4.10 MARINE BIOLOGY

Section 4.10 describes the direct and indirect impacts to marine biology that could result from implementation of the proposed action. Both the construction and operations elements of the proposed action have the potential to impact marine biology on Tinian and Pagan. In-water construction would occur on Tinian at Unai Chulu. Construction and operations/training activities that may affect marine water quality in the region of influence are described in Section 4.3, *Water Resources*.

4.10.1 Approach to Analysis

A variety of laws, regulations, Executive Orders, plans, and policies, including the Clean Water Act, Endangered Species Act, Marine Mammal Protection Act, Magnuson-Stevens Fishery Conservation and Management Act, and Executive Order 13089 (Coral Reef Protection), are applicable to evaluating the proposed action impacts for marine biology. A complete listing of applicable regulations is provided in Appendix E, *Applicable Federal and Local Regulations*.

The marine biology impact analysis addresses potential effects to marine habitat and Essential Fish Habitat, marine flora, marine invertebrates, fish, and special-status species including sea turtles, marine mammals, and other legally protected species. Sources of impacts to marine biology include: physical disturbance to habitats; acoustic disturbance or injury due to underwater noise; injury or mortality to individuals due to being struck by vessels or construction equipment; and indirect impacts.

Under the proposed action, impacts may be either temporary (reversible) or permanent (irreversible). Direct and indirect impacts are distinguished as follows. *Direct impacts* may include, but are not limited to, the following:

- Permanent removal of coral and marine habitat at Unai Chulu due to dredging and underwater ramp construction
- Acoustic impacts to marine species from pile driving
- Temporary disturbance of habitat due to amphibious landings
- Disturbance or mortality to individuals resulting from in-water vessel movements

Indirect impacts are may include, but are not limited to, the following:

- Indirect impacts to marine habitats and coral (from rubble, etc.) during operation
- Sedimentation/siltation of marine habitat that occurs as a result of erosion and sediment transport from facilities construction on land
- Changes in the abundance, distribution, or behavior of one species, which in turn would affect other species and their interactions

Factors used to assess the significance of impacts to marine resources include the context and intensity of the impact (40 CFR 1508.27). Context refers to the setting in which the impact occurs; intensity refers to severity of the impact, taking into account the characteristics of the affected resource and the consequences of the impact.

Important considerations determining whether an impact to marine resources would be significant include the following:

- The extent, if any, that the action would result in the substantial loss or degradation of a marine community, ecosystem functions (natural features and processes), or Essential Fish Habitat, relative to the abundance and importance of the resource in the marine ecosystems of Tinian and Pagan.
- The extent, if any, that the action would cause injury or mortality to individuals, and could diminish the population size, distribution, habitat, or prospects for conservation and recovery, of a special-status species, relative to the abundance of that species in the marine ecosystems of Tinian and Pagan.

Impact analysis methodologies specific to each marine resource component are summarized in Sections 4.10.1.1 through 4.10.1.5.

Based on the scope of operational activities and the characteristics and small quantities of expended materials from training (fragments from munitions/target use) that would enter the marine environment, other potential stressors such as energy, entanglement, or ingestion, are considered insignificant. It is also unlikely that sea turtles would accidentally ingest expended materials while foraging on algae or seagrass. These types of impacts are not discussed further in this analysis.

Airborne noise, including construction noise from pile driving and dredging, and operational noise from aircraft, vessels, and over-water gunfire, has the potential to affect marine species. The effects of airborne noise on sea turtles on land are considered in Section 4.9, *Terrestrial Biology*. Airborne noise impacts would be limited based on (1) the transitory nature of airborne noise sources; (2) the limited exposure of animals that spend most or all of their time underwater to noise above water; and (3) the physics of sound transmission from air into the water column, in which much of the sound is reflected off the surface of the water unless the source is at a near-vertical angle (Young 1973). In addition, quantitative data or thresholds relating airborne sound levels to important physiological or behavioral responses by marine animals other than pinnipeds (which are not present in the CNMI) are generally lacking (National Oceanic and Atmospheric Administration West Coast Region 2015). As a result, airborne noise is considered to have only temporary, if any, impacts to individuals (e.g., brief startle responses), which would be unlikely to result in reduced fitness to the individual or to have population-level effects. Accordingly, airborne noise impacts to marine resources are considered less than significant and not discussed further in this analysis.

4.10.1.1 Marine Habitat and Essential Fish Habitat

A geographic information systems analysis was used to determine the areas of direct impact to habitat, focusing on the substrate, the nature and duration of the impact, and the resulting direct and indirect impacts to the organisms associated with that habitat. Acoustic impacts from pile driving, and indirect impacts to habitat (e.g., from runoff) were also considered. The analysis determined the degree to which impacts would have more than minimal and/or temporary significant effects on the quantity or quality of Essential Fish Habitat, in which case consultation with National Marine Fisheries Service is required.

4.10.1.2 Marine Flora

Impacts to marine flora were determined as described for habitats above. This included quantifying areas of direct physical disturbance to habitats that support macroalgae and seagrasses, as well as the potential for indirect effects.

4.10.1.3 Marine Invertebrates

Although a wide diversity of marine invertebrates live within the region of influence, the impact analysis focuses on corals since the integrity of the corals would be critical to the survival of other invertebrates (as well as turtles and fish). Impacts to corals are expected to affect other invertebrates because coral provides habitat for these species and measures to protect corals are expected to protect other invertebrates as well. The amount of coral impact due to construction of the Amphibious Assault Vehicle landing area at Unai Chulu was calculated based on the data from the *Coral Marine Resources Survey Report* conducted in support of this EIS/OEIS (Appendix M) (DoN 2014a).

4.10.1.4 Fish

Impacts to fish were evaluated in terms of direct and indirect impacts to habitat as described in the previous sections, as well as the spatial extent and duration of acoustic disturbance and injury to individual fish.

4.10.1.5 Special-status Species

Special-status marine species of the project action area include species that are listed under the Endangered Species Act and under the Marine Mammal Protection Act. Impacts to special-status species were evaluated on the presence of these species and the anticipated level of disturbance to the areas where they are present. The presence of species and their estimated population densities were determined based on field surveys conducted in support of this EIS/OEIS as well as reviews of applicable data and scientific literature.

4.10.1.5.1 Endangered Species Act-listed Species

In accordance with section 7 of the Endangered Species Act of 1973 (16 U.S. Code 1531 et seq.), a Biological Assessment is being prepared to analyze the potential effects of Department of Defense actions on threatened and endangered species under the jurisdiction of the National Marine Fisheries Service. Section 7(a)(2) of the Endangered Species Act requires federal agencies to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any federally threatened or endangered species or result in the destruction or significant modification of critical habitat. In accordance with Section 102 of NEPA, the Department of Defense is in section 7 consultation with the National Marine Fisheries Service on actions proposed under the preferred alternative presented in this EIS/OEIS.

Based on the information provided in Section 3.10, *Marine Biology*, listed marine species with a reasonable possibility of occurrence in the project region of influence, and thus likely to be impacted, are considered in this section. These include the coral species, *Acropora globiceps,* the green and hawksbill sea turtles, and the blue, fin, sei, humpback and sperm whale. Impacts to other listed species that are unknown or remotely possible in the project region of influence and whose exposure to direct or indirect impacts, if any, would be rare, brief, and unlikely to have any important biological consequences, are not considered further in this document. However, these impacts will be considered as required during the section 7 consultation.

Impacts of the proposed action under section 7 of the Endangered Species Act are analyzed as impacts to individuals (as defined by "take" under the Endangered Species Act). In contrast, analysis of impacts to species under NEPA, presented here, relates to the impacts to populations of these species. The potential mitigation measures proposed in this EIS/OEIS to benefit Endangered Species Act-listed and proposed species are preliminary and may be revised or augmented during Endangered Species Act section 7 consultation.

4.10.1.5.2 Marine Mammal Protection Act-listed Species

Section 3.10, *Marine Biology*, identifies the marine mammal species that could occur in the project region of influence. Due to underwater noise from pile driving, the Department of Defense will apply for an Incidental Harassment Authorization from the National Marine Fisheries Service in advance of construction. The application will fully detail potential effects to individuals of various species based on the acoustic analysis and marine mammal data provided in Appendix M, *Marine Biology Technical Memo and Survey Reports*. The NEPA analysis in this document summarizes the information from Appendix M, *Marine Biology Technical Memo and Survey Reports* and considers the effects of acoustics and other potential impacts to individuals and populations of marine mammals.

4.10.2 Resource Management Measures

Resource management measures applicable to marine biological resources are described below.

4.10.2.1 Avoidance and Minimization Measures

4.10.2.1.1 Tinian

All beaches within the Military Lease Area were considered for amphibious training operations; however, a careful selection process was employed based on analysis and environmental factors. Beaches on the windward side of the Military Lease Area, including Unai Chiget, Unai Dankulo, and Unai Masalok, were not considered for use of Amphibious Assault Vehicle landings due to wind and wave action. Unai Dankulo was eliminated for amphibious training due to the coral habitat and high tourist use. Unai Masalok was the only windward beach identified as a feasible location for amphibious training with Landing Craft Air Cushion vessels, small boats, and swimmers. On the leeward side, Unai Lam Lam, Unai Babui, and Unai Chulu were considered for amphibious training. Unai Lam Lam was considered too small for Amphibious Assault Vehicle and Landing Craft Air Cushion vessel training, but suitable for small boats and swimmers. Based on environmental criteria including analysis of bathymetry and coral cover, Unai Babui and Unai Chulu were both considered for Amphibious Assault Vehicle and Landing Craft Air Cushion vessel training. A detailed engineering analysis of construction alternatives was conducted for these two locations (see Appendix J, *Amphibious Beach Landing Site Engineering and Coastal Processes Analyses*). After careful consideration it was determined that the tactical amphibious landing training beach requirements could be met at one beach. Unai Chulu was chosen as the single beach for

Amphibious Assault Vehicle landings because of its wider configuration. Unai Babui was dismissed for Amphibious Assault Vehicle training to lessen environmental impacts; however, it would still support training for Landing Craft Air Cushion vessels, small boat, and swimmer training. The selection of one beach for Amphibious Assault Vehicles results in fewer environmental impacts to coral and other important marine resources.

Three different methods for constructing amphibious landing ramps were considered; a dredge only option, a pile-armored ramp, and a tribar-armored ramp. The dredge only option was dismissed, as the longevity of the exposed reef surface with no armoring was uncertain. The tribar alternative was also dismissed due to uncertainty of the tribar surface compatibility with Amphibious Assault Vehicle operations. The pile-armored ramp alternative was chosen for its stable design and long-term durability of the surface.

4.10.2.1.2 Pagan

All beaches on Pagan were considered for amphibious training operations. A careful selection process was employed based on training operations and environmental factors. Beaches on the windward side were not considered for use of Amphibious Assault Vehicle landings due to wind and wave action. Based on environmental criteria, including analysis of bathymetry, bottom type and coral cover, Blue, Green and Red Beach were considered for Amphibious Assault Vehicle landings. Adjustments were made in the approach zone to lessen potential effects to coral. Blue, Green, Red, and South were also considered for Landing Craft Air Cushion vessel training.

4.10.2.2 Best Management Practices and Standard Operating Procedures

Best management practices and standard operating procedures that are applicable for marine biological resources are listed below and described in Appendix D, *Best Management Practices*.

4.10.2.2.1 Construction

- All project-related materials and equipment (e.g., dredges) placed in the water should be clear of pollutants prior to use. No project-related materials (fill, revetment rock, etc.) should be stockpiled in the water (intertidal zones, reef flats, etc.).
- Construction contracts would include appropriate biosecurity measures.
- *Erosion Control Measures*. The erosion control measures such as retention ponds, swales, silt fences, fiber rolls, gravel bag berms, mulch, and erosion control blankets would be implemented during construction and operations to eliminate and/or minimize nonpoint source pollution in surface waters due to sediment.
- *Clean Water Act National Pollutant Discharge Elimination System Program*. A Stormwater Management Plan and Stormwater Pollution Prevention Plan would be prepared and implemented in compliance with the CNMI Stormwater Management Manual. Best management practices could include:
  - Soil stabilization (such as mulch and erosion control blankets).

  - Perimeter and sediment control (such as silt fences, fiber rolls, gravel bag berms, and sediment traps).
  - Management and covering of material, waste, and soil stockpiles when not in use.
  - Storage of fuels and hazardous materials with proper secondary containment, and establishment of designated vehicle and equipment maintenance and fueling areas.
- Management of spills and leaks from vehicles and equipment through inspections and use of drip pans, absorbent pads, and spill kits.
- A contingency plan to control petroleum products accidentally spilled during the project would be developed.
- *Contractor Education Program.* The DoN has developed an education program to ensure construction contractor personnel are informed of the biological resources in the project area, including special-status species, avoidance measures, and reporting requirements.
- If sea turtles or marine mammals are noticed within 150 feet (46 meters) after in-water construction work has begun, that work may continue only if the activity would not affect the animal(s). For example, divers performing surveys or underwater work would likely be permissible, whereas operation of heavy equipment is likely not.
- Personnel shall remain alert for marine mammals before and during pile driving. Pile driving will not commence if a marine mammal is observed within 300 feet (90 meters) or a sea turtle is observed within 50 feet (15 meters) of operation. Pile driving can begin 30 minutes after the last sighting of the marine mammal or sea turtle. If pile driving is already started and a marine mammal or sea turtle is sighted within 300 feet (90 meters) after drilling has commenced, drilling can continue unless the marine mammal or sea turtle comes within 210 feet (64 meters) during drilling; operations should then cease until the animal leaves the area of its own volition or after 30 minutes have passed since the last sighting.
- During pile driving and removal, the shutdown zone will be sized and established to avoid injury to marine mammals.
- Soft Start – The use of a soft-start procedure is believed to provide additional protection to marine mammals, sea turtles, and fish by providing a warning and/or giving marine species a chance to leave the area prior to the hammer operating at full capacity. Soft start shall be conducted at the beginning of each day's activity and at any time pile driving has ceased for more than 30 minutes. If vibratory pile driving has been occurring but impact has not for more than 30 minutes, soft start for the impact hammer must occur. The soft start requires contractors to initiate noise from vibratory hammers for 15 seconds at reduced energy followed by a 30-second waiting period. This procedure should be repeated two additional times. If an impact hammer is used, contractors are required to provide an initial set of three strikes from the impact hammer at 40% energy, followed by a 30-second waiting period, then two subsequent 3-strike sets.

4.10.2.2.2 Operation

- All established harbor navigation rules are observed during amphibious operations occurring within an established harbor. During amphibious operations (landings and departures) occurring outside of an established harbor, Landing Craft Air Cushion vessels stay fully on-cushion or hover when over shallow reefs to avoid corals, hard bottom, and other substrate that could potentially damage equipment.
- Flagging or marking of particular coral heads at Green Beach to avoid during training operations.
- Amphibious vehicles and small boats would avoid approaching marine mammals and sea turtles head on, to the greatest extent practical given operational need and vessel safety (necessary steerage, sea state, navigational need).
- A contingency plan to control petroleum products accidentally spilled during the project would be developed.
- *Biosecurity Outreach and Education*. A biosecurity outreach and education program would be implemented to inform contractors and Department of Defense civilian and military personnel about native versus non-native invasive species and the impacts of non-native invasive species on native ecosystems.

4.10.3 Tinian

4.10.3.1 Tinian Alternative 1

4.10.3.1.1 Construction Impacts

The majority of the land-based construction activities would take place inland and away from the nearshore environment. However, some construction activities would take place near the shore including port improvements, portions of road improvements, some observation posts, and construction of an amphibious beach landing area. An amphibious landing ramp would be constructed at Unai Chulu to create a safe landing surface for training operations. Causes of impact would include physical disturbance to the habitat, potential indirect effects, and, for some of the marine species, the underwater acoustic effects of pile driving. In-water construction activities would disturb sediment and increase turbidity and thus impact water quality. Best management practices would be utilized to capture sediment and debris caused by in-water construction activities. See Appendix J, *Amphibious Beach Landing Site Engineering and Coastal Processes Analyses* for additional details on the proposed construction methods for the amphibious landing ramp. An assessment of the potential impacts of construction of Unai Chulu to coastal processes was completed. The assessment concluded that construction of the proposed amphibious landing ramp would not significantly modify shoreline coastal processes or trigger erosion of the beach.

4.10.3.1.1.1 Marine Habitat and Essential Fish Habitat

Construction of the in-water amphibious landing ramp for Amphibious Assault Vehicles would modify the seafloor (i.e., limestone, coral reef) by contouring the approach zone (landing area) to create a flat shelf in the substrate and a pile-armored ramp at a 15-degree slope. The pile-armored ramp would consist of a gravel bed atop the coral base and a durable grooved concrete slab surface designed to be stable under severe wave conditions. Trenches with concrete anchors would secure the toe and top of the ramp and join the ramp with existing substrate surfaces.

During construction, temporary causeways would be constructed to allow an excavator access over the water. The temporary causeways would be created using pile-supported trestles through the surf zone and out to 12 feet (4 meters) depth. Steel sheet piles and steel pipe piles would be installed into the reef and penetrate approximately 40 feet (12 meters) into the substrate. The causeways would be constructed using dredged material and would be removed after amphibious landing ramp construction was complete. After the removal of the causeways, excess fill material (i.e., dredge material) would be reused or disposed of at an approved in-water or upland disposal site.

The construction would create a stable landing area for the Amphibious Assault Vehicles to safely come ashore on a repeated basis. The amphibious landing ramp at Unai Chulu would be approximately 656 feet (200 meters) long and average 160 feet (50 meters) wide with an anticipated dredge volume of 798,111 cubic feet (22,600 cubic meters). Construction is anticipated to take approximately 36 weeks.

Construction of the amphibious landing ramp and temporary construction causeways would permanently change the habitat of the nearshore areas of the beach at Unai Chulu (see Figures 4.10-1 and 4.10-2). During and subsequent to construction, coral rubble and sediments generated by the activities would be dispersed by wave action and currents, resulting in the abrasion and burial of adjacent habitats and increasing suspended sediments in the water column. Underwater noise levels would be increased during pile driving and dredging. The areas affected include soft shore habitats and reef flat and hard bottom habitat at depth. The entire water column and seafloor within the affected area is designated as Essential Fish Habitat Area for bottomfish, crustaceans, coral reef ecosystems, and pelagics. In-water construction would result in a reduction in the quality and quantity of Essential Fish Habitat within the nearshore area.

Table 4.10-1 presents the areas of potential direct and indirect impacts to marine habitats during construction of the proposed action on Tinian. The direct impacts include permanent removal of marine habitat to create the amphibious landing ramp at Unai Chulu. The analysis assumes that in addition to the area exposed to direct physical disturbance during construction, an additional area surrounding the construction footprint would be exposed to indirect physical impacts associated with mobilized rubble generated by the construction activities. When mobilized by water motion, any mobile rubble can strike or smother corals and degrade coral habitat. In this context, mobilized rubble includes living and dead coral colonies that are broken off of the substrate and reduced to a size that can be mobilized by water motion; reef substrate itself that is broken off; and preexisting unattached fragments. Smaller fragments are likely to be transported farther than larger fragments. Both upslope and downslope transport would occur but transport downslope is more likely. Transport alongshore would occur but this is likely to be less than downslope transport. Reef flats and topographic lows (grooves in the coral reef) are more likely to be affected than topographic highs. The likelihood of an unattached fragment becoming mobilized is a function of its density, shape, water depth, and intensity of the water motion.

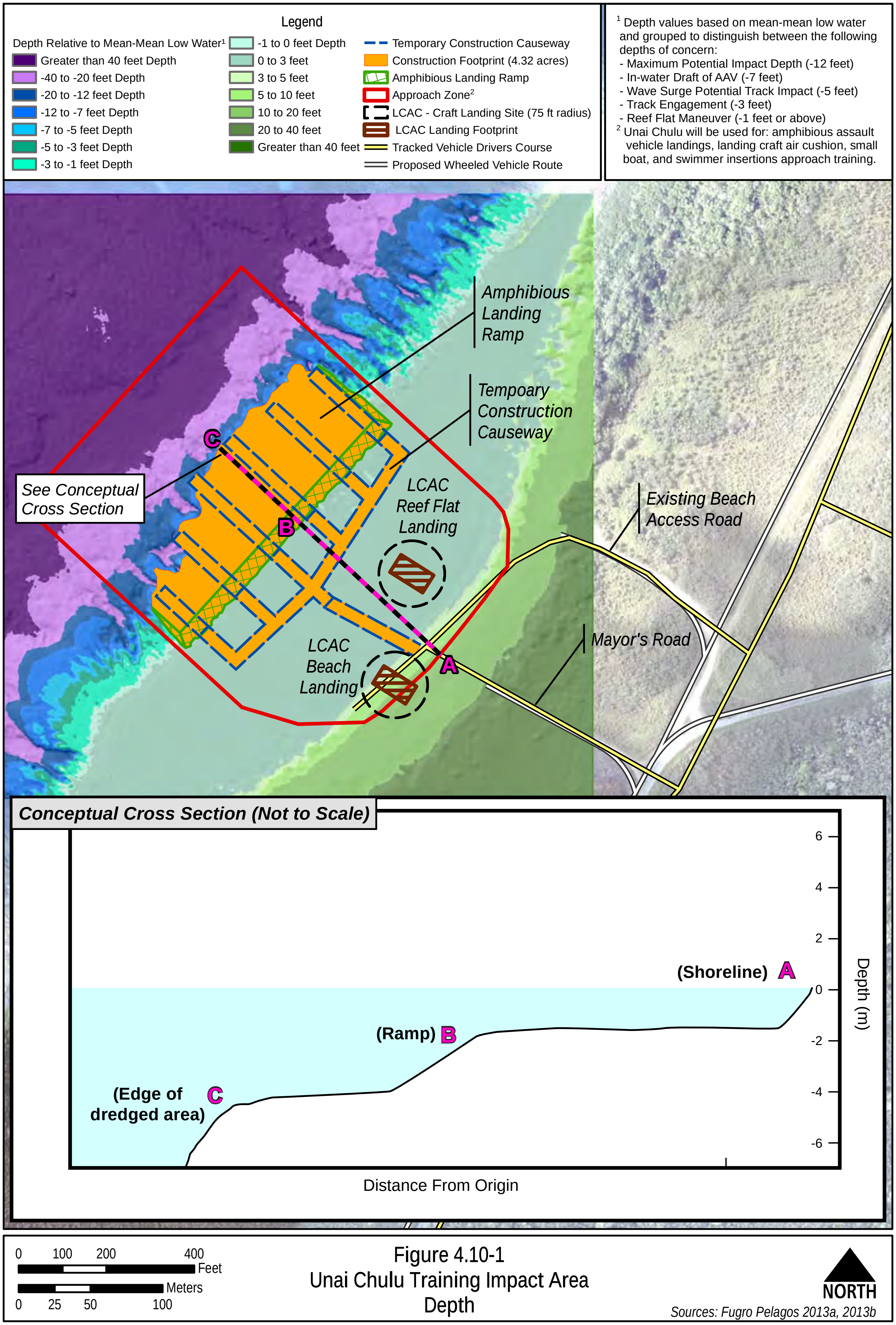


Figure 4.10-1
Unai Chulu Training Impact Area
Depth

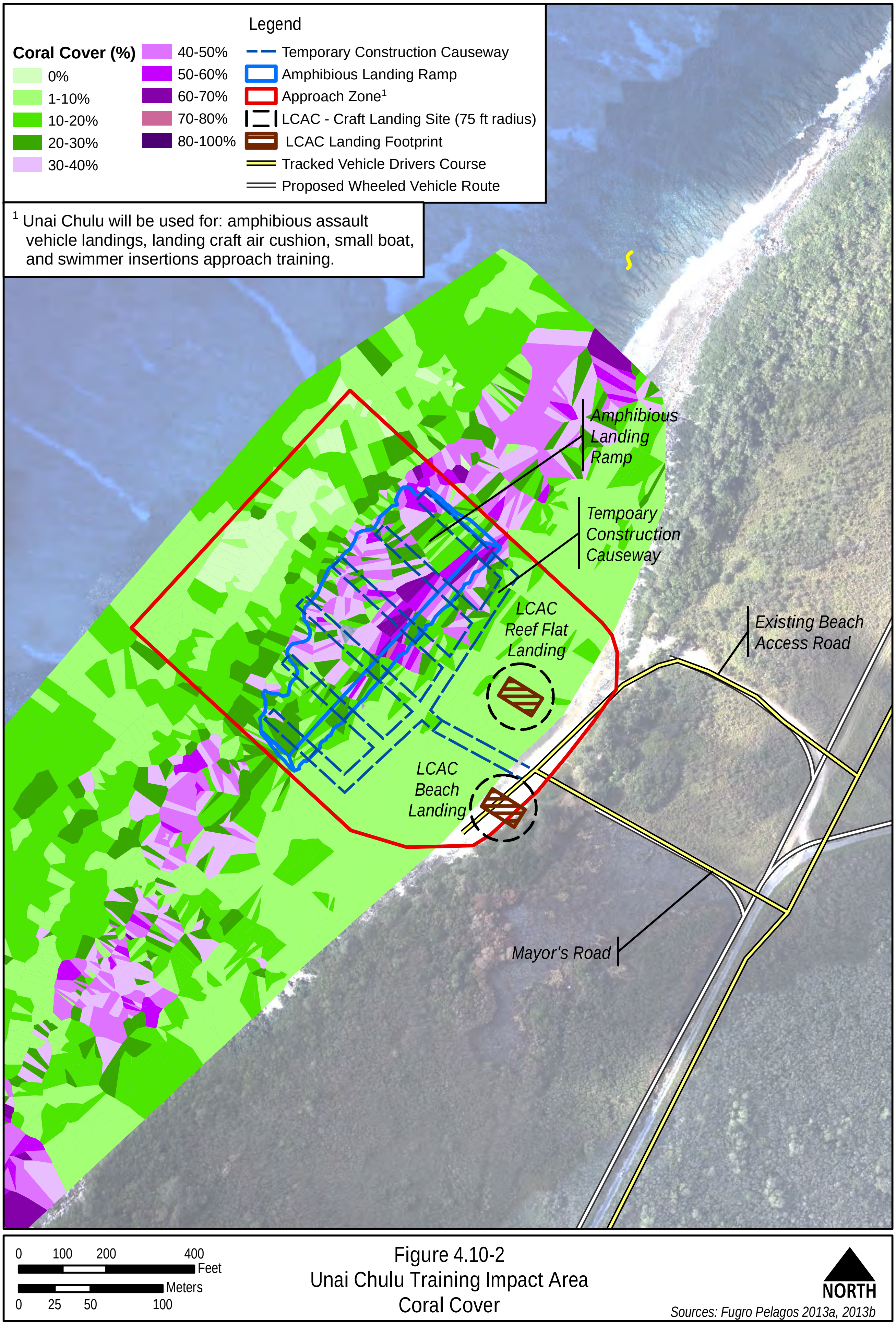


Figure 4.10-2
Unai Chulu Training Impact Area
Coral Cover

Table 4.10-1. Summary of Potential Direct and Indirect Impacts to Marine Habitat at Unai Chulu

Parcel and Activity	***Area of Direct Effects (acres)***	***Area of Indirect Effects (acres)***	***Total Area of Likely Direct and Indirect Effects (acres)***
Unai Chulu Landing	10.3	10.3	20.6

Note: This analysis estimates the size of the area exposed to indirect effects of mobile rubble would be equal to the area exposed to direct effects.

The size of the area exposed to indirect effects of mobile rubble (outside of the direct physical disturbance footprint), is conservatively estimated to be equal to the area exposed to direct effects. The shape of the indirectly affected area cannot be quantitatively estimated. There will be a gradient of disturbance within the area of indirect effect. The effects of mobilized rubble would be greater closer to the construction area and reduced at increasing distances from construction based on the assumptions for rubble movement.

A coastal processes analysis was completed to assess the potential impacts from construction of an amphibious landing ramp at Unai Chulu to coastal processes (see Appendix J, *Amphibious Beach Landing Site Engineering and Coastal Processes Analyses*). Model results comparing the existing condition with the Amphibious Assault Vehicle landing zone configuration suggest that the alteration of the nearshore bathymetry by dredging the Amphibious Assault Vehicle approach area and ramp would not significantly modify shoreline coastal processes and/or trigger erosion of the beach.

Construction impacts to the water column, as well as acoustic impacts, would be intermittent during construction, resulting in only short-term effects. Turbidity would be briefly and locally increased, but suspended sediments would either settle or be rapidly dispersed, with no long-term effects on photosynthesis. Potential impacts to water quality characteristics of the marine environment during coastal and inland construction activities would be minimized by implementing best management practices to control fugitive dust, stormwater runoff, and eutrophication (the process by which a body of water acquires a high concentration of nutrients).

The primary physical impact of in-water construction would be to permanently convert complex and variable reef habitat to an essentially flat surface bordered by disturbed areas of coral rubble, sand, and scoured rock. The diverse microhabitats associated with the topographic complexity of the reef would be eliminated. Substrate that currently supports a relatively high cover of macroalgae would be removed or buried. The mosaic-like character of the habitat, which includes patches of sand, macroalgae, and varying amounts of coral cover, would be replaced by a more homogeneous area consisting of the ramp and adjacent disturbed areas. With the loss of structural diversity, biological diversity and productivity within the impacted area would be diminished. Construction impacts would directly or indirectly affect all of the species that occur in or would otherwise utilize the habitat.

The impacted water column constitutes Essential Fish Habitat for the egg, larval, juvenile, and adult life stages for all of the species or groups of species that are managed under the Mariana Archipelago Fishery Ecosystem Plan (Western Pacific Regional Fishery Management Council 2009). Impacts to the water column would be temporary as noted previously. The substrate, which would be more severely impacted, constitutes Essential Fish Habitat for the juvenile and adult life stages of shallow water bottomfish and crustaceans, as well as the harvested and potentially harvested species of coral reef ecosystems.

The area impacted by physical disturbance at Unai Chulu during construction represents 0.34% of the total reef habitat on Tinian (see Table 3.10-1). The reef flat at Unai Chulu has high taxa richness for algae but lower taxa richness for fish and invertebrates (Minton et al. 2009). The reef flat at Unai Chulu also supports a relatively high cover of algae, which would be removed or subject to burial within the construction area. Use of this area during operations would prevent the recovery of marine algae. The loss of marine flora habitat would impact the invertebrates, fish, and sea turtles that use marine flora species as shelter or as a food source.

Essential Fish Habitat for juvenile and adult spiny lobsters includes the substrate from the shoreline to a depth of 492 feet (150 meters). Adult and juvenile spiny lobsters move onto the reef flats from rocky shelters in the surf zone at night to forage. Physical disturbance to the reef flat would permanently reduce algal cover in the impacted area, and a loss of reef flat habitat may impact both larval and adult spiny lobsters through loss of nursery and foraging habitat. This would result in permanent impacts to larval spiny lobsters, but juvenile and adult spiny lobsters in the immediate vicinity of the construction would be expected to move to more suitable foraging areas.

The estimated noise levels and areas affected by impact pile driving and vibratory pile driving and extraction are described in Appendix M, *Marine Biology Technical Memo and Survey Reports*. These noise levels would result in temporary impacts to Essential Fish Habitat, with increased noise potentially causing some fish to move out of the loudest areas closest to the source. The noise levels would also affect fish behaviors such as detection of predators and prey, schooling, mating, navigating, and in the case of coral larvae, settlement over a much larger area. Given the shallow depths and the uneven topography, any underwater noise as a result of the pile driving/extraction and coral dredging would likely dissipate quickly within the surf zone, but it may extend laterally along the coast as well as into the deeper nearshore environment, depending on environmental variables such as tide or weather patterns in the area. The distances within which various effects on fish are predicted to occur are as follows:

- Behavioral effects on fish during impact pile driving could extend to a distance of 20,695 feet (6.31 kilometers) from the pile. Corresponding effects during vibratory driving or extraction would extend a smaller distance of 243 feet (74 meters).
- Injury due to peak sound pressure levels during impact pile driving would occur to fish within 30 feet (9 meters) of the pile being driven.
- Injury due to an accumulated sound exposure level during impact pile driving would occur to fish that remain within a distance of 928 feet (283 meters) for fish weighing more than 0.07 ounces (2 grams), or 1,715 feet (523 meters) for smaller fish, throughout an entire day of pile driving activity. The corresponding distances during vibratory driving or extraction are smaller, 52 feet (16 meters) for fish weighing more than 0.07 ounces (2 grams), and 95 feet (29 meters) for smaller fish.

Pile driving activities at Tinian would occur during the daytime, and the effects would occur for a maximum of 105 days. Adherence to best management practices such as the soft-start procedure would minimize potential impacts by giving individuals a chance to leave the area to avoid injury prior to the impact hammer operating at full capacity. This would lessen the potential for fish to experience permanent injury or death and would reduce temporary or short-term and recoverable hearing loss due to acoustic impacts from pile driving. The likelihood of impacts from underwater noise are further reduced by the fact that proposed construction operations would not be in deep water but would occur in the shallow intertidal environment of Unai Chulu (approximately 5.0 to 20 feet [1.5 to 6.0 meters]).

The use of an underwater excavator to break up coral and remove sediments from the location of the proposed ramp would also generate underwater sound. Based on comparable operations that measured underwater excavation noise in an area with a limestone bottom, the loudest sounds would be associated with the bottom impact during rock fracturing and excavation (Reine et al. 2014). These sounds would be intermittent, not continuous, and would be substantially less than those predicted for impact pile driving (see Appendix M, *Marine Biology Technical Memo and Survey Reports*).

Potential impacts to water quality characteristics of the marine environment during coastal and inland construction activities would be minimized by implementing resource management measures (see Section 4.3, *Water Resources* for details) to control fugitive dust, stormwater runoff, and eutrophication (the process by which a body of water acquires a high concentration of nutrients). In-water construction would cause temporary water quality impacts, including increased turbidity. Increases in turbidity could temporarily decrease the foraging efficiency of species using Essential Fish Habitat at Unai Chulu. However, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized. Impacts would be minimized to the maximum extent practicable through adherence to best management practices. Post-development stormwater management would mainly focus on a combination of natural and engineered features (i.e., Low Impact Development) that control the volume and rate of stormwater runoff and filter out pollutants.

In-water construction would cause temporary, as well as permanent, loss and degradation of coral reef habitat that comprises Essential Fish Habitat at Unai Chulu. Fish may be temporarily displaced for the duration of construction activities. Coral reef flat habitat at Unai Chulu would be permanently physically altered and removed. Due to loss of habitat, changes to local fish populations and management unit species would likely occur. Populations of reef-associated fish would be expected to decrease in rough proportion to the relative area of reef that would be impacted. While this represents a small percentage of the total, it would be more than minor and/or temporary. It would reduce the quality and quantity of Essential Fish Habitat for the coral reef ecosystem and the complex trophic (i.e., feeding and nutrition) structure of the reef ecosystem. The high levels of primary (plant) and secondary (animal) production of the reef itself would be largely eliminated.

Although the area impacted by in-water construction at Unai Chulu represents 0.34% of the total reef habitat on Tinian (see Table 3.10-1), it represents 20-30% of Tinian's reef flat habitat. Unai Chulu is one of seven well-developed reef flats on Tinian (Analytical Laboratories of Hawaii 2004; National Oceanic and Atmospheric Administration, National Centers for Coastal Ocean Science 2005; Bearden et al. 2008; Riegl and Dodge 2008; Brainard et al. 2011). Therefore, given the importance of this habitat as Essential Fish Habitat and its limited availability on Tinian, the removal of the coral reef at this beach during Tinian Alternative 1 construction activities would result in significant impacts to marine habitat and Essential Fish Habitat.

4.10.3.1.1.2 Marine Flora

Marine flora would be removed and otherwise negatively impacted by mobilized rubble within the areas of direct and indirect physical disturbance to habitat by in-water construction at Unai Chulu (see Table 4.10-1). Alteration of marine flora habitat would impact ecological function at Unai Chulu and eliminate habitat and food sources for other species. Marine flora, such as seagrasses, provide a food source for sea turtles and habitat for fishes within the region of influence (Spalding et al. 2003). Seagrasses also play a major role in fisheries production and have been shown to provide protection from coastal erosion (Spalding et al. 2003). In-water construction would also temporarily increase sedimentation within the nearshore waters, thereby increasing turbidity, reducing light availability, photosynthesis, and primary production by marine flora. However, as described in Section 3.10, *Marine Biology*, marine flora are abundant in Tinian waters, and in-water construction at Unai Chulu would eliminate approximately 0.34% of Tinian's reef habitat that could support marine flora. Therefore, Tinian Alternative 1 construction activities would result in less than significant impacts to marine flora.

4.10.3.1.1.3 Marine Invertebrates

Based on the *Marine Resource Surveys of Tinian, Volume I* (Minton et al. 2009), the reef slope at Unai Chulu is far more diverse than the reef flat. The surveys documented at least 79 coral and 89 non-coral invertebrate taxa (distinct species, genera, or families) on the reef slope, versus 15 coral and 28 non-coral taxa on the reef flat. The most abundant non-coral invertebrates on the reef slope were rock-boring urchins; on the reef flat, sea cucumbers, sea stars, and tube worms were the most abundant. Individual coral and coral colonies at Unai Chulu within the construction area would be exposed to direct physical removal and disturbance during construction. Coral located adjacent to the amphibious landing ramp would be exposed to indirect impacts associated with mobilized rubble generated by the construction activities. Non-coral marine invertebrates (starfish, sea urchins, sea cucumbers, mollusks, and tube worms) would also be subject to direct and indirect impacts associated with in-water construction. Some non-coral marine invertebrates would be directly impacted (i.e. mortality) during in-water construction. Non-coral marine invertebrates not directly impacted during in-water construction would experience temporary as well as permanent habitat loss in the construction footprint.

The in-water construction of the amphibious landing area would also result in the impacts associated effects of sedimentation. In addition, coastal construction could lead to increased runoff from supporting land-based construction activities (e.g., construction equipment staged on the beach). Sediments created and/or mobilized during dredging or other construction activities would be expected to occur within and adjacent to the construction area. When mobilized by water motion, mobile rubble can strike or smother marine invertebrates. These effects would be relatively localized and constrained to the time of construction.

In addition, underwater noise from construction equipment, vibratory and impact pile-driving, and the sounds of the substrate fragmenting and moving during the dredging process could mask the natural reef sounds that coral larvae use as settlement cues (Vermeij et al. 2010). The nature of coral larvae's use of acoustic information is related to navigation towards suitable reef habitat for settlement (Vermeij et al. 2010). Coral larvae could be anywhere in the water column to at least as deep as each species' typical depth range, and typical larval stage durations range from a few days to a few weeks (Baird et al. 2009). A possible consequence of construction noise is that coral larvae may avoid settling and remain in the water column for a slightly longer time, drifting until the sound-generating activity subsides. Based on the level of disturbance at the construction site, it is unlikely that natural reef sounds like those made by snapping shrimp and reef fish would be present, where the habitat would be degraded and inhospitable for larval settlement. Coral larvae that do not settle because of construction noise or degraded habitat conditions would drift to other nearby locations with suitable habitat within a short time (possibly minutes, depending on currents), which would be expected to have a small effect on larval survival given the duration of the planktonic phase (Baird et al. 2009). Accordingly, acoustic effects on larvae would be local, temporary, and less than significant. The proposed construction methods would permanently introduce concrete to the marine environment. Concrete sometimes inhibits settlement of coral larvae, which would be beneficial in this context, and cured concrete is not known to have effects on post-settlement corals (Jaap 2000; Southeast Florida Coral Reef Initiative 2011; Tan and Chou 2012). Apart from the physical destruction and degradation of coral reef habitat, which is already recognized as a significant impact under *Marine Habitat and Essential Fish Habitat*, the additional impact to adjacent coral reef habitat, the associated coral and non-coral invertebrates, and coral larvae would be relatively localized and temporary.

In the vicinity of Unai Chulu, coral populations would experience a population discontinuity within the construction footprint. Currently, this location is a continuous coral reef. It is expected the permanent loss of 0.34% of the Tinian reef habitat within and adjacent to the construction area at Unai Chulu would reduce non-coral marine invertebrates by a roughly equivalent amount. Therefore, Tinian Alternative 1 construction activities would result in significant impacts to coral and less than significant impacts to non-coral marine invertebrates.

4.10.3.1.1.4 Fish

In-water construction would cause temporary, as well as permanent, habitat disturbance and loss for fish species as fish may be temporarily or permanently displaced. Since reef flat coral habitat at Unai Chulu would be permanently physically altered and removed, changes to local fish populations dependent on this habitat would likely occur. Populations of reef fish would decrease, and trophic (i.e., feeding and nutrition) structure would be affected. Because many individual fish depend on specific coral habitats for survival, mortality would likely occur in these areas. Given the loss of approximately 0.34% of Tinian reef habitat during construction at Unai Chulu, a roughly equivalent reduction in populations of reef-associated fish can be anticipated.

During in-water construction, construction equipment could potentially strike any fish species found within the construction area, although some fish may be more susceptible to strike potential than others. Potential responses to physical strikes are varied, but include physiological stress, physical injury or mortality, and behavioral changes such as avoidance of the area, altered swimming speed and direction, and reduced performance of key behaviors such as eating, hiding, and predator avoidance. Construction equipment would interact with species that inhabit the seafloor, and the water column above the seafloor in the construction area. Early life stages of fish (including fish eggs, larvae, and juveniles) that inhabit the construction impact area would be the most vulnerable and could suffer mortality if they do not vacate the area during construction.

Fish are susceptible to acoustic stressors in multiple ways. Fish exposed to short-duration, high-intensity signals, such as those that emanate from pile driving, could result in injury, long-term consequences (A. N. Popper et al. 2006; Stadler and Woodbury 2009), and hearing loss, also known as a noise-induced threshold shift, or simply a threshold shift (Miller 1974). A temporary threshold shift is a temporary, recoverable loss of hearing sensitivity. Fish with hearing specializations (i.e., greater sensitivity to lower sound pressures and higher frequencies) experience some hearing loss after several days or weeks of exposure to increased background sounds, although the hearing loss seems to recover (e.g., Scholik and

Yan 2002; Smith et al. 2004, 2006). When human-generated noise interferes with natural sounds associated with behaviors such as detection of predators and prey, schooling, mating, and navigating (Myrberg 1980; A. Popper et al. 2003), such auditory masking could have impacts to fish by reducing their ability to perform these biological functions. Human-generated noise has also been documented to cause behavioral reactions such as avoidance or fleeing the area. In addition to potential effects on hearing and behavior, fish that have swim bladders are susceptible to injury by the rapid expansion/decompression of their swim bladders that is caused by pressure waves from underwater noises (Hastings and Popper 2005). At a sufficient pressure level (a measure closely related to the loudness of the sound), this exposure can be fatal.

To minimize the potential for fish to be present in the immediate vicinity of the impact or vibratory pile driving, the equipment operators would use a soft-start procedure that involves a slow increase in intensity of noise and allows individuals in the area to disperse and avoid injury before maximum noise levels are reached. It is expected that during the soft start and as the activity progresses, fish would move farther away or into sheltered locations where sound would be less intense. Hence, although there would be temporary behavioral effects, the likelihood of injury to individual fish would be low.

Currently accepted thresholds for behavioral and physiological effects to fish from underwater sound generated by activities such as pile driving are summarized below (Fisheries Hydroacoustic Working Group 2008).

- Behavioral disturbance is assumed to be likely when fish are exposed to a sound pressure level (root mean square – a mathematical process used to measure the typical magnitude of a set of numbers, regardless of whether the values are positive or negative) greater than 150 decibels (referenced to 1 micro Pascal, a measure of pressure).
- Injuries are assumed to occur when fish are: a) exposed to a peak sound pressure level (which is the greatest absolute instantaneous sound pressure during a stated time interval) of 206 decibels (referenced to 1 micro Pascal); or b) when they receive a cumulative sound exposure level (a mathematical way of summing the effects of sound over a duration of time) during a single day of 187 decibels (referenced to 1 micro Pascal squared-second). For fish that weigh less than 0.07 ounces (2 grams), the latter threshold is 183 decibels (referenced to 1 micro Pascal squared-second).

Appendix M.1, *Marine Biology Technical Memo*, provides the estimated sound levels that would be produced by impact and vibratory pile driving and vibratory pile extraction during the construction and removal of temporary causeways at Unai Chulu. Using the model described in Appendix M.1 to estimate the decrease in sound levels with distance from the pile, and estimating 10 minutes of impact pile driving (600 pile strikes) per day, the distances within which the above thresholds would be exceeded can be calculated. Output from the model showed that the potential for injury due to peak sound pressure level would exist within 30 feet (9 meters), and the sound exposure level thresholds for injury to small and large fish would only be exceeded for fish that remain exposed within distances of 1,715 feet (523 meters) and 928 feet (283 meters), respectively, for the entire 600 pile strikes. It is considered unlikely that fish would remain within these distances where injuries could occur. Small life stages that drift passively in the water column could drift through the area but would be unlikely to remain within these distances long enough to be impacted. Finally, the behavioral effects threshold would be exceeded within a distance of 120,695 feet (6,310 meters), but this would accumulate over a period that is estimated to be a total of 10 minutes distributed over the day that the pile is being hammered by the impact pile driver. This amount of behavioral disturbance is unlikely to have important biological consequences. In-water construction would cause temporary water quality impacts including increased turbidity. Increases in turbidity could temporarily decrease the foraging efficiency of fish. In sandy areas, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized. Potential impacts from run-off from land-based construction could degrade water quality, particularly the construction of impervious access roads built close to the shoreline. These impacts would be minimized through adherence to best management practices (Appendix D, *Best Management Practices*).

The permanent loss of 0.34% of Tinian reef habitat within and adjacent to the construction area at Unai Chulu would reduce populations of reef-associated fish by a roughly equivalent amount. With the implementation of a soft start during pile driving, the likelihood of injuries to fish would be low, although behavioral effects would occur. Apart from the loss of coral reef and Essential Fish Habitat already discussed, the additional impact to fish populations and communities would be relatively small. Therefore, Tinian Alternative 1 construction activities would result in less than significant impacts to fish.

4.10.3.1.1.5 Special-status Species

Corals

The *Coral Marine Resource Survey* conducted in support of this EIS/OEIS recorded the presence of one coral species, *Acropora globiceps*, listed under the Endangered Species Act (National Marine Fisheries Service 2012; DoN 2014a). Other listed species are considered unlikely to occur or be affected. Table 4.10-2 presents an estimate of the number of *Acropora globiceps* that will be directly impacted and removed during in-water construction at Unai Chulu. In addition, Table 4.10-2 lists the total estimated area of coral loss. Tables for Unai Babui, Unai Masalok and Unai Lam Lam can be found in Section 4.10.3.1.2, *Operation Impacts*.

Table 4.10-2. Potential Impacts to Acropora globiceps at Unai Chulu During Construction[1]

	***Unai Chulu*[2]**
Extrapolated number of *Acropora globiceps* colonies in the Approach Zone	1,344
Density of *Acropora globiceps* colonies in the Approach Zone (colonies per square meter)	0.09
Extrapolated area (square meter) covered by *Acropora globiceps* in the Approach Zone	49.2

Notes: [1]Calculations assume that the entire susceptible area of each Approach Zone (based on depth of construction or training activity: 5 feet (1.5 meters) for small boat landings and swimmers, 12 feet (4 meters) for Amphibious Assault Vehicles) is subject to physical effects. Effects to corals/seafloor outside of these depths in each area (e.g., deep grooves) and potential effects outside of the Approach Zone are excluded from this analysis, but are considered separately as potential indirect physical effects.
[2]Includes all areas that construction will have direct physical impacts - also including temporary structures.

Due to the number of colonies that will be removed in relation to the rarity of the species, the destruction of the established colonies of *Acropora globiceps* within the construction footprint, Tinian Alternative 1 construction activities would result in significant impacts to special-status coral species.

Since there is no evidence of differential susceptibility among coral species to acoustic and indirect effects, the effects on *Acropora globiceps* are considered to be the same as were discussed previously for corals in general under *Marine Invertebrates* and would be less than significant.

Sea Turtles

The sea turtle survey conducted in support of this EIS/OEIS (DoN 2014b) confirmed the presence of sea turtles within the construction area. At the time of the survey, the density within the study area was estimated at 65 turtles per square mile (25 turtles per square kilometer), approximately one quarter the density of other areas around Tinian. Using the highest estimated density available (based on swimming transects [DoN 2014b]), this equates to an average of less than one turtle within the 10.3 acre (4.1 hectare) in-water construction footprint at any given time. However, it can reasonably be assumed that turtles move through the area and that numbers would vary from zero to several individuals. Construction impacts related to sea turtles include habitat disturbance, acoustic impacts, and physical disturbance and strike.

In-water construction of the amphibious landing area at Unai Chulu would cause temporary and permanent effects to sea turtle foraging and resting habitat within the 10.3 acre (4.1 hectare) construction footprint, and possibly a small area of degraded habitat adjacent to the construction footprint. Sea turtles could be displaced from these waters for the duration of construction activities. Coral habitat at Unai Chulu would be physically altered and permanently removed during the proposed construction activities. Sea turtles depend on this nearshore coral reef habitat for food and shelter. The loss of this coral habitat may temporarily affect sea turtles within the project footprint, as coral habitat in the surrounding areas has similar characteristics and the sea turtle population density appears low enough for relocation without overcrowding or displacement. As a result, nearshore habitat loss at Unai Chulu resulting from Tinian Alternative 1 construction activities would not be likely to impact the current population or future recovery of green and hawksbill sea turtles, and is considered a less than significant impact.

Sea turtles occurring in the shallow waters of the Unai Chulu construction area would be subject to construction noise. In most cases, during the soft start procedure, sea turtles would either surface or swim away from the noise source and therefore avoid injury before maximum noise levels are reached. Over the course of construction, sea turtles may relocate at a distance where the noise would not further affect their behavior, or individual turtles may become habituated to the noise at disturbance levels between 160-190 decibels (Moein et al. 1994). Designating a zone to where behavioral impacts can occur to 1,000 feet (309 meters) from the source noise would indicate approximately twelve turtles could be impacted from construction noise. Based on past (Kolinski et al. 2004) and recent transects (DoN 2014b), the density of sea turtles within the construction area at Unai Chulu is the lowest calculated density across the island (Kolinski et al. 2004; DoN 2014b). Sea turtles in the southern Mariana Islands, including Tinian, are locally harvested, and as a result, many have developed a conditioned response to flee or vacate an area due to the presence of people or other human disturbances. The presence of personnel, equipment and vessels in the water during construction are likely to cause a flight response in sea turtles. As such, injury and behavior impacts from pile driving or other construction noise resulting from implementation of Tinian Alternative 1 would result in less than significant impacts.

Sea turtles, especially juveniles, could be struck by construction equipment, which could cause mortality or injury. Smaller, younger turtles require refuge from predators, primarily sharks, and occupy crevices in the spur and groove coral habitat. There is a possibility that these animals could use the specific habitat within the proposed construction footprint at the time of construction. However, a direct strike would be unlikely due to the low density of turtles in the construction footprint and expected flight response from construction noise. Proper surveillance would also be implemented during construction activities to further reduce the potential for a sea turtle strike from construction equipment. Therefore, Tinian Alternative 1 construction activities would result in less than significant impacts to sea turtles.

Through the Endangered Species Act section 7 consultation process, potential effects to individual sea turtles and on the continued existence of the species would be evaluated and detailed in the Biological Assessment. Best management practices, such as implementation of a soft start during pile driving, would be implemented during construction to reduce potential impacts. Additional mitigation measures may be recommended during agency consultations.

Marine Mammals

As discussed in 3.10.4.6, *Marine Mammals,* no marine mammals were sighted in the Tinian region of influence during the *Marine Mammal Survey* conducted in support of this EIS/OEIS (DoN 2014c). However, marine mammals have been previously documented in the region of influence and may travel through the region of influence during proposed construction. Based on an analysis of the marine species surveys associated with Tinian, sightings data provided in Hill et al. (2014) shows that the marine mammal most often sighted in the nearshore environment (less than 3 nautical miles [5.6 kilometers]) was the spinner dolphin (54% of encounters). However, sightings around Tinian primarily occurred on the eastern side of the island, away from areas currently proposed for construction or operations. Ligon et al. (2011) did not sight spinner dolphins off Tinian during a survey around the island, but did report anecdotal evidence of spinner dolphins off Tinian Harbor on the southwestern coast of the island. While a lack of sightings specific to the region of influence does not preclude the species from being present, it does indicate that spinner dolphins appear to use other areas around Tinian more regularly, and would likely be transmitting through the region of influence.

Proposed construction would involve construction equipment and human activity on the beach in the shallow-water environment for approximately 36 weeks. Pile driving/extraction would occur intermittently and for relatively brief periods during daylight hours throughout this period. Since there would be considerable noise and human activity with the construction area at Unai Chulu, it is unlikely that a marine mammal would closely approach this area during construction. Best management practices, such as implementation of a soft start during pile driving, would be implemented during construction. Construction personnel would not commence pile driving if a marine mammal was observed within 300 feet (90 meters). Acoustic impacts to marine mammals would be limited to temporary physiological and behavioral effects that would be considered non-injury disturbance. For these reasons, it is assumed that construction at Unai Chulu would result in non-injurious behavioral impacts due to acoustic harassment of a relatively small numbers of cetaceans as a result of pile driving and pile removal during construction activities; however, no injury or mortality are anticipated. Any effects experienced by individual marine mammals are anticipated to be limited to short-term disturbance of normal behavior or temporary displacement of animals near the source of the noise. Appendix M, *Marine Biology Technical Memo and Survey Reports*, provides a general discussion of marine mammal hearing and communication and potential acoustic effects on marine mammal hearing, communication, and behavior. Impacts to marine mammals resulting from Tinian Alternative 1 construction activities would be limited to temporary physiological and behavioral effects and result in less than significant impacts to marine mammals.

4.10.3.1.2 Operation Impacts

As described in Chapter 2, Tactical Amphibious Beach Landings (non-live-fire) would occur on Tinian up to 20 weeks per year. Table 4.10-3 gives an overview of each operational/training activity per beach. Figures 4.10-1 to 4.10-8 show proposed amphibious training activities for the beaches on Tinian. Each pair of figures presents proposed activities for a specific beach in relation to bathymetry (Figures 4.10-3, 4.10-5, 4.10-7) and coral cover (Figures 4.10-4, 4.10-6, 4.10-8)." The number of daily landings may vary based on factors such as the training scenario and objectives, weather/sea state, and vehicle availability. In general, amphibious training on Tinian would be spread evenly throughout the 20 weeks of military training, consistent with the unit level of training emphasis, with daily variations as noted below.

Table 4.10-3. Tinian Beach Activity Overview

Beach	***Activity***
Unai Chulu	• Amphibious Assault Vehicle landings • Landing Craft Air Cushion vessel landings • Small boat landings • Swimmer insertions
Unai Babui	• Landing Craft Air Cushion vessel landings • Small boat landings • Swimmer insertions
Unai Masalok	• Landing Craft Air Cushion vessel landings • Small boat landings • Swimmer insertions
Unai Lam Lam	• Small boat landings • Swimmer insertions

Potential impacts to marine water quality as a result of land-based training activities in support of the proposed action would be limited by the best management practices described in Section 4.3, *Water Resources*, and would be less than significant.

4.10.3.1.2.1 Marine Habitat and Essential Fish Habitat

At Unai Chulu, four main activities would directly affect marine habitat as deep as 12 feet (4 meters) below mean low water: Amphibious Assault Vehicle landings, Landing Craft Air Cushion vessel landings, small boat landings, and swimmer landings. Due to the turbulent nature within this area, the mobile rubble would be distributed and transported outside of the landing zone, with the potential to cause damage to the deeper reef over time, particularly during storm events. Landings at Unai Chulu would occur within the construction footprint already accounted for (see Table 4.10-1). The additional disturbance associated with operations in the degraded footprint would be less than significant, although it would prevent the long-term recovery of the coral reef ecosystem that could eventually occur in the absence of disturbance. Indirect impacts may include future impact by mobilized rubble from training operations associated with the proposed facilities and training areas.

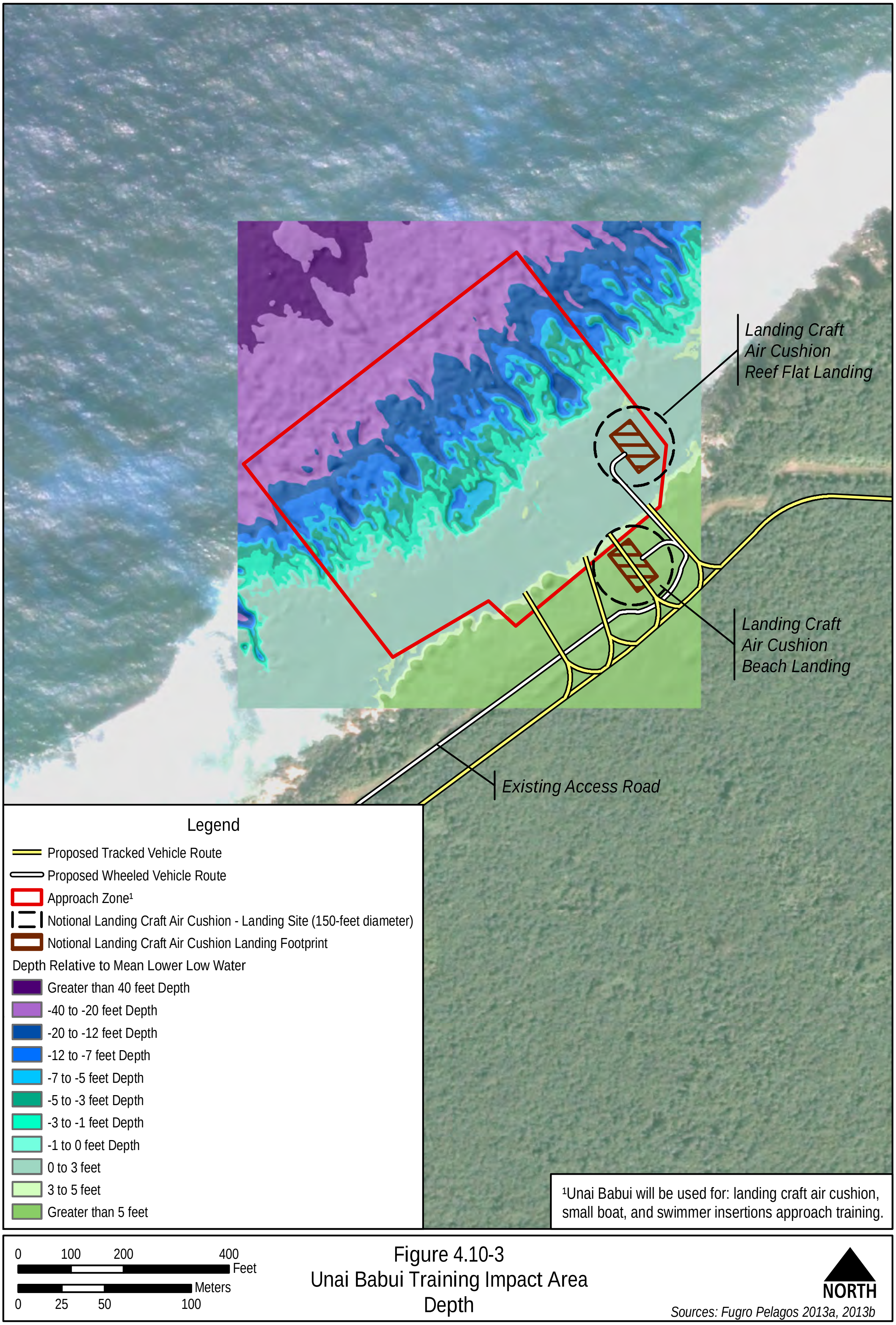


Figure 4.10-3
Unai Babui Training Impact Area
Depth

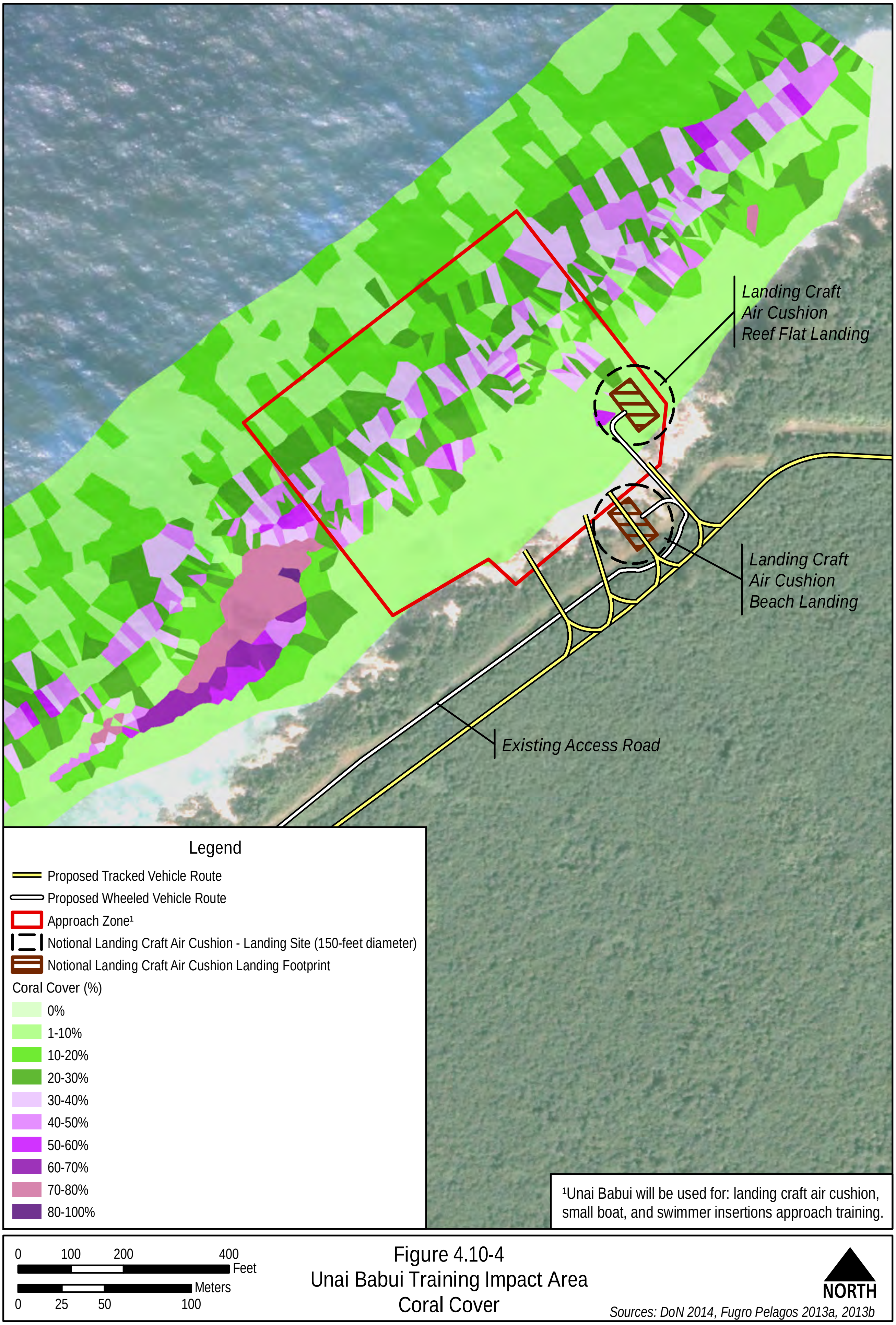


Figure 4.10-4
Unai Babui Training Impact Area
Coral Cover

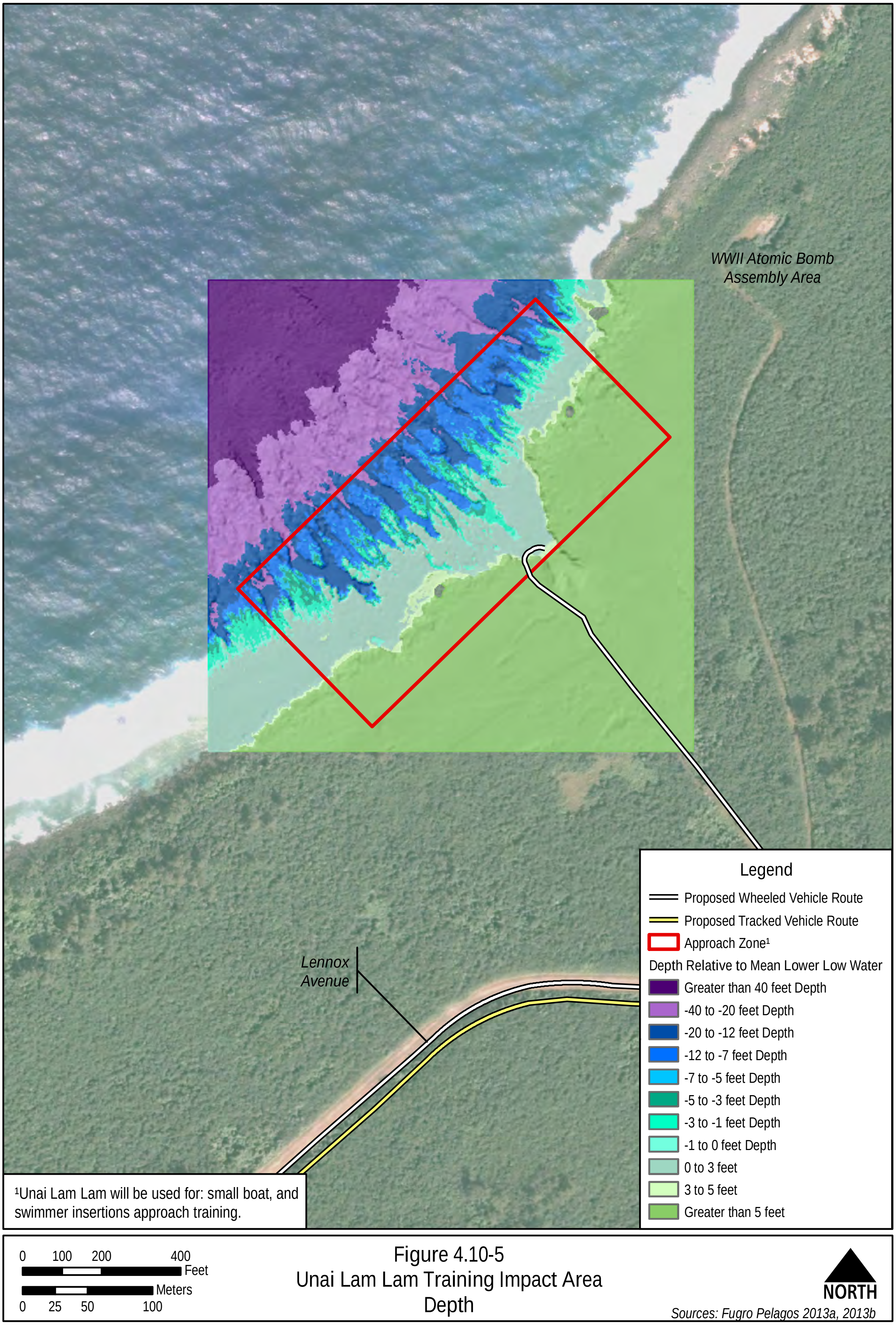


Figure 4.10-5
Unai Lam Lam Training Impact Area
Depth

Sources: Fugro Pelagos 2013a, 2013b

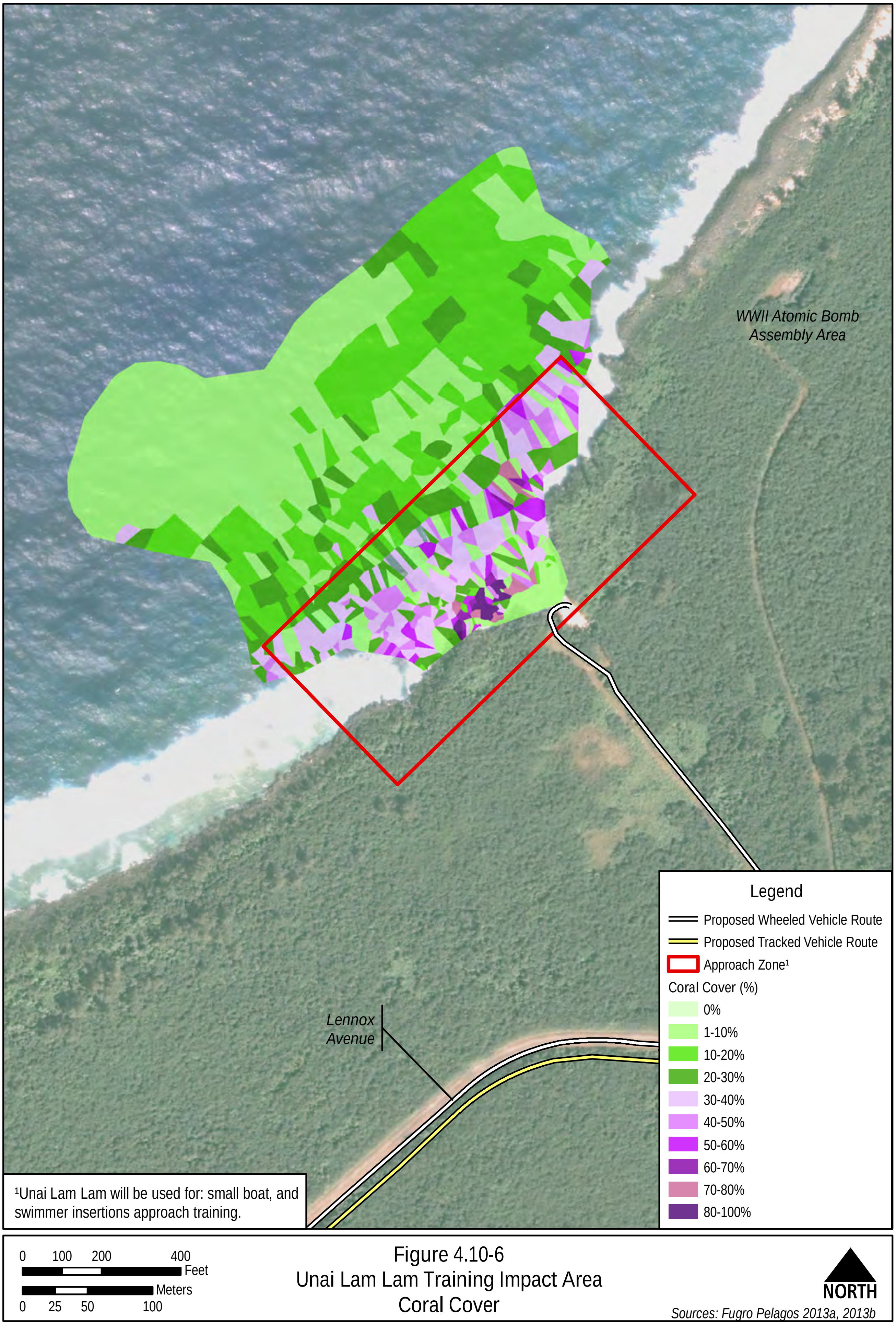


Figure 4.10-6
Unai Lam Lam Training Impact Area
Coral Cover

Sources: Fugro Pelagos 2013a, 2013b

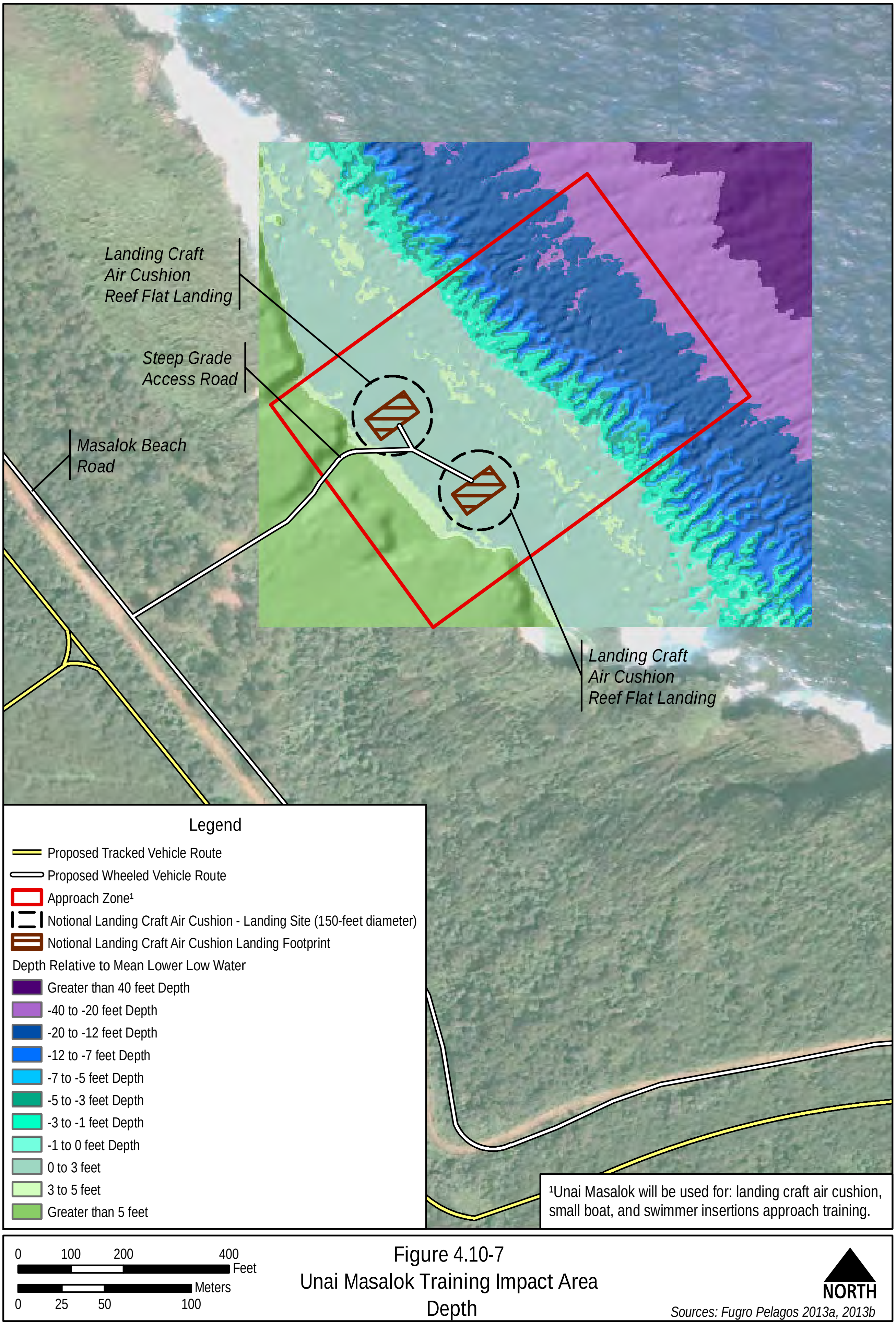


Figure 4.10-7
Unai Masalok Training Impact Area
Depth

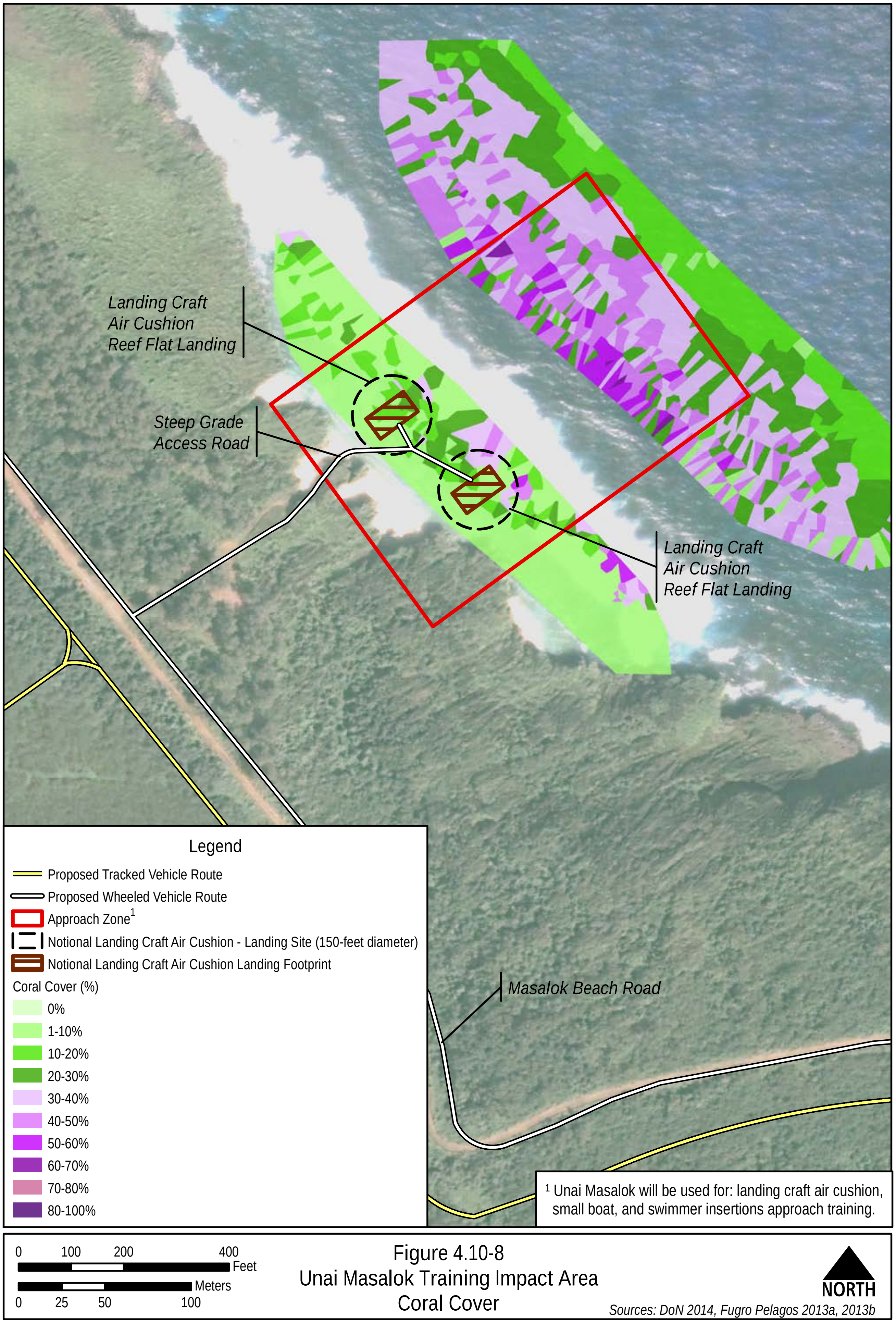


Figure 4.10-8
Unai Masalok Training Impact Area
Coral Cover

At Unai Babui, three training activities would directly affect marine habitat: Landing Craft Air Cushion vessels landings, small boat landings, and swimmer landings. Landing Craft Air Cushion vessels landings would affect coral colonies and coral reef habitat where habitat occurs within the set-down circle(s), which could occur anywhere along the beach at Unai Babui. Inflatable boats and swimmer landings could affect coral colonies and coral reef habitat to as deep as 5 feet (1.5 meters) below mean low water (see Figures 4.10-3 and 4.10-4). The area of reef substrate shallower than 5 feet (1.5 meters) in the landing area at Unai Babui is 3.05 acres (1.2 hectares).

At Unai Lam Lam, the two main activities with the potential to directly affect marine habitat are small boat landings and swimmer landings. Small boats and swimmer landings could affect coral colonies and coral reef habitat to as deep as 5 feet (1.5 meters) below mean low water (see Figures 4.10-5 and 4.10-6). The area of reef substrate shallower than 5 feet (1.5 meters) in the Approach Zone at Unai Lam Lam is 3.83 acres (1.54 hectares). These operational activities could affect marine habitats by disturbing or altering the seafloor, water quality, or physical environment. The primary effect would be physical strike and disturbance from equipment such as boat hulls and swimmers boots that could break or abrade corals and could create mobile rubble that is capable of being transported outside of the small boat and swimmer landing areas with the potential to cause damage to the deeper reef over time. Consequences of these potential effects would reduce the volume and complexity of Essential Fish Habitat in the affected areas. These activities would result in periodic short-term and long-term/permanent impacts to Essential Fish Habitat.

At Unai Masalok, the three main activities with the potential to directly affect marine habitat include Landing Craft Air Cushion vessels landings, small boat landings, and swimmer landings. Landing Craft Air Cushion vessels landings would affect coral colonies and marine habitat where habitat occurs within the set-down circle(s) which could occur anywhere along the beach at Unai Masalok. Inflatable boats and swimmer landings could affect coral colonies and marine habitat to as deep as 5 feet (1.5 meters) below mean low water (see Figures 4.10-7 and 4.10-8). The area of reef substrate shallower than 5 feet (1.5 meters) at Unai Masalok is 4.5 acres (1.8 hectares).

At any one time, a small fraction of the total area, corresponding to the area of disturbance by individual vehicles/vessels would be impacted. Over time, some portions would likely be used more frequently and intensively than others, but the cumulative areas disturbed would approach the acreages shown in Table 4.10-4. Operations could create sediment and mobile rubble that is capable of causing ongoing indirect effect (physical disturbance outside the amphibious landing area), both along-shore and downslope. The size of the area exposed to indirect effects of mobile rubble is conservatively estimated to be equal to the area exposed to direct effects. The shape of the indirectly affected area cannot be quantitatively estimated as there would be a gradient of disturbance within the area of indirect effect. The effects of mobilized rubble would be greater closer to the area of operation and reduced at increasing distances from operation activities based on the assumptions for rubble movement.

Consequences of these potential effects would reduce the volume and complexity of Essential Fish Habitat in the affected areas. Table 4.10-4 presents the areas of the potential direct and indirect impacts to marine habitat with implementation of the proposed action on Tinian.

Table 4.10-4. Summary of Potential Direct and Indirect Impacts to Marine Habitat on Tinian

Beach and Activity	***Area of Direct Effects (acres)***	***Area of Indirect Effects[1] (acres)***	***Total Area of Likely Direct and Indirect Effects (acres)***
Unai Chulu	10.3[2]	10.3[2]	20.6
Unai Babui	3.05	3.05	6.10
Unai Lam Lam	3.83	3.83	7.66
Unai Masalok	4.50	4.50	9.00

Note: [1]This analysis assumes the size of the area exposed to indirect effects of mobile rubble is assumed to be equal to the area exposed to direct effects.
[2]Impacts at Unai Chulu were analyzed under construction impacts; see Section 4.10.3.1.1.1, *Marine Habitat and Essential Fish Habitat*

Operational activities may impact the water quality and introduce noise in the water column within the designated Essential Fish Habitat area for pelagics, bottomfish, crustaceans, and coral reef ecosystems. Potential impacts to the water column habitat by vessel noise during the proposed operational activities would mainly include impacts to prey species, including fish and invertebrates. Vessel movements have the potential to expose fish and invertebrates to sound and general disturbance, which could result in short-term behavioral or physiological responses (e.g., avoidance, stress, increased heart rate). However, this would not be expected to compromise the general health or condition of individual fish or populations of invertebrates. Given typical underwater vessel noise of about 160 decibels at 3.3 feet (1 meter), the 150-decibel threshold for behavioral effects to fish would be exceeded within about 15 feet (4.6 meters) of the vessel. Such effects would be brief and infrequent, resulting in relatively minor, temporary effects on the quantity and quality of Essential Fish Habitat in the water column. There would be no effects on the substrate. As a result, vessel noise during operations of Tinian Alternative 1 would not have a significant impact to marine habitat or Essential Fish Habitat.

Operational activities would cause temporary water quality impacts including increased turbidity. Increases in turbidity could temporarily decrease the foraging efficiency of Essential Fish Habitat at the proposed tactical amphibious landing beaches. In sandy areas, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized. Potential impacts from run-off from land-based construction could degrade water quality, particularly the construction of impervious access roads built close to the shoreline. Training activities are not expected to cause long-term erosion or to modify marine habitat outside of the footprints identified in Table 4.10-4. Impacts would be minimized to the maximum extent practicable through adherence to resources management measures.

Approximately 3.05 acres (1.2 hectares) of marine habitat, including corals and coral reef habitat would be directly impacted at Unai Babui, 3.83 acres (1.55 hectares) would be directly impacted at Unai Lam Lam, and 4.50 acres (1.82 hectares) would be directly impacted at Unai Masalok (see Table 4.10-3). As stated in Chapter 3, Table 3.10-1, 65,920 acres (26,676 hectares) of total reef habitat are present across the Mariana Islands, 5,696 acres (2,305 hectares), which is present around Tinian (Analytical Laboratories of Hawaii 2004; National Oceanic and Atmospheric Administration, National Centers for Coastal Ocean Science 2005; Bearden et al. 2008; Riegl and Dodge 2008; Brainard et al. 2011). Based on the sum of the area shallow enough to be affected by the in-water training activities at Unai Babui, Unai Lam Lam, and Unai Masalok (as deep as 5 feet [1.5 meters]), Tinian Alternative 1 operations would directly and indirectly impact approximately 0.44% of total reef habitat from Tinian during operations. It is expected the permanent loss of 0.34% of the Tinian reef habitat within and adjacent to the construction area at Unai Chulu and the additional disturbance associated with operations would prevent the long-term recovery of the coral reef ecosystem that could eventually occur in the absence of disturbance. Total reef habitat around Tinian, which may include marine flora habitat or potential habitat, totals 5,696 acres (2,305 hectares). Based on the low percentage of marine habitat loss in comparison to the total available marine habitat around Tinian, Tinian Alternative 1 operations would result in less than significant impacts to marine habitat and Essential Fish Habitat.

4.10.3.1.2.2 Marine Flora

The actions that could potentially impact marine flora during operation include in-water training, landings of Amphibious Assault Vehicles, Landing Craft Air Cushion vessels and small inflatable boats, and operation of vessels in nearshore waters. Marine flora that could be impacted from training activities would be reef substrate shallower than 12 feet (4 meters) below mean low water. Vessels conducting or supporting training could impact marine flora by disturbing the bottom and swimmers could impact marine flora through disturbance of the nearshore environment. Small boats and swimmer landings could affect marine flora to as deep as 5 feet (1.5 meters) below mean low water.

Operational impacts would be periodic. Marine flora already impacted during construction at Unai Chulu would continue to be impacted during operation. With recurring operations and disturbance of the substrate, limited regrowth of marine flora would occur following construction activities, and it would then be directly impacted from vessels or swimmers disturbing or uprooting any marine flora habitat shallower than 12 feet (4 meters).

Marine flora habitat would not be directly removed at Unai Babui, Unai Lam Lam, or Unai Masalok as a result of Tinian Alternative 1, but habitat may be disturbed during training activities. As described in Section 3.10, *Marine Biology*, marine flora is abundant in Tinian waters as Tinian has one of the highest mean macroalgal covers of all the islands in the Marianas Archipelago (Brainard 2012).

As stated in Chapter 3, total reef habitat around Tinian, which may include marine flora habitat or potential habitat, totals 5,696 acres (2,305 hectares) (Analytical Laboratories of Hawaii 2004; National Oceanic and Atmospheric Administration, National Centers for Coastal Ocean Science 2005; Bearden et al. 2008; Riegl and Dodge 2008; Brainard et al. 2011). The total area potentially disturbed at these three beaches during training activities is equal to 0.44% of the total reef habitat area. It is expected the permanent loss of 0.34% of the Tinian reef habitat within and adjacent to the construction area at Unai Chulu and the additional disturbance associated with operations would prevent the long-term recovery of the marine flora that could eventually occur in the absence of disturbance. Marine flora is plentiful at various locations and depths around the training area and across Tinian nearshore waters and there are no known special-status species. As a result, Tinian Alternative 1 operations would result in less than significant impacts to marine flora.

4.10.3.1.2.3 Marine Invertebrates

Landings at Unai Chulu would occur within the construction footprint already accounted for (see Table 4.10-1). The reefs at Unai Babui, Unai Lam Lam, and Unai Masalok show moderate to high topographic complexity and moderate (Unai Babui and Unai Lam Lam) to high (Unai Masalok) coral cover with little sand. The reef flat at Unai Lam Lam is rich with high coral cover (90%), whereas the reef flat on Unai Masalok has low coral cover (DoN 2014a). Swimmers and small boats transitioning through the reef flat at Unai Lam Lam are expected to impact corals, and it is assumed that those corals would be permanently impacted or destroyed. Landing Craft Air Cushion vessels landings, small boat landings, and swimmer landing would occur at Unai Masalok and would also result in loss of existing corals, but the limited density of corals would limit the total amount of coral loss. Non-coral invertebrate communities dominated by tube worms, sea urchins, and sea cucumbers (Minton et al. 2009), would also be impacted to the extent that the coral habitat is degraded, although sea cucumbers would be less affected because they burrow and feed on detritus in the sediments rather than living on the reef.

It is expected the permanent loss of 0.34% of the Tinian reef habitat within and adjacent to the construction area at Unai Chulu and the additional disturbance associated with operations would prevent the long-term recovery of the coral reef ecosystem that could eventually occur in the absence of disturbance. As describe in *Marine Habitat and Essential Fish Habitat*, training activities at Unai Babui, Unai Lam Lam, and Unai Masalok (as deep as 5 feet [1.5 meters]) would directly and indirectly impact an additional 0.44% of total reef habitat at these three beaches on Tinian. Based on the low percentage of marine habitat loss in comparison to the total available marine habitat available to support marine invertebrates around Tinian, Tinian Alternative 1 operations would result in less than significant to marine invertebrates.

4.10.3.1.2.4 Fish

Actions that could potentially impact fish during proposed operations include landings of Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, and small inflatable boats. Fish may be temporarily displaced for the duration of training activities at these beaches. The coral section above details the loss of coral habitat that would occur during training activities. Coral impacts would directly and indirectly impact fish, as many fish species depend on this coral habitat for shelter, feeding, and reproduction. The overall impact to reef-associated fish populations on Tinian would be roughly proportional to the area of impact by the in-water training activities at Unai Chulu, Unai Babui, Unai Lam Lam, and Unai Masalok.

In-air noise has no potential to affect fish. As described previously (Section 4.10.3.1.2.1, *Marine Habitat and Essential Fish Habitat*) the underwater noise from vessels engaged in training would be brief, infrequent, and would not exceed levels likely to cause behavioral reactions in fish more than about 15 feet (4.6 meters) from the vessel. As a result, no significant impacts would result from underwater noise during operations. In addition, the potential for direct strikes to fish as a result of the proposed training is low as the noise and presence of vessels would likely cause fish to temporarily flee the area, and the resulting impact would be less than significant.

Tinian operation activities could cause temporary water quality impacts including increased turbidity, erosion, and sediment transport. Increases in turbidity could temporarily decrease the foraging efficiency of fish. In sandy areas, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized. Potential impacts from run-off from land-based operational activity, such as the landing of amphibious and small craft vehicles on beaches, could degrade water quality; however, any impacts would be localized, temporary in nature and be limited to training periods.

The use of beaches on Tinian for training operations would impact reef habitat through recurring disturbance and the resulting degradation of habitat. It is expected the permanent loss of 0.34% of the Tinian reef habitat within and adjacent to the construction area at Unai Chulu and the additional disturbance associated with operations would prevent the long-term recovery of the marine habitat that could eventually occur in the absence of disturbance. As described in *Marine Habitat and Essential Fish Habitat*, training activities at Unai Babui, Unai Lam Lam, and Unai Masalok (as deep as 5 feet [1.5 meters]) would directly and indirectly impact an additional 0.44% of total reef habitat at these three beaches on Tinian. Based on the low percentage of fish habitat loss in comparison to the total available marine habitat available to support fish around Tinian, Tinian Alternative 1 operations would result in less than significant to fish.

4.10.3.1.2.5 Special-status Species

Corals

The *Coral Marine Resource Survey* (provided in Appendix M, *Marine Biology Technical Memo and Survey Reports*) conducted in support of this EIS/OEIS recorded the presence of one Endangered Species Act-listed coral species, *Acropora globiceps*, at each beach (DoN 2014a). The three other Endangered Species Act-listed coral species discussed in Chapter 3 are not known to occur, and would be unlikely to occur, in appreciable numbers or areas within the training area footprints. Therefore, impacts to these other coral species are unlikely and considered less than significant.

Table 4.10-5 describes the impacts to *Acropora globiceps* in the Approach Zone at Unai Chulu, Unai Babui, Unai Masalok and Unai Lam Lam during operation/training activities. Vessels have the potential to impact marine species by disturbing the water column. Wash from vessel movement (water displaced by propellers/impellers used for propulsion) and water displaced from vessel hulls can potentially impact eggs and pelagic larvae of Endangered Species Act-listed corals (Bishop 2008; Bickel et al. 2011; Marshall 2012). Amphibious craft may affect the water column to a depth of approximately 12 feet (4 meters). Disturbance caused by propeller wash could extend to approximately twice this depth.

Table 4.10-5. Potential Impacts to Acropora globiceps at Unai Chulu, Unai Babui, Unai Masalok, and Unai Lam Lam During Operation/Training Activities[1]

	Unai Chulu[2]	*Unai Babui*[3]	*Unai Lam Lam*[4]	*Unai Masalok*[3]
Total extrapolated *Acropora globiceps* coral area (square feet) in the Approach Zone[5]	388	187.4	107.4	1.9
Extrapolated number of *Acropora globiceps* colonies in the Approach Zone	995	381	550	22
Density of *Acropora globiceps* colonies in the Approach Zone (per square meter)	0.09	0.06	0.04	< 0.005
Extrapolated area (square meter) covered by *Acropora globiceps* in the Approach Zone	36.1	17.4	10.0	0.2

Notes: [1]Calculations assume that the entire susceptible area of each Approach Zone (based on depth of construction or training activity: 5 feet (1.5 meters) for small boat landings and swimmers, 12 feet (4 meters) for Amphibious Assault Vehicles) is subject to physical effects. Effects to corals/seafloor outside of these depths in each area (e.g., deep grooves) and potential effects outside of the Approach Zone are excluded from this analysis, but are considered separately as potential indirect physical effects.
[2]Excludes entire Unai Chulu construction area to prevent double-counting.
[3]No Amphibious Assault Vehicles at Unai Babui or Unai Masalok. Calculation includes swimmers, small boat landings, and Landing Craft Air Cushion vessels set-down/turning circles.
[4]No Amphibious Assault Vehicles or Landing Craft Air Cushion vessels at Unai Lam Lam. Calculation includes swimmers and small boat landings.
[5]Species presence is based on recent high-intensity surveys of the Approach Zone (Minton et al. 2009; Sukhraj et al. 2010; DoN 2014d). Quantitative estimates of the numbers of Endangered Species Act-listed coral species are based on the most recent high-intensity survey (DoN 2014d). Calculations are based on in situ data that intersects with the proposed action areas to develop quantitative extrapolations for each reef zone. The values in the table are weighted sums.

Landing activities that contact the seafloor during operation include Amphibious Assault Vehicles, Landing Craft Air Cushion vessels and small boat landings. At the level of the individual coral, the consequences of physical strike by heavy equipment would be functionally equivalent to the consequences of physical strike by a swimmer's boot. However, at the level of coral reef habitat, the consequences of physical strike by an Amphibious Assault Vehicle would be greater than Landing Craft Air Cushion vessels, small boat, and swimmer landings because of the increased potential to reduce larger corals and reef substrate to smaller pieces of mobile rubble. In reef habitats, mobile fragments are transported up and down slope with greater amplitude than when they are transported laterally (Allingham and Neil 1995; Erftemeijer et al. 2012). Rubble mobilized from inside the area of direct physical impact would be transported outside the area of direct impact (Allingham and Neil 1995; Chew III 1999). The consequences of physical strike by an Amphibious Assault Vehicle would be greater in magnitude than the consequences of physical strike by rubble.

Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, and small boat landing activities all would generate underwater sound during Tinian operations. Although vessel noise could theoretically mask natural reef sounds that coral larvae use as settlement cues (Vermeij et al. 2010; Simpson et al. 2011), this would occur briefly, infrequently, and on a small scale. Therefore, noise impacts associated with Tinian Alternative 1 operations are not expected to impact *Acropora globiceps*.

However, in combination with the impact to *Acropora globiceps* from construction at Unai Chulu, the impact of physical disturbance on this species resulting from Tinian Alternative 1 operations would result in significant impacts to this species.

Sea Turtles

Training activities could cause sea turtles to avoid habitat or cause habitat to be unavailable since turtles may be temporarily displaced for the duration of training activities during operational activities. This would directly impact the local sea turtle population, as they depend on algae, sponges, and hiding locations on the reef for survival. In-water habitat disturbance during operations would be caused by Amphibious Assault Vehicles (at Unai Chulu) and Landing Craft Air Cushion vessels, which may contact the reef or otherwise alter the nearshore habitat. The regrowth of marine flora at Unai Chulu would be disrupted by periodic training activities, thus sea turtles would be disturbed or limited from foraging or resting in the low-relief habitat during training. As such, habitat disturbance from activities associated with Tinian Alternative 1 operations would have limited impacts to sea turtles. See Section 4.9, *Terrestrial Biology*, for potential impacts to nesting sea turtles.

Sea turtles cannot hear high frequency noises and have the greatest sensitivity between 200 to 400 hertz (Ridgway et al. 1969; Bartol and Ketten 2006). As sea turtles generally cannot hear well in air (Lenhardt et al. 1983), in-air noise is unlikely to cause any behavioral modification. Vessel noise could disturb sea turtles and potentially elicit an alerting, avoidance, or other behavioral reaction. Sea turtles are frequently exposed to research, ecotourism, commercial, government, and private vessel traffic. Some sea turtles may have habituated to vessel noise, and may be more likely to respond to the sight of a vessel rather than the noise of a vessel, although both may play a role in prompting reactions (Hazel et al. 2007). Any reactions are likely to be minor and short-term avoidance reactions, leading to no long-term consequences for the individual or population. Such disturbances would be brief, infrequent, and relatively isolated, affecting a small number of individuals at any one time, based on the size of the vessels (a small portion of the Approach Zone would be impacted at any one time) and turtle densities described in Section 3.10, *Marine Biology*. As such, acoustic disturbance by vessels resulting from Tinian Alternative 1 operations is considered less than significant.

Research suggests that sea turtles may not react quickly enough to move out of the way of vessels going faster than about 2.2 knots (4.0 kilometers per hour) (Hazel et al. 2007). Accordingly, there would be a risk of vessel strikes for turtles within the approach zones. The likelihood of vessel strikes to sea turtles is considered low given relatively few sea turtles in the approach zones and infrequent and localized vessel activity within these zones. While the risk would be low, some mortality due to vessel strikes cannot be ruled out and should be anticipated. Given the dynamic wave environment, increased turbidity and sedimentation would be temporary effects and unlikely to have any lasting impact to photosynthesis and food supply.

Overall, training activities may impact a small number of sea turtles due to the unavoidable risk of vessel strikes; however, this would be minimized due to the relatively few sea turtles in the approach zones and infrequent and localized vessel activity within these zones. Therefore, Tinian Alternative 1 operations would have a less than significant impact to sea turtle populations.

Marine Mammals

Vessel noise has the potential to cause minor disturbance to marine mammals and elicit an alerting, avoidance, or other behavioral reaction. Most studies have reported that marine mammals react to vessel noise and traffic with short-term interruption of behavior or social interactions (Watkins 1981; Richardson et al. 1995; Magalhaes et al. 2002; Noren et al. 2009). Some species respond negatively by retreating or responding to the vessel aggressively, while other animals ignore vessel noises altogether (Watkins 1986).

In conventional vessels, the sounds of the engine, transmission, and drive shaft(s) are conducted through the hull and into the water. When small, fast vessels are operated at high speeds, considerably less hull is exposed to the water, thus less sound is transmitted into the water. When a vessel planes above the water surface air is sucked under the hull as it travels. These bubbles of air, as well as the flow of water under the hull, produce some noise but also attenuate and scatter sounds for the engine. The bubbles of the wake also mask, scatter, and absorb sounds. When the Amphibious Assault Vehicles would be launched, they begin maneuvering in the idle mode, using jets only. Once they reach high speeds, planing above the water surface, a matter of seconds, the sound level drops off rapidly. When traveling, the sound increases as the Amphibious Assault Vehicle approaches, then falls off after it passes, like any moving sound source.

Given low densities of marine mammals in the surrounding waters (Section 3.10, *Marine Biology*), and the infrequent, localized occurrence of training activities, disturbance by vessels would be less than significant. Sightings data presented in Hill et al. (2014) shows that the spinner dolphin was the most often seen marine mammal species in the nearshore environment, with 54% of all encounters including sightings of the species. While Ligon et al. (2011) did not observe spinner dolphins during a concerted survey around Tinian; they did report anecdotal evidence of spinner dolphins off Tinian Harbor.

However, while this species was the most often sighted species by Hill et al. (2014), the locations of sightings indicated a greater presence in areas not associated with the region of influence. Based on these data, spinner dolphins that would be exposed to vessel traffic during operations would likely be transmitting through the region of influence, and their exposure would result in less than significant impacts. While other marine mammal species are present in the region of influence, their densities are lower than spinner dolphins, and impacts would be expected to be less than that for spinner dolphins. Furthermore, there are no known vessel strikes to marine mammals attributed to or by the U.S. Navy or U.S. Coast Guard vessels or amphibious vehicles in the region of influence or for Department of Defense amphibious vehicles at other training locations. Along with exposure to vessel traffic, marine mammals may detect and react to aircraft, but no more than momentary reactions would be anticipated, with negligible impacts to important behaviors.

In conclusion, Tinian Alternative 1 operations would result in less than significant impacts to marine mammals.

4.10.3.2 Tinian Alternative 2

4.10.3.2.1 Construction Impacts

The impacts to marine biological resources from construction activities associated with Tinian Alternative 2 would be the same as those described for Tinian Alternative 1. See Section 4.10.3.1, *Tinian Alternative 1*, for a discussion of impacts.

4.10.3.2.2 Operation Impacts

The impacts to marine biological resources from operational activities associated with Tinian Alternative 2 would be the same as those described for Tinian Alternative 1. See Section 4.10.3.1, *Tinian Alternative 1*, for a discussion of impacts.

4.10.3.3 Tinian Alternative 3

4.10.3.3.1 Construction Impacts

The impacts to marine biological resources from construction activities associated with Tinian Alternative 3 would be the same as those described for Tinian Alternative 1. See Section 4.10.3.1, *Tinian Alternative 1*, for a discussion of impacts.

4.10.3.3.2 Operation Impacts

The impacts to marine biological resources from operational activities associated with Tinian Alternative 2 would be the same as those described for Tinian Alternative 1. See Section 4.10.3.1, *Tinian Alternative 1*, for a discussion of impacts.

4.10.3.4 Tinian No-Action Alternative

The periodic non-live-fire military training exercises that have and would continue to occur in the Military Lease Area on Tinian would be primarily land based and not involve substantial activities in the nearshore marine environment. Vessel traffic would also carry some troops and equipment to Tinian causing minor turbidity from prop wash and other vessel actions. Additionally, activities covered in the Guam and CNMI Military Relocation EIS (DoN 2010a) and associated with constructing and operating four live-fire training ranges on Tinian would have less than significant impacts to marine biology (see Table 11.2-5, DoN 2010a). No significant impacts to marine biology would occur due to Mariana Islands Range Complex operations (see Table 3.7-21; DoN 2010b). Therefore, the no-action alternative would result in less than significant impacts to marine resources around Tinian.

4.10.3.5 Summary of Impacts for Tinian Alternatives

Table 4.10-6 provides a comparison of the potential impacts to marine biological resources for the three Tinian alternatives and the no-action alternative.

Table 4.10-6. Summary of Impacts for Tinian Alternatives

Resource Area	***Tinian (Alternative 1)***		***Tinian (Alternative 2)***		***Tinian (Alternative 3)***		***No-Action Alternative***	
Marine Biology	**Construction**	**Operation**	**Construction**	**Operation**	**Construction**	**Operation**	**Construction**	**Operation**
Marine Habitat/Essential Fish Habitat (Coral Reef)	*SI*	*LSI*	*SI*	*LSI*	*SI*	*LSI*	*LSI*	*LSI*
Marine Flora	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Marine Invertebrates (Coral)	*SI*	*LSI*	*SI*	*LSI*	*SI*	*LSI*	*LSI*	*LSI*
Marine Invertebrates (Non-coral)	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Fish	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Special-status Corals	*SI*	*SI*	*SI*	*SI*	*SI*	*SI*	*LSI*	*LSI*
Sea Turtles	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Marine Mammals	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*

Legend: *LSI* = less than significant impact; *SI* = significant impact. Shading is used to highlight the significant impacts.

4.10.3.6 Summary of Potential Mitigation Measures for Tinian Alternatives

Unlike resource management measures, which are implemented as part of the proposed action, commitment to the mitigation measures would be documented through the Record of Decision, a permit/approval, programmatic agreement or other formal agreement. Department of Defense may implement the following mitigation measures specifically for marine biological resources. Table 4.10-7 summarizes these measures.

Table 4.10-7. Summary of Potential Mitigation Measures for Tinian Alternatives

Impacts	*Category*	*Potential Mitigation Measures*	*Tinian Phase*	
			Construction	***Operation***
Marine Habitat and Essential Fish Habitat • Construction of underwater landing areas for Amphibious Assault Vehicles at Unai Chulu would result in the loss of 20.6 acres (8.3 hectares) of marine habitat within these areas impacted by direct and indirect physical disturbance stressors at Unai Chulu. • Construction would cause short- and long-term impacts to ecological function, including abundance/distribution of marine organisms. • Construction would result in loss/alteration of hard-bottom habitat and bathymetry.	*SI*	• DoD may consider transplantation of coral species. • DoD may consider debris removal and disposal as a one-time effort to collect large quantities of debris from an area such as Dankulo Beach on Tinian. • DoD may consider recreational mooring Buoys and/or Fish Aggregation Devices to avoid impacts to coral by dropping anchors and to reduce the potential effects on access to fishing areas. • Implementation of Marine Species Awareness Training for all lookouts and other key personnel. • Additional measures may be recommended during agency consultations.	X	X
Marine Invertebrates • A total area of 20.6 acres (8.3 hectares) of marine habitat that includes coral reef substrate (coral colonies and coral reef habitat) and supports populations of non-coral invertebrates would be directly and indirectly impacted by the construction of the Amphibious Assault Vehicle landing area at Unai Chulu. Adjacent corals outside the Amphibious Assault Vehicles landing areas may be indirectly impacted from the construction activities due to movement of coral	*SI*	See above, *Potential Mitigation Projects to Offset Impacts to Coral.*	X	X

Table 4.10-7. Summary of Potential Mitigation Measures for Tinian Alternatives

Impacts	***Category***	***Potential Mitigation Measures***	***Tinian Phase***	
			Construction	***Operation***
rubble, and from the movement of mobile species out of the construction area. Construction would cause direct loss of coral reef substrate: 10.3 acres (4.1 hectares). • Amphibious training activities at Unai Babui would directly impact 3.05 acres (1.2 hectares), 3.83 acres (1.55 hectares) would be directly impacted at Unai Lam Lam, and 4.50 acres (1.82 hectares) of marine habitat, including corals and coral reef habitat, would be directly impacted at Unai Masalok.				
Special-status Coral Species • Construction of the Amphibious Assault Vehicle landing area would cause a loss of 1,344 *Acropora globiceps* coral colonies at Unai Chulu. • At Unai Chulu, an estimate of 995 colonies of *Acropora globiceps* would be likely to be directly affected by training activities. At Unai Babui, an estimate of 381 colonies of *Acropora globiceps* would be likely to be directly affected by amphibious landings; at Unai Lam Lam, an estimate of 550 colonies of *Acropora globiceps* would likely be directly affected by amphibious landings; and at Unai Masalok, an estimate of 22 colonies of *Acropora globiceps* would likely be directly affected by amphibious landings.	*SI*	See above, *Potential Mitigation Projects to Offset Impacts to Coral.*	X	X

Legend: *SI* = significant impact. Shading is used to highlight the significant impacts.
Note: Mitigation measures associated with marine biology do not alter the significance of the impacts.

4.10.4 Pagan

As described in Chapter 2, up to six beaches would be used to conduct amphibious landings including Green, Red, Blue, South, Gold, and North Beach. No in-water construction activities would occur at proposed amphibious landing beaches. Table 4.10-8 provides a summary of the proposed training activities on Pagan.

Table 4.10-8. Pagan Beach Activity Overview

Beach	***Activity***
Green Beach	• Amphibious Assault Vehicle landings • Landing Craft Air Cushion vessel landings • Small boat landings • Swimmer insertions
Red Beach	• Amphibious Assault Vehicle landings • Landing Craft Air Cushion vessel landings • Small boat landings • Swimmer insertions
Blue Beach	• Amphibious Assault Vehicle landings • Landing Craft Air Cushion vessel landings • Small boat landings • Swimmer insertions
South Beach	• Landing Craft Air Cushion vessel landings • Small boat landings • Swimmer insertions
Gold Beach	• Small boat landings • Swimmer insertions
North Beach	• Small boat landings • Swimmer insertions

The operational activities associated with the Pagan Alternatives may result in impacts to marine resources at Green, Red, Blue, South, Gold, and North Beach. Sources of potential impact vary in intensity, frequency, duration, and location within the region of influence and would include: physical disturbance and vessel strikes, acoustic, and indirect impacts.

The approach to analysis for Pagan follows the methodology described in Section 4.10.1, *Approach to Analysis.* Section 4.10.2, *Resource Management Measures*, also applies to Pagan.

4.10.4.1 Pagan Alternative 1

4.10.4.1.1 Construction Impacts

No in-water construction is proposed under Pagan Alternative 1. The amphibious landing areas would not include any construction improvements (i.e., grading, drainage, or permanent improvements). Potential short-term impacts related to land-based construction include erosion, sedimentation, turbidity, and decreased water clarity. Storage and maintenance of construction equipment and supplies is anticipated to occur away from nearshore waters to reduce potential for impacts. In addition, best management practices including silt fence, turbidity barriers, tracking pads, filter strips, and other forms of temporary erosion/sedimentation control would be utilized to minimize impacts to nearshore waters resulting from construction activities. Based upon the above analysis and the implementation of resource management measures, Pagan Alternative 1 construction activities would result in less than significant impacts to marine biological resources.

4.10.4.1.2 Operation Impacts

Vessel-to-shore firing would occur in Pagan waters during live-fire amphibious training. As vessels (e.g., Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, and inflatable boat landings) come ashore, personnel would fire at targets on land. These vessels would use the same Approach Zones as non-live-fire activities. There would be a small chance (a tiny fraction of a percent) that an expended projectile would fall outside of the immediate range footprint, within the surface danger zone. There would be an even smaller chance for an expended projectile to fall within the nearshore waters portion or the fringes of the surface danger zone.

The landing of amphibious and small craft vehicles on beaches, beach and amphibious training maneuvers, and the use of Amphibious Assault Vehicles could impact nearshore water quality. Potential impacts include erosion, sedimentation, turbidity, decreased water clarity, and accidental discharge of pollutants. Stormwater runoff from High Hazard Impact Areas could also transport munitions constituents to nearshore waters resulting in indirect water quality impacts. Targets in the northern High Hazard Impact Area and most of the isthmus High Hazard Impact Area would be placed away from coastal cliff lines on relatively flat terrain that is visible from the firing positions. However, proposed targets on the steep slopes along the isthmus High Hazard Impact Area are close enough to the coast that dislodged rock, soil, or target material could fall into the nearshore waters below.

Potential indirect impacts would be reduced through the implementation of a stormwater management system, which would include the use of integrated management practices (Low Impact Development/best management practices), for the proposed development. The post-development stormwater management system for Pagan Alternative 1 would be developed, and Low Impact Development features would be utilized to control stormwater runoff from the Pagan RTA. Best management practices could include filter strips, bio-retention, vegetated swales and other forms of permanent erosion/sedimentation control and management measures. Implementation of a Range Environmental Vulnerability Assessment program would reduce potential impacts to water quality. Reevaluation of the effectiveness of management techniques being used would occur at a minimum every 5 years. Munitions and explosives constituents from munitions expended on land and the impacts to surface water runoff into the ocean are discussed in Section 4.3, *Water Resources*, and Section 4.16, *Hazardous Materials and Waste*.

4.10.4.1.2.1 Marine Habitat and Essential Fish Habitat

Table 4.10-9 presents the potential impacts to marine communities with implementation of the proposed action on Pagan. In addition to direct impacts, there are also potential indirect impacts associated with the proposed facilities and training areas.

Table 4.10-9. Summary of Potential Direct and Indirect Impacts to Marine Habitat on Pagan

Beach	*Area of Direct Effects (acres)*	*Area of Indirect Effects (acres)*	*Total Area of Likely Direct and Indirect Effects (acres)*
Green Beach Landings	10.98	*	10.98
Red Beach Landings	6.56	*	6.56
Blue Beach Landings	19.10	*	19.10
South Beach Landings	36.18	36.18 (**)	72.35
Gold Beach Landings	2.11	2.11 (**)	4.22
North Beach Landings	4.03	4.03 (**)	8.06

Note: * Mobile rubble would not be generated at these beaches and indirect effects would be limited to temporary increases in suspended sediments

**This analysis assumes mobile rubble would be generated at South, Gold, and North Beach. The size of the area exposed to indirect effects of mobile rubble generated by operations is conservatively estimated to be equal to the area of reef that would be exposed to direct effects.

The marine habitat at Green, Red, and Blue Beach consists of unconsolidated sediment (sand). Mobile rubble would not be generated at these beaches and indirect effects would be limited to temporary increases in suspended sediments in the water column rather than an increase in the acreage of impact.

The marine habitat at South, Gold, and North Beach is different in character (as described in Chapter 3) and mobile rubble could be generated during operation/training activities. When mobilized by water motion, any mobile rubble can strike or smother corals and degrade coral habitat. In this context, mobilized rubble includes living and dead coral colonies that are broken off of the substrate and reduced to a size that can be mobilized by water motion; reef substrate itself that is broken off; and preexisting unattached fragments.

This analysis makes reasonable qualitative assumptions about the movement of mobile rubble including: smaller fragments would be likely transported farther than larger fragments; both upslope and downslope transport would occur but net transport downslope would be likely; transport alongshore would occur but this would likely be smaller than downslope transport; flats and topographic lows (grooves in the coral reef) would be more likely to be affected than topographic highs; the likelihood of an unattached fragment becoming mobilized would be a function of its density, shape, water depth, and intensity of the water motion. The size of the area exposed to indirect effects of mobile rubble (outside of the direct physical disturbance from training) is conservatively estimated to be equal to the area exposed to direct effects. The shape of the indirectly affected area cannot be quantitatively estimated. There would be a gradient of disturbance within the area of indirect effect. The effects of mobilized rubble would be greater closer to locations where vehicles and personnel contact the bottom and reduced at increasing distances from the location of direct impacts based on the assumptions for rubble movement.

Operation and training activities would result in minor short- and long-term impacts to Marine Habitat and Essential Fish Habitat. A small portion of the entire landing area would be subject to impact during a given exercise. The physical disturbance impact would be limited to the immediate area of the vessels, and if landings are conducted in different parts of the beach at different times, areas of previous disturbance would recover to varying degrees. Recurring disturbance in the same locations would result in more severe impacts but within smaller areas. Thus the acreages in Table 4.10-9 represent the maximum cumulative extent of physical disturbance to marine habitats over time.

Operational activities may impact the water quality and introduce noise in the water column within the designated Essential Fish Habitat area for pelagics, bottomfish, crustaceans, and coral reef ecosystems. Potential impacts to the water column habitat by vessel noise during the proposed operational activities would mainly include impacts to prey species, including fish and invertebrates. Vessel movements have the potential to expose fish and invertebrates to sound and general disturbance, which could result in short-term behavioral or physiological responses (e.g., avoidance, stress, increased heart rate) by fish that happen to be in close proximity to training. The effects would not be expected to compromise the general health or condition of individual fish or populations of invertebrates. It is expected that during training, fish would move away from the area of activity into sheltered or adjacent Essential Fish Habitat. Fish within Essential Fish Habitat may be affected by auditory masking or behavioral responses to vessel noise during operations, but these impacts to individuals would be temporary and occasional. As a result, vessel noise during operations would result in less than significant impacts to marine habitat or Essential Fish Habitat from implementation of Pagan Alternative 1.

Additional acoustic elements for combined level training on Pagan include weapons firing that would occur during amphibious training. Noise-generating activities would include live-firing, explosions within High Hazard Impact Areas, aircraft, land-based vehicles, and other ground-based acoustic sources. There would be land-based target areas inside of the High Hazard Impact Area(s) for high explosives. Small caliber weapons would fire at the Battle Sight Zero range and during live-fire amphibious beach training, less than 50-caliber munitions would be shot from amphibious craft at nearshore targets at Red, Blue, and Green Beach. Exposure of fish to noise generated from these activities would be negligible due to the distance of many of these operations from marine habitats and the limited transmission of airborne sound across the air-water boundary (Young 1973).

Increases in turbidity could occur at the proposed tactical amphibious landing beaches. However, given the dynamic nature of the habitat and the grain size of the material, turbidity would be expected to be minimal and localized. Potential impacts to water quality characteristics of the marine environment during coastal and inland operational activities would be reduced to the maximum extent practicable by implementing best management practices to control stormwater runoff and eutrophication (the process by which a body of water acquires a high concentration of nutrients). Potential impacts to water quality as a result of beach and amphibious training maneuvers, the use of Amphibious Assault Vehicles, and stormwater runoff from High Hazard Impact Areas are addressed in 4.3, *Water Resources.*

A minimal amount of total reef habitat at the beaches on Pagan would be affected by the in-water training activities. Current habitat types (hard bottom and, to a lesser degree, soft shore) would be impacted on a periodic basis over an area of currently undisturbed marine habitat whereby current habitat types and ecosystem functions could be lost or degraded, and recovery prevented. Therefore, Pagan Alternative 1 operational activities would result in less than significant impacts to marine habitats, including Essential Fish Habitat, on Pagan.

4.10.4.1.2.2 Marine Flora

The periodic training activities would temporarily disturb and alter the seafloor, water quality, and physical environment, but most of the seafloor in the training areas is sand and cobble, thus lacking in marine flora.

The actions that could potentially impact marine flora during the proposed operations include in-water training, landings of Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, and small boats, and operation of vessels in nearshore waters. Marine flora that could be impacted from the proposed training activities would be reef substrate shallower than 12 feet (4 meters) below mean low water. Vessels conducting or supporting training could impact marine flora by disturbing the bottom and uprooting marine flora. Swimmers could impact flora through disturbance of the near shore environment. Operational impacts would be periodic.

Marine flora habitat may be directly and indirectly disturbed at Green, Red, Blue, South Beach, North, and Gold Beaches respectively during training activities associated with Pagan Alternative 1 (see Table 4.10-9). Based on the sum of the area shallow enough to be affected by the in-water training activities at the identified Pagan training beaches, implementation of Pagan Alternative 1 would impact approximately 1.37% of total reef habitat where marine flora could grow around Pagan through direct and indirect effects from operational activities.

Therefore, given the limited extent of marine flora and reef habitat that would be affected, Pagan Alternative 1 operations would result in less than significant impacts to marine flora.

4.10.4.1.2.3 Marine Invertebrates

The primary actions that could impact marine invertebrates during training activities would be operation of Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, inflatable boat landings, and swimmers in nearshore waters.

Overall, Pagan has low coral densities across the proposed action beaches; therefore, the overall total coral loss would be limited. The coral communities at Green Beach, Red Beach, and Blue Beach are primarily confined to the rocky headlands adjacent to the proposed landing areas. Sand and turf covered rubble dominate much of the sea floor at Red and Blue Beach (DoN 2014a). Gold and South Beach are rich and complex reefs and proposed operation activities would impact a larger number of coral colonies and species as discussed below.

Non-coral marine invertebrates (starfish, sea urchins, sea cucumbers, mollusks, and tube worms) could also be subject to direct and indirect impacts associated with operations and training. Some non-coral marine invertebrates would be directly impacted (i.e. mortality) during training. Non-coral invertebrate communities dominated by mollusks snails, sea slugs, clams and sea urchins (Sukhraj et al. 2010), could also be impacted to the extent that the coral habitat is affected on Pagan. Sea cucumbers are a significant part of the invertebrate community on Pagan, but would be less affected because they burrow and feed on detritus in the sediments rather than living on the hard coral reef.

Green Beach

Most of the seafloor in the Approach Zone at Green Beach is sand and cobble, while reef substrate is uncommon (DoN 2014a). At Green Beach, landings of Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, small boat landings, and swimmers could directly affect coral colonies and coral reef habitat shallower than 12 feet (4 meters), but the total loss would be limited because of low coral densities in these areas (see Figures 4.10-9 and 4.10-10). The area of seafloor shallower than 12 feet (4 meters) in the Approach Zone at Green Beach is 10.9 acres (4.4 hectares).

Red Beach

Most of the seafloor in the Approach Zone at Red Beach is sand and cobble, while reef substrate shallower than 12 feet (4 meters) is absent (DoN 2014a). At Red Beach, landings of Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, small boats, and swimmers could directly affect coral colonies and coral reef habitat, but the total loss would be limited because of low coral densities in these areas (see Figures 4.10-11 and 4.10-12). No portions of the Red Beach seafloor were of high complexity or high coral cover. The majority of the coral at Red Beach was observed at the headlands to the north and south of Red Beach at depths shallower than 12 feet (4 meters), but not directly in front of the sandy beach. The area of seafloor shallower than 12 feet (4 meters) in the Approach Zone at Red Beach is 6.5 acres (2.6 hectares).

Blue Beach

Most of the seafloor in the Approach Zone at Blue Beach is sand and cobble, while substrate suitable for coral is uncommon (DoN 2014a). At Blue Beach, Amphibious Assault Vehicles landings, Landing Craft Air Cushion vessels landings, small boat landings, and swimmer landings could directly affect the seafloor and impact coral, but the total loss would be limited because of low coral densities in these areas (see Figures 4.10-13 and 4.10-14). The majority of the coral at Blue Beach was observed at the headlands to the north and south of Blue Beach, but not directly in front of the sandy beach. The area of seafloor shallower than 12 feet (4 meters) in the Approach Zone at Blue Beach is 19.0 acres (7.6 hectares).

South Beach

The area of reef habitat shallower than 5 feet (1.5 meters) in the bounds of the Approach Zone at South Beach is 36 acres (14.5 hectares). At South Beach, Landing Craft Air Cushion vessels landings, small boat landings, and swimmer landings would directly affect coral colonies and coral reef habitat shallower than 5 feet (1.5 meters), but the total loss would be limited because of low coral densities in these areas (see Figures 4.10-15 and 4.10-16).

North Beach

The coral species at North Beach are less diverse relative to other sites on Pagan (DoN 2014a) (Figure 4.10-17). At North Beach, small boat landings, and swimmer landings could directly affect coral colonies and coral reef habitat as deep as 5 feet (1.5 meters) below mean low water.

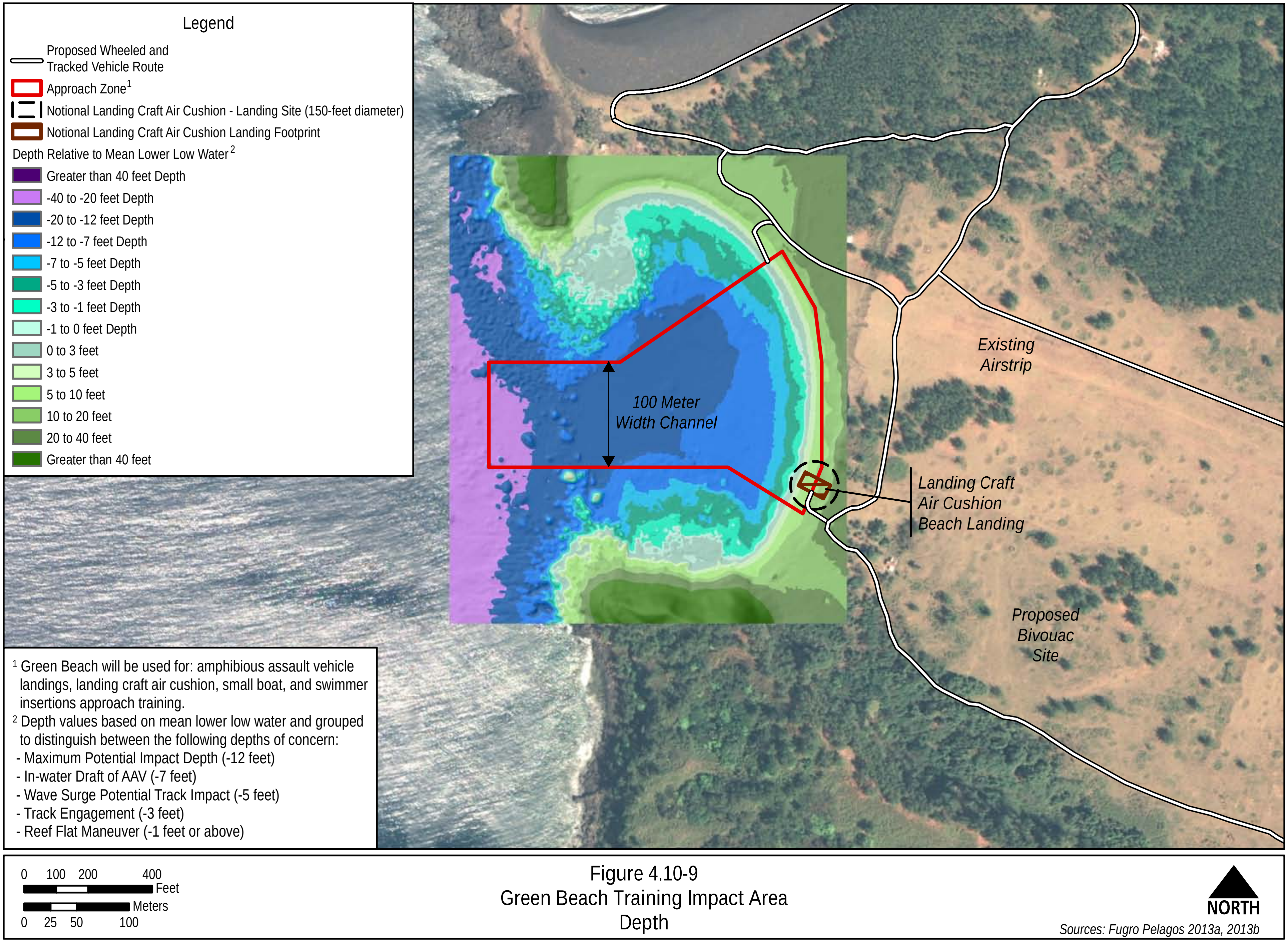


Figure 4.10-9
Green Beach Training Impact Area
Depth

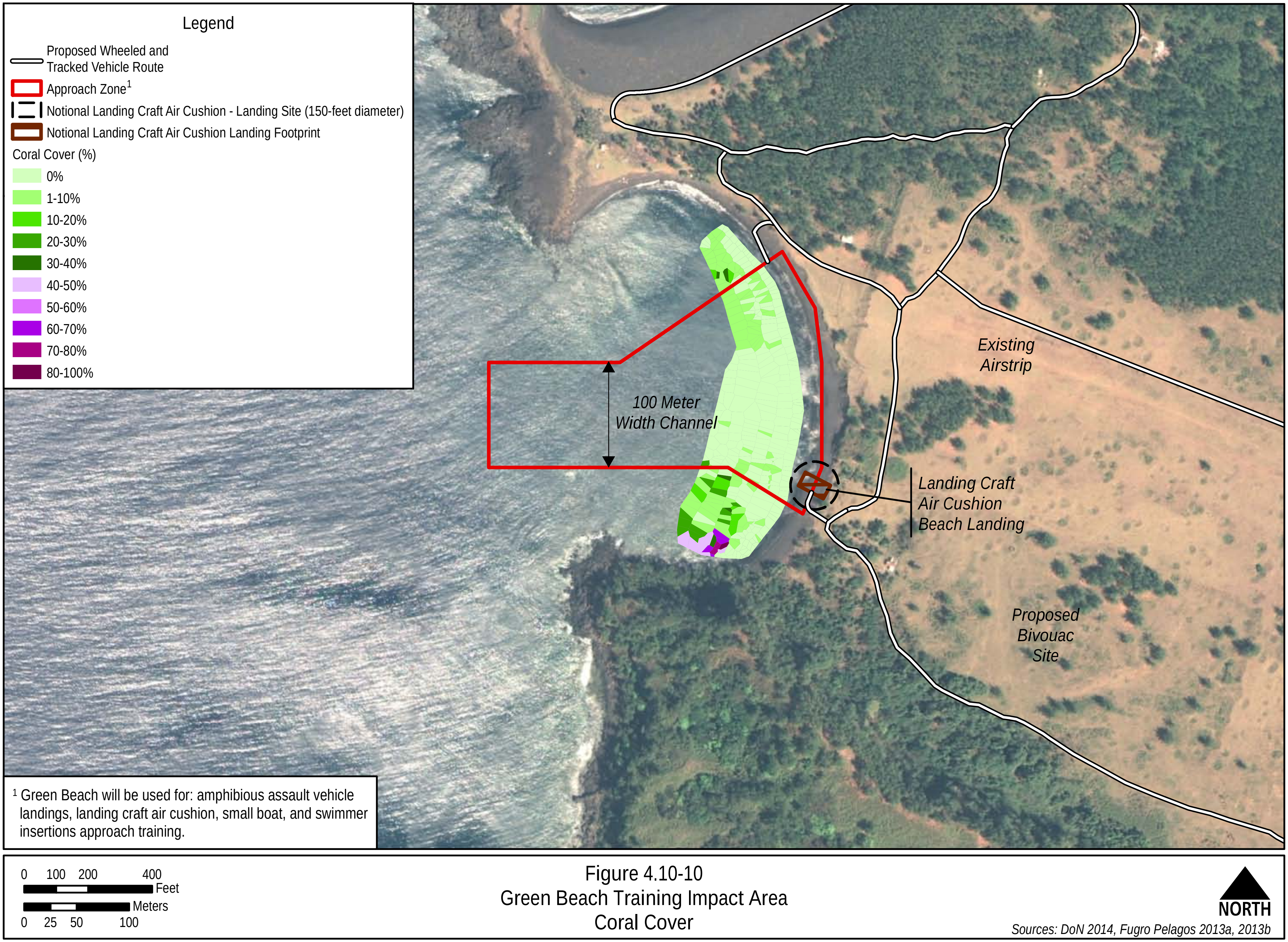
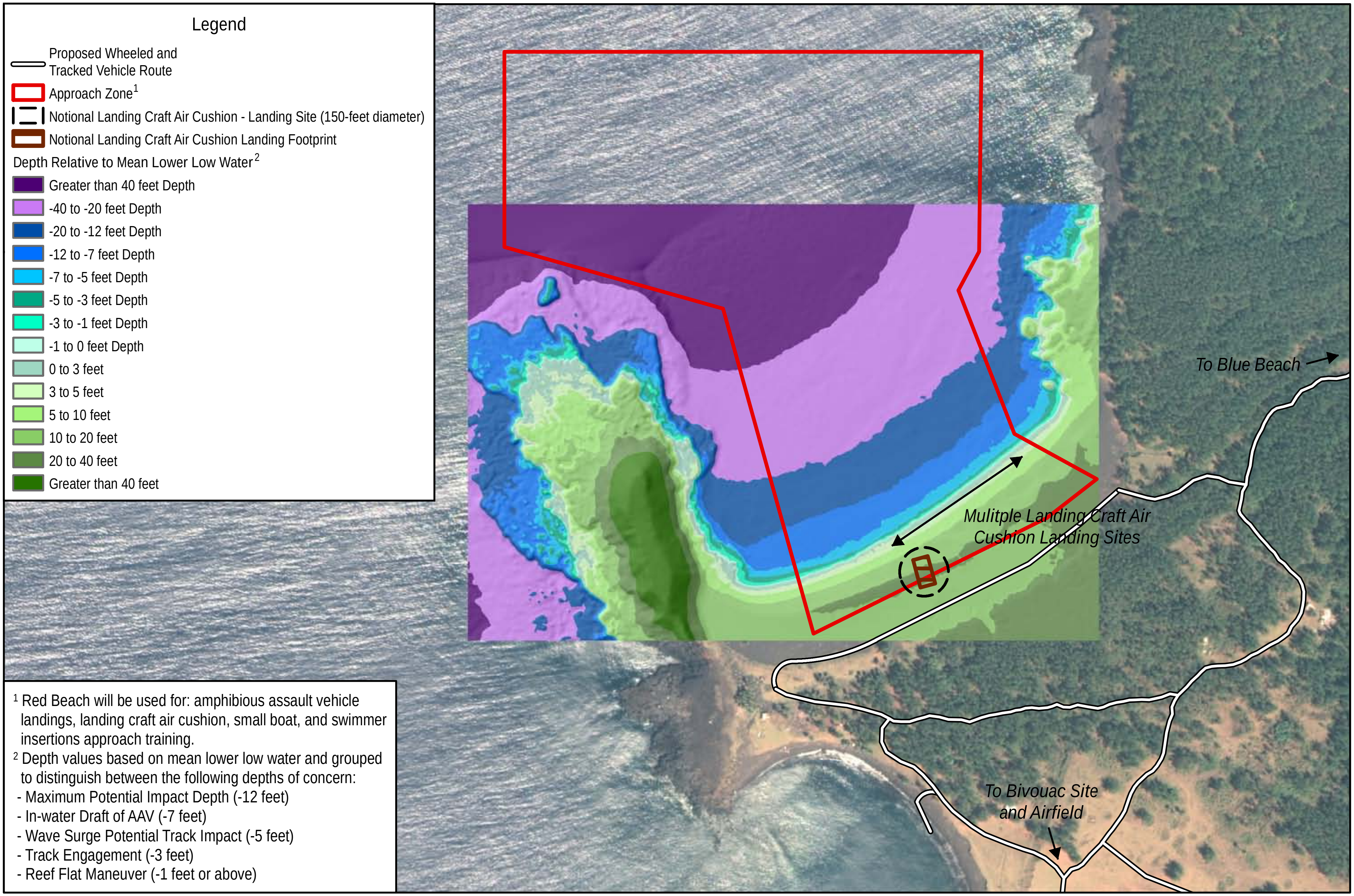


Figure 4.10-10
Green Beach Training Impact Area
Coral Cover

Sources: DoN 2014, Fugro Pelagos 2013a, 2013b



[1] Red Beach will be used for: amphibious assault vehicle landings, landing craft air cushion, small boat, and swimmer insertions approach training.

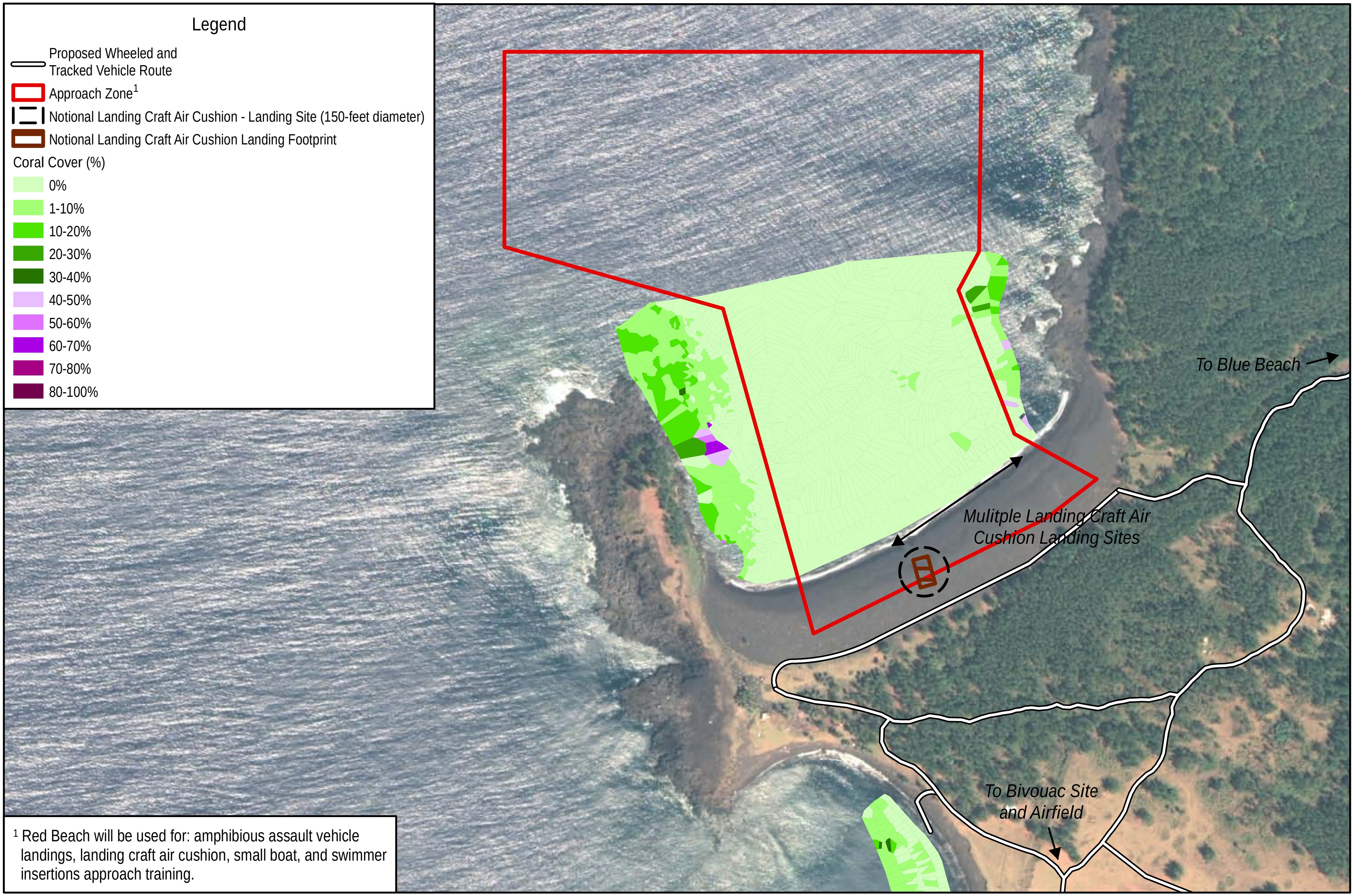
[2] Depth values based on mean lower low water and grouped to distinguish between the following depths of concern:
- Maximum Potential Impact Depth (-12 feet)
- In-water Draft of AAV (-7 feet)
- Wave Surge Potential Track Impact (-5 feet)
- Track Engagement (-3 feet)
- Reef Flat Maneuver (-1 feet or above)

0 100 200 400 Feet
0 25 50 100 Meters

Figure 4.10-11
Red Beach Training Impact Area
Depth

NORTH

Sources: Fugro Pelagos 2013a, 2013b



0 100 200 400 Feet

0 25 50 100 Meters

Figure 4.10-12
Red Beach Training Impact Area
Coral Cover

NORTH

Sources: Fugro Pelagos 2013a, 2013b

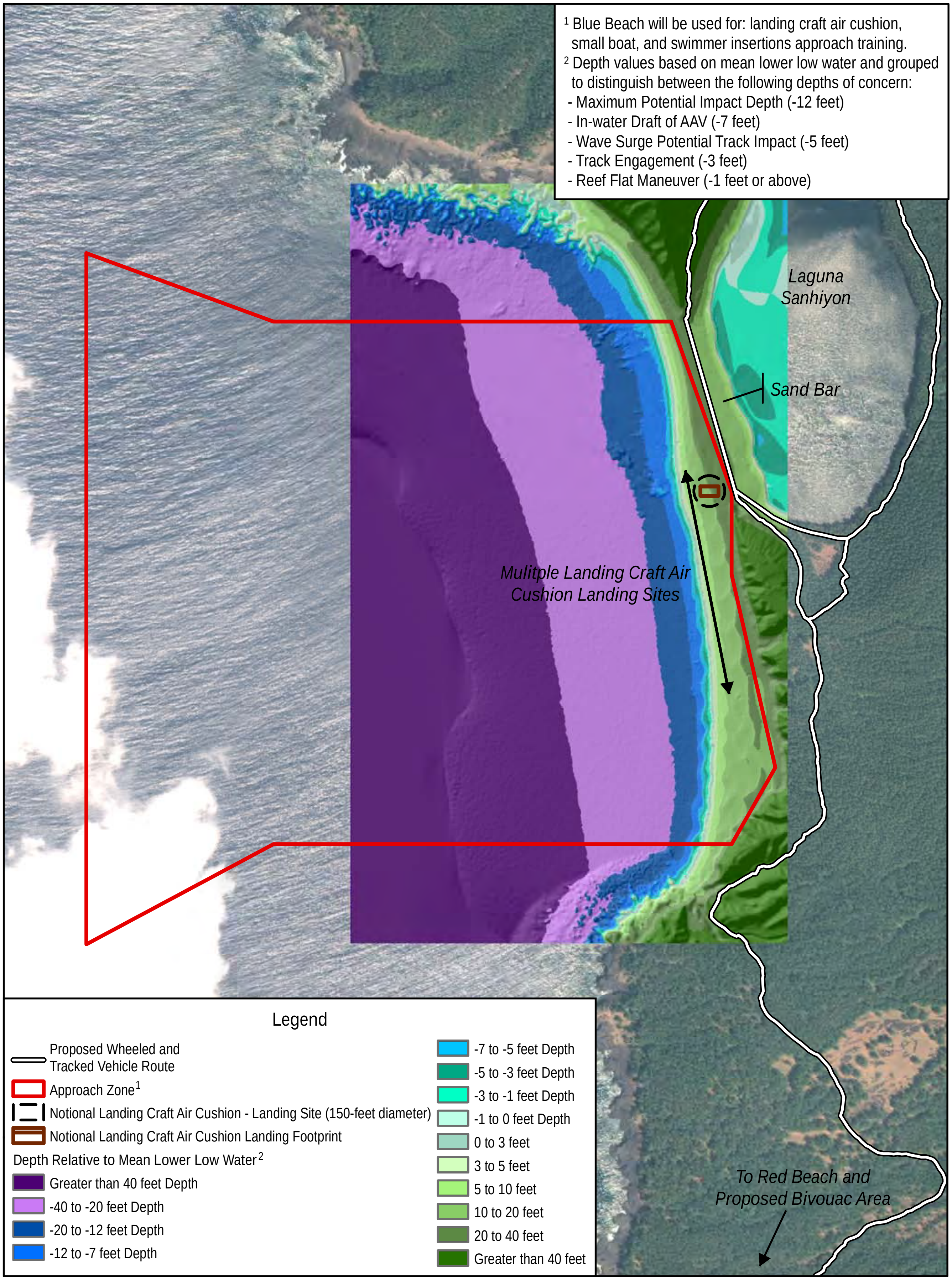


Figure 4.10-13
Blue Beach Training Impact Area
Depth

Sources: Fugro Pelagos 2013a, 2013b

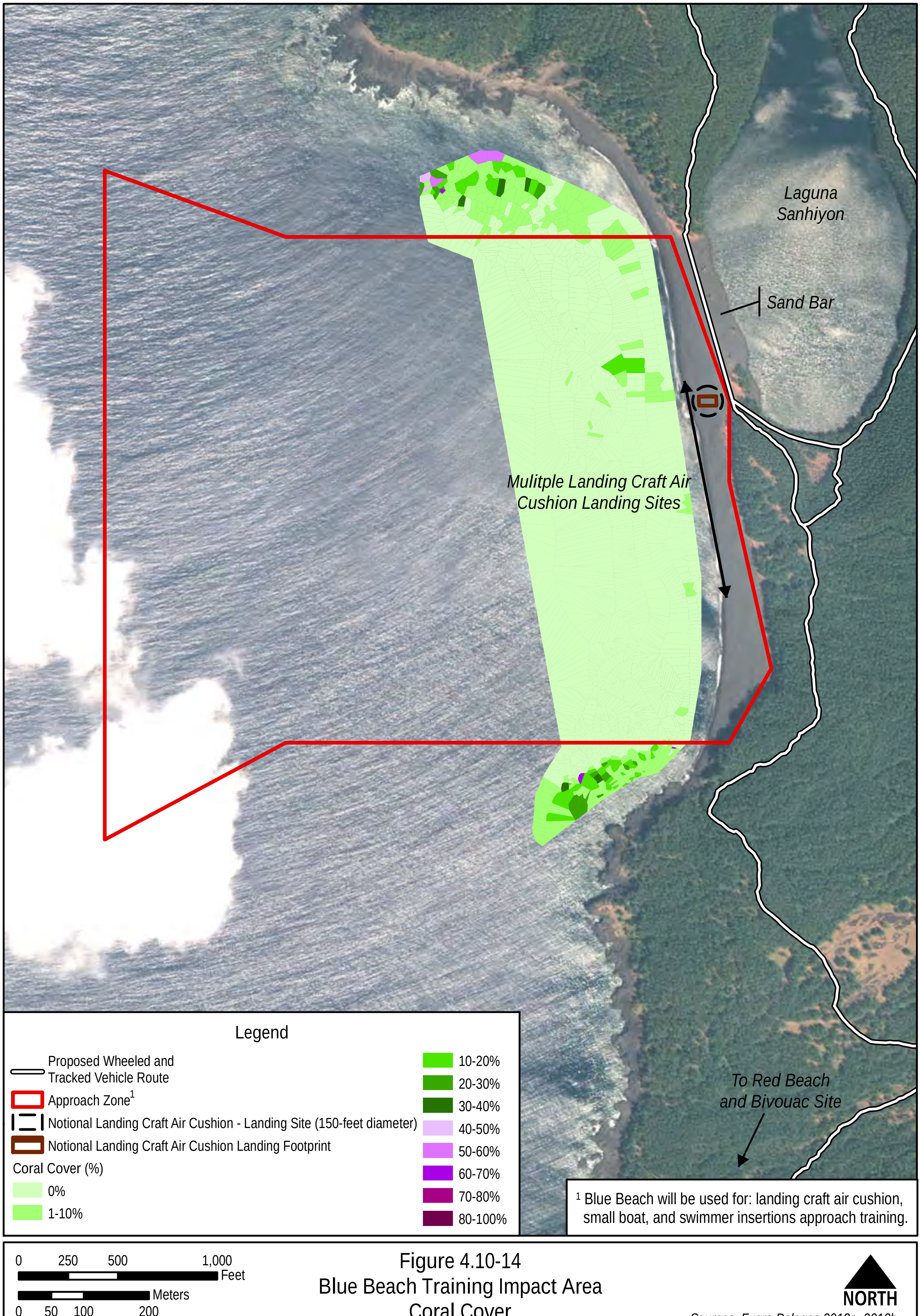


Figure 4.10-14
Blue Beach Training Impact Area
Coral Cover

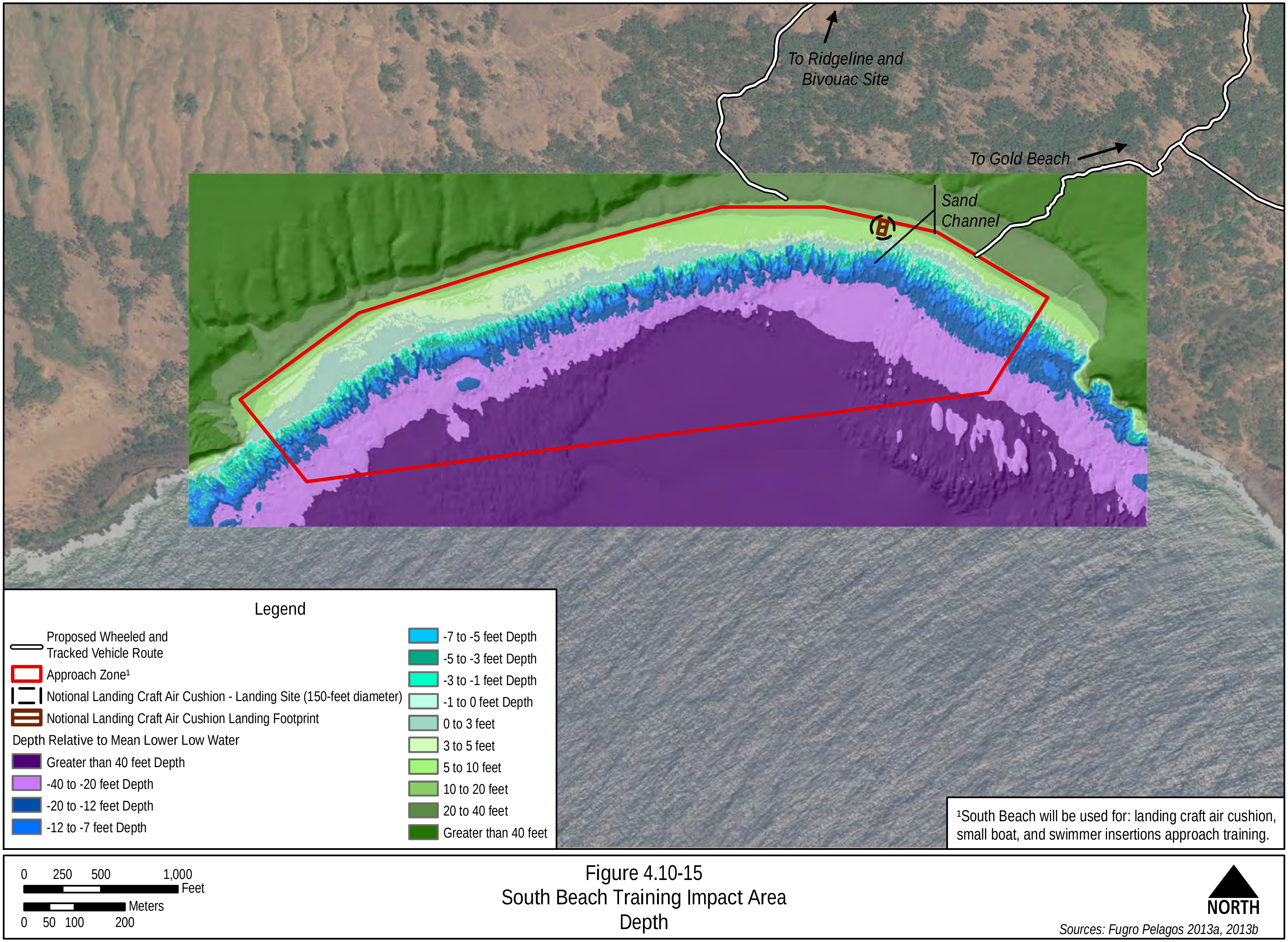


Figure 4.10-15
South Beach Training Impact Area
Depth

Sources: Fugro Pelagos 2013a, 2013b

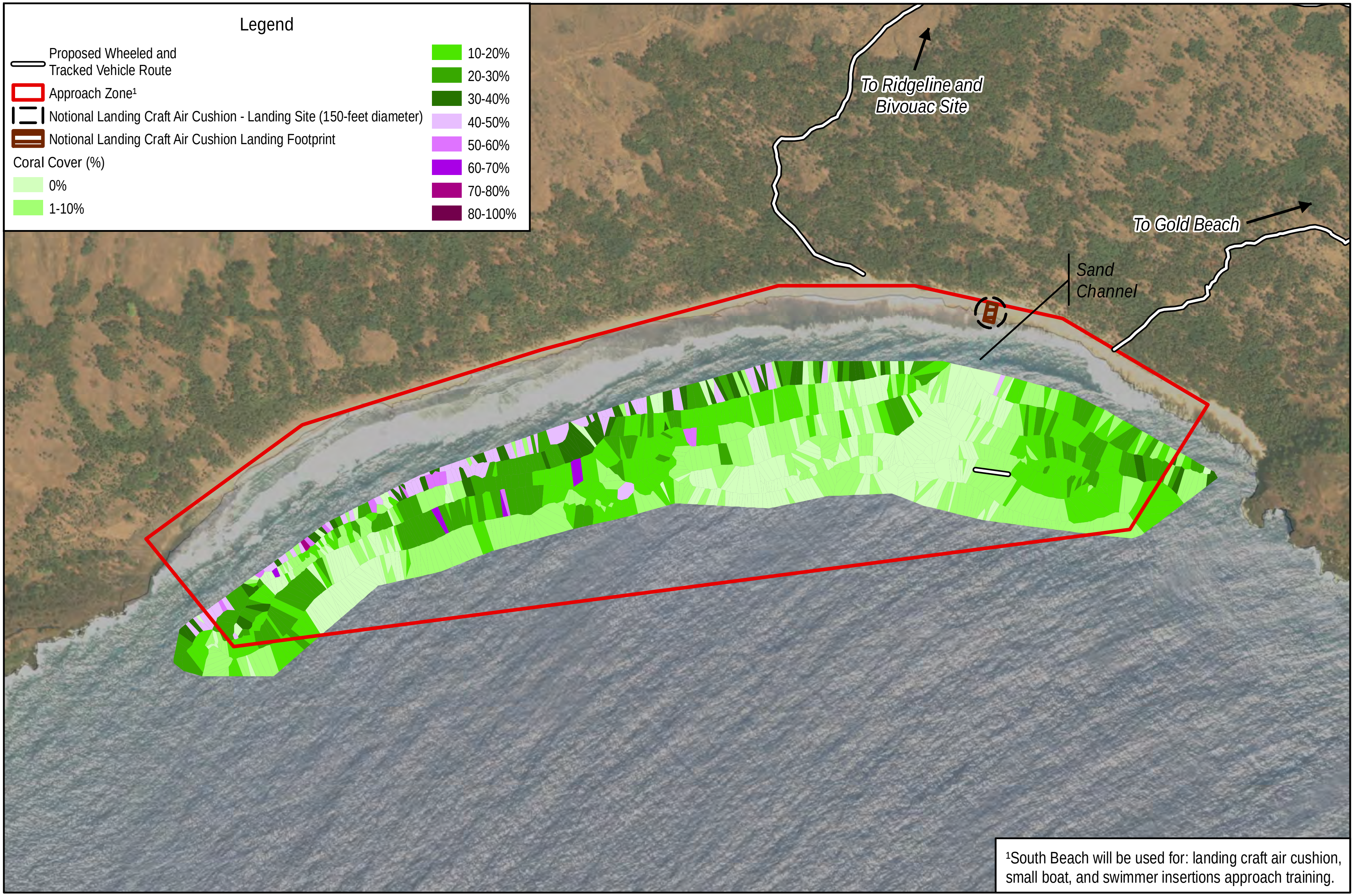


Figure 4.10-16
South Beach Training Impact Area
Coral Cover

Sources: Fugro Pelagos 2013a, 2013b

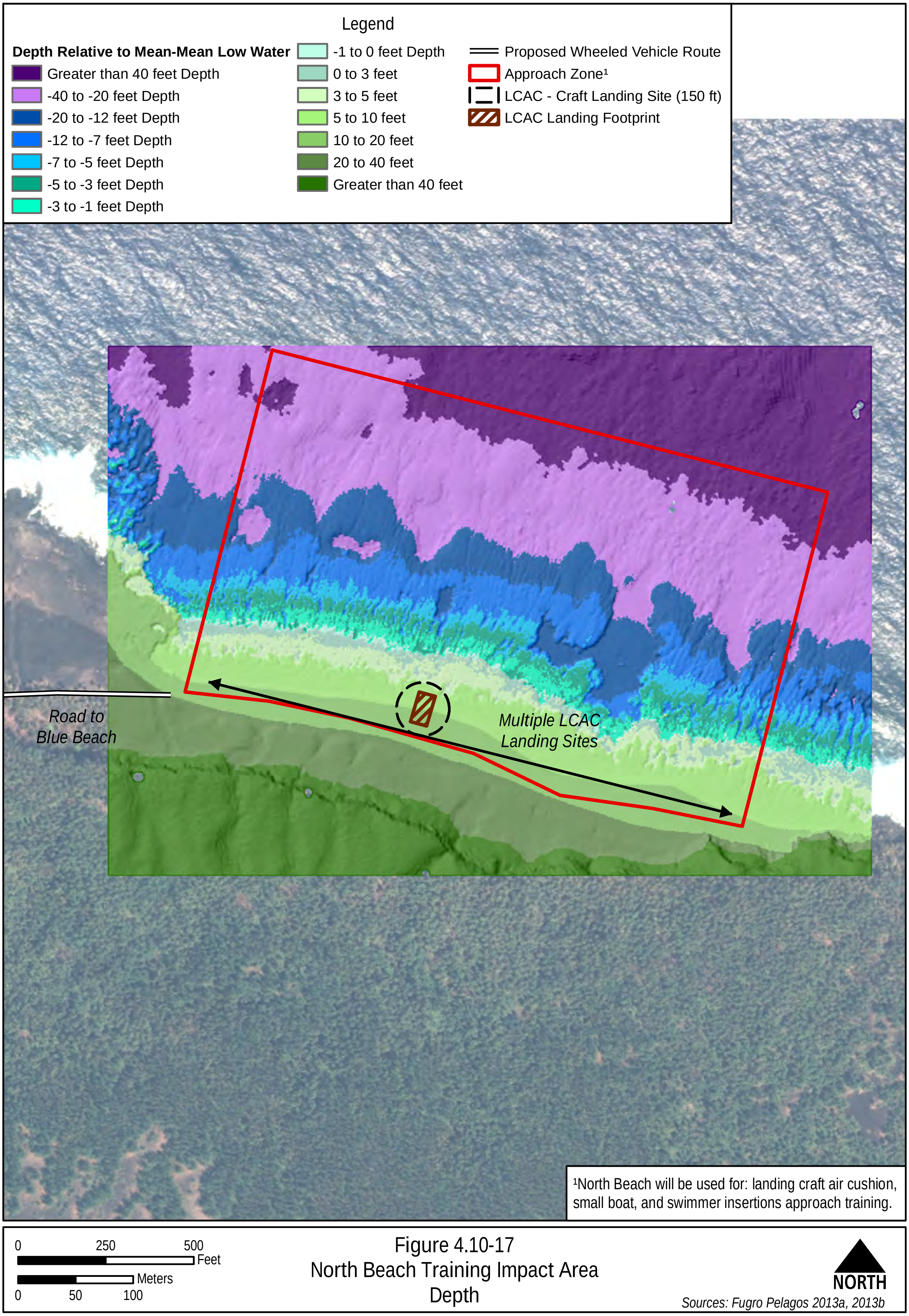


Figure 4.10-17
North Beach Training Impact Area
Depth

Gold Beach

Coral species richness was relatively high at Gold Beach (see Figures 4.10-18 and 4.10-19). At Gold Beach, small boat landings, and swimmer landings could directly affect coral colonies and coral reef habitat shallower than 5 feet (1.5 meters) below mean lower low water. The habitat is more similar to South Beach than to Green, Red, or Blue Beaches. Because of challenging sea states affecting this beach much of the time, Gold Beach is likely to accommodate draining less often than any other training beach on Pagan.

Marine habitat at Pagan beaches, including some corals and coral reef habitat, would be directly impacted by Pagan Alternative 1 operations (see Table 4.10-9). The beaches are relatively species-rich; however, the coral communities are confined to the rocky headlands adjacent to the proposed landing areas that would receive the largest training activity and would be largely unaffected. As stated in Chapter 3, Table 3.10-1, 65,920 acres (26,676 hectares) of total reef habitat are present across the Mariana Islands, 4,416 acres (1,787 hectares) of which is present around Pagan. Based on the sum of the area shallow enough to be affected by the in-water training activities at the identified Pagan training beaches, Pagan Alternative 1 operations would impact approximately 1.37% of total reef habitat around Pagan through direct and indirect effects. Therefore, based on the relatively small areas of impact to marine habitat and corals, Pagan Alternative 1 operations would result in less than significant impacts to marine invertebrates.

4.10.4.1.2.4 Fish

Actions that could potentially impact fish during proposed operations include landings of Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, and small inflatable boats; in-water training, increased vessel traffic, increased noise levels from vessels and weapons fire, and operation of vessels in nearshore waters. Fish may be temporarily displaced for the duration of training activities at these beaches. The coral section above details the loss of coral habitat that would occur during training activities. Coral impacts would directly and indirectly impact fish, as many fish species depend on this coral habitat for shelter, feeding, and reproduction. The overall impact to reef-associated fish populations on Pagan would be expected to be less than proportional to the area of impact, which is 1.37% of the reef habitat on Pagan. This impact would be less than significant.

In-air noise has no potential to affect fish. As described previously in Section 4.10.4.1.2.1, *Marine Habitat and Essential Fish Habitat* the underwater noise from vessels engaged in training would be brief, infrequent, and would not exceed levels likely to cause behavioral reactions in fish more than about 15 feet (4.6 meters) from the vessel. As a result, no significant impacts would result from underwater noise during operations. Additional acoustic elements for combined level training on Pagan include weapons firing that would occur during amphibious training. Weapons firing activities would occur as Amphibious Assault Vehicles approach the shoreline for proposed training beaches on Pagan. Firing of these weapons could have acoustic effects from sound generated by firing the gun and vibration propagating through the vessel hull. It is anticipated that the acoustic effect of weapons firing would be temporary and minimal.

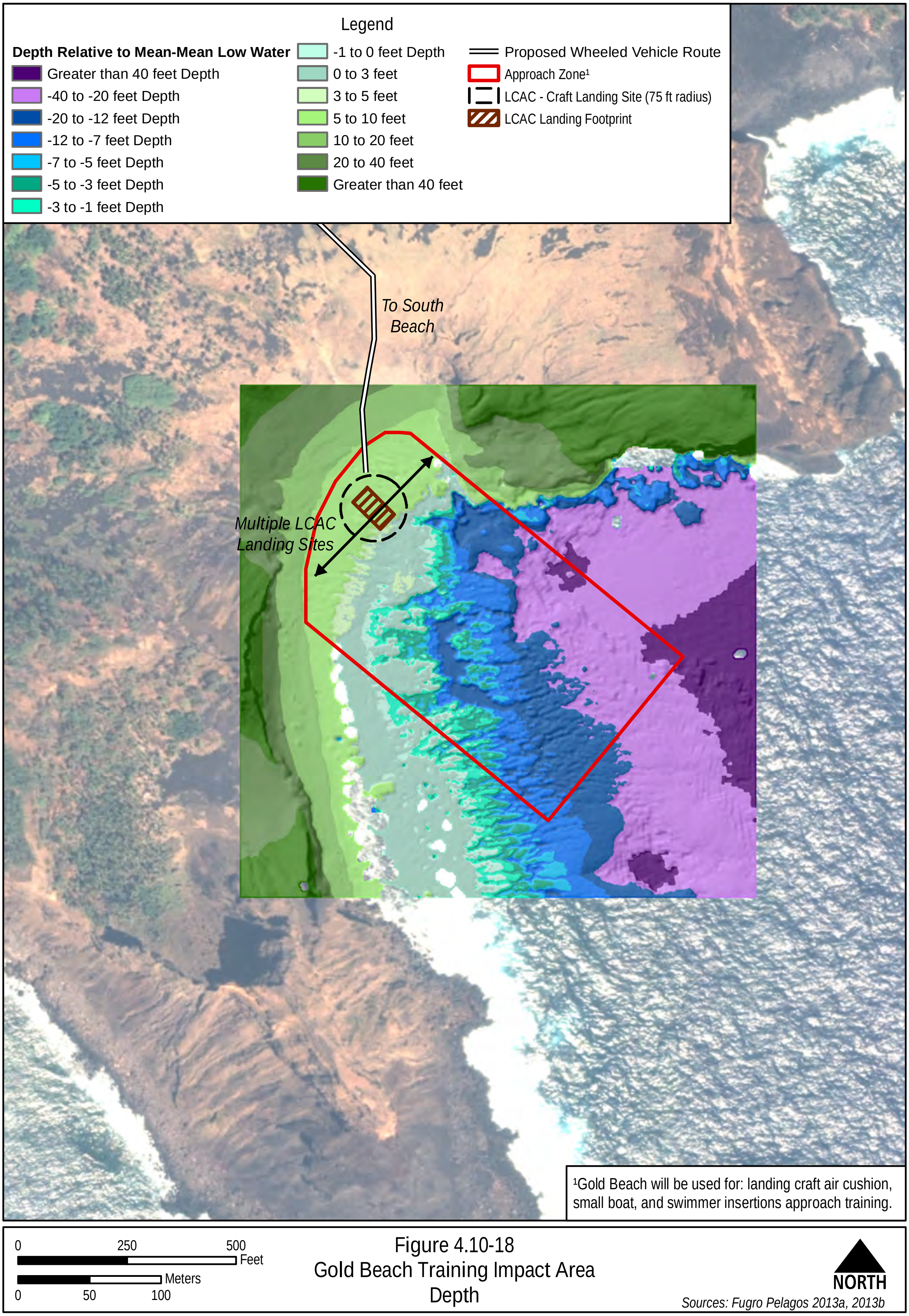
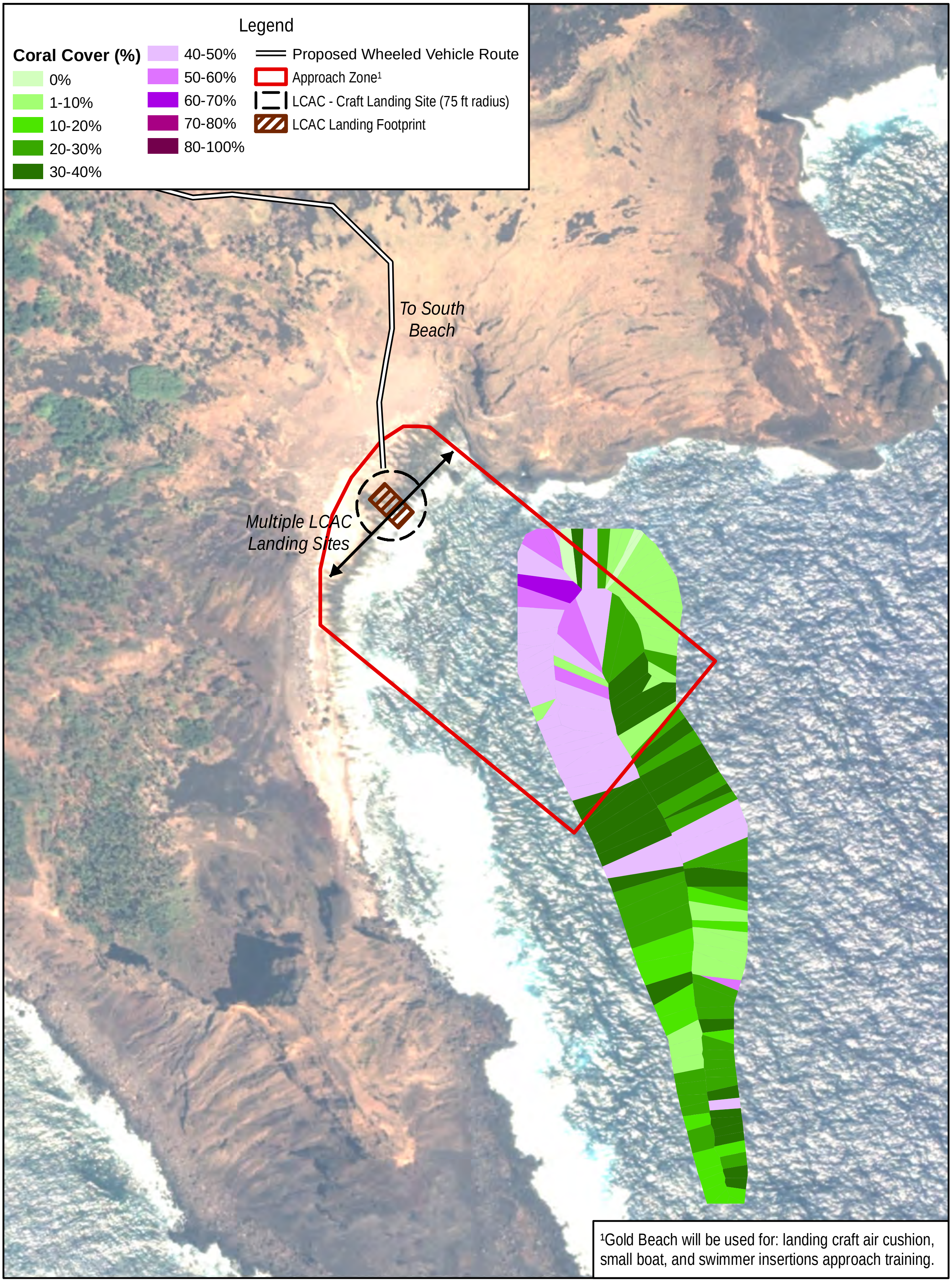


Figure 4.10-18
Gold Beach Training Impact Area
Depth

Sources: Fugro Pelagos 2013a, 2013b



0 250 500 Feet

0 50 100 Meters

Figure 4.10-19
Gold Beach Training Impact Area
Coral Cover

NORTH

Sources: Fugro Pelagos 2013a, 2013b

The potential for direct strikes to fish as a result of the proposed training is low as the noise and presence of vessels would likely cause fish to temporarily flee the area, and the resulting impact would be less than significant. As Amphibious Assault Vehicles plane along on the surface of the water, these vessels have a low chance of striking fish at or near the surface. Landing Craft Air Cushion vehicles operates above the surface and would not be likely to strike fish. It is assumed that small inflatable boats used for combat swimmer training would be similar to other small vessel activity in nearshore waters and would not have a high likelihood of striking fish. Most adult fish can detect and avoid vessels in response to engine noise and would likely flee the area during training activities.

Operational activities at Pagan may expose fish to sounds and general disturbance that could result in short-term behavioral or physiological responses (e.g., avoidance, stress, increased heart rate), but would not be expected to compromise the general health or condition of individual fish or populations. The underwater noise from vessels engaged in training activities would be brief, infrequent, and would not exceed levels likely to cause behavioral reactions in fish more than about 15 feet (4.6 meters) from the vessel.

Potential impacts to water quality characteristics of the marine environment during coastal and inland operational activities would be reduced but not avoided by implementing resource management measures to control stormwater runoff, and eutrophication. Pagan operational activities could cause temporary water quality impacts including increased turbidity, erosion, and sediment transport. Increases in turbidity could temporarily decrease the foraging efficiency of fish. Habitat disturbance is expected to be minimal at the proposed landing beaches given the predominance of sand in the nearshore environment. Significant direct impacts to the reef at South and Gold Beaches are possible, which could adversely impact fish habitat and food sources (see Section 4.10.4.1.2.1, *Marine Habitat and Essential Fish Habitat*). The impact would be, at most, directly proportional to the total area altered. However, these impacts would be temporary in nature and limited to training activities. These impacts would be minimized through adherence to best management practices (Appendix D, *Best Management Practices*). Potential impacts to water quality as a result of beach and amphibious training maneuvers, the use of Amphibious Assault Vehicles, and stormwater runoff from High Hazard Impact Areas are addressed in 4.3, *Water Resources*.

The operational use of beaches on Pagan would impact approximately 1.37% of the reef habitat on Pagan through recurring disturbance and the resulting degradation of fish habitat. Therefore, Pagan Alternative 1 operations would result in less than significant impacts to fish.

4.10.4.1.2.5 Special-status Species

Corals

The *Coral Marine Resources Survey* conducted in support of this EIS/OEIS recorded the presence of one Endangered Species Act-listed coral species, *Acropora globiceps,* at all beaches on Pagan proposed for training (National Marine Fisheries Service 2012; DoN 2014a).

Table 4.10-10 lists the number of individual special-status coral colonies that would be directly affected at Green, Red, Blue, and South Beaches under the proposed action. In addition, the table lists the total area of coral loss.

Table 4.10-10. Potential Impacts to *Acropora globiceps* at Green, Red, Blue, South, Gold, and North Beach on Pagan[1]

	Green Beach[2]	*Red Beach[2]*	*Blue Beach[2]*	*South Beach[3]*	*Gold Beach[4]*	*North Beach[4]*
Total extrapolated *Acropora globiceps* coral area (square feet) in the Approach Zone*	0	0	0	2,242.2	‡	‡
Extrapolated number of *Acropora globiceps* colonies in the Approach Zone	1	†	†	10,609	‡	‡
Density of *Acropora globiceps* colonies in the Approach Zone (per square meter)	< 0.005	†	†	0.07	‡	‡
Extrapolated area (square meter) covered by *Acropora globiceps* in the Approach Zone	< 0.05	†	†	208	‡	‡

Notes: † Species is confirmed adjacent to the Approach Zone but not within.
‡ Species in confirmed within and adjacent to the Approach Zone, but no population data are available for effect calculations.
* Species presence is based on recent high-intensity surveys of the Action Area (Minton et al. 2009; Sukhraj et al. 2010; DoN 2014d). Quantitative estimates of the numbers of Endangered Species Act-listed coral species are based on the most recent high-intensity survey (DoN 2014d). Calculations are based on in situ data that intersects with the proposed action areas to develop quantitative extrapolations for each reef zone. The values in the table are weighted sums.
[1]Calculations assume that the entire susceptible area of each Approach Zone (based on depth of construction or training activity: 5 feet (1.5 meters) for small boat landings and swimmers, 12 feet (4 meters) for Amphibious Assault Vehicles) is subject to physical effects. Effects to corals/seafloor outside of these depths in each area (e.g., deep grooves) and potential effects outside of the Approach Zone are excluded from this analysis, but are considered separately as potential indirect physical effects.
[2]Green Beach, Red Beach, and Blue Beach are nearly 100% sand inside and adjacent to the proposed action areas. Consequently, corals in the areas are extremely uncommon.
[3]No Amphibious Assault Vehicles at South Beach. Calculation includes small boat landings and one Landing Craft Air Cushion vehicles set-down/turning circle. In a cursory survey of the shore-attached reef crest where Landing Craft Air Cushion vehicles set-down would occur, no Endangered Species Act corals were noted.
[4]No Amphibious Assault Vehicles or Landing Craft Air Cushion vehicles at North Beach, and Gold Beach.

Vessels have the potential to impact eggs and pelagic larvae of Endangered Species Act-listed corals by disturbing the water column (Bishop 2008; Marshall 2012). Wash from vessel movement (water displaced by propellers/impellers used for propulsion) and water displaced from vessel hulls can potentially impact eggs and pelagic larvae of Endangered Species Act-listed corals (Bickel et al. 2011). Amphibious craft may affect the water column to a depth of approximately 12 feet (4 meters). Disturbance caused by propeller wash could extend to approximately twice this depth.

Landing activities that contact the seafloor during operation include Amphibious Assault Vehicles, Landing Craft Air Cushion vessels and small boat landings. At the level of the individual coral, the consequences of physical strike by heavy equipment would be functionally equivalent to the consequences of physical strike by a swimmer's boot. However, at the level of coral reef habitat, the consequences of physical strike by an Amphibious Assault Vehicle would be greater than Landing Craft Air Cushion vessels, small boat, and swimmer landings because of the increased potential to reduce larger corals and reef substrate to smaller pieces of mobile rubble. Little to no coral is expected in the landing areas where Amphibious Assault Vehicles would be operating, so damage to Endangered Species Act-list corals from Amphibious Assault Vehicles is expected to be negligible.

The marine habitat at Green, Red, and Blue Beach consists of unconsolidated sediment. Mobile rubble would not be generated at these beaches and indirect effects would be limited to temporary increases in suspended sediments in the water column rather than an increase in the acreage of impact.

The marine habitat at South, Gold, and North Beach is different in character (as described in Chapter 3), and mobile rubble could be generated. Mobile fragments are transported up and down slope with greater amplitude than when they are transported laterally (Allingham and Neil 1995; Erftemeijer et al. 2012). Rubble mobilized from inside the area of direct physical impact would be transported outside the area of direct impact (Allingham and Neil 1995; Chew III 1999).

Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, and small boat landing activities all would generate underwater sound during Pagan operations. Although vessel noise could mask natural reef sounds that coral larvae use as settlement cues (Vermeij et al. 2010; Simpson et al. 2011), this would occur briefly, infrequently, and on a small scale. As such, the impact would be less than significant.

Green Beach has a single colony of *Acropora globiceps* and South Beach has an estimated 10,609 colonies. Coral heads at Green Beach would be flagged or marked to alert vessel operators and swimmers to avoid the area during training operations. No Endangered Species Act-listed corals are present in habitats shallower than 12 feet (4 meters) at Red and Blue Beach. Therefore, given the number of colonies of *Acropora globiceps* that would be impacted, primarily at South Beach, Pagan Alternative 1 operations would have a significant impact to this Endangered Species Act-listed species.

Sea Turtles

Red, Green, and Blue Beaches provide relatively limited foraging and resting habitat for sea turtles. High quality habitat occurs adjacent to these operational areas and sea turtles are likely to migrate through these zones. In-water operation of Amphibious Assault Vehicles, Landing Craft Air Cushion vessels, and small craft vehicles at Green, Red, and Blue Beaches could cause sea turtles to avoid habitat or cause habitat to be unavailable since turtles may be temporarily displaced for the duration of training activities. Sea turtle resting and foraging habitat disturbance from operations in the region of influence would be expected to be temporary and inconsequential. Impacts from underwater noise would likely result in a temporary fleeing response from turtles. Such impacts would be less than significant.

Sea turtles primarily hear low frequency sounds and have the greatest sensitivity between 200 to 400 hertz (Ridgway et al. 1969; Bartol and Ketten 2006). They generally cannot hear well in air (Lenhardt et al. 1983); therefore, in-air noise is unlikely to cause any behavioral modification. Vessel noise could disturb sea turtles and potentially elicit an alerting, avoidance, or other behavioral reaction. Such disturbances would be brief, infrequent, and relatively isolated, affecting a small number of individuals at any one time, based on turtle densities described in Section 3.10, *Marine Biology*. As such, acoustic disturbance by vessels resulting from Pagan Alternative 1 operations is considered less than significant.

Physical strike and disturbance of sea turtles could occur from the proposed operation actions on Pagan. Direct physical strike could cause death or injury and physical disturbance could negatively affect foraging, resting, and mating behavior as a result of the proposed action. Physical strikes from vessels would be the most significant in-water threat to sea turtles at Pagan, as it often causes serious injury or mortality. Research suggests that sea turtles may not react quickly enough to move out of the way of vessels going faster than about 2.2 knots (4.0 kilometers per hour) (Hazel et al. 2007). Accordingly, there would be a risk of vessel strikes for turtles within the approach zones. While the risk would be low, some mortality due to vessel strikes cannot be ruled out, and should be anticipated. Increased turbidity and sedimentation would be temporary effects due to the dynamic wave environment and would be unlikely to have any lasting impact to photosynthesis and food supply.

The total area of the Approach Zone at Green Beach is approximately 0.01 square mile (0.03 square kilometer), 0.08 square mile (0.21 square kilometer) at Red Beach, and 0.36 square mile (0.93 square kilometers) at Blue Beach. The area is 0.45 square mile (0.117 square kilometer) in total, which corresponds to approximately 50 sea turtles in the cumulative operations footprint. Amphibious Assault Vehicles and Landing Craft Air Cushion vessels, as well as small boats, would be operating at all locations. Therefore, it has been assumed that the entire Approach Zone presents a potential threat for vessel strikes. The turtles within this footprint, as well as any turtles migrating through the area, would be at risk of vessel strike.

Landing Craft Air Cushion vessels and small vessels would be operating at South Beach, while small inflatable boats would operate at North and Gold Beaches. There is a limited possibility of a Landing Craft Air Cushion vessel striking a sea turtle, so South Beach is discounted as a possible threat. Turtles within the footprint of North and Gold Beach would be at risk of vessel strike.

Hawksbill sea turtles contributes to approximately 33% of the total sea turtle population on Pagan (DoN 2014b). In addition, the island wide population of sea turtles is estimated at approximately 50% of Tinian's population, while total available habitat is similar between the two islands (DoN 2014b). As such, Pagan's average sea turtle density is approximately half of Tinian's average sea turtle density. As a result of the increase in total number of vehicles per landing associated with Combined Level Training over Unit Level Training, there may be an increase in the likelihood of impacts (particularly direct vessel strikes) to sea turtles due to the increase in training assets and complexity associated with this proposed training. However, this risk would be negated by the relatively few sea turtles in the approach zones and infrequent and localized vessel activity within these zones. Therefore, Pagan Alternative 1 operations would have less than significant impacts to sea turtles.

Marine Mammals

Vessel noise has the potential to cause minor disturbance to marine mammals and elicit an alerting, avoidance, or other behavioral reaction. Most studies have reported that marine mammals react to vessel noise and traffic with short-term interruption of behavior or social interactions (Watkins 1981; Richardson et al. 1995; Magalhaes et al. 2002; Noren et al. 2009).

In conventional vessels, the sounds of the engine, transmission, and drive shaft(s) are conducted through the hull and into the water. When small, fast vessels are operated at high speeds, considerably less hull is exposed to the water, thus less sound is transmitted into the water. When a vessel planes above the water surface air is sucked under the hull as it travels. These bubbles of air, as well as the flow of water under the hull, produce some noise but also attenuate and scatter sounds for the engine. The bubbles of the wake also mask, scatter, and absorb sounds. When the Amphibious Assault Vehicles would be launched, they begin maneuvering in the idle mode, using jets only. Once they reach high speeds, planing above the water surface, a matter of seconds, the sound level drops off rapidly. When traveling, the sound increases as the Amphibious Assault Vehicle approaches, then falls off after it passes, like any moving sound source.

Vessel-to-shore firing would occur in Pagan waters during live-fire amphibious training. Marine mammals in the vicinity of these activities would be expected to have an initial startle response.

Because these events are short-term, localized, and infrequent, they would not be expected to have long-term consequences for individuals or populations.

There is an increased potential for noise in the water from training vessels, but there would be no anticipated long-term consequences to the individual or populations. Short-term behavioral responses to noise associated with vessels is not likely to disrupt major behavior patterns such as migrating, breeding, feeding, and sheltering, or to result in serious injury to marine mammals. Along with exposure to vessel traffic, marine mammals may detect and react to aircraft, but no more than momentary reactions would be anticipated, with negligible impacts to important behaviors.

Given low densities of marine mammals in the surrounding waters (Section 3.10, *Marine Biology*), and the infrequent, localized occurrence of training activities, disturbance by vessels would be less than significant.

Based on data provided in the *Marine Mammal Survey* conducted in support of this EIS/OEIS (DoN 2014c) spinner dolphins were the marine mammal species most often observed (54% of encounters) around Pagan, with five of the groups seen on the eastern side of the island, and two on the western side of the island off Green Beach. All sightings were within 0.54 nautical miles (1 kilometer) of the shoreline, and the sightings were at depths of less than 686 feet (212 meters). Bottlenose dolphins and Cuvier's beaked whales were also encountered around the island. The bottlenose dolphins were sighted off the northwest coast and the Cuvier's beaked whale was encountered in over 2,000 feet (606 meters) of water. Based on their presence in the region of influence, spinner dolphins and the bottlenose dolphins would be the species most likely impacted by operations. However, short-term reactions to vessels are not likely to disrupt major behavior patterns such as migrating, breeding, feeding, and sheltering, or to result in serious injury to marine mammals. Furthermore, both spinner dolphins and bottlenose dolphins are highly mobile species that would likely leave the area in the event that operations were to occur in close proximity to individuals. Marine mammals being struck by vessels is not expected to occur in association with training around Pagan. There are no known ship strikes of marine mammals by U.S. Navy or U.S. Coast Guard vessels in the region of influence or for Department of Defense amphibious vessels at other training locations.

Military training activities could result in indirect impacts to marine mammals via habitat degradation or an effect on prey availability. Effects to prey items for marine mammals are less likely given that a large portion of their prey consist of pelagic plankton and fishes. Any effects to prey would be temporary, occurring during training activities involving direct use of landing area. No lasting impact to prey availability or the pelagic food web would be expected.

The overall impact to marine mammals from the proposed training activities during Pagan Alternative 1 operations would be less than significant.

4.10.4.2 Pagan Alternative 2

4.10.4.2.1 Construction Impacts

The impacts to marine biological resources from construction activities associated with Pagan Alternative 2 would be the same as those described for Pagan Alternative 1. See Section 4.10.4.1, *Pagan Alternative 1*, for a discussion of impacts.

4.10.4.2.2 Operation Impacts

The impacts to marine biological resources from operational activities associated with Pagan Alternative 2 would be the same as those described for Pagan Alternative 1. See Section 4.10.4.1, *Pagan Alternative 1*, for a discussion of impacts.

4.10.4.3 Pagan No-Action Alternative

Under the no-action alternative, there would be infrequent and minor DoD activities (i.e., search and rescue) around Pagan would be low impact and short duration. These activities would present less than significant impacts to Pagan's marine resources. Non-DoD activities include periodic visits for eco-tourism and scientific surveys.

4.10.4.4 Summary of Impacts for Pagan Alternatives

Table 4.10-11 provides a comparison of the potential impacts to marine biological resources for the two Pagan alternatives and the no-action alternative.

Table 4.10-11. Summary of Impacts for Pagan Alternatives

Resource Area	***Pagan (Alternative 1)***		***Pagan (Alternative 2)***		***No-Action Alternative***	
Marine Biology	**Construction**	**Operation**	**Construction**	**Operation**	**Construction**	**Operation**
Marine Habitat/Essential Fish Habitat	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Marine Flora	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Marine Invertebrates (Coral)	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Marine Invertebrates (Non-Coral)	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Fish	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Special-status Coral Species	*LSI*	*SI*	*LSI*	*SI*	*LSI*	*LSI*
Sea Turtles	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Marine Mammals	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*

Legend: *LSI* = less than significant impact; *SI* = Significant impact. Shading is used to highlight the significant impacts.

4.10.4.5 Summary of Potential Mitigation Measures for Pagan Alternatives

Table 4.10-12 provides a summary of the potential mitigation measures for marine biology resources for the two Pagan alternatives.

Table 4.10-12. Summary of Potential Mitigation Measures for Pagan Alternatives

Impacts	*Category*	*Potential Mitigation Measures*	*Pagan Phase*	
			Construction	*Operation*
Special-status Coral Species Amphibious training activities would cause a loss of one *Acropora globiceps* coral colony at Green Beach and an estimated 10,609 colonies at South Beach.	*SI*	• DoD may consider transplantation of coral species. • DoD may consider debris removal and disposal as a one-time effort to collect large quantities of debris from an area such as Gold Beach. • DoD may consider recreational mooring Buoys and/or Fish Aggregation Devices to avoid impacts to coral by dropping anchors and to reduce the potential effects on access to fishing areas. • Implementation of Marine Species Awareness Training for all lookouts and other key personnel. • Additional measures may be recommended during agency consultations.		X

Legend: *SI* = significant impact. Shading is used to highlight the significant impacts.
Note: Mitigation measures associated with marine biology do not alter the significance of the impacts.