CHAPTER 3. GEOLOGICAL AND SOIL RESOURCES

3.1 INTRODUCTION

This chapter describes the potential environmental consequences to geological and soil resources associated with implementation of the alternatives within the region of influence (ROI), i.e., areas that could be affected by construction or operation of facilities associated with transient berthing of an aircraft carrier. For a description of the affected environment for all resources, refer to the respective chapters of Volume 2 (Marine Corps Relocation – Guam). The locations described in that Volume include the ROI for the aircraft carrier berthing component of the proposed action and the chapters are presented in the same order as in this Volume.

3.2 ENVIRONMENTAL CONSEQUENCES

3.2.1 Approach to Analysis

3.2.1.1 Methodology

The methodology for identifying, evaluating, and mitigating impacts to geology and soil resources was established through review of reports of relevant geologic and soils studies, federal laws and regulations, local building codes and grading ordinances, and Navy guidance documents. The impact analyses in this chapter are presented by alternative and geographic area as described in the affected environment sections in Volume 2. Geology and soils conditions may also constrain the placement of a facility or location of a land use; where such constraints occur, they are discussed below.

Analysis of topography, soil, and vegetation was completed during site characterization using LIDAR Contour Data, geotechnical reports, and site visits to ensure minimal impacts to geologic and soil resources.

Activities associated with construction and operation of facilities for the transient aircraft carrier berthing, their potential effects on geologic and soils resources, and potential constraints to facilities siting resulting from geologic or soils conditions are as follows:

Construction

- Cut and fill activities leading to soil erosion
- Removal of vegetation, landscaping and/or existing facilities leading to soil erosion
- Use of heavy equipment resulting in soil compaction
- Creation of impervious surfaces resulting in increased runoff and soil erosion

Operation

- Vehicle movements on unpaved surfaces resulting in increased soil erosion and compaction
- Potential damage from soil liquefaction, landslides, or tsunamis, which constrain facilities siting

The potential effects of these activities or constraints and their significance within the ROI under the alternatives are described below. The analysis of potential impacts to geology and soils identifies direct and indirect impacts. Direct impacts are those that may occur during the construction phase of the project and result in physical soil disturbance. Such disturbance may cause increased erosion, compaction, and

loss of productive soil. Potential direct impacts of construction include stormwater discharges that contain elevated sediment concentrations that may increase pollutant loading into surface waters.

Indirect impacts are those that result from the completed project, such as the leaching of contaminants into soils. For non-training activities, indirect impacts include stormwater discharges that contain elevated sediment concentrations that may increase pollutant loading into surface waters. Potential soil contamination issues are addressed in Chapter 17, Hazardous Materials and Waste.

Indirect groundwater impacts associated with construction and operational activities include contamination of groundwater resources through percolation of surface runoff. Direct spills and leaks as well as stormwater runoff can contribute to groundwater contamination. Increased soil erosion also may indirectly impact water quality and aquatic ecosystems. Potential impacts to these resources are described in Chapter 4, Water Resources; Chapter 10, Terrestrial Biological Resources; and Chapter 11, Marine Biological Resources.

Applicable Regulatory Standards

The U.S. Environmental Protection Agency (USEPA) Region 9 grants the Guam Environmental Protection Agency (GEPA) the authority to enforce portions of federal statutes via a Memorandum of Agreement. Under this agreement, the Safe Drinking Water Program, Water Resources Management Program, and the Water Pollution Control Program (WPCP) are administered by GEPA. The GEPA WPCP 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 Storm Water Pollution Prevention Plan (SWPPP). Permits are required for projects that disturb greater than 1 acre (ac) (0.4 hectares [ha]) of soil, including lay-down, ingress and egress areas. Phase I regulates construction activities disturbing 5 ac (2 ha) or more of total land area and Phase II regulates small construction activities disturbing between 1 and 5 ac (0.4 and 2 ha) of total land area.

An Environmental Protection Plan (EPP) is required for all 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 shall include nonpoint source control measures including erosion and sedimentation control; vegetation, wildlife and coral/marine 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.

Minimization of seismic, liquefaction, and ground shaking impacts and hazards are addressed in Unified Facility Code (UFC) 3-310-04 Seismic Design for Buildings (USACE 2007).

3.2.1.2 Determination of Significance

For geology and soils, the significance of impacts is determined by subjective criteria, as well as by regulatory standards. A significant impact may result from any of the following:

- Increased rate of erosion and soil loss from physical disturbance including removal of vegetation
- Reduced amounts of productive soils

- Alteration of surrounding landscape and effect on important geologic features (including soil or rock removal and filling of sinkholes)
- 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

3.2.1.3 Issues Identified during Public Scoping Process

The following analysis focuses on potential effects to geology and soils that would arise from the proposed action. As part of the analysis, concerns relating to geology and soils that were identified during scoping meetings by the public, including regulatory stakeholders, were addressed. These included:

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

3.2.2 Alternative 1 Polaris Point (Preferred Alternative)

3.2.2.1 Onshore

Onshore activities associated with Alternative 1, Polaris Point (referred to as Alternative 1) include construction of a wharf and staging area with ground disturbance of approximately 5.8 ac (2.3 ha), a Morale, Welfare, and Recreation (MWR) area of 2.4 ac (1.0 ha), security structures including a 50 ft (15.2 m) watch tower and fencing, and various buildings including a Port Operations Support Building, substation, water treatment facility, and a pump station. As part of the project, four existing structures (Buildings 4407, 4408, 4409, and an existing guard tower) would be demolished. A 300 ft (94 m) roadway would be demolished and replaced with a new access road to connect Polaris Point Drive to the staging area. Underground utilities would be constructed in existing utility corridors except in the vicinity of the wharf where extensions from nearby utility systems would be constructed.

There would be the potential for an increased rate of erosion, compaction, and soil loss from the physical disturbance of construction activities. Soil erosion is primarily a concern for discharge into surface or nearshore waters. The erosion potential of soil types found in the proposed action is found in Table 3.2-1.

Table 3.2-1. Erosion Potential at Apra Harbor

Soil Type	*Location*	*Erosion Potential*
Ritidian Rock Outcrop at 3-15% slope	Orote	slight
Urban Land Coastal Fill at 0% slope	Orote	slight

Source: Young 1988.

The construction Standard Operating Procedures (SOPs) would include requirements for stormwater compliance with stormwater best management practices (BMPs), including a Stormwater Pollution Prevention Plan (SWPPP) to ensure that all aspects of 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 these measures such as silt fences and hay bales would prevent erosion and limit sediment runoff in stormwater; thus, there would be minimal impacts from soil erosion and stormwater runoff. A more detailed explanation of regulatory permitting requirements is available in Volume 8.

Soil types potentially lost are not agriculturally productive. Topography or landscape features would not be changed substantially by the proposed action.

Apra Harbor is located in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, and slope instability would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). The developments proposed as Alternative 1 would be located on a relatively flat area that would not be subject to slope instability. The underlying fill at Apra Harbor is vulnerable to liquefaction. Alternative 1 would result in less than significant impacts associated with geologic hazards.

Construction

Apra Harbor

Alternative 1 would disturb soil during construction at Apra Harbor. There is a risk of an increased rate of erosion, compaction, and soil loss from the physical disturbance caused by construction activity. Erosion potential for soils found at Apra Harbor is shown in Table 3.2-1.

To reduce the potential for significant impacts during construction of Alternative 1, the following soil conservation and management procedures would be followed:

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

The construction SOP would include requirements for stormwater compliance, with BMPs to ensure that all aspects of project construction would be performed in a manner to minimize soil loss 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 such as silt fences and hay bales would prevent erosion; thus, there would be minimal impacts from soil erosion. A more detailed explanation of regulatory permitting requirements is available in Volume 8.

As stated in Volume 2, there are no sinkholes in the project vicinity. Therefore, Alternative 1 would result in less than significant impacts to a unique geologic resource.

Apra Harbor is located in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). The developments proposed as Alternative 1 would be located on a relatively flat area that would not be subject to slope instability. The high risk of liquefaction at Apra Harbor requires a geotechnical survey prior to construction. Wherever possible, liquefiable soils would be replaced with properly compacted fill soils as recommended in the site-specific geotechnical report. UFC 3-310-04 Seismic Design for Buildings (USACE 2007) would be followed to minimize structural hazards associated with ground shaking.

Alternative 1 would result in less than significant impacts associated with geologic hazards.

Naval Base Guam

The feasible upland placement sites for dredged materials and resulting potential geological impacts are described for the Inner Apra Harbor dredging in Volume 2, Chapter 3 of this EIS/OEIS. The upland placement sites are considered temporary (3 to 4 years). The sites are all vacant lands and would be developed with bermed perimeters approximately 16 to 30 ft (5 to 9 m) in height. When the material is dry it can be reused by the receiver, resulting in a beneficial impact to geological and soil resources, or stockpiled.

Soil types disturbed would not be agriculturally productive. Construction SOPs and a SWPPP (required by the NPDES permit) would be followed to minimize soil erosion. Therefore, Alternative 1 would result

in less than significant impacts to unique geologic resources and would not result in significant soil erosion, compaction, or loss of agriculturally productive soil.

The construction SOPs would include requirements for stormwater compliance and BMPs to ensure that all aspects of 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 these measures would prevent erosion; thus, there would be minimal impacts from soil erosion. A more detailed explanation of regulatory permitting requirements may also be available in Volume 8.

There are no known sinkholes in the vicinity of any of the proposed projects. Therefore, Alternative 1 would result in less than significant impacts to a unique geologic resource.

Naval Base Guam is located in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). The developments proposed as Alternative 1 would be located on a relatively flat area that would not be subject to slope instability. The underlying fill at Naval Base Guam is vulnerable to liquefaction. The high risk of liquefaction at Naval Base Guam requires a geotechnical survey prior to construction. Wherever possible, liquefiable soils would be replaced with properly compacted fill soils as recommended in the site-specific geotechnical report. UFC 3-310-04 Seismic Design for Buildings (USACE 2007) would be followed to minimize structural hazards associated with ground shaking. Alternative 1 would result in less than significant impacts associated with geologic hazards.

Operation

Apra Harbor

Operations under Alternative 1 would result in less than significant impacts to unique geologic resources and would not result in significant soil erosion or compaction or loss of agriculturally productive soil.

In addition to SOPs to account for the high potential for liquefaction, appropriate construction planning measures as discussed below would be implemented. Although Apra Harbor is located in a potentially active seismic zone, the hazards associated with earthquakes, fault rupture, and liquefaction would be minimized during construction. The developments proposed as Alternative 1 would be located on a relatively flat area that would not be subject to slope instability. Alternative 1 would result in less than significant impacts associated with geologic hazards.

Naval Base Guam

Operations under Alternative 1 would result in less than significant impacts to unique geologic resources and would not result in significant soil erosion, compaction, or loss of agriculturally productive soil.

Although Naval Base Guam is located in a potentially active seismic zone, the hazards associated with earthquakes, fault rupture, and liquefaction would be minimized during construction. The Alternative 1 proposed developments would be located on a relatively flat area that would not be subject to slope instability. Alternative 1 would result in less than significant impacts associated with geologic hazards.

3.2.2.2 Offshore

Construction

Offshore construction activities associated with Alternative 1 include dredging of the berthing area, the turning basin, and the channel bend; construction of a wharf at Polaris Point; and the operations

associated with berthing of the aircraft carrier. Approximately 30% of the dredged volume would be removed from the shoreline area, as excavation would be required to achieve the appropriate slope for wharf construction. Direct impacts to benthic habitats and their organisms would result from the proposed dredging activities. The underwater topography would change somewhat in that dredging of coral within the turning basin area would remove underwater structural relief. Areas that are dredged would change from coral cover to sand, with the exception of the area near the shoreline of Polaris Point, which is mostly silty clay. Chapter 11, Marine Biological Resources, describes impacts from these disturbances to marine flora and fauna in greater detail.

The conditions of the applicable U.S. Army Corps of Engineers (USACE) dredging permits would include measures to minimize effects of dredging, including the use of silt curtains. Dredging activities are a concern for water resources and are addressed under Chapter 4, Water Resources, in this Volume.

Operation

The proposed USEPA Ocean Dredged Material Disposal Site (ODMDS) was evaluated for geological impacts as described in the project–specific ODMDS EIS (USEPA 2009). The designation of the ODMDS is anticipated in January 2010. Briefly summarized, the impact assessment analysis concluded that the geological impacts would be significant if the disposal of dredged material would: 1) alter the regional and site-specific bathymetry, 2) interfere with or change sediment transport processes, or 3) alter the existing characteristics of the seafloor (e.g., change the substrate from predominantly silty sand to gravel). The analysis was based on sediment analysis and sediment transport modeling; the conclusion was that impacts to regional geology would be minor.

Offshore construction and operation activities would have minimal impacts to geologic and soil resources.

3.2.2.3 Summary of Alternative 1 Impacts

Table 3.2-2 summarizes construction and operation impacts from Alternative 1.

Table 3.2-2. Summary of Alternative 1 Impacts

Area	*Project Activities*	*Project Specific Impacts*
Onshore	Construction	• Alternative 1 would result in minimal impacts to topography by changing the landscape at Apra Harbor. • Soil disturbances and loss of vegetation could cause increased rates of erosion and soil loss from physical disturbance in all proposed construction areas under Alternative 1. Minimal impacts would occur with the use of BMPs. • Soil types impacted would not be agriculturally productive; thus, minimal impacts to soil resources would occur. • Adherence to UFC 3-310-04 Seismic Design for Buildings would reduce risk of damage to structures from seismic hazards.
	Operation	Adherence to UFC 3-310-04 Seismic Design for Buildings during construction would reduce risk of damage to structures from seismic hazards that could potentially impact operation. Minimal impacts would occur due to geologic hazards.
Offshore	Construction	Alternative 1 would result in minimal impacts to geological resources.
	Operation	Alternative 1 would result in minimal impacts to geological resources.

3.2.2.4 Alternative 1 Potential Mitigation Measures

No potential mitigation measures are required or recommended under Alternative 1.

3.2.3 Alternative 2 Former Ship Repair Facility (SRF)

3.2.3.1 Onshore

Construction

Under Alternative 2, the Former SRF would be the project area. Although sited in a different location, the geology of and soil types found at the Former SRF are similar to those described under Alternative 1; thus, impacts would not differ from those of Alternative 1.

Operation

Under Alternative 2, the Former SRF would be the project area. Although sited in a different location, the geology of and soil types found at the Former SRF are similar to those described under Alternative 1; thus, impacts would not differ from those of Alternative 1.

3.2.3.2 Offshore

Construction

Impacts would not differ from those of Alternative 1.

Operation

Impacts would not differ from those of Alternative 1.

3.2.3.3 Summary of Alternative 2 Impacts

Table 3.2-3 summarizes construction and operation impacts from Alternative 2.

Table 3.2-3. Summary of Alternative 2 Impacts

Area	*Project Activities*	*Project Specific Impacts*
Onshore	Construction	• Alternative 2 would result in minimal impacts to topography by changing the landscape at Apra Harbor. • Soil disturbances and loss of vegetation could cause increased rates of erosion and soil loss from physical disturbance at all proposed construction areas under Alternative 2. Minimal impacts would occur with the use of BMPs. • Soil types impacted would not be agriculturally productive; thus, minimal impacts to soil resources would occur. • Adherence to UFC 3-310-04 Seismic Design for Buildings would reduce risk of damage to structures from seismic hazards.
	Operation	Adherence to UFC 3-310-04 Seismic Design for Buildings during construction would reduce risk of damage to structures from seismic hazards that could potentially impact operation. Minimal impacts would occur due to geologic hazards.
Offshore	Construction	Alternative 2 would result in minimal impacts to geological resources.
	Operation	Alternative 2 would result in minimal impacts to geological resources.

3.2.3.4 Alternative 2 Potential Mitigation Measures

Potential mitigation measures would not differ from those of Alternative 1.

3.2.4 No-Action Alternative

Under the no-action alternative, no construction, dredging, or operation associated with the aircraft carrier berthing would occur. Existing operations at Polaris Point, as a military training and recreational facility, and at the Former SRF, as a commercial ship repair facility, would continue. Therefore, the no-action alternative would have impacts to geology or soils.

3.2.5 Summary of Impacts

Table 3.2-4 summarizes the potential impacts of each action alternative and the no-action alternative. A text summary is provided below.

Soil types disturbed would not be agriculturally productive. Construction SOPs and a SWPPP (required by the NPDES permit) would be followed to prevent soil erosion. Therefore, the proposed action would result in less than significant soil erosion, compaction, or loss of agriculturally productive soil. The construction SOPs would include requirements for stormwater compliance and BMPs to ensure that all aspects of project construction would be performed in a manner to minimize impacts during construction activity. A description of standard BMPs and resource protection measures required by regulatory mandates can be found in Volume 7. Implementations of measures such as silt fences and hay bales would prevent erosion, thus there would be minimal impacts from soil erosion. A more detailed explanation of regulatory permitting requirements is available in Volume 8.

There are no known sinkholes in the vicinity of any of the proposed projects; therefore, no sinkholes would be affected.

Apra Harbor and Naval Base Guam are located in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). The proposed developments would be located on a relatively flat area that would not be subject to slope instability. Neither Alternative 1 nor Alternative 2 would result in significant impacts associated with geologic hazards.

3.2.6 Summary of Potential Mitigation Measures

As previously described, there would be no significant impacts to geological and soil resources from the proposed action; therefore, no mitigations have been identified or would be required.

Table 3.2-4. Summary of Impacts

Alternative 1	*Alternative 2*	*No-Action Alternative*
Topography		
LSI • Alternative 1 would result in minimal impacts to topography by changing the landscape at Apra Harbor.	LSI • Alternative 2 would result in minimal impacts to topography by changing the landscape at Apra Harbor.	NI • No impacts to geological and soil resources.
Geology		
NI • No impacts to geological resources.	NI • No impacts to geological resources.	NI • No impacts to geological and soil resources.
Soil		
LSI • Soil disturbances and loss of vegetation could cause increased rates of erosion and soil loss from physical disturbance at all proposed construction areas under Alternative 1. Minimal impacts would occur with the use of BMPs. • Soil types impacted would not be agriculturally productive; thus, minimal impacts to soil resources would occur. BI Dredged material can be beneficially re-used by receiver.	LSI • Soil disturbances and loss of vegetation could cause increased rates of erosion and soil loss from physical disturbance at all proposed construction areas under Alternative 2. Minimal impacts would occur with the use of BMPs. • Soil types impacted would not be agriculturally productive; thus, minimal impacts to soil resources would occur. BI Dredged material can be beneficially re-used by receiver.	NI • No impacts to geological and soil resources.
Geological Hazards		
LSI • Adherence to UFC 3-310-04 Seismic Design for Buildings would reduce risk of damage to structures from seismic, liquefaction and ground shaking hazards.	LSI • Adherence to UFC 3-310-04 Seismic Design for Buildings would reduce risk of damage to structures from seismic liquefaction, and ground shaking hazards.	NI • No impacts to geological and soil resources.

Legend: SI = Significant impact, SI-M = Significant impact mitigable to less than significant, LSI = Less than significant impact, NI = No impact, BI = Beneficial impact

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