in rebuilding the entire roadway, including removing the existing roadway segment. A new sub-base, base course, asphalt, and friction course layers would be constructed.	Road widening activities would affect previously undisturbed soil and topography of affected areas.
6	Construction of New Road	The Finegayan Connection would be constructed on a new alignment with new asphalt pavement on a compacted base or engineered fill.	New road construction would affect previously undisturbed soil and topography of affected areas.
7	Other	Temporary placement of equipment laydown areas may be required.	Equipment laydown areas associated with any of the above project types may require clearing and other disturbance of soils.

Potential impacts to geological and soil resources can occur during cut and fill operations, removal of vegetation, use of heavy equipment, and as a result of leaks and spills onto soils. Direct impacts that result in physical soil loss would occur during construction, while indirect impacts can result from the completed project (e.g., geologic hazards, increased erosion, or contaminants leach into soils). To evaluate the geologic resource impacts of each project, physical activities associated with each project type were identified, as shown in Table 5.2-2.

Table 5.2-2. Activities Associated with Guam Road Network Roadway Project Types

Item	*Project Type*	*Minor Grading*	*Vegetation Removal*	*Excavation and/or Cut and Fill*	*Heavy Equipment Use*	*Leaks and Spills of Contaminants*
1	Intersection Improvement (including military access points)	•			•	•
2	Bridge/Culvert Replacement		•	•	•	•
3	Pavement Strengthening	•		•	•	•
4	Road Relocation (Route 15 only)		•	•	•	•
5	Road Widening	•	•	•	•	•
6	Construction of New Road		•	•	•	•
7	Temporary placement of equipment laydown areas or storage areas for road demolition material	•	•		•	•

Based on the anticipated activities associated with each project type, it was determined that:

- Intersection improvements and pavement strengthening projects represented the project types with the lowest potential for impacts to geological and soil resources. These projects would involve the least amount of physical soil disturbance because most work would occur on existing pavements or developed areas.
- The placement of temporary equipment laydown areas at any of the Guam Road Network (GRN) project work sites would represent a moderate potential for impacts to geological and soil resources only when the use of previously undisturbed areas are selected. To avoid this impact, previously disturbed (e.g., paved) areas adjacent to the work site would be selected for use as temporary construction staging areas or storage for roadway demolition materials whenever possible. The use of heavy equipment would occur, and leaks or spills of contaminants could occur at equipment staging areas.
- Bridge/culvert replacement, road relocation, road widening, and construction of the new road would represent the greatest potential for impacts to geological and soil resources because vegetation removal, excavation, and/or cut and fill operations would be required at various locations. These projects would result in changes in topographic features, exhibit the greatest degree of soil disturbance, and have the most potential for erosion.

For roadway projects that would not require road widening, all proposed improvements would occur within the existing impervious cover footprint. These projects would not directly or indirectly affect geological resources. Intersection improvement projects associated with Military Access Points would require removal of vegetation and soil intrusion; therefore, they were not eliminated from evaluation.

Indirect impacts from the roadway projects could also occur. Indirect impacts would be associated with geologic hazards, increased erosion, or contaminants leaching into soils. Projects with the most potential for increased vulnerability to geologic hazards would be those located in areas of high liquefaction potential and those in or near karst geologic formations (nearest to known sinkholes or caves). In general, the potential vulnerability to effects from seismic activity is consistent throughout the island because of known and inferred earthquake faults that transect Guam. Increased erosion from the operation of new roadways and bridges would not be expected due to improved design features and proper maintenance. The potential for contaminants leaching into the soil would be prevented or managed through implementation of spill prevention and emergency spill response procedures.

5.2.1.2 Determination of Significance

For geological and soil resources, the significance of potential project impacts is determined by subjective criteria, as well as by regulatory standards. An impact to geologic resources would be considered significant if the action could disrupt geologic features, or if actions were to be affected by potential geologic hazards. The following factors are considered in determining the importance of the impacts:

- An increase in rate of erosion and soil loss from physical disturbance
- Reduced amounts of productive soils
- Alteration of surrounding landscape and effect on important geologic features (including soil or rock removal that would adversely affect site drainage)
- Diminished slope stability
- Increased vulnerability to a geologic hazard (e.g., seismic activity, tsunami, liquefaction), and the probability that such an event could result in injury

5.2.1.3 Issues Identified during Public Scoping Process

The following analysis focuses on possible effects to the geological and soil resources that could be impacted by the proposed alternatives. As part of the analysis, concerns relating to geological and soil resources mentioned by the public, including regulatory stakeholders, during scoping meetings were addressed. These include:

- Implementing erosion control measures for construction and post construction phases.
- Ensuring that proper permitting and local government clearances are sought, where applicable.

5.2.2 Power

5.2.2.1 Basic Alternative 1: Recondition up to 5 Existing Guam Power Authority Permitted Facilities to Provide Peaking Power/Reserve Capacity

Basic Alternative 1 would recondition existing Combustion Turbines (CTs) and upgrade and install new Transmission and Distribution (T&D) systems. This work would be undertaken by the Guam Power Authority on its existing permitted generation facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo (2 units), and Macheche CTs. These CTs are hardly being used and upon reconditioning would have the necessary reliability to serve as peaking and reserve units to ensure system reliability. T&D system upgrades and new installations would include above ground and underground transmission lines and modifications to existing substations. This alternative supports Main Cantonment Alternatives 1 and 2. Main Cantonment Alternatives 3 and 8 would require additional upgrades and new additions to the T&D system.

Development under Basic Alternative 1 would disturb soil during construction associated with T&D upgrades and new installations within current utility corridors, but would not require enlargement of the footprint of the power facilities. Underground transmission lines would be placed along roadways and in existing utility corridors. There is a risk of increased rate of erosion, compaction, and soil loss from physical disturbance caused by construction activity. Land disturbing activities would trigger the requirement to seek coverage under the Construction General Permit. A site-specific SWPPP would be prepared and implemented in accordance with the Construction General Permit. The SWPPP would identify site-specific Best Management Practices (BMPs) (Volume 2, Chapter 4, Table 4.2.1) that would be implemented as part of Basic Alternative 1 to reduce the potential for erosion, runoff, sedimentation, and subsequent water quality impacts. Standard operating procedures (SOPs) and BMPs would be

implemented to control and minimize impacts. The following measures are current SOPs for activities that could impact geological and soil resources in the project area:

- Locate ground-disturbing roadwork on previously disturbed sites whenever possible.
- Restrict vehicular activities to designated/previously identified areas.
- Prohibit off-road vehicle use except in designated off-road areas or on established trails.
- Monitor erosion and drainage at select locations.
- Comply with existing policies and management activities to conserve soils.
- Implement standard erosion control measures (i.e., temporary and permanent soil stabilization; location of temporary soil piles; placement of sediment barriers around storm sewer inlets; sediment controls such as filter fabric fences, straw bales, or vegetative barriers; timely disposal of construction material wastes) during ground-disturbing activities (e.g., excavation and grading).
- Place any topsoil removed from the site in the immediate area and reuse it for re-compaction purposes (if appropriate, in accordance with geotechnical recommendations).
- Dispose of any contaminated topsoil from the site in an approved landfill in accordance with applicable regulatory requirements.
- Plan and conduct any earthwork in such a manner as to minimize the duration of exposure of unprotected soils.
- Install berms and plastic sheeting for soil disturbance activities that occur during the rainy season.
- Locate temporary equipment laydown areas on previously disturbed or developed (i.e., paved) areas whenever possible to avoid the need for vegetation removal or grading.
- Use proper storage and containment of contaminants at all temporary equipment staging areas.
- Prepare and implement erosion control plans for roadway work in construction plans and practices to the maximum extent practicable, including but not limited to:
- the area of land to be graded shall be kept to a minimum, stabilized, or receive temporary covering if delays exceeding 2 months of exposure occur;
- critical areas shall be protected during construction with the use of temporary ditches, dikes, vegetation, and/or mulching;
- all disturbed areas, slopes, channels, ditches, and banks shall be stabilized as soon as possible after final grading has been completed;
- stormwater runoff from disturbed areas would be collected and diverted for removal of sediment before discharge to any surface or marine waters; and
- all erosion and sedimentation control facilities would be maintained until stabilization of the site is complete.
- Ensure that all construction work areas are clearly identified or marked on contractor drawings. Restrict vehicular activities to designated/previously identified areas within the construction work zone only.
- Prohibit off-road vehicle use except in designated off-road areas or on established trails.
- Ensure that contaminants (i.e., oils, greases, lubrication fluids for heavy equipment) are properly stored at the work site to avoid spills and leaks.

Erosion potential of soils found at facilities proposed for reconditioning and in the areas underlying T&D upgrades under Basic Alternative 1 is shown in Table 5.2-3.

Table 5.2-3. Erosion Potential at Power Alternative Sites

Soil Type	*Location*	*Erosion Potential*
Guam Yigo Complex at 0-7% slope	Marbo, Yigo, and Dededo	slight
Guam Cobbly Clay Loam at 3-7% slope	Marbo, Yigo, Macheche, and Dededo, Andersen AFB, Potts Junction	slight
Guam Cobbly Clay Loam at 3-7% slope	Harmon/Yigo and Dededo/Andersen, Andersen AFB	slight
Guam Urban Land Complex at 0-3% slope	Orote Point, Potts Junction	slight
Urban Land-Ustorthents complex at 0% slope	Cabras/Piti	slight

Legend: AFB = Air Force Base.
Source: Young 1988.

Construction activities under Basic Alternative 1 would include clearing, grading and grubbing, trenching, and demolition of existing earthwork and grass. Direct impacts include temporary loss of vegetation. Installation of underground T&D lines would permanently displace soil; however, the volume of soil moved would result in less than significant impacts to soil resources. Therefore, Basic Alternative 1 would result in less than significant impacts to topography.

There are no known sinkholes near Basic Alternative 1 construction. A survey by a licensed geologist is required prior to construction to ensure that all sinkholes have been identified. If additional sinkholes are discovered, the project would be designed to minimize any impacts associated with sinkholes. Any sinkholes discovered would be avoided and buffer zones of vegetation would be left around them to prevent further erosion or expansion. Therefore, Basic Alternative 1 would result in less than significant impacts to unique geologic resources.

Construction areas are in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Basic Alternative 1 would result in less than significant impacts associated with geologic hazards during construction and operation.

Soil types disturbed would not be agriculturally productive soils. Construction SOPs and BMPs would be followed to control and minimize soil erosion. The construction SOPs would include requirements for stormwater compliance, and with BMPs implementation, would ensure that all aspects of the project construction would be performed in a manner to minimize direct and indirect impacts during construction activity. A description of the standard BMPs and resource protection measures required by regulatory mandates can be found in Volume 7. Implementation of measures noted in the geological and soil resources column would prevent erosion; therefore, the impacts from soil erosion would be less than significant. A more detailed explanation of regulatory permitting requirements is available in Volume 8.

Proposed Mitigation Measures

Implementation of Basic Power Alternative 1 would have less than significant impacts to geological and soil resources. Therefore, no mitigation measures are proposed. Implementation of SOPs and BMPs including erosion and sedimentation controls and stormwater management would minimize impacts to geological and soil resources.

5.2.2.2 Summary of Impacts

Table 5.2-4 summarizes the potential impacts of Basic Power Alternative 1. A text summary is provided below.

Table 5.2-4. Summary of Potential Power Impacts

Basic Alternative 1
Construction (direct and indirect impacts are the same)
Topography – LSI Geology – NI Soil – LSI Geologic Hazards – LSI
Operation (direct and indirect impacts are the same)
Topography – LSI Geology – NI Soil – LSI Geologic Hazards – LSI

Legend: LSI = Less than significant impact; NI = No impact.

Relocation of Marines to Guam would require construction and reconditioning that would potentially disturb soil, increase erosion, and change the landscape of Guam in multiple areas. Reconditioning of existing generation facilities and trenching for underground transmission line upgrades are required to support the increase in population.

Rates of erosion and soil loss from physical disturbance due to construction would temporarily increase during construction and renovation associated with the alternative for power infrastructure improvements. With implementation of BMPs, less than significant impacts from soil erosion would occur. The soil types that would be lost are not agriculturally productive soils. The topographic and landscape features would not be substantially changed by proposed construction activities. Some areas contain karst geologic features that would be of concern during the construction and operation of the facilities.

5.2.3 Potable Water

5.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would provide additional water capacity of 11.3 MGd (42.8 MLd), which is anticipated to be met by an estimated 22 new wells at Andersen Air Force Base (AFB), rehabilitate existing wells, interconnect with the Guam Waterworks Authority (GWA) water system, and associated treatment, storage and distribution systems. Two new 2.5 MG (9.5 ML) water storage tanks would be constructed at ground level at NCTS Finegayan. Up to two new elevated 1 MG (3.8 ML) water storage tanks would be constructed at Finegayan within the Main Cantonment footprint. Basic Alternative 1 would affect the following areas of Guam:

- North (water supply wells)
- Central (rehabilitation of Navy Regional Medical Center well)

The estimated 22 new water wells (including one contingency well) at AFB would be drilled through the limestone plateau into the Northern Guam Lens Aquifer. Total well depths would be from 512 to 577 feet (156 to 175 meters). The two new 2.5 MG (9.5 ML) water storage tanks would be placed on the ground on site at Finegayan and would be connected to the new and existing system. Two new 1 MG (3.8 ML) elevated water storage tanks would be constructed at Finegayan and connected to the new distribution system. New underground water transmission lines would be placed along roadways and existing utility corridors.

Generally, soil erosion is a concern primarily for discharge into surface or nearshore waters that are not located near the proposed wells. However, potential sediment contamination of groundwater may result

from drilling new wells. Erosion potential for soils found at proposed upgrade sites is shown in Table 5.2-5. The two new ground-level 2.5 MG (9.5 ML), up to two elevated 1 MG (3.8 ML) storage tanks, and new underground transmission lines are proposed on Naval Computer and Telecommunications Station Finegayan. Development under Alternative 1 would disturb soil, but SOPs and BMPs would be implemented to control and minimize direct and indirect impacts. Therefore, Alternative 1 well-drilling would not result in significant soil erosion, compaction, or loss of agriculturally productive soil.

Table 5.2-5. Erosion Potential at Potable Water Sites

Soil Type	*Location*	*Erosion Potential*
Guam Cobbly Clay Loam at 3-7% slope	Andersen AFB	slight
Guam Cobbly Clay Loam at 7-15% slope	Andersen AFB	slight
Guam Urban Land Complex at 0-3% slope	Andersen AFB	slight
Guam Urban Land Complex at 0-3% slope	NCTS Finegayan	slight
Guam Cobbly Clay Loam at 7-15% slope	Andersen South	slight
Guam Cobbly Clay Loam at 7-15% slope	Andersen South	slight
Guam Urban Land Complex at 0-3% slope	Andersen South	slight
Guam Cobbly Clay Loam at 3-7% slope	Air Force Barrigada	slight
Chacha Clay at 0-5% slope	Air Force Barrigada	slight
Pulantat-Kagman Clays at 0-7% slope	Air Force Barrigada	slight
Inaranjan Clay at 0-4% slope	NMS	slight
Akina Silty Clay at 7-15% slope	NMS	severe
Akina-Urban Land Complex at 0-7% slope	NMS	slight

Legend: AFB = Air Force Base; NCTS = Naval Computer and Telecommunications Station; NMS = Naval Munitions Site.
Source: Young 1988.

Construction of wells and water distribution lines under Basic Alternative 1 would include minor clearing, grading, and grubbing, and demolition of existing earthwork and grass. Direct impacts to topography include temporary loss of vegetation. Landscape changes under Basic Alternative 1 would result in minimal impacts to topography by changing the landscape of the affected area.

Known sinkholes would be avoided and buffer zones of vegetation would be left around them as a mitigation measure to prevent further erosion or expansion. A survey by a licensed geologist is required prior to construction to ensure that all sinkholes have been identified. If additional sinkholes are discovered, the project would be designed to minimize any impacts associated with sinkholes. Sinkholes would be fenced off and educational signs would be put in place to warn of their potential danger. Alternative 2 would not result in impacts associated with geologic resources or hazards.

Therefore, with mitigation, Alternative 1 would result in less than significant impacts to unique geologic resources.

Construction areas are in a potentially active seismic zone. Effects associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Alternative 1 would result in less than significant impacts associated with geologic hazards during construction and operation.

Soil types disturbed would not be agriculturally productive soils. Construction SOPs would be followed to minimize soil erosion. The construction SOPs would include requirements for stormwater compliance, with BMPs to ensure that all aspects of the project construction would be performed in a manner to minimize impacts during construction activity. A description of the standard BMPs and resource

protection measures required by regulatory mandates can be found in Volume 7. Implementation of measures noted in the geological and soil resources column would prevent erosion; therefore, the impacts from soil erosion would be less than significant. A more detailed explanation of regulatory permitting requirements is available in Volume 8.

Potential upgrades to the GWA system to meet indirect population growth demand would have similar impacts to those of the direct DoD impacts described above, including less than significant impacts from landscape alteration, from geologic hazards, and erosion.

To reduce significant impacts during construction under Basic Alternative 1, the following measures are suggested for implementation in accordance with site-specific geotechnical reports produced for project planning and construction:

- Revegetation would occur as soon as possible after any ground disturbance or grading.
- Construction and grading would be minimized during times of inclement weather.

Construction and operation impacts from seismic activity and associated liquefaction and ground shaking would be reduced by following UFC 3-310-04 Seismic Design for Buildings (USACE 2007).

Proposed Mitigation Measures

Known sinkholes would be avoided and a buffer zone of vegetation would be left around them as a mitigation measure to prevent further erosion or expansion. If additional sinkholes are discovered, the project would be designed to minimize any impacts associated with sinkholes. Sinkholes would be fenced off and educational signs would be put in place to warn of their potential danger as a mitigation measure. Therefore, with mitigation, less than significant impacts to a unique geologic resources would occur.

5.2.3.2 Basic Alternative 2

Basic Alternative 2 would provide additional water capacity of 11.7 MGd (44.3 MLd), which is anticipated to be met by an estimated 20 new wells at Andersen Air Force Base (AFB) and 11 new wells at Air Force Base Barrigada, rehabilitate existing wells, interconnect with the Guam Waterworks Authority (GWA) water system, and associated treatment, storage and distribution systems. Two new 1.8 MG (6.8 ML) water storage tanks would be constructed at ground level at NCTS Finegayan and one 1 MG (3.8 ML) water storage tank would be construction at Air Force Base Barrigada. Up to two new elevated 1 MG (3.8 ML) water storage tanks would be constructed at Finegayan within the Main Cantonment footprint.

Impacts to soil and geological resources at Andersen AFB are identical to those under Basic Alternative 1.

At Navy Barrigada, installation of up to 11 new wells, as well as replacement and upgrades to water distribution lines, would include minor clearing, grading and grubbing, and demolition of existing earthwork and grass. Direct impacts to topography include temporary loss of vegetation. If additional sinkholes are discovered, the project would be designed to minimize any impacts associated with sinkholes. Any sinkholes discovered would be avoided and a buffer zone of vegetation would be left around them as a mitigation measure to prevent further erosion or expansion Sinkholes would be fenced off and educational signs would be put in place to warn of their potential danger. Therefore, Basic Alternative 2 would result in less than significant impacts to unique geologic resources.

Construction areas are in a potentially active seismic zone. Effects associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic

Design for Buildings (USACE 2007). Therefore, Basic Alternative 2 would result in less than significant impacts associated with geologic hazards to construction or operations.

Soil types disturbed would not be agriculturally productive soils. Construction SOPs would be followed to minimize soil erosion as stated in Alternative 1 impacts.

Potential upgrades to the GWA system to meet indirect population growth demand would have similar impacts to those of the direct DoD impacts described above, including less than significant impacts from landscape alteration, from geologic hazards, and erosion.

Impacts from seismic activity and associated liquefaction and ground shaking would be reduced by following UFC 3-310-04 Seismic Design for Buildings (USACE 2007).

Proposed Mitigation Measures

Potential mitigation measures are the same as those for Basic Alternative 1.

5.2.3.3 Summary of Impacts

Table 5.2-6 summarizes the potential impacts of each action alternative. A text summary is provided below.

Table 5.2-6. Summary of Potential Potable Water Impacts

*Basic Alternative 1**	*Basic Alternative 2*
Construction (direct and indirect impacts are the same)	
Topography – LSI Geology – SI-M Soil – LSI Geologic Hazards – LSI	Topography – LSI Geology – SI-M Soil – LSI Geologic Hazards – LSI
Operation (direct and indirect impacts are the same)	
Topography – LSI Geology – SI-M Soil – LSI Geologic Hazards – LSI	Topography – LSI Geology – SI-M Soil – LSI Geologic Hazards – LSI

Legend: LSI = Less than significant impact; SI-M= Significant impact mitigable to less than significant
* Preferred Alternative.

Relocation of Marines to Guam would require construction and renovation that would potentially disturb soil, increase erosion, and change the landscape of Guam in multiple areas. Buildup of the potable water infrastructure is required to support the increase in population.

Temporarily increased rates of erosion, compaction, and soil loss due to physical disturbance from construction would occur during construction and renovation associated with all of the alternatives for the potable water infrastructure improvements. With implementation of BMPs, less than significant impacts from soil erosion would occur. The soil types that would be lost are not agriculturally productive soils. The topographic and landscape features would not be substantially changed by construction activities. Some areas contain karst geologic features that are of concern during construction and operation of the facilities. Known sinkholes would be avoided and a buffer zone of vegetation would be left around them as a mitigation measure to prevent further erosion or expansion. A survey by a licensed geologist is required prior to construction to ensure that all sinkholes have been identified. If additional sinkholes are discovered, the project would be designed to minimize any impacts associated with sinkholes. Sinkholes would be fenced off and educational signs would be put in place to warn of their potential danger as a mitigation measure to prevent significant impacts to operations. With mitigation, less than significant impacts to sinkholes. would occur. Details regarding potential upgrades to the GWA system would have

similar impacts to those of the DoD impact, including less than significant impacts from landscape alteration, from geologic hazards, and erosion.

5.2.4 Wastewater

5.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (1a supports Main Cantonment Alternatives 1 and 2; and 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). Upgrades include new underground sewer lines. The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

The action areas are located in northern Guam, an area with karst geologic features that would require consideration when planning new construction. The proposed upgrade to the facilities does not include enlargement of the plant footprint. Expansion of the NDWWTP outfall would require a laydown area.

Generally, soil erosion is a concern primarily for discharge into surface or nearshore waters, none of which are found near Alternative 1 construction. Erosion potential for soils found at proposed upgrade sites is shown in Table 5.2-7. Soil types disturbed would not be agriculturally productive soils.

Table 5.2-7. Erosion Potential at Wastewater Alternative Sites

Soil Type	*Location*	*Erosion Potential*
Guam Cobbly Clay Loam at 3-7% slope	NDWWTP	Slight
Guam Yigo Complex at 0-7% slope	Proposed Sewer Line	Slight
Guam Cobbly Clay Loam at 3-7% slope	Proposed Sewer Line	Slight

Legend: NDWWTP = Northern District Wastewater Treatment Plant.
Source: Young 1988.

Construction under Basic Alternatives 1a and 1b would include minor clearing, grading, and grubbing, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Changes to the landscape associated with Basic Alternatives 1a and 1b would result in less than significant impacts to topography. Therefore, Alternative 1 would result in minimal impacts to topography by changing the landscape of the affected area.

A survey by a licensed geologist is required prior to construction to ensure that all sinkholes have been identified. If additional sinkholes are discovered, the project would be designed to minimize any impacts associated with sinkholes. Any sinkholes discovered would be avoided and buffer zones of vegetation would be left around them as a mitigation measure to prevent further erosion or expansion. Sinkholes would be fenced off and educational signs would be put in place to warn of their potential danger. as a mitigation measure to prevent significant impacts to operations. Therefore, with mitigation, Basic Alternative 1 would result in less than significant impacts to unique geologic resources.

Construction areas are in a potentially active seismic zone. Effects associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Basic Alternative 1 would result in less than significant impacts associated with geologic hazards.

Standard construction BMPs would be included in the Regional SWPPP as part of the Construction Stormwater Management Program for the military relocation. As part of an integrated approach to stormwater management, construction managers and contractors would be required to follow this Regional SWPPP for development of their site specific SWPPP. To prevent soil erosion, erosion and

sediment control measures would be included as part of the Regional SWPPP, and required for inclusion in the Contractor's Site Specific SWPPP under NPDES Construction Permit Compliance Program for the military relocation. A description of the standard BMPs and resource protection measures required by regulatory mandates can be found in Volume 7. Implementation of measures noted in the geological and soil resources column would prevent erosion, thus the impacts from soil erosion would be less than significant. A more detailed explanation of regulatory permitting requirements is available in Volume 8.

To reduce significant impacts during construction under Basic Alternative 1, the following measures are suggested for implementation in accordance with site-specific geotechnical reports produced for project planning and construction:

- Revegetation would occur as soon as possible after any ground disturbance or grading.
- Construction and grading would be minimized during times of inclement weather.

Impacts from seismic activity and associated liquefaction and ground shaking would be reduced by following UFC 3-310-04 Seismic Design for Buildings (USACE 2007).

Proposed Mitigation Measures

Sinkholes would be avoided and buffer zones of vegetation would be left around them as a mitigation measure to prevent further erosion or expansion. As a result of mitigation, the sinkholes would not be affected by construction activities. If additional sinkholes are discovered, significant impacts to these sinkholes would be determined and projects would be designed in consideration of these sinkholes as appropriate. Sinkholes would be fenced off and educational signs would be put in place to warn of their potential danger as a mitigation measure to prevent significant impacts to operations. With mitigation, less than significant impacts to sinkholes would occur. No proposed mitigation measures.

5.2.4.2 Summary of Impacts

Table 5.2-8 summarizes the potential impacts of each action alternative. A text summary is provided below.

Table 5.2-8. Summary of Wastewater Impacts

Basic Alternative 1a and 1b* (direct and indirect impacts are the same)
Construction (direct and indirect impacts would be the same)
Topography – LSI Geology – SI-M Soil – LSI Geologic Hazards – LSI
Operation (direct and indirect impacts would be the same)
Topography – LSI Geology – SI-M Soil – LSI Geologic Hazards – LSI

Legend: LSI = Less than significant impact; SI-M= Significant impact mitigable to less thansignificant;
* Preferred Alternative.

Relocation of Marines to Guam would require construction and renovation that would potentially disturb soil, increase erosion, and change the landscape of Guam in multiple areas. Buildup of wastewater treatment infrastructure is required to support the increase in population.

Rates of erosion and soil loss from physical disturbance due to construction would temporarily increase during construction and renovation associated with all of the alternatives for wastewater treatment infrastructure improvements. With implementation of BMPs, less than significant impacts from soil

erosion would occur. The soil types that would be lost are not agriculturally productive soils. The topographic and landscape features would not be substantially changed by proposed construction activities. Some areas contain karst geologic features that would be of concern during the construction and operation of the facilities. Known sinkholes would be avoided and buffer zones of vegetation would be left around them as a mitigation measure to prevent further erosion or expansion. As a result of mitigation, the sinkholes would not be affected by construction activities. A survey by a licensed geologist is required prior to construction to ensure that all sinkholes have been identified. If additional sinkholes are discovered, the project would be designed to minimize any impacts associated with sinkholes. There would be less than significant impacts to sinkholes with proposed mitigation measures.

5.2.5 Solid Waste

5.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative would be to continue to use the Navy landfill at Apra Harbor for municipal solid waste (MSW) until the new GovGuam Layon Landfill at Dandan is available for use. Disposal of other waste streams excluded from Layon Landfill would continue at the Navy landfill. Construction and demolition (C&D) debris would continue to be disposed at the Navy hardfill.

Though no construction or upgrades to utilities occur, geological and soil resources need to be analyzed for impact from increased amounts of solid waste at current facilities. An increase in the volume of solid waste would potentially impact the daily soil-covering routines at the existing plant. More soil would potentially be required to cover greater amounts of solid waste. Impact to soils and geological resources would be minimal, because soil is used at the landfill for the purpose of covering solid waste and more soil is available to use as pressure on the existing facility increases. There are no sinkholes or unique karst features found in the area. There would be no impacts from construction, and less than significant impacts from operation.

Proposed Mitigation Measures

No mitigation measures are required.

5.2.5.2 Summary of Impacts

Table 5.2-9 summarizes the potential impact of the Preferred Alternative. A text summary is provided below.

Table 5.2-9. Summary of Potential Solid Waste Impacts

Basic Alternative 1(direct and indirect impacts are the same)*
Construction
Topography – NI Geology – NI Soil – NI Geologic Hazards – NI
Operation
Topography – LSI Geology – LSI Soil – LSI Geologic Hazards – NI

Legend: LSI = Less than significant impact; NI=No impact; * Preferred Alternative.

Solid waste Basic Alternative 1 would not involve new or expanded facilities. It would involve higher generation of solid waste. Therefore, the impacts of solid waste to geological and soil resources would be less than significant.

5.2.6 Off Base Roadways

5.2.6.1 Alternative 1

Alternative 1 would result in direct impacts to geologic resources as a result of construction. Impacts to geologic resources could include soil disturbance and the suspension of soil, soil loss, and localized erosion. Ground disturbance for roadway improvements would be conducted in accordance with construction SOPs listed in Section 5.2.2.1 and below and BMPs listed in Volume 7:

- Individual roadway projects would be designed and constructed in accordance with recommendations of the project- and site-specific geotechnical investigation and applicable geotechnical code requirements. Each project would be designed and constructed in accordance with recommendations from a registered professional geologist for the following aspects, as applicable, and included in the project-specific geotechnical investigation: liquefaction, erosion, site grading, excavation and utility trenches, foundations, mitigation of soil corrosivity on concrete and seismic design criteria. Approval by a licensed Geotechnical Engineer would be required for placement and compaction of fill, backfilling of trenches, and testing of soils.
- Earthwork would be conducted using BMPs to minimize erosion during demolition and road or bridge construction including, but not limited to, watering for dust control during earthwork to minimize soil loss; and establishing grass or other landscaping in disturbed areas immediately after construction is completed.
- Material from demolition of existing road pavements shall be stored in previously disturbed areas whenever possible.
- For projects involving military access, control erosion through the Site Approval Process, whereby each proposed project is reviewed for its erosion potential. Obtain concurrence of the designated installation Natural Resource Specialist in the process.
- Manage erosion in accordance with the applicable SWPPPs at each roadway project location.
- 141,542 tons of aggregate for roadway construction would be imported from Japan. Local rules and regulations for importing would be followed to prevent significant impacts.

<u>North</u>

Thirteen GRN projects would occur in the North Region as a result of Alternative 1:

- One intersection improvement project (GRN #117) and two pavement strengthening projects (GRN #s 8 and 23) would not require road widening or road realignment in previously undisturbed ground. No impacts to geologic and soil resources would occur.
- Four intersection improvement projects involving modifications to Military Access Points (MAPs) (GRN #s 38A, 39A, 41A, and 42) would be required. To construct new access gates, removal of vegetation and disturbance to Limestone Upland soils would be required.
- Five road widening projects (GRN #s 9, 10, 22, 22A, and 57) would require removal of vegetation and disturbance to Limestone Upland soils.
- Construction of the Finegayan Connection, a new road (GRN #124), would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the latter three project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of construction SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Alternative 1 would result in less than significant impacts to unique geologic resources and would not result in significant soil erosion. Therefore, impacts to soils would be less than significant.

Central

Twenty-seven GRN projects would occur in the Central Region as a result of Alternative 1:

- Three intersection improvement projects (GRN #s 1, 2, and 113) and 16 pavement strengthening projects (GRN #s 6, 7, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 30, 31, 32, and 33) would not require road widening or road realignment in previously undisturbed ground. No impacts to geological and soil resources would occur.
- Two intersection improvement projects involving modifications to MAPs (GRN #s 44 and 46) would be required. Both projects would occur in previously developed areas, and minimal soil disturbance would be required.
- Two bridge/culvert replacement projects (GRN #s 3 and 35) would require clearing and excavation of soil, as well as construction activities adjacent to, and over water.
- Three road widening projects (GRN #s 16, 28, and 29) would require removal of vegetation and disturbance to Limestone Upland soils.
- The relocation of Route 15 (GRN #36) would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the latter three project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of appropriate SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Therefore, impacts to soils would be less than significant.

Apra Harbor

Five GRN projects would occur in the Apra Harbor Region as a result of Alternative 1:

- One intersection improvement project (GRN #5) and three pavement strengthening projects (GRN #4, #24, and #26) would be required. While GRN #4, #24, and #26 would not require road widening or realignment, GRN #5 would require removal of vegetation for road widening and would result in limited soil disturbance.
- One intersection improvement project involving modification to a MAP (GRN #50) would be required. This access point would be constructed on previously cleared ground, and soil disturbance would be minimal.

Soil disturbances from projects GRN #5 and GRN #50 could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of appropriate SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Therefore, impacts to soils would be less than significant.

South

Four GRN projects would occur in the South Region as a result of Alternative 1:

- One intersection improvement project (GRN #110) and two pavement strengthening projects (GRN #25 and 27) would not require road widening. No impacts to geological and soil resources would occur.
- One intersection improvement project involving modification to a MAP (GRN #52) would be required. This access point would be constructed on previously cleared ground, and soil disturbance would be minimal.

Soil disturbances from the GRN #52 project could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of appropriate SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Therefore, impacts to soils would be less than significant.

Proposed Mitigation Measures

No mitigation measures would be required.

5.2.6.2 Alternative 2

North

Thirteen GRN projects would occur in the North Region as a result of Alternative 2:

- One intersection improvement project (GRN #117) and two pavement strengthening projects (GRN #8 and 23) would not require road widening or road realignment in previously undisturbed ground. No impacts to geological and soil resources would occur.
- Four intersection improvement projects involving modifications to MAPs (GRN #s 38, 39, 41, and 42) would be required. To construct new access gates, removal of vegetation and disturbance to Limestone Upland soils would be required.
- Five road widening projects (GRN #s 9, 10, 22, 22A and 57) would require removal of vegetation and disturbance to Limestone Upland soils.
- Construction of the Finegayan Connection, a new road (GRN #124), would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the MAP intersection improvements and road widening project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of construction SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Alternative 2 would result in less than significant impacts to unique geologic resources. Therefore, impacts to soils would be less than significant.

Central

Twenty-seven GRN projects would occur in the Central Region as a result of Alternative 2:

- Three intersection improvement projects (GRN #1, 2, and 113) and 16 pavement strengthening projects (GRN #6, 7, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 30, 31, 32, and 33) would not require road widening or road realignment in previously undisturbed ground. No impacts to geological and soil resources would occur.
- Two intersection improvement projects involving modifications to MAPs (GRN #44 and 46) would be required. These projects would occur in previously developed areas, and minimal soil disturbance would be required.
- Two bridge/culvert replacement projects (GRN #3 and 35) would require clearing and excavation of soil, as well as construction activities adjacent to, and over water.

- Three road widening projects (GRN #16, 28, and 29) would require removal of vegetation and disturbance to Limestone Upland soils.
- The relocation of Route 15 (GRN #36) would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the latter three project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of construction SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Therefore, impacts to soils would be less than significant.

Apra Harbor

Impacts would be identical to Alternative 1 because the same projects would be constructed.

South

Impacts would be identical to Alternative 1 because the same projects would be constructed.

Proposed Mitigation Measures

No mitigation measures would be required. Standard construction SOPs and BMPs would be identical to Alternative 1.

5.2.6.3 Alternative 3

North

Fourteen GRN projects would occur in the North Region as a result of Alternative 3. Roadway projects would be identical to those described for Alternative 1, with the exclusion of GRN #124 (Finegayan Connection) that would not be constructed. Different intersection improvements at MAPs would be included, as well as pavement strengthening along Routes 8A and 16. Soil disturbances from Alternative 3 projects could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of construction SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Therefore, impacts to soils would be less than significant.

Central

Thirty-one GRN projects would occur in the Central Region as a result of Alternative 3:

- Three intersection improvement projects (GRN #1, #2, and #113) and 14 pavement strengthening projects (GRN #6, #7, #11, #12, #13, #14, #15, #17, #18, #19, #21, #30, #32, and #33) would not require road widening or road realignment in previously undisturbed ground. No impacts to geologic resources and soils would occur.
- Six intersection improvement projects involving modifications to MAPs (GRN #44, #46, #47, #48, #49, and #49A) would be required. These projects would occur in previously developed areas, and minimal soil disturbance would be required.
- Two bridge/culvert replacement projects (GRN #3 and #35) would require clearing and excavation of soil, as well as construction activities adjacent to, and over water.
- Five road widening projects (GRN #16, #28, #29, #63, and #74) would require removal of vegetation and disturbance to Limestone Upland soils.
- The relocation of Route 15 (GRN #36) would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the latter three project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of construction SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Therefore, impacts to soils would be less than significant. Therefore, impacts to soils would be less than significant.

Apra Harbor

Impacts would be the same as Alternative 1 because the same projects would be constructed.

South

Impacts would be the same as Alternative 1 because the same projects would be constructed.

Proposed Mitigation Measures

No mitigation measures would be required.

5.2.6.4 Alternative 8

North

Impacts would be identical to Alternative 1 because the same projects would be constructed.

Central

Impacts would be nearly identical to Alternative 1 with the addition of a new access along Route 15 for Barrigada (Air Force) (GRN #49A).

Apra Harbor

Impacts would be to the same as Alternative 1 because the same projects would be constructed.

South

Impacts would be to the same as Alternative 1 because the same projects would be constructed.

Proposed Mitigation Measures

No mitigation measures would be required.

5.2.6.5 No-Action Alternative

Under the no-action alternative, Marine Corps units would remain in Japan and would not relocate to Guam, the visiting aircraft carrier would berth at Kilo Wharf, and an Army Air and Missile Defense Task Force would not be positioned on Guam; therefore, the no-action alternative would obviate the need to improve roads necessary for the military relocation. While none of the GRN projects identified herein would be constructed, road improvements associated with the organic growth of Guam's population would continue. The road segment and intersection improvement projects planned by GovGuam are identified in Table 5.2-10. Road improvements supporting organic growth would most likely require vegetation removal, grading, excavation and/or cut and fill, use of heavy equipment, and possible leaching of contaminants into soils; therefore, direct and indirect effects associated with localized soil disturbance would also occur as a result of the no-action alternative. Future organic growth projects would be conducted in previously disturbed areas in accordance with established procedures and site-specific constraints, including BMPs to prevent effects such as erosion or loss of topsoil. With incorporation of SOPs and BMPs identified for Alternative 1, the roadway projects to be conducted for the no-action alternative would have minimal impacts to geological and soil resources.

The geologic hazards associated with earthquakes, active volcanoes, and collapse of subterranean cavities in limestone formation have not resulted in any impact on existing roadways. Localized disruption of soils may result from GovGuam road widening projects that extend beyond the existing road footprints. With adherence to SOPs and BMPs for control of erosion, impacts to geologic resources would be less than significant.

2014

The no-action alternative for future year 2014 represent the roadway network assuming that construction associated with military relocation had not occurred. While no construction associated with the planned military relocation would occur, GovGuam would have initiated construction of road segment and intersection improvement projects along segments of Routes 1, 7, 10A, and 27 (extension), and Tiyan Parkway, as identified in Table 5.2-10. With incorporation of SOPs and BMPs for roadway construction, the no-action alternative would have less than significant impacts to geological or soil resources.

2030

The no-action alternative for future year 2030 represent the roadway network assuming that construction associated with military relocation had not occurred. While no construction associated with the planned military relocation would occur, GovGuam would have completed construction of road segment and intersection improvement projects along segments of Routes 1, 2, 4, 7A, 16, 25, and 26, as identified in Table 5.2-10. With incorporation of SOPs and BMPs for roadway construction, the no-action alternative would have less than significant impacts to geological or soil resources.

5.2.6.6 Summary of Impacts

Table 5.2-10 summarizes the potential impacts of each alternative.

Table 5.2-10. Summary of Potential Roadway Project Impacts

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Increased rate of erosion and soil loss from physical disturbance	LSI	LSI	LSI	LSI
Soil contamination levels that are potentially harmful to human health or the environment	LSI	LSI	LSI	LSI
Increased vulnerability to geologic hazards	LSI	LSI	LSI	LSI

Legend: LSI = Less than significant impact. * Preferred Alternative.

Construction activities would consist of intersection improvements, bridge/culvert replacements, pavement strengthening, road relocation, road widening, and construction of a new road. While the typical activities associated with each of these types of roadway construction projects would involve work in developed and paved areas, some roadway projects could result in alteration of topography and disturbance to soils. These disturbances could lead to an increased rate of erosion and soil loss. Loss of vegetation would contribute to soil loss and erosion. Improper storage of construction materials could result in spills or leaks that could result in contaminants leaching into the soil. Construction SOPs and BMPs would be implemented to avoid or minimize potential effects on geological and soil resources. Roadways and bridges would be designed in accordance with specific geotechnical considerations to prevent impacts from geologic hazards. With implementation of SOPs and BMPs, these impacts would be less than significant.

5.2.6.7 Summary of Proposed Mitigation Measures

No mitigation measures would be required for impacts to geological and soil resources under all alternatives for roadway projects.