4.3 WATER RESOURCES

Section 4.3 describes impacts to water resources as a result of the proposed action. It presents the analysis for the potential of the proposed action and its alternatives to alter drainage patterns, decrease water recharge rates, or adversely affect water quality. In general, potential impacts to water resources can cause changes to water quality and water supply, increased flooding, and concerns for erosion and sedimentation associated with stormwater runoff. The impacts of water resources on terrestrial and aquatic ecosystems are addressed in Section 4.9, *Terrestrial Biology* and Section 4.10, *Marine Biology*, respectively. Potential impacts to water supply and hydrology are addressed in Section 4.14, *Utilities*.

4.3.1 Approach to Analysis

This analysis considers information from the technical studies and surveys conducted for the CJMT EIS/OEIS and factors and conditions that can potentially affect water resources.

4.3.1.1 Surface Water

Surface water concerns include impacts to surface water features, drainage alterations, flood protection, and water quality degradation. Threats to surface water features include increased pollutant loads and loss of surface water area (dredge/fill alterations). Effects were assessed relative to the potential impacts from area loss where the proposed action may directly involve the fill or excavation of surface water features. Indirect impacts to surface water features were also assessed if the proposed action would potentially alter (i.e., divert or restrict) water circulation into/from surface waters features, and/or potentially involve the release of pollutants into these ecosystems. Potential impacts to surface water quantity during construction and operation were analyzed by examining changes in drainage patterns and runoff rates associated with alterations to topography/groundcover and increased impervious area. Loss of functionality in surface water features (i.e., ecosystem health and circulation) is assessed in Section 4.9, *Terrestrial Biology*.

In areas prone to flooding, construction of buildings and roads were evaluated relative to flood risks and hazards, such as inundation and erosion. Effects that also contribute to increasing flood flows (e.g., impermeable surface increases and reduced natural infiltration) were also addressed in this assessment. Topographic changes from grading and re-contouring of natural slopes were analyzed for their potential contribution to altering existing drainage patterns and potentially exacerbating flood hazards.

4.3.1.2 Groundwater

Groundwater concerns include potential impacts to groundwater quality and quantity associated with construction activities and training operations, such as the handling, use, and potential discharge (e.g., munitions constituents, spills, leaks, and deposition) of pollutants from materials and equipment. Once introduced to the ground surface, such contamination has the potential to impact groundwater quality through percolation. The availability of adequate groundwater resources may be impacted from increased impervious area, decreased infiltration potential, and increased groundwater consumption as a result of the proposed action. These issues were evaluated relative to construction and operation activities that could potentially affect groundwater recharge by altering the infiltration ability, and natural filtering qualities of area soils, as well as possibly introducing pollutants to groundwater resources through percolation, both of which would potentially decrease groundwater quality and availability.

4.3.1.3 Nearshore Waters

The nearshore water impact analysis focused on both potential impacts to water quality and the placement of permanent fill (e.g., structures or fill) in nearshore waters as a result of the proposed action. The potential impacts to nearshore water quality during construction and training operations were evaluated with respect to dredge/fill activities, training activities, potential chemical releases, munitions constituents deposition, and improper stormwater management that could lead to increases in or accidental direct discharges of pollutants and sediment laden stormwater runoff into nearshore waters. These activities and materials could result in localized turbidity; decreased water clarity and quality (e.g., reduced dissolved oxygen, photosynthetic potential, and increased nutrient load); or benthic siltation of marine resources that could individually or collectively impact the ecological health of the nearshore environment.

4.3.2 Resource Management Measures

Resource management measures applicable to water resources are provided below.

4.3.2.1 Avoidance and Minimization Measures

- **No Training Areas.** The U.S. military would implement training restrictions for surface water features on Tinian. Lake Hagoi and the two Bateha sites remain designated by the U.S. military as "No Training Areas." Within these "No Training Areas," ground disturbance and vegetation removal of any kind will be prohibited during construction. "No Training Area" restrictions will be implemented upon initiation of CJMT training activities on Tinian.
- **Amphibious Assault Vehicle Landings.** As discussed in Section 2.3, all beaches within the Military Lease Area were initially considered for amphibious training. A careful selection process was employed to determine where amphibious training with Amphibious Assault Vehicles could occur. Based on environmental criteria including analysis of bathymetry and coral cover, Unai Babui and Unai Chulu were both considered for Amphibious Assault Vehicle 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 for Amphibious Assault Vehicle training could be met at one beach. Unai Chulu was chosen as the single beach for Amphibious Assault Vehicle landings because of its wider configuration in comparison to Unai Babui. Ultimately, Unai Babui was dismissed for Amphibious Assault Vehicle training but it would still support training for Landing Craft Air Cushion vessels, small boat, and swimmer training.

Potential operational impacts would be minimized or avoided through the proper design and implementation of stormwater management practices, which would include the use of Low Impact Development best management practices for the proposed action. Low Impact Development provides a sustainable stormwater management system, in an environmentally conscious manner. A pre-versus-post development hydrologic analysis would be performed to provide a basis of design for monitoring and controlling the quality and quantity of stormwater runoff generated from the proposed action. Permanent stormwater management facilities would include a combination of natural and engineered features such as retention/detention ponds that control the volume, direction, and rate of stormwater runoff (i.e., minimize or eliminate hydromodification), filter out pollutants, and facilitate groundwater recharge through increased infiltration; with a focus on mimicking pre-development hydrology to the maximum extent feasible, while protecting water resources from pollutants. Hydrologic analysis would follow the *CNMI Stormwater Management Manual, Department of Defense Guidance, and Navy Low Impact Development* criteria, as described in the *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects* under Section 438 of the Energy Independence and Security Act (U.S. Environmental Protection Agency 2009).

4.3.2.2 Best Management Practices and Standard Operating Procedures

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

- **Properly closed existing groundwater wells.** To the extent that unused wells are encountered, the U.S. military will properly close existing unused (production or monitoring) wells within the Military Lease Area to protect the groundwater resources.
- **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:
  - Avoidance and/or minimization of soil disturbing and earth moving work during the wet season.
  - Limiting in-water construction activities to period around low tide.
  - Temporary soil stabilization (such as mulch and erosion control blankets).
  - Temporary 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.

The Stormwater Pollution Prevention Plans are based on construction plans and drawings and will specifically identify these best management practices, inspection frequency, and water sampling to be performed throughout the construction phase for protection of water quality.

Ranges would be managed in accordance with current Marine Corps range management policies and procedures. The proposed RTAs on Tinian and Pagan would be managed in accordance with Marine Corps Order 3550.10, *Policies and Procedures for Range and Training Area Management* (DoN 2005). The Marine Corps would utilize the Range Environmental Vulnerability Assessment program, in compliance with Department of Defense Instruction 4715.14 *Operational Range Assessment*, to assess the potential impacts to human health and the environment from live-fire training operations (Department of Defense 2005). Department of Defense Instruction 4715.14 *Operational Range Assessment* requires the establishment and implementation of procedures to assess the potential environmental impacts of military munitions use on operational ranges and determine whether there has been a release or substantial threat of release of munitions constituents to an off-range area as well as a determination if the release of munitions constituents creates an unacceptable risk to human health or the environment. Operational ranges that are addressed under the Range Environmental Vulnerability Assessment program include target/impact areas, firing positions, small arms ranges, and training and maneuver areas. The Range Environmental Vulnerability Assessment program also assesses areas with historical munitions use within operational range boundaries. The Range Environmental Vulnerability Assessment program does not evaluate future ranges or ranges that are covered under a separate program (e.g., cleanup of closed ranges under the Munitions Response Program, permitted Open Burning/Open Detonation sites under the Resource Conservation and Recovery Act).

The Range Environmental Vulnerability Assessment would be implemented on all live-fire operational ranges after they have been in use for a minimum of 1 year to provide a snapshot of the current environmental conditions of operational ranges as well as a detailed assessment of potential munitions constituent migration from operational ranges to off-range areas. Reevaluations would occur at a minimum every five years. The munitions constituents evaluated under the Range Environmental Vulnerability Assessment program include high explosives (e.g., trinitrotoluene, royal demolition explosive, high melting explosive from munitions items containing high explosives), perchlorate (from propellant in rocket fuels), and lead (from small arms). The analyses would include the development of a range Conceptual Site Model that uses physical, hydrologic, geographic, and operational range data to characterize current environmental conditions at the range and identify whether people or endangered/threatened animal species, could potentially be impacted by munitions constituents (chemical components of munitions) migrating from operational range activities via surface water, sediment, or groundwater and to identify potential pathways for munitions constituents to reach humans and sensitive animal species. Key factors that influence the potential for the migration of munitions constituents including range design/layout, physical and chemical characteristics of the area, and current/past maintenance operations would also be evaluated under the Range Environmental Vulnerability Assessment program.

The results of the Range Environmental Vulnerability Assessments would determine if additional actions are necessary. These additional actions may include environmental sampling, characterization of physical properties, implementing best management practices, and/or conducting a risk assessment.

4.3.3 Tinian

4.3.3.1 Tinian Alternative 1

4.3.3.1.1 Construction Impacts

A comprehensive drainage and Low Impact Development study is being prepared for Tinian. Under Tinian Alternative 1, construction would require ground-disturbing activities that would include vegetation clearing and grubbing, grading, and excavation activities, all of which would increase the potential for erosion and sedimentation from exposed earth. In addition, an amphibious landing ramp at Unai Chulu would be constructed which would require in-water work. Improvements to an existing public boat ramp at the Port of Tinian may be required to support continued or increased military use, but would not require in-water construction or fill. Tinian RTA development and construction is generally described in Section 2.4, *Tinian Alternatives*, and summarized in Section 4.2, *Geology and Soils;* a detailed evaluation is presented in Appendix F, *Geology and Soils Technical Memo*. Impacts to coastal processes, coral, and coral reefs are described in Section 4.10, *Marine Biology*.

The anticipated stormwater management system would include improvements to address both stormwater quantity and quality. The stormwater quantity would be managed through the use of directional flow controls (i.e., vegetated swales and grading) to maintain the pre-development flow patterns and through the use of detention/retention ponds downstream of new impervious surfaces to maintain the pre-development flow rates.

Stormwater quality would be addressed in conjunction with groundwater recharge to provide appropriate treatment and infiltration of rainwater/stormwater throughout the proposed development in order to maintain and protect the quality of the groundwater resources. The treatment would be provided via small scale structural devices and landscape treatments integrated into the proposed master plan to capture and treat stormwater at or near its source. The Low Impact Development best management practices would be selected based on land use and known pollutants and combined into treatment trains that applied downstream of the pollutant generating facilities to provide pollutant removal prior to discharge to downstream conveyances.

Findings from the comprehensive drainage and Low Impact Development study would be used to inform the final design of the proposed stormwater management system. The majority of these proposed stormwater facilities are expected to occur within and adjacent to the base camp, Munitions Storage Area, airport improvements, and port improvements where impervious surfaces and/or potential pollutant generating facilities are proposed. Additional water quality controls would be located throughout the live-fire ranges to address munitions concerns and along access roads to address transportation of sediment, including improvements adjacent to surface and coastal waters. Proposed stormwater features associated with each of the improvement areas is provided below.

- **Base Camp:** Up slope stormwater flows would be redirected around the proposed base camp improvements where feasible, limiting the internal stormwater facility sizes. On-site flows generally flow southwesterly across the base camp. Frequent, low volume, low intensity surface stormwater flows would be directed to Low Impact Development best management practices treatment devices/trains for capture, treatment, and infiltration. These small scale integrated Low Impact Development devices would be selected and strategically located across the entire base camp site to address the pollutants anticipated from each land use/facility and to meet groundwater recharge requirements. Overflow from these devices during higher volume, higher intensity storm events would be routed via vegetated swales and culverts to detention ponds located within the base camp boundary, downstream of new impervious areas. The ponds would restrict discharge flows to pre-development rates for the 25-year 24-hour design storm and provide additional groundwater recharge. The ponds would also include high level controlled overflow weirs (dams created to reduce, but not stop the flow of water) directing excessive runoff during rainfall events beyond the 25-year design storm towards downstream receiving conveyance systems.

- **Munitions Storage Area:** The Munitions Storage Area contains a minimal amount of new impervious area and ground disturbance consisting primarily of access roads and storage pads. As a result, the stormwater management facilities would be minimal, including roadside channels, culverts, and Low Impact Development features for water quality and groundwater recharge adjacent to and downstream of pads, with some small detention ponds to mitigate additional runoff rates from proposed impervious surfaces. The stormwater runoff occurs in a westerly direction, therefore, stormwater facilities would be placed westerly of the proposed improvements.
- **Tinian International Airport:** The airport improvements would generate a substantial volume of stormwater runoff due to the high quantity of new impervious surfaces. As a result, detention ponds would be designed to accommodate this volume to maintain pre-development hydrology to downstream receiving conveyance systems. The direction of flow is southwesterly; therefore, proposed stormwater facilities would be located southwesterly of the proposed impervious areas. Runoff from paved surfaces would flow across filter strips and bio-retention swales prior to comingling with other surface runoff. Pre-treated sheet flow and shallow channelized flow would then be directed to larger vegetated swales to convey stormwater to detention ponds, which would provide extended detention for both water quantity and quality including groundwater recharge. Additional inline pre-treatment, if required, may be provided within conveyance system including baffle boxes, hydrodynamic separators, and/or additional bio-retention. High level overflow would be provided with the same intent as used for the base camp.
- **Port of Tinian:** The port improvements would generate a significant volume of stormwater runoff for the relatively small facility size because nearly all improvements proposed are impervious. Structural best management practices and perimeter Low Impact Development features would be utilized to intercept and treat runoff from pavement areas before stormwater is routed to detention ponds. Stormwater runoff would flow in a southerly direction towards the harbor and Philippine Sea; therefore, stormwater ponds would be located just south of the improvements/impervious surfaces. Treated discharge and high level overflow would be directed southwesterly away from existing boat ramps and public areas, towards natural points of discharge into the Philippine Sea.
- **Unai Chulu amphibious landing ramp:** As described in Section 4.2.3.1.1, *Construction Impacts* (for Geology and Soils), a Coastal Processes Assessment was completed to assess the potential impacts of construction of Unai Chulu to coastal processes. The Coastal Processes Report (Appendix J, *Amphibious Beach Landing Site Engineering and Coastal Processes Analyses*)

concluded that construction of the proposed Amphibious Assault Vehicle landing ramp would not significantly modify shoreline coastal processes and trigger erosion of the beaches. 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.

- **Range Complex A:** Grading within the High Hazard Impact Area consists of the perimeter road, roadside drainage swale, and live hand grenade range pits. Drainage facilities would include conveyance swales, culverts, and linear detention ponds to control flow rates. Stormwater flow would be split with a high point located at the south central portion of the High Hazard Impact Area. Half of the potential stormwater runoff would flow internally to the High Hazard Impact Area in a northwesterly direction toward the Mahalang Complex, while the remainder of the High Hazard Impact Area would flow easterly.
- **Range Complex B:** Grading associated with the Range Complex B is primarily limited to the Tracked Vehicle Driver's Course and the small arms ranges. With minimal impervious surfaces and grade changes, drainage improvements would be focused on capturing munitions constituents as part of the range management program. Additional conveyance swales and minor detention ponds would be utilized as needed to maintain pre-development flows.
- **Range Complex C:** The grading associated with the Range Complex C primarily consists of range access roads, the Multi-purpose Automated Unknown Distance Range, and limited grading for access and objective operations for the Infantry Platoon Battle Course and associated Urban Assault Courses. Drainage improvements would be minimal primarily consisting of channelized conveyance and flow control via culverts and spreader swales. Low Impact Development would be utilized in conjunction with other range management practices to provide treatment, control munitions constituents and protect water resources.
- **Range Complex D:** No grading or drainage improvements are proposed at North Field.

4.3.3.1.1.1 Surface Water Resources

Lake Hagoi is located in northern Tinian, west of the proposed Battle Area Complex (Range Complex D). The Bateha isolated wetlands are outside of the proposed boundaries of Range Complex C and no training facilities or other improvements are proposed within 1,500 feet (450 meters). Lake Hagoi and the Bateha isolated wetlands have been designated a "No Training Area," where no construction activities are proposed. Therefore, as a result of the separation of these surface waters from construction activities and use of best management practices, the existing topography would be maintained and construction activities associated with Tinian Alternative 1 would result in no direct or indirect impacts to Lake Hagoi or the Bateha isolated wetlands. Surface waters on Tinian are shown in Figure 4.3-1.

Figure 4.3-1
Tinian Alternative 1
Surface Waters and Flood Zones

Sources: DoN 2010, DoN 2013

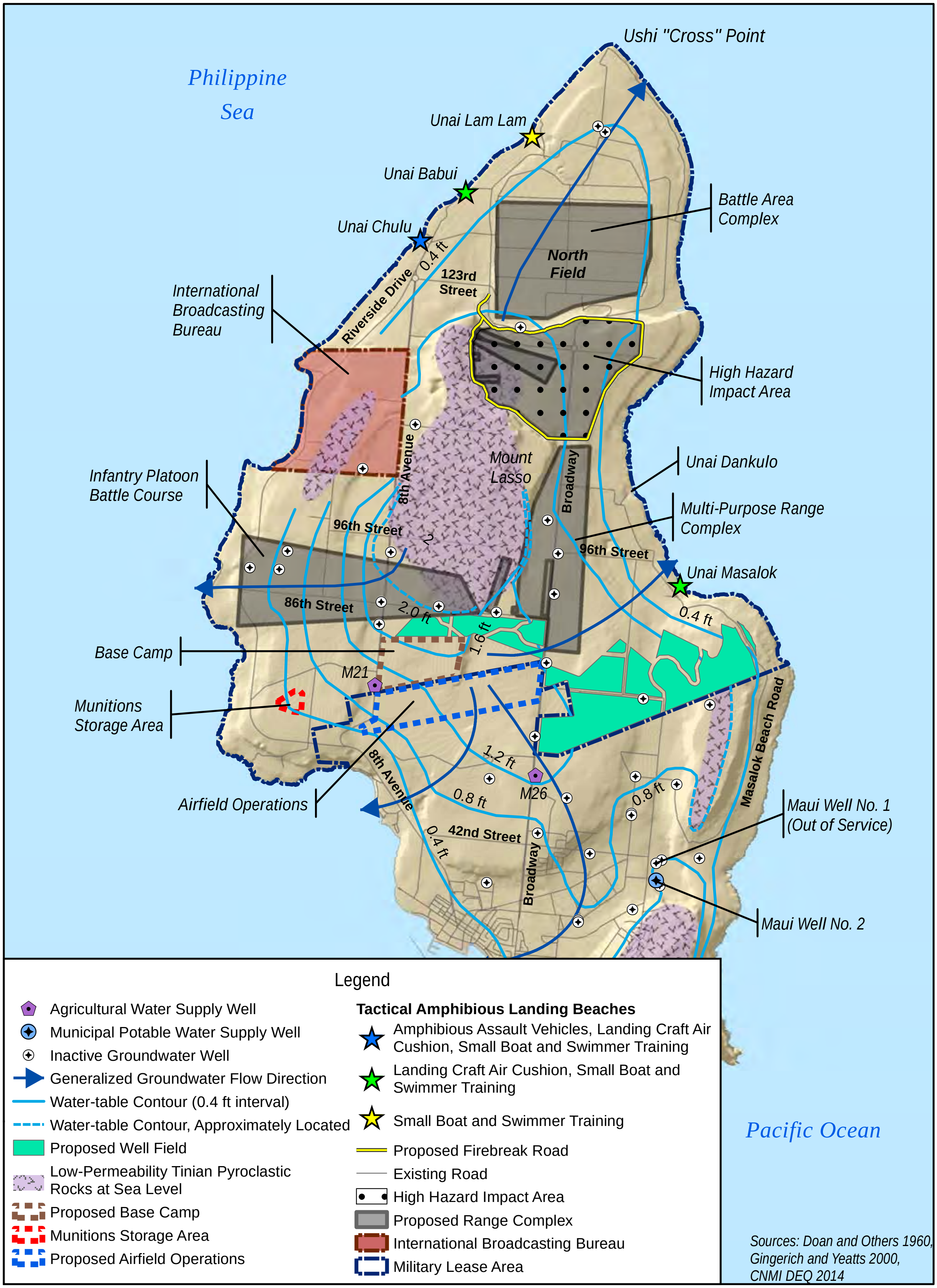
The majority of the Mahalang Complex, approximately 92% of the complex (22 out of 24 mapped depressions), is located within the proposed Range Complex A, High Hazard Impact Area. Construction activities within Range Complex A include a perimeter road/firebreak, grenade range with grenade pits, and fencing. Proposed construction of the Hand Grenade Range and Grenade Launcher Range within the western portion of the High Hazard Impact Area would remove two ephemeral ponds (labeled MC2 and MD3), totaling less than 0.5 acre (0.2 hectare) of the Mahalang Complex. As described in Section 3.3, *Water Resources*, MC2 is not considered a wetland and MD3 is considered an isolated wetland (see the *Wetland Survey Report* in Appendix L). Although Tinian Alternative 1 construction activities would result in direct impacts to these two surface water features, the remainder of the Mahalang Complex would not be impacted by construction; therefore, construction activities associated with Tinian Alternative 1 would result in less than significant direct impacts to the Mahalang Complex.

Low-lying areas, including areas surrounding the surface water features, could be subject to flooding during heavy rainfall events. Small areas near the proposed base camp, along the proposed Tracked Vehicle Driver's Course and Convoy Course, and within Tinian RTA are within depressions that could be subject to a greater flooding hazard. Nearshore areas may also be subject to flooding and wave hazards during extreme storm and tidal events. Construction work would follow the CNMI erosion control requirements and utilize best management practices such as limiting ground disturbance during wet weather, minimizing compaction of native soils, and through use of temporary diversions and sedimentation basins that direct stormwater away from construction areas to minimize potential erosion and transportation of sediment and pollutants to downstream conveyance and surface waters. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, construction activities associated with Tinian Alternative 1 would result in less than significant direct and indirect impacts from flooding hazards. Flood zones are shown in Figure 4.3-1.

Drainage throughout most of Tinian is internal (underground), and water generally percolates downward into porous limestone rock (Doan et al. 1960). With the natural drainage of the porous limestone rock and through the implementation of erosion control practices including perimeter controls, construction scheduling, tracking pads, minimizing disturbance and sedimentation basins (as detailed in Appendix D, *Best Management Practices*), stormwater runoff impacted by construction activities is not anticipated to discharge to surface water features and would not affect surface water quality. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, construction activities associated with Tinian Alternative 1 would result in less than significant indirect impacts to surface water quality.

4.3.3.1.1.2 Groundwater Resources

Existing groundwater wells, the proposed notional well fields, groundwater elevations, and the general direction of groundwater flow are shown in Figure 4.3-2. The increase in residents living on Tinian during the construction phase (i.e., temporary construction workers) may result in an increased dependence on the Commonwealth Utilities Corporation's potable water system. This would require increased pumping from Maui Well #2 and could result in temporary increased chloride levels as a result of saltwater intrusion (the movement of saline water into freshwater aquifers). However, this increase would be limited to the duration of construction and the modest increase in pumping over and above current levels is expected to result in less than significant impacts to groundwater in the Makpo Valley sub-watershed.



0 0.5 1 2 Miles
0 0.5 1 2 Kilometers

Figure 4.3-2
Tinian Alternative 1
Groundwater Wells, Elevation, and Flow Direction

NORTH

A proposed well field has been identified north and east of the airport. New wells are required to support construction activities and operations associated with the proposed action. The new well sites would be selected to minimize negative impacts to groundwater quantity and quality resulting from increased extraction. New well sites would be established in compliance with *CNMI Well Drilling and Well Operation Regulations* (CNMI Division of Environmental Quality 2005). These regulations include well seal and construction specifications, pump testing, water quality analysis, and designated wellhead setback distances from potential sources of contamination. Testing and monitoring would be performed prior to production at each new well site.

The pumping of groundwater from the proposed new military wells could potentially cause saltwater intrusion by reducing the thickness and lateral limits of the fresh water lens, reducing the quality of groundwater in the Military Lease Area. However, this impact would be limited to the duration of construction and due to the size of the freshwater basal lens (i.e., availability of groundwater) impacts are expected to be minimal.

Improperly abandoned existing wells in the Military Lease Area could provide a preferential flow path for runoff from the RTA; therefore, encountered unused wells (production or monitoring will properly close existing unused (production or monitoring) wells within the Military Lease Area to protect the groundwater resources.

Best management practices that would be implemented during construction to protect groundwater resources include capture and treatment of pollutant laden stormwater with Low Impact Development devices; restricting untreated stormwater runoff from entering depressional areas and surface waters; limiting use of heavy equipment in areas that support groundwater recharge; proper abandonment (closure) of historic groundwater wells, and proper management of spills and leaks of hazardous materials and waste. Based on the general direction of groundwater flow (shown in Figure 4.3-2), pollutants unintentionally released from construction sites or proposed facilities within the Military Lease Area would not flow to the public water system well (i.e., Maui Well #2). Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, Tinian Alternative 1 construction activities would result in less than significant direct and indirect impacts to groundwater resources.

4.3.3.1.1.3 Nearshore Water Resources

General Construction Activities in Coastal Areas

The majority of the 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 surface radars and an amphibious beach landing area. Construction activities could result in the accidental release of pollutants (e.g., petroleum, oils, and lubricants) resulting in impacts to nearshore water quality. However, accidental release of pollutants would be rare, and best management practices would be followed to reduce the likelihood of an accidental release or spill occurring. Any spills that do occur would be cleaned up immediately. With the implementation of pollutant prevention best management practices, including construction scheduling only during ideal conditions, sediment traps to control stormwater flowing through and from the work area, vehicle tracking pads, silt fencing and floating turbidity barriers, construction impacts to nearshore waters are not anticipated. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, land-based construction activities under Tinian Alternative 1 would result in less than significant direct and indirect impacts to nearshore water resources.

In-Water Work at Tactical Amphibious Landing Beach

An amphibious landing ramp would be constructed at Unai Chulu to create a safe landing surface for training operations. In-water construction at Unai Chulu would result in direct impacts to nearshore waters. Construction activities would disturb sediment and increase turbidity and thus impact water quality, clarity, and dissolved oxygen levels. Best management practices, including isolating the in-water construction area with floating turbidity barriers, would be utilized to capture sediment and debris caused by in-water construction activities.

An assessment was completed to assess the potential impacts of construction of Unai Chulu to coastal processes. The *Coastal Processes Report* included in Appendix J concluded that construction of the proposed amphibious landing ramp would not significantly modify shoreline coastal processes or trigger erosion of the beaches. Best management practices would be in place to monitor and minimize impacts to nearshore water resources that may result from the construction of the underwater landing areas. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, in-water construction activities under Tinian Alternative 1 would result in less than significant direct and indirect impacts to nearshore water resources.

4.3.3.1.2 Operation Impacts

The post-development stormwater management system would maintain pre-development hydrology and reduce flooding hazards to downstream facilities and new infrastructure, including the base camp facilities, Munitions Storage Area, port facilities, and airport facilities. Tinian Alternative 1 training and maintenance operations may result in impacts to localized natural hydrology/drainage systems with potential impacts to surface water, groundwater, and nearshore waters. Newly constructed impervious surfaces (primarily associated with the proposed base camp area, airfield improvements, Munitions Storage Area, port improvements, and limited roadway improvements), vegetation removal and control, foot-trails created during training maneuvers, and off-road vehicle use may alter natural drainage courses. Vegetation maintenance, foot-trails, and use of vehicles off-road may cause erosion and increased sediment in stormwater runoff, which would be minimized through the use of strategically selected and located erosion control techniques and devices.

Newly created impervious surfaces would be created at the port, base camp, airport, Munitions Storage Area, roadways, and at some of the training facilities (see Section 2.4.1.2, *Construction and Improvements*). The proposed impervious surfaces along with a brief summary of operational facilities are provided for each improvement area below.

- **Base Camp:** The base camp area would include a variety of hardscaping as part of the support facilities, new roads, vehicle wash racks with effluent treatment ponds and wash-water recycling system, a package wastewater treatment plant, wastewater disposal field, Low Impact Development features, and stormwater detention basins. Wastewater would be treated prior to disposal via leach field, minimizing potential impacts to groundwater quality. Vegetated roadside swales would convey runoff while providing water quality treatment, and minimize erosion and sediment runoff from gravel/stabilized roads.

- **Munitions Storage Area:** The Munitions Storage Area includes eight munitions storage magazines, a maintenance facility in addition to the entry control gate, access roads, and storage facilities. The proposed improvements also include Low Impact Development features for water quality, vegetated swales for stormwater conveyance, and stormwater detention basins.
- **Port of Tinian:** Port improvements would include a vehicle inspection area; cargo inspection and holding area; vehicle wash-down area with effluent treatment pond and wash-water recycling system; and stormwater detention basins. The stormwater management system would be maintained to ensure proper function and to prevent release of pollutants to downstream receiving waters.
- **Tinian International Airport:** The Tinian International Airport improvements include significant impervious areas such as the aircraft parking ramps, hot fuel pits, and aircraft taxi lanes. The proposed improvements also include Low Impact Development features for water quality, vegetated swales for stormwater conveyance, and stormwater detention basins.

Following the completion of construction, vegetation within the Tinian RTA would be allowed to reestablish or managed at allowable heights. The preservation and reestablishment of vegetation would minimize the potential for erosion and sediment runoff. The height of vegetation would be managed in certain portions of the RTA, including objective areas, fire breaks, roadway/trail alignments, firing points, Landing Zones, Drop Zones, target areas, and Observation Posts. Because root systems and ground cover would be maintained, these areas would remain anchored and not pose a significant source of erosion. Controlled burning may be used to manage vegetation within Range Complex A, which could create temporary increases in soil erosion during periods of vegetation grow in.

4.3.3.1.2.1 Surface Water Resources

New wells would be developed in the Military Lease Area for U.S. military use outside the Makpo Valley sub-watershed. None of the identified surface waters are near the notional locations of the new wells.

Lake Hagoi is located west of the proposed Range Complex D, northern Battle Area Complex (see Figure 4.3-1). Lake Hagoi and surrounding areas have been designated a "No Training Area," where no training activities or target areas are proposed. As a result, no direct or indirect impacts from training or munitions are anticipated. The majority of the Mahalang Complex is located within the Range Complex A, with the exception of a small portion on the western border of the High Hazard Impact Area. The High Hazard Impact Area would not be utilized during Maneuver Area (Light Forces) training thus protecting the portion of the Mahalang Complex within Range Complex A, not already permanently impacted during construction, from potential direct impacts associated with foot traffic. The Bateha isolated wetlands are located within the proposed Range Complex C (see Figure 4.3-1). However, the isolated wetlands have been designated a "No Training Area." No training facilities, targets objective areas, or other improvements (i.e., roads) are proposed in the vicinity (i.e., within 1,500 feet [500 meters]) of the Bateha isolated wetlands. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, Tinian Alternative 1 operations would result in no direct impacts to Lake Hagoi or the Bateha isolated wetlands.

Training operations in the High Hazard Impact Area, including controlled burning of vegetation and use of high explosives and other munitions, may result in indirect impacts to the remaining surface water features of the Mahalang Complex because half of the potential stormwater runoff from the High Hazard Impact Area would flow in a northwesterly direction toward the Mahalang Complex. Stormwater runoff can erode and transport contaminated soil and leachable munition constituents. Munitions constituents from operation of the Tinian RTA contain potentially leachable compounds that can impact water quality if not managed properly. Low Impact Development features would be utilized to control stormwater runoff from the Tinian RTA and water quality controls would be located throughout the live-fire ranges to address munitions concerns. With proper range management and the implementation of the Range Environmental Vulnerability Assessment program, Tinian Alternative 1 operations would result in less than significant indirect impacts to surface water quality. Reevaluations would occur at a minimum every 5 years.

Without proper stormwater management controls, increased impervious areas would increase the amount of runoff and the potential for downstream flooding. Development in the floodplain may also result in potential damage to facilities within low lying areas from inundation during high runoff storm events. Some of the proposed improvements east of the base camp, along the Tracked Vehicle Driver's Course and Convoy Course, and within the Tinian RTA are proposed within the Federal Emergency Management Agency "100-year flood zone" and may be subject to flood hazards. However, with the implementation of avoidance and minimization measures such as low impact training within high risk areas, along with monitoring and adaptive management of range operations and proper maintenance of the stormwater management facilities, runoff rates and erosion would be controlled and flooding hazards would be minimized. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, Tinian Alternative 1 operations would result in less than significant impacts from flooding hazards.

4.3.3.1.2.2 Groundwater Resources

Newly constructed impervious surfaces could alter infiltration characteristics within the project footprint, but in many cases, the impacted acreage is relatively small and potentially adverse effects would be mitigated through increased infiltration through other means within the development, meeting the required groundwater recharge rates and resulting in no net impact. In cases such as the airport improvements with significant increases in impervious areas, additional infiltration galleries would be used, after treatment, and within vegetated areas to capture, retain, and infiltrate larger volumes of stormwater to recharge groundwater resources.

Additional groundwater extraction would occur due to the proposed action that could affect groundwater availability and quality. New potable extraction wells (same wells established during construction) would be utilized in the Military Lease Area for U.S. military use to prevent overextending the existing Makpo Valley well (i.e., Maui Well #2). This change in source would result in no impacts to the municipal water supply. The new well sites would be selected to minimize negative impacts to groundwater quantity and quality resulting from increased extraction. The pumping of groundwater from the proposed new military wells to support military operations could potentially cause saltwater intrusion (the movement of saline water into freshwater aquifers) by reducing the thickness and lateral limits of the fresh water lens, thus reducing the quality of groundwater in the Military Lease Area during operations. However, this impact is not expected to be significant because the pumping would be limited to periods when training exercises occur and because of the size and recharge characteristics of the freshwater basal lens (i.e., availability of groundwater).

Munitions constituents could affect groundwater quality through percolation of leachable compounds. The accidental release of other pollutants associated with the use and maintenance of vehicles and septic leachate from the wastewater leach field also has the potential to impact groundwater quality. Impacts to the public water system (i.e., Maui Well #2 in the Makpo Valley sub-watershed), are not anticipated based of the separation distance and direction of general groundwater flow (see Figure 4.3-2). Groundwater resources located along the northern and eastern portions of the High Hazard Impact Area would have the greatest potential to be affected. Those are the areas where the surface soils are moderately permeable, shallow rocky clays, and/or moderately deep to deep clay (see Appendix F, *Geology and Soils Technical Memo*, for details). However, the risk of munitions constituent contamination to groundwater is expected to be less than significant because of: (1) limited existence of basal groundwater in the High Hazard Impact Area, (2) relatively deep soil formation in the gentler sloping areas, (3) the depth to groundwater (i.e., greater than 200 feet [60 meters]), and (4) proper range management and the implementation of the Range Environmental Vulnerability Assessment program.

Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, Tinian Alternative 1 operations would result in less than significant impacts to groundwater resources.

4.3.3.1.2.3 Nearshore Waters

Groundwater could potentially carry munitions constituents from training facilities to nearshore waters through the porous limestone, affecting nearshore water quality. These impacts would be minimized by employment of resource management measures described in Section 4.3.2.

Unai Chulu, Unai Babui, Unai Lam Lam, and Unai Masalok are proposed tactical amphibious landing beaches (see Figure 4.3-1). Training at amphibious landing beaches could include combat swimmer training and landing of rigid-hulled inflatable boats at all four beaches. Landing Craft Air Cushion vessels would land at Unai Chulu, Unai Babui, and Unai Masalok. Amphibious Assault Vehicles would land at Unai Chulu only. Amphibious Assault Vehicles are tracked vehicles that would come ashore at Unai Chulu and cross the beach to access the Tracked Vehicle Driver's Course.

Rigid-hulled inflatable boats, Landing Craft Air Cushion vessels, and Amphibious Assault Vehicles are powered by diesel engines and must be operated with petroleum-based products. The use of these products creates a possibility of accidental discharge of pollutants into the nearshore waters, but impacts would be minimized by personnel awareness (visual observations) and by implementing standard spill response procedures. In addition, the Amphibious Assault Vehicles track mechanism is lubricated with water repellant grease that would have a negligible impact on water quality (Marine Corps Forces Reserve 2014).

Operation of Landing Craft Air Cushion vessels and Amphibious Assault Vehicles would result in temporary increase in suspended sediment and turbidity (suspension of sand in the water column) in localized areas when approaching the shore, resulting in a temporary impact to water quality. Observations from Landing Craft Air Cushion operations at Unai Chulu (Department of Defense 1999) documented that the sediment plumes generated by these vehicles are likely not qualitatively different from naturally occurring turbidity during periods of storm-generated waves that routinely occur on

Tinian. When the Landing Craft Air Cushion vessel is stationary, water displacement is similar to a small wave, localized, and of short duration.

The landing of amphibious and small craft vehicles on beaches could affect nearshore water quality through increased turbidity, erosion, sediment transport, and accidental discharge of pollutants. However, these impacts would be temporary in nature and only occur during training activities. Accidental release of pollutants would be rare, and best management practices would be followed to reduce the likelihood of an accidental release or spill occurring. Any spills that do occur would be cleaned up immediately. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, Tinian Alternative 1 operations would result in less than significant impacts to nearshore water resources.

4.3.3.2 Tinian Alternative 2

Tinian Alternative 2 construction activities and operations would have similar impacts to water resources as those identified under Tinian Alternative 1 (see Section 4.3.3.1, *Tinian Alternative 1*). The main difference that would affect water resources is that the southern Battle Area Complex and associated Urban Assault Course would be constructed and operated within the present location of the International Broadcasting Bureau and other portions of Range Complex C (Figure 4.3-3). The Bateha isolated wetlands are located within the proposed southern Battle Area Complex (Range Complex C).

4.3.3.2.1 Construction Impacts

Tinian Alternative 2 construction impacts to water resources would be similar to those identified under Tinian Alternative 1. Construction of the training facilities and support facilities (buildings, roads, and related infrastructure) associated with the Tinian Alternative 2 would require ground-disturbing activities similar to but slightly greater than those under Tinian Alternative 1. The Bateha isolated wetlands and surrounding areas would not be included in any construction footprint (i.e., objectives, access roads, pathways). Therefore, Tinian Alternative 2 construction of activities would result in no impacts to Lake Hagoi or the Bateha isolated wetlands; less than significant direct and indirect impacts to the Mahalang Complex (as described under Tinian Alternative 1); and less than significant direct and indirect impacts from flooding hazards and to surface water quality, groundwater resources, and nearshore waters.

4.3.3.2.2 Operation Impacts

Impacts to water resources from Tinian Alternative 2 operations would be similar to those identified under Tinian Alternative 1. The Bateha isolated wetlands and surrounding areas would be included in Range Complex C; however, they have been designated a “No Training Area,” where no training activities or object areas are proposed. Therefore, Tinian Alternative 2 operations would result in no impacts to Lake Hagoi or the Bateha isolated wetlands and less than significant direct and indirect impacts to the Mahalang Complex (as described under Tinian Alternative 1); and less than significant direct and indirect impacts from flooding hazards and to surface water quality, groundwater resources, and nearshore waters.

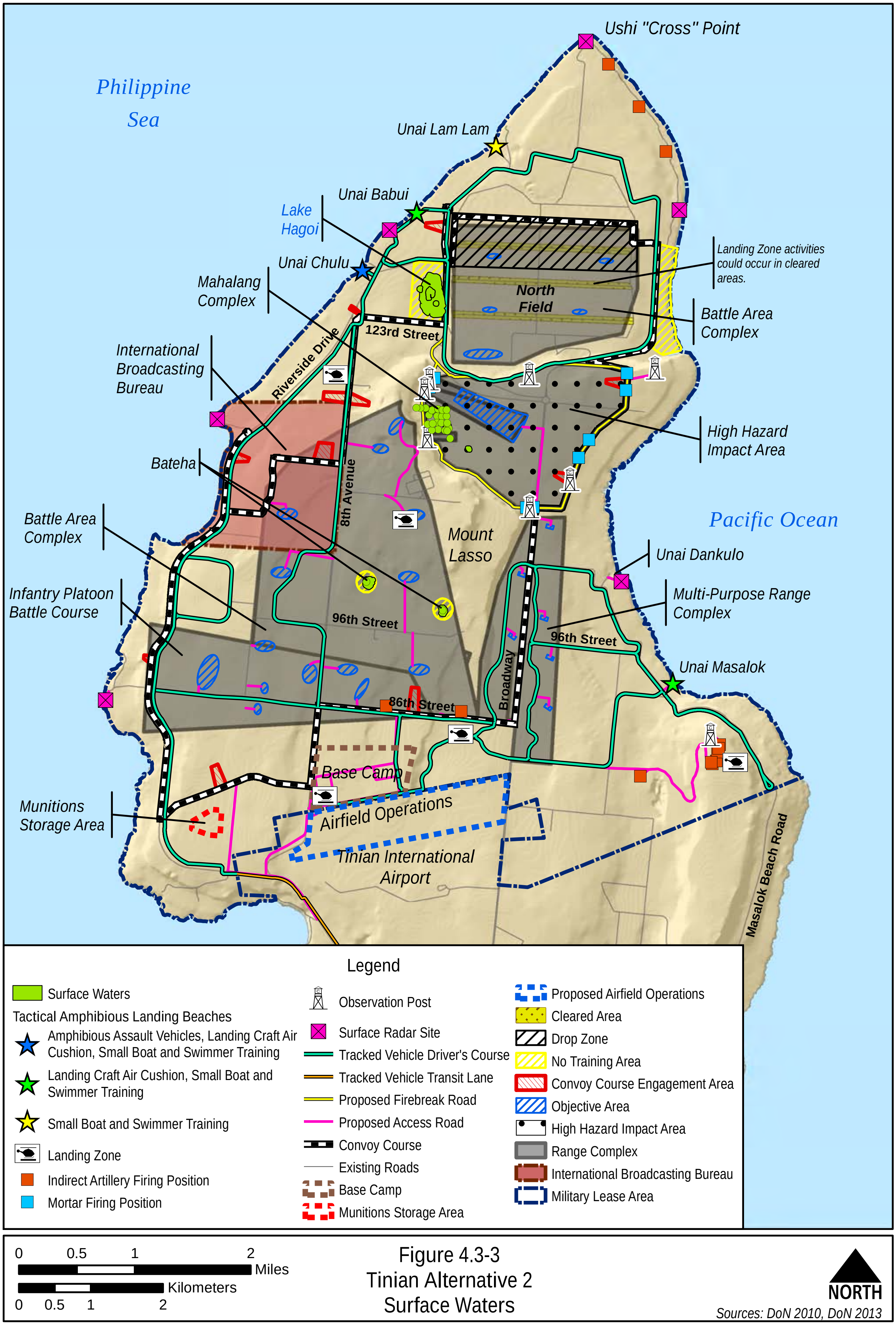


Figure 4.3-3
Tinian Alternative 2
Surface Waters

4.3.3.3 Tinian Alternative 3

Tinian Alternative 3 construction activities and operations would have similar impacts to water resources as those identified under Tinian Alternative 1. The main differences that would affect water resources are that Range Complex D would not include a northern Battle Area Complex and associated Urban Assault Course at North Field, and Range Complex C would include a southern Battle Area Complex and associated Urban Assault Course. The Bateha isolated wetlands are located within the proposed southern Battle Area Complex (Range Complex C), as shown in Figure 4.3-4.

4.3.3.3.1 Construction Impacts

Tinian Alternative 3 construction impacts to water resources would be similar to those identified under Tinian Alternative 1. Construction of the training facilities and support facilities (buildings, roads, and related infrastructure) associated with the Tinian Alternative 3 would require ground-disturbing activities similar to but slightly greater than those under Tinian Alternative 1. The Bateha isolated wetlands and surrounding areas would not include any construction footprint (i.e., objectives, access roads, pathways). This alternative would minimize construction activities at Range Complex D. Therefore, Tinian Alternative 3 construction would result in no impacts to Lake Hagoi or the Bateha isolated wetlands; less than significant direct and indirect impacts to the Mahalang Complex (as described under Tinian Alternative 1); and less than significant direct and indirect impacts from flooding hazards and to surface water quality, groundwater resources, and nearshore waters.

4.3.3.3.2 Operation Impacts

Impacts to water resources resulting from Tinian Alternative 3 operations would be similar to those identified under Tinian Alternative 1. The Bateha isolated wetlands have been designated a "No Training Area," where no training activities or objective areas are proposed. Therefore, Tinian Alternative 3 operations would result in no impacts to Lake Hagoi or the Bateha isolated wetlands and less than significant direct and indirect impacts to the Mahalang Complex (as described under Tinian Alternative 1); and less than significant direct and indirect impacts from flooding hazards and to surface water quality, groundwater resources, and nearshore waters.

4.3.3.4 Tinian No-Action Alternative

The periodic non-live-fire military training exercises that occur in the Military Lease Area on Tinian consist of troop maneuvering, ground vehicle movements, and helicopter and fixed-wing aircraft operations. These military training exercises are short term with limited activities on Tinian and would result in less than significant impacts to water resources on Tinian. As included in the Guam and CNMI Military Relocation EIS (DoN 2010a), military training on the four live-fire training ranges would introduce minor increases in stormwater runoff with introduction of more impervious surfaces along with potential for surface water and localized groundwater contamination because of the increase in training activities (see Table 4.2-1; DoN 2010a). Training in the Mariana Islands Range Complex would not introduce any long-term degradation of stormwater, groundwater, surface waters, or wetlands (see Table 3.3-13; DoN 2010b). Significant impacts would be avoided by implementing best management practices. Therefore, the no-action alternative would result in less than significant impacts to surface water, groundwater, and nearshore waters.

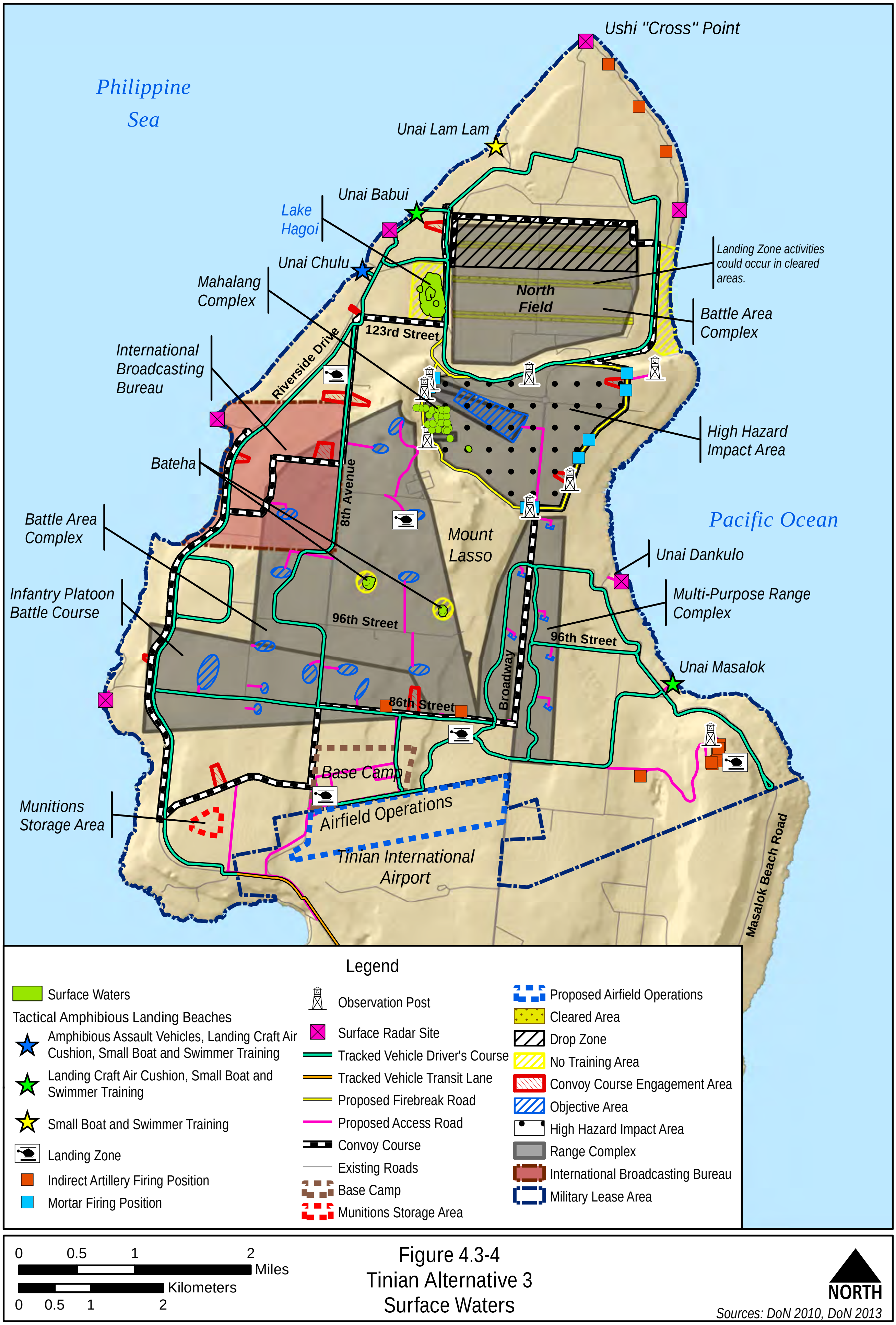


Figure 4.3-4
Tinian Alternative 3
Surface Waters

Sources: DoN 2010, DoN 2013

4.3.3.5 Summary of Impacts for Tinian Alternatives

Table 4.3-1 provides a comparison of the potential impacts to water resources for the three Tinian alternatives and the no-action alternative.

Table 4.3-1. Summary of Impacts for Tinian Alternatives

Resource Area	***Tinian (Alternative 1)***		***Tinian (Alternative 2)***		***Tinian (Alternative 3)***		***No-Action Alternative***	
Water Resources	**Construction**	**Operation**	**Construction**	**Operation**	**Construction**	**Operation**	**Construction**	**Operation**
Surface Water Resources	*NI (Lake Hagoi, Bateha isolated wetlands) LSI (Mahalang Complex) LSI (flooding hazards and surface water quality)*	*NI (Lake Hagoi, Bateha isolated wetlands) LSI (Mahalang Complex) LSI (flooding hazards and surface water quality)*	*NI (Lake Hagoi, Bateha isolated wetlands) LSI (Mahalang Complex) LSI (flooding hazards and surface water quality)*	*NI (Lake Hagoi, Bateha isolated wetlands) LSI (Mahalang Complex) LSI (flooding hazards and surface water quality)*	*NI (Lake Hagoi, Bateha isolated wetlands) LSI (Mahalang Complex) LSI (flooding hazards and surface water quality)*	*NI (Lake Hagoi, Bateha isolated wetlands) LSI (Mahalang Complex) LSI (flooding hazards and surface water quality)*	*LSI*	*LSI*
Groundwater Resources	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Nearshore Water Resources	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*

Legend: *NI* = no impact; *LSI* = less than significant impact.

4.3.4 Pagan

4.3.4.1 Pagan Alternative 1

4.3.4.1.1 Construction Impacts

A comprehensive drainage and Low Impact Development study is currently underway for Pagan. Under Pagan Alternative 1, development and construction would occur in the level area surrounding the existing airfield, along the military training trails, and within the proposed High Hazard Impact Areas for target placement.

The anticipated stormwater management system would include improvements to address both stormwater quantity and quality. The stormwater quantity would be managed through the use of directional flow controls (i.e., vegetated swales and grading) to maintain the pre-development flow patterns and through the use of detention/retention ponds downstream of new and reduced impervious surfaces to maintain the pre-development flow rates.

The improvements on Pagan are primarily expeditionary in nature with minimal additional impervious surfaces proposed. Some training facilities would have a reduced infiltration rate due to the compaction associated with the proposed training activity and may contribute to increased stormwater flows. Therefore, these areas are considered in the stormwater analysis and associated facilities are included in construction. The proposed grading and drainage improvements would also be minimal and focused on strategic placement of vegetated swales and small detention ponds for conveyance and flow control along with specific Low Impact Development and best management practices to address water quality for pollutant generating facilities.

- **Airfield and Bivouac Area:** Airfield and bivouac improvements are proposed in the same area as an existing airfield and within a relatively flat valley. Minimal earthwork would be required, with the exception of removal of the lava flow from the 1981 eruption that has covered the eastern half of the former grass airfield. The airfield would require compaction which may reduce surface water infiltration. As a result, stormwater that does not infiltrate would flow westerly along the airfield and bivouac area through bio-retention swales for treatment and infiltration, and to detention ponds for additional infiltration and flow rate control into downstream receiving conveyance systems towards the Philippine Sea.
- **Munitions Storage Area:** The five small proposed pads for biosecurity, assembly, and storage would include a minimal amount of new impervious area and require minimal grading and drainage improvements.
- **Military Training Trails:** Many of the proposed trails follow existing trail alignments. Widening and stabilization of these trails would occur. New trail alignments would require additional slope cut, fill, and stabilization. All trails would be all-weather surfaces using local materials as a compacted granular base. Drainage culverts or protected low water crossings are anticipated to maintain hydrology, slope stabilization, and trail function. The military training trails would be pervious and thus are not anticipated to increase runoff volumes or adversely affect hydrology. Therefore, the trail would require minimal volume controls for stormwater runoff. The focus would be on stabilization and erosion control to maintain trail usability and prevent transportation of sediment downstream.

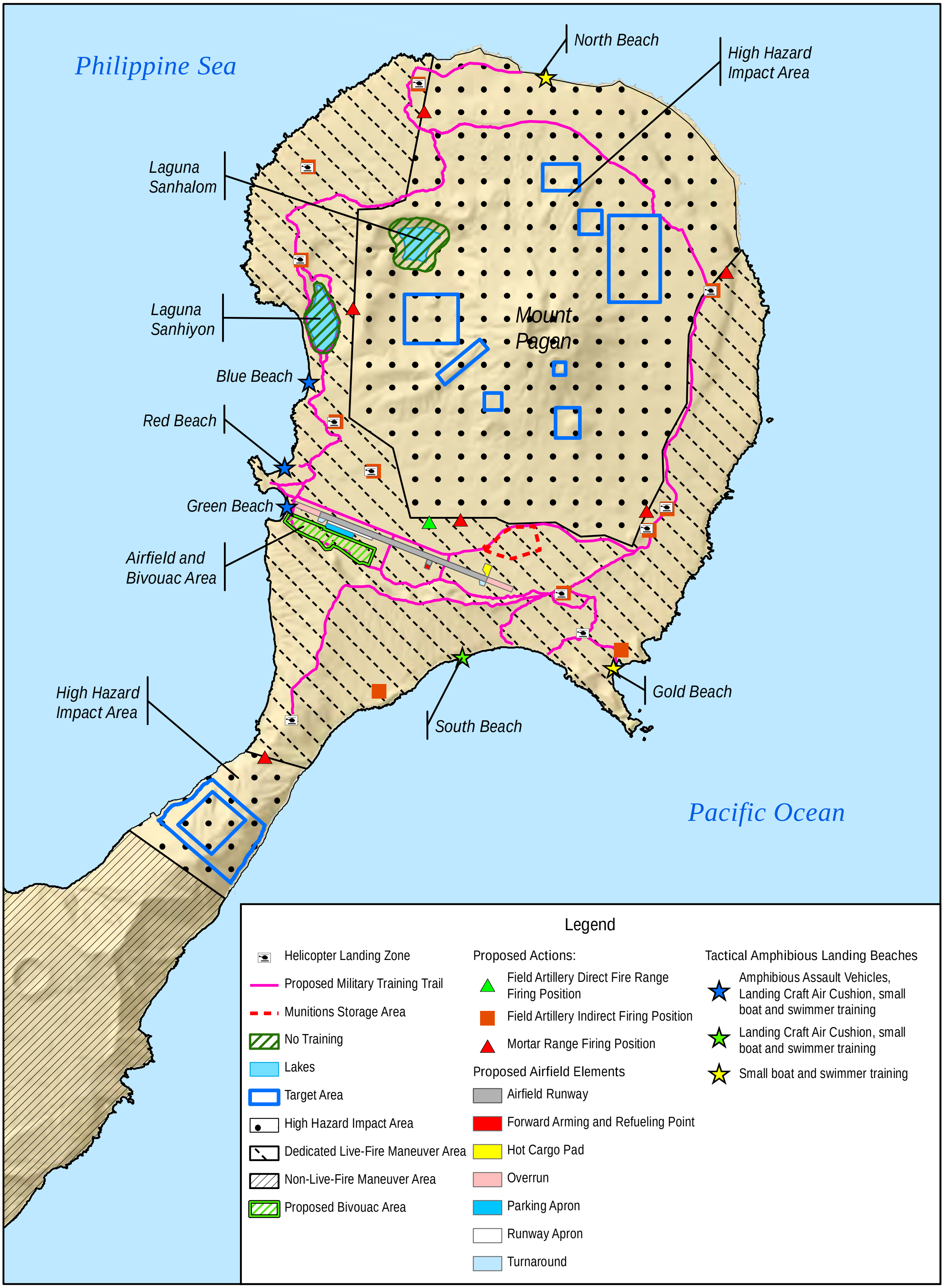
- **Landing Zones:** Numerous landing zones are proposed at locations throughout the north half of the island along military trails and firing positions. Nominal vegetation clearing and minimal grading is anticipated at each site, with natural drainage patterns being preserved. No impervious areas or permanent improvements are proposed at these sites.
- **Beach Landings:** The beach landing areas would not include any construction improvements (i.e., grading, drainage, or permanent improvements).
- **Target Areas:** Minor localized disturbances are anticipated for construction and maintenance of target structures throughout the northern and isthmus High Hazard Impact Areas. Minimal grading, clearing, and drainage is anticipated for these improvements. Small retention swales would be located down-gradient of targets to capture and retain target and munitions constituents in compliance with a range management plan.

4.3.4.1.1.1 Surface Water Resources

No in-water construction is proposed under Pagan Alternative 1. Laguna Sanhiyon is located outside of the northern High Hazard Impact Area, and Laguna Sanhalom is surrounded by the northern High Hazard Impact Area. Surface Water Resources on Pagan are shown in Figure 4.3-5. Because of increased exposed surface area and soil disturbance activities associated with construction activities (i.e., military training trails, target placements), the potential for erosion and sedimentation would be greater during the construction period. Construction-specific best management practices (such as temporary erosion control practices, perimeter controls, construction scheduling, tracking pads, minimizing disturbance, and sedimentation basins) would be implemented to reduce indirect impacts (e.g., sediment and pollutant-laden runoff) to Laguna Sanhalom from construction of military training trails and target placement areas.

New impervious surfaces would be limited to the munitions storage pads; however, other improvements such as expeditionary airfield, expeditionary base camp/bivouac area, access trails and military training trails may take on impervious characteristics in some areas due to high levels of compaction and repeated use. The areas anticipated to reduce infiltration would be minimal, and would not alter surface drainage or flood patterns significantly as high porosity in surrounding areas would compensate. Construction activities could result in the accidental release of pollutants that could affect surface water quality through percolation and stormwater runoff. However, accidental release of pollutants would be rare, and best management practices would be followed to reduce the likelihood of an accidental release or spill occurring. Any spills that do occur would be cleaned up immediately. Storage and maintenance of construction equipment and supplies is anticipated to occur away from surface waters to reduce potential for impacts. In addition, sediment basins, silt fence, tracking pads, filter strips and other forms of temporary erosion control would be utilized to mitigate adverse effects to surface water resources resulting from construction activities.

Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, Pagan Alternative 1 construction activities would result in less than significant impacts to surface water resources.



0 0.5 1 Mile

0 0.5 1 Kilometer

Figure 4.3-5
Pagan Alternative 1
Surface Waters

NORTH

Source: USGS 2010

4.3.4.1.1.2 Groundwater Resources

Groundwater is not planned to be used during construction. Instead, temporary reverse osmosis of seawater would be used to provide potable water during construction. The accidental release of other pollutants associated with the use and maintenance of construction vehicles could also impact groundwater. However, accidental release of pollutants would be rare, and best management practices would be followed to reduce the likelihood of an accidental release or spill occurring. Any spills that do occur would be cleaned up immediately. Silt fence, sediment basins, turbidity barriers, tracking pads, filter strips, and other forms of temporary erosion/sedimentation control would be utilized to mitigate adverse effects to groundwater resulting from construction activities. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, Pagan Alternative 1 construction activities would result in less than significant impacts to groundwater resources.

4.3.4.1.1.3 Nearshore Water Resources

No in-water construction is proposed under Pagan Alternative 1. Potential short-term impacts related to land-based construction include erosion, sedimentation, turbidity, decreased water clarity, and accidental discharge of pollutants. The accidental release of pollutants associated with the use and maintenance of vehicles could also impact nearshore waters. However, accidental release of pollutants would be rare, and best management practices would be followed to reduce the likelihood of an accidental release or spill occurring. Any spills that do occur would be cleaned up immediately. 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 in Section 4.3.2, Pagan Alternative 1 construction activities would result in less than significant impacts to nearshore water resources.

4.3.4.1.2 Operation Impacts

Pagan Alternative 1 training and maintenance operations may result in impacts to surface waters, groundwater resources, and nearshore waters. Groundwater is not planned to be used during operations. Instead, temporary reverse osmosis of seawater would be used to provide potable water during operations.

4.3.4.1.2.1 Surface Water Resources

Laguna Sanhiyon is located adjacent to proposed military training trails. The proposed trail to the west of the lake would be located on the sand bar that separates the lake from the ocean. During windy conditions and high tides, waves occasionally over the top of the sand bar. Use of vehicles on this trail would be limited to emergencies. During a rare emergency event, sediment and hydrocarbon runoff from military vehicles using the training trail could impact Laguna Sanhiyon water quality.

Much of the proposed material used on trails throughout Pagan will include crushed lava from lava flow across the air strip. This angular material will be crushed to appropriate size for use as road base and surface with minimal quantities of fine particles, reducing the likelihood of being easily transported by stormwater runoff. Additional protection from sediment laden runoff resulting from military trail use would be provided through the use of vegetated swales and stormwater velocity dissipaters and other best management practices at crossings. High porosity of surface soils and geology limit the volume of surface stormwater runoff, further decreasing the likelihood of transportation of sediment.

Stormwater runoff from the northern High Hazard Impact Area could transport munitions constituents to Laguna Sanhalom and Laguna Sanhiyon either as surface runoff or sub-surface conveyance, resulting in indirect water quality impacts to those surface waters. Target placement has been selected so that stormwater runoff potentially transporting munition constituents would drain away from the lakes, with the following target placement exceptions: the two targets due west of Mount Pagan, which would potentially drain to Laguna Sanhalom via surface flow and to both Laguna Sanhalom and Laguna Sanhiyon via sub-surface flow. Stormwater runoff can erode and transport contaminated soil and leachable munition constituents. Munitions constituents from operation of the Pagan RTA contain potentially leachable compounds that can impact water quality if not managed properly. Low Impact Development features would be utilized to control stormwater runoff from the Pagan RTA and water quality controls would be located throughout the live-fire ranges to address munitions concerns. The distance between the two targets sited up gradient of Laguna Sanhalom and Laguna Sanhiyon on Mount Pagan within the High Hazard Impact Area is greater than 1,150 feet (350 meters) horizontally, reducing likelihood of transportation of munitions constituents via surface stormwater runoff. However, the potential for transportation of munitions constituents to the surface waters does exist based on the target location relative to the surface waters and as a result of the nature of the fractured surface geology and potential for sub-surface flow. Whether by intense rainfall events or by sub-surface conveyance there is the potential for future impacts. As a result of the target placement up gradient of the surface waters and military trail adjacent to Laguna Sanhiyon, Pagan Alternative 1 operations could result in impacts to surface water resources. Best management practices including filter strips, bio-retention, vegetated swales, and other forms of permanent erosion/sedimentation control practices would be utilized to minimize impacts to surface waters resulting from operation activities. Monitoring and adaptive management plans would identify if conditions change and concerns arise, allowing early intervention to reduce potential impacts to the surface water resources. Through creation of downstream catch areas to prevent direct runoff from transporting pollutants via overland flow directly to surface waters and proper range construction and management and the implementation of the Range Environmental Vulnerability Assessment program, Pagan Alternative 1 operations would result in less than significant impacts to surface water resources.

Low-lying areas, including areas surrounding Laguna Sanhalom, Laguna Sanhiyon, and shoreline areas, could be subject to flooding during high wind, high tide, and storm surge events. Proposed operational activities are not anticipated to increase flooding hazards; therefore, Pagan Alternative 1 operations would result in no impacts with regards to flooding.

4.3.4.1.2.2 Groundwater Resources

Surface runoff within the areas of target placements in each of the High Hazard Impact Areas is expected to be moderate due to the relative flatness of the target areas and the underlying soil/rock conditions. Once the water passes through the rooting zone of the soils (primarily associated with the isthmus High Hazard Impact Area) or through course, highly permeable lava rock (associated with the northern High Hazard Impact Area) it would percolate to the groundwater aquifer system several hundred feet below. Risk of contamination to groundwater from munitions constituent in the northern

High Hazard Impact Area on Mount Pagan is possible, however, would be somewhat reduced by: (1) the possibly limited existence of a basal groundwater lens in the area and (2) dilution from rapidly percolating waters migrating radially toward the coast. The High Hazard Impact Area on the isthmus was mapped as containing "generally meager to small quantities of fair to poor quality water" (Corwin et al. 1957). There is not likely to be a substantial groundwater resource in this area. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2, Pagan Alternative 1 operations would result in less than significant impacts to groundwater resources.

4.3.4.1.2.3 Nearshore Water Resources

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. The accidental release of other pollutants associated with the use and maintenance of vehicles could also impact nearshore water quality. However, accidental release of these pollutants would be rare and only occur as a result from the failure of a materials-handling best management practice, and any spills would be cleaned up immediately.

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.

Constituents associated with target material that falls into nearshore waters are not expected to substantially impact nearshore water quality. When metals are exposed to seawater, they begin to slowly corrode, a process that creates a layer of corroded material between the seawater and metal. This layer of corrosion removes the metal from direct exposure to the corrosiveness of seawater, a process that further slows movement of the metals into the adjacent sediments and water column. This is particularly true of aluminum. Elevated levels of metals in sediments would be restricted to a small zone around the metal, and any release to the overlying water column would be diluted. In a similar fashion, as materials become covered by marine life, the direct exposure of the material to seawater decreases and the rate of corrosion decreases. Dispersal of these materials in the water column is controlled by physical mixing and diffusion, both of which tend to vary with time and location. Consequently, impacts to nearshore marine water quality would be minimal. Furthermore, a recent study conducted by the U.S. Marine Corps sampled sediments and water quality for 26 different constituents related to munitions at several U.S. Marine Corps training ranges. Metals included lead and magnesium. These areas were also used for bombing practice. No munitions constituents were detected above screening values used at these ranges (DoN 2010c).

Potential indirect impacts would be minimized (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 practices. Proper range management and implementation of a Range Environmental Vulnerability Assessment program would reduce potential impacts to water quality. Reevaluations would occur at a minimum every 5 years. Based upon the above analysis and the implementation of resource management measures in Section 4.3.2 Pagan Alternative 1 operations would result in less than significant impacts to nearshore water resources.

4.3.4.2 Pagan Alternative 2

Pagan Alternative 2 construction and training activities would have similar impacts to water resources as those identified under Pagan Alternative 1 (Figure 4.3-6). The main differences that would affect water resources are the northern High Hazard Impact Area would be smaller and the isthmus High Hazard Impact Area would not be constructed.

4.3.4.2.1 Construction Impacts

Under Pagan Alternative 2, development and construction would occur in largely the same areas as under Pagan Alternative 1. However, there would be differences in the number of firing positions associated with the Mortar Range (total of five; one less than Pagan Alternative 1), the number of landing zones (total of 13; 2 more than Pagan Alternative 1), and there would no target areas on the isthmus because the isthmus High Hazard Impact Area would not be constructed. The South Range Complex would consist of maneuver area and would not involve construction improvements. Impacts to water resources under Pagan Alternative 2 construction would be similar to those identified under Pagan Alternative 1. Therefore, Pagan Alternative 2 construction activities would result in less than significant impacts to water resources.

4.3.4.2.2 Operation Impacts

Impacts to water resources resulting from Pagan Alternative 2 training activities would be similar to those identified under Pagan Alternative 1 but would not include the potential impacts to nearshore water quality associated with the isthmus High Hazard Impact Area. Therefore, Pagan Alternative 2 operations would result in less than significant impacts to surface water, groundwater, and nearshore water resources.

4.3.4.3 Pagan No-Action Alternative

Limited activities would occur on Pagan under the no-action alternative. There would be no live-fire military training. As described in the Chapter 2, the no-action alternative would assume the continued infrequent and low impact events of periodic eco-tourism and scientific survey visits. Military activities would consist of periodic and low impact search and rescue training. The no-action alternative would continue to have less than significant impacts.

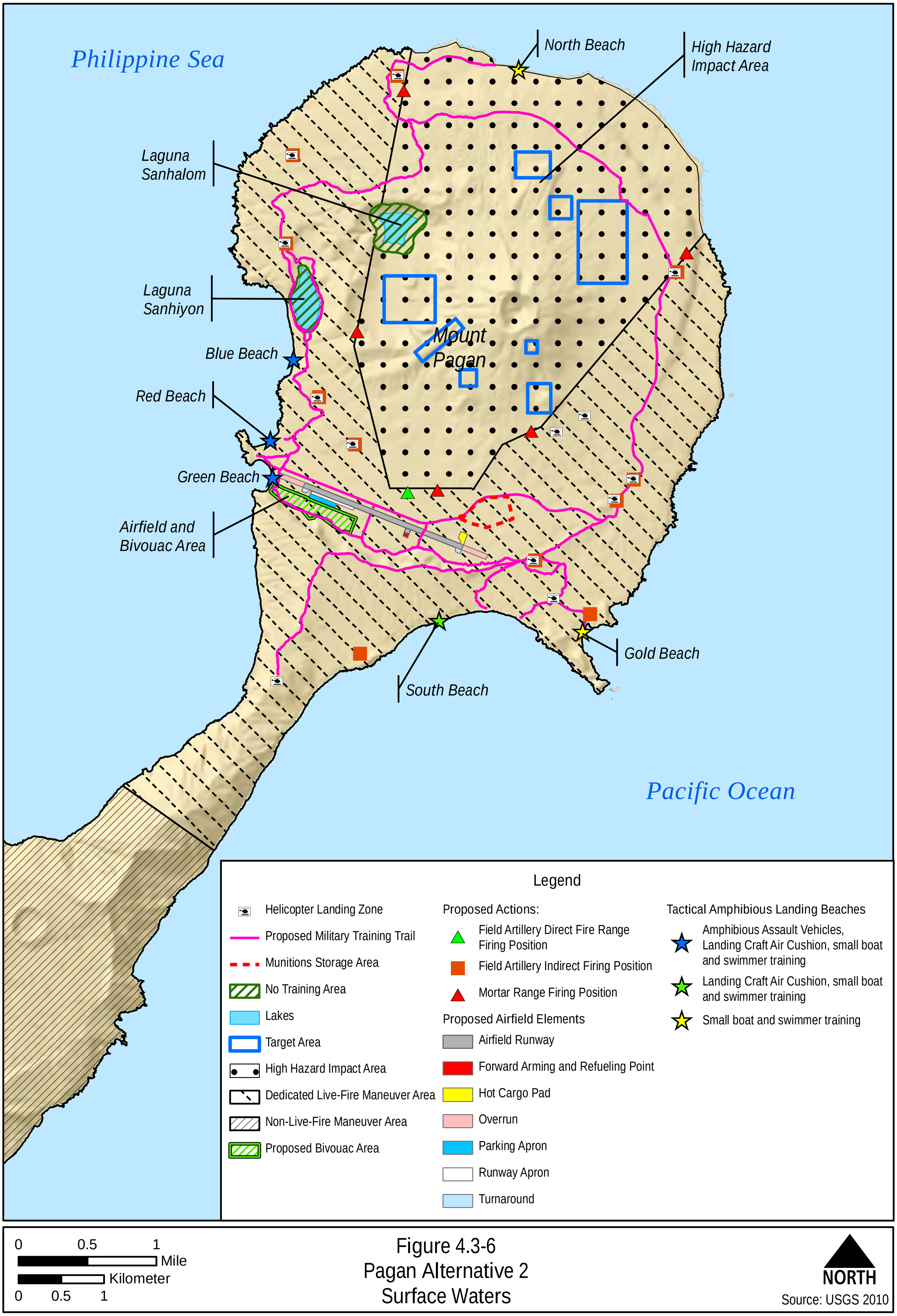


Figure 4.3-6
Pagan Alternative 2
Surface Waters

4.3.4.4 Summary of Impacts for Pagan Alternatives

Table 4.3-2 provides a comparison of the potential impacts to water resources for the two Pagan alternatives and the no-action alternative.

Table 4.3-2. Summary of Impacts for Pagan Alternatives

Resource Area	***Pagan (Alternative 1)***		***Pagan (Alternative 2)***		***No-Action Alternative***	
Water Resources	**Construction**	**Operation**	**Construction**	**Operation**	**Construction**	**Operation**
Surface Water Resources	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Groundwater Resources	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*
Nearshore Water Resources	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*	*LSI*

Legend: *LSI* = less than significant impact.