4.0 ENVIRONMENTAL CONSEQUENCES

Chapter 4:

4.0 Environmental Consequences

4.1 Physical Environment

4.2 Biological Environment

4.3 Socioeconomic Environment

4.4 Cumulative Impacts

4.5 Relationship Between Short-term and Long-term Resource Uses

4.6 Irreversible or Irretrievable Commitment of Resources

4.1 PHYSICAL ENVIRONMENT

4.1.1 Climate and Air Quality

4.1.1.1 Significance Criteria

Air quality impacts would be significant if emissions directly related to the use of the proposed ODMDS would: 1) increase ambient air pollution concentrations above the National Ambient Air Quality Standards (NAAQS); 2) contribute to an existing violation of the NAAQS; 3) interfere with, or delay timely attainment of the NAAQS; or 4) impair visibility within federally-mandated Prevention of Significant Deterioration Class I areas.

4.1.1.2 Impact Analysis

Potential impacts, if any, to air quality are expected to occur from the emissions of tug vessels transiting to and from the proposed ODMDS. Air quality impacts at dredging sites associated with the dredge plant during dredge operations were not assessed herein, and would be assessed on a project-specific basis. Emissions from the tug vessels include particulate matter, nitrogen oxides (NO_x), sulfur dioxide (SO_2), CO and hydrocarbons.

Ambient air quality impacts were estimated using an USEPA derived model, SCREEN3. This model is constrained to estimating only volume sources (stationary source); it does not incorporate line sources (moving sources such as a tug in transit). However, these screening results are considered a maximum possible scenario, since the model assumes two tugs continuously operating side-by-side, rather than one tug operating within Apra Harbor and the other periodically in transit to and from the ODMDS. Results from the modeling effort were compared to Guam ambient air quality standards.

Emissions factors were derived from the Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (USEPA 2000). Other factors were derived from the specification sheet for a tug vessel (M/T Chamorro) based in Apra Harbor, Guam. The tug's main engine was assumed to generate 3,183 kW of power, and the two auxiliary generators were assumed to each produce 99 kW of power. Sulfur content of fuel oil was assumed to be 0.5% by weight. The vessel was assumed to stand 26 ft (8 m) off the water line, have a beam width of 30 ft (9.1 m), and maximum draft of 12 ft (3.7 m).

For air quality impact analysis, dredging operations were assumed to be comprised of two tugs, one tending in Apra Harbor while one transits to and from the ODMDS. The tender in Apra Harbor was assumed to be in operation for 12 hours/day. For a tug transiting to the North Alternative ODMDS, operations were assumed to take place for 7.5 hours/day (15 nm one-way distance, one trip per day, 4 knots underway). For a tug transiting to the Northwest Alternative ODMDS, operations were assumed to take place for 5.5 hrs/day (11 nm one-way distance, one trip per day, 4 knots underway). The maximum number of trips per year was estimated at 333, with only one trip per day.

<u>North Alternative</u>

Table 4-1 presents the total calculated annual emissions (tons/yr) for a tug tending in Apra Harbor and a tug transiting to the North Alternative ODMDS. Table 4-2 uses these values (converted to g/sec) to determine the maximum possible ambient air quality impacts (measured at 21 m downwind). The annual average emissions of NO_x (593 µg/m^3) and SO_2 (159 µg/m^3) were estimated to exceed the Guam ambient air quality standards (100 µg/m^3 and 80 µg/m^3, respectively). As mentioned previously, this is assumed to be a conservative approach and any potential air quality impacts would likely be temporary. What is not taken in to account in this model of air quality impact is that Guam ambient air quality standards would be met through mixing and dilution within 1,310 ft (400 m) downwind of the source location (Table 4-3). All residential use areas within the Apra Harbor Naval Complex are located greater than 1,310 ft (400 m) downwind of the western boundary of Inner Apra Harbor.

Overall, potential impacts on air quality from dredged material disposal operations are expected to be transient and localized, therefore insignificant.

<u>Northwest Alternative</u>

The potential impacts of dredging operations on the air quality in the Northwest ODMDS Alternative area are expected to be slightly less than those outlined above for the North ODMDS Alternative area because the distance travelled from Apra Harbor to the Northwest Alternative ODMDS would be less. Modeling of potential air quality impacts resulted in minor differences in the annual average emissions of NO_x and SO_2 as compared impacts associated with the North Alternative (Tables 4-2 and 4-3). Therefore, impacts from the Northwest Alternative would be similarly negative, as levels above acceptable air quality standards would be reached, but mixing and dilution within 1,310 ft (400 m) downwind of the source location would occur, leading to acceptable levels reaching residential areas.

<u>No Action Alternative</u>

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. The No Action Alternative would not affect climate and air quality. However, if an ODMDS is not designated, the planned volume of material to be dredged from Apra Harbor would still need to be managed. Under this scenario, material would likely be managed in an upland placement site (e.g., confined disposal facility or beneficial use project). Managing material in an upland setting would likely result in air quality impacts associated with the use of heavy equipment for rehandling and placement of the dredged material and would need to be assessed on a project-by-project basis.

4.1.2 Physical Oceanography

4.1.2.1 Significance Criteria

Physical oceanographic impacts would be significant if the disposal of dredged material would alter the regional and site-specific wave and current patterns. Changes to the wave and current patterns may adversely impact coastal processes or increase the erosion rate of sediments deposited on the seafloor.

Table 4-1. Emission Estimates for Guam ODMDS Alternate Sites

Operating Scenario	Size of Engine(s), kW[a]	Emission Factor, g/kW-hr[b]	Short-term Emissions lb/hr	Short-term Emissions g/sec	Operating Hours, hr/day or hr/trip[c]	Annual Operation, days/yr or trips/yr[d]	Annual Emissions, tons/yr[e]
Tug tending in Apra Harbor							
Main engine	3183				12	333	
PM		0.321	2.25	0.28			4.5
NO_x		11.853	83.16	10.48			166.2
SO_2		3.279	23.01	2.90			46.0
CO		4.189	29.39	3.70			58.7
HC		0.746	5.23	0.66			10.5
Auxiliary generators	198				12	333	
PM		0.261	0.11	0.01			0.2
NO_x		10.575	4.62	0.58			9.2
SO_2		2.609	1.14	0.14			2.3
CO		0.838	0.37	0.05			0.7
HC		0.067	0.03	0.00			0.1
Tug to North Alternative Site							
Main engine	3183				15	333	
PM		0.278	1.95	0.25			4.9
NO_x		10.946	76.80	9.68			191.8
SO_2		2.860	20.07	2.53			50.1
CO		2.095	14.70	1.85			36.7
HC		0.264	1.85	0.23			4.6
Auxiliary generators	198				15	333	
PM		0.261	0.11	0.01			0.3
NO_x		10.575	4.62	0.58			11.5
SO_2		2.609	1.14	0.14			2.8
CO		0.838	0.37	0.05			0.9
HC		0.067	0.03	0.00			0.1
Tug to Northwest Alternative Site							
Main engine	3183				11	333	
PM		0.278	1.95	0.25			3.6
NO_x		10.946	76.80	9.68			140.7
SO_2		2.860	20.07	2.53			36.8
CO		2.095	14.70	1.85			26.9
HC		0.264	1.85	0.23			3.4
Auxiliary generators	198				11	333	
PM		0.261	0.11	0.01			0.2
NO_x		10.575	4.62	0.58			8.5
SO_2		2.609	1.14	0.14			2.1
CO		0.838	0.37	0.05			0.7
HC		0.067	0.03	0.00			0.1
Total Emissions							
North Alternative Site							
PM			4.43	0.56			9.9
NO_x			169.20	21.32			378.7
SO_2			45.35	5.71			101.2
CO			44.82	5.65			97.1
HC			7.14	0.90			15.2
Northwest Alternative Site							
PM			4.43	0.56			8.5
NO_x			169.20	21.32			324.5
SO_2			45.35	5.71			87.1
CO			44.82	5.65			87.0
HC			7.14	0.90			14.0

a Per EPA 420-R-00-002, Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (February 2000), typical tug horsepower = 4268 hp = 3183 kW.
From data sheet on the Cabras Marine Corporation M/T "Chamorro", the two auxiliary generators are each 99 kW.

b Emission factor algorithms from EPA 420-R-00-002, Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (February 2000), Table 5-1. Load factors from Table 5-2 for non-oceangoing vessels of 40% for slow cruise and 20% for maneuvering (in harbor) for main engine and from page 5-5 of 100% for auxiliary engines.
Sulfur content of fuel oil assumed to be 0.5% by weight.

c Operating hours of tug tending in harbor assumed to be 12 hr/day.
North alternative tug transits 15 nm one-way distance 2 times/day at 4 knots.
Northwest alternative tug transits 11 nm one-way distance 2 times/day at 4 knots.

d Maximum number of trips per year is 333. (Average number is 100 trips per year.) Maximum number of days per year assumes maximum number of trips and one trip per day.

Table 4-2. Ambient Air Quality Impacts at Maximum Impact Location

	Short-term Emissions, g/sec	Annual Average Emissions, g/sec	Worst Case Ambient Impacts, µg/m³				Guam Ambient Air Quality Standards, µg/m³ [d]			
			1-hour Average[a]	8-hour Average[b]	24-hour Average[b]	Annual Average[b,c]	1-hour Average	8-hour Average	24-hour Average	Annual Average
Total Emissions										
North Alternative Site										
PM	0.56	0.28	380	266	152	15	NA	NA	150	50
NO_x	21.32	10.89	14,509	10,157	5,804	593	NA	NA	NA	100
SO_2	5.71	2.91	3,889	2,723	1,556	159	NA	NA	365	80
CO	5.65	2.79	3,843	2,690	1,537	152	40,000	10,000	NA	NA
HC	0.90	0.44	612	429	245	24	NA	NA	NA	NA
Northwest Alternative Site										
PM	0.56	0.24	380	266	152	13	NA	NA	150	50
NO_x	21.32	9.33	14,509	10,157	5,804	508	NA	NA	NA	100
SO_2	5.71	2.51	3,889	2,723	1,556	136	NA	NA	365	80
CO	5.65	2.50	3,843	2,690	1,537	136	40,000	10,000	NA	NA
HC	0.90	0.40	612	429	245	22	NA	NA	NA	NA

a Worst case ambient impact of a volume source of 10 m vertical extent (8 m vessel height plus 2 m estimated plume rise), 5 m release height and 9 m vessel width as the worst case horizontal dimension using EPA SCREEN3 Dispersion Model for maximum impact location = 680.6 µg/m³/(g/sec)
SCREEN3 Model was run assuming average stability class of D and mean wind speed on Guam of 8.2 mph based on hourly averages by month from a 30-year dataset given at http://www.microclimates.org/diurnal/index.html.
Assuming as a worst case the brief time that both tugs are together in the harbor. Maximum impact occurs at 21 m downwind.
b Assuming meteorological scaling factors suggested by EPA for SCREEN3 model of:
8-hour/1-hour = 0.7
24-hour/1-hour = 0.4
annual/1-hour = 0.08
c Using scaling factor and annual average emissions.
d From Guam Air Pollution Control Standards and Regulations, Section 1103.2.

Table 4-3. Ambient Air Quality Impacts at Downwind Distance Below Guam Ambient Air Quality Standards

	Short-term Emissions, g/sec	Annual Average Emissions, g/sec	Worst Case Ambient Impacts, µg/m³				Guam Ambient Air Quality Standards, µg/m³ [d]			
			1-hour Average[a]	8-hour Average[b]	24-hour Average[b]	Annual Average[b,c]	1-hour Average	8-hour Average	24-hour Average	Annual Average
Total Emissions										
North Alternative Site										
PM	0.56	0.28	57	40	23	2	NA	NA	150	50
NO_x	21.32	10.89	2,181	1,527	872	89	NA	NA	NA	100
SO_2	5.71	2.91	585	409	234	24	NA	NA	365	80
CO	5.65	2.79	578	404	231	23	40,000	10,000	NA	NA
HC	0.90	0.44	92	64	37	4	NA	NA	NA	NA
Northwest Alternative Site										
PM	0.56	0.24	57	40	23	2	NA	NA	150	50
NO_x	21.32	9.33	2,181	1,527	872	76	NA	NA	NA	100
SO_2	5.71	2.51	585	409	234	21	NA	NA	365	80
CO	5.65	2.50	578	404	231	20	40,000	10,000	NA	NA
HC	0.90	0.40	92	64	37	3	NA	NA	NA	NA

a ambient impact of a volume source of 10 m vertical extent (8 m vessel height plus 2 m estimated plume rise), 5 m release height and 9 m vessel width as the worst case horizontal dimension using EPA SCREEN3 Dispersion Model for 400 meters downwind = 102.3 µg/m³/(g/sec)
SCREEN3 Model was run assuming average stability class of D and mean wind speed on Guam of 8.2 mph based on hourly averages by month from a 30-year dataset given at http://www.microclimates.org/diurnal/index.html.
Assuming as a worst case the brief time that both tugs are together in the harbor.
b Assuming meteorological scaling factors suggested by EPA for SCREEN3 model of:
8-hour/1-hour = 0.7
24-hour/1-hour = 0.4
annual/1-hour = 0.08
c Using scaling factor and annual average emissions.
d From Guam Air Pollution Control Standards and Regulations, Section 1103.2.

4.1.2.2 Impact Analysis

The disposal of dredged material at an ODMDS is not expected to have any measurable effect on the regional or site-specific physical oceanographic conditions. In general, physical oceanographic conditions are driven ultimately by energy from the sun and the rotation of the earth. Atmospheric circulation (e.g., wind) generates friction on the ocean surface, in effect creating waves and surface currents. Temperature and salinity changes in ocean water due to processes such as heating, evaporation, precipitation, and the freezing and melting of ice create density differences between surface and underlying water which drives vertical circulation, (e.g., thermohaline circulation) (Brown et al. 1989b).

Conversely, the regional and site-specific physical oceanographic conditions will influence the fate and transport of dredged material disposed at an ODMDS. The predominant wind-driven, tidal and thermohaline currents will affect the dispersion, settling and deposition of dredged material through the water column to the seafloor. Dredged material disposed at the proposed ODMDS will initially fall vertically through the water column under the influence of gravity. Once the dredged material reaches a point of neutral buoyancy through the entrainment of water, vertical transport is replaced with horizontal spreading. Subsequently, site-specific oceanographic currents and turbulence dominate the movement of dredged material until the material is deposited on the seafloor (USEPA and USACE 1998). The impacts associated with the dispersion of dredged material into the water column and the deposition of dredged material onto the seafloor are discussed in subsequent sections specific to the water quality (Section 4.1.3), regional geology (Section 4.1.4), sediment quality (Section 4.1.5) and biological resources (Section 4.2).

North Alternative

Based on *in situ* measurements near the North Alternative Area, oceanographic currents are characterized by a strong wind-driven westerly surface current extending to a depth of approximately 98 ft (30 m) with maximum speeds of approximately 3.8 ft/s (1.16 m/s, 2.25 kt). Below the surface currents, intermediate layer currents, driven by thermohaline circulation and influenced by tidal circulation, are variable. To the south, currents in the intermediate layer have a net current velocity of 0.1 ft/s (0.03 m/s, 0.06 kt) to the southwest while to the west, intermediate layer currents have a net current velocity of 0.13 ft/s (0.04 m/s, 0.08 kt) to the north. Near the seafloor, bottom currents are likely influenced by bathymetric features such as the ridge of seamounts on the western edge of the Alternative Area and a slope rising towards the east. Bottom currents measured south of the North Alternative Area trend toward the northeast at 0.07 ft/s (0.02 m/s, 0.04 kt) while bottom currents measured to the west of the North Alternative Area trend to the northwest at 0.07 ft/s (0.02 m/s, 0.04 kt). Disposal of dredged material at the North Alternative Area is not expected to have any negative effect on site-specific oceanographic current patterns.

Northwest Alternative

Similar to the North Alternative Area, oceanographic currents in the Northwest Alternative Area are characterized by a strong wind-driven westerly surface current extending to a depth of approximately 98 ft (30 m) with maximum speeds of approximately 3.8 ft/s (1.16 m/s, 2.25 kt). Below, intermediate layer currents, driven by thermohaline circulation and influenced by tidal circulation, are variable. To the east, currents in the intermediate layer have a net current velocity of 0.1 ft/s (0.03 m/s, 0.06 kt) to the northeast while to the north, intermediate layer currents have a net current velocity of 0.13 ft/s (0.04 m/s, 0.08 kt) to the north direction. Near the seafloor, bottom currents are likely influenced by a seamount (Perez Bank) northwest of the proposed ODMDS and rising to approximately 2,625 ft (800 m). Bottom currents measured in the northern portion of the Northwest Alternative Area trend northwest between two seamounts towards the deeper waters of the East Marianas Basin at a rate of 0.07 ft/s (0.02 m/s, 0.04 kt).

Results from scientific studies at a similar, isolated deep seamount can be applied to the Perez Bank seamount. Oceanographic data, collected over the Fieberling Guyot, was the target area of a multidisciplinary program to study the impact of seamounts on tides, internal waves, turbulent mixing, and upwelling of oceanic waters near steep and isolated topography. It is the largest isolated feature in a group of seamounts in the northeast Pacific and is an almost axis-symmetric seamount (like Perez Bank seamount) extending from bottom depths of approximately 13,125 ft (4,000 m) up to a summit at approximately 1,640-2,300 ft (500-700 m) below the surface (closer to the surface than Perez Bank). Water column profiles show seamount-influenced currents up to 655 ft (200 m) above the seamount summit below a distinct surface layer of weak currents (Kunze and Toole 1997). Similar findings were found in a detailed numerical simulation study by Beckmann and Hadivogel (1997) of the flow regime of Fieberling Guyot. The horizontal structure of the seamount trapped wave is clearly visible at the upper flanks of the seamount, while there is only a weak indication of the trapped wave at a height of 328-655 ft (100-200 m) above the seamount's summit (Beckmann and Hadivogel 1997). These studies found that the seamount effects driven by tidal and oceanic currents occur within a limited area above the seamount summit and diminish with height. Therefore, the variability in the physical flow field associated with the Perez and Spoon Banks, including upwelling of nutrients or other organic materials is likely limited to 328-655 ft (100-200 m) above the seamount summit (e.g., approximately 1,970 ft [600 m] below the sea surface), well below the euphotic zone, thermocline, and vertical migration pattern of most pelagic fish species in the area of these seamounts in both study areas.

Disposal of dredged material at the Northwest Alternative Area is not expected to have any significant effect on site-specific oceanographic current patterns.

<u>No Action Alternative</u>

Under the No Action Alternative the ODMDS would not be created, and therefore conditions at the sites would not change. There would be no effect of the No Action Alternative on regional oceanographic current patterns.

4.1.3 Water Column Characteristics and Chemical Analysis

4.1.3.1 Significance Criteria

Sediment impacts would be significant if actions directly related to disposal of dredged material at the proposed ODMDS would exceed the water quality criteria for the ocean disposal of dredged material are specified in 40 CFR 227 or did not meet criteria set out in the USEPA's Green Book (USEPA and USACE 1991).

The USEPA's Green Book (USEPA and USACE 1991) specifies two criteria related to dilution of dredged material:

- Criterion I – The maximum concentration of a constituent outside the disposal site boundary at any time after discharge must satisfy applicable water quality standards.
- Criterion II – The maximum concentration of a constituent within the disposal site four hours after discharge must satisfy the water quality standards. The final concentration of a conservative constituent after mixing is expressed as the initial concentration divided by the dilution factor, assuming an ambient concentration of the constituent of zero.

4.1.3.2 Impact Analysis

Dredged material disposal is expected to produce temporary and localized impacts at the proposed ODMDS, including increased turbidity and decreased light transmittance due to the suspension of sediments (finer-grained silts and clays). The degree of suspension of sediments from dredged material disposal depends on four main variables; size, density and quality of the dredged material; method of disposal; hydrodynamic regime of disposal area; and ambient water quality and characteristics of the disposal site (Pennekamp and Quaak 1990). STFATE was used to model suspended sediment plumes in the upper water column (see Section 4.1.4.2 for a description of STFATE). The STFATE model was used to ascertain *in situ* changes in background suspended sediment concentration (e.g., turbidity) after disposal of a typical barge load of 3,000 cy (2,294 m^3) of both predominantly coarse and fine-grained material under various atmospheric and oceanographic conditions, including those representing La Niña (surface currents increased by a factor of four resulting from stronger than normal tradewinds) and El Niño (surface currents reversed and increased by a factor of four resulting from weaker and/or reversed tradewinds) conditions. No changes were made to the bottom current layers as these currents are driven by thermohaline circulation rather than atmospheric conditions. It is assumed that the entrained mass of suspended sediment would not be radially distributed about the point of disposal, but instead would be concentrated within a narrower arc emanating from the point of disposal and expanding under the influence of winds and currents. Figures 4-1 and 4-2 illustrate the additional STFATE modeling results and assume a current direction under normal or La Niña conditions. Under other atmospheric and oceanographic conditions, the surface plume would maintain the same geometry but would be oriented in the direction of the prevailing current.

STFATE model results under any of the observed conditions suggest that the largest surface plume geometry having a suspended sediment concentration of at least 1 mg/L, would have a radius of approximately 292 ft (89 m) and a penetration depth of 458 ft (140 m). After four hours from the disposal event, the surface plume will have expanded to have a radius of approximately 4,737 ft (1,444 m) and would penetrate the upper water column to a maximum depth of approximately 2,590 ft (789 m). With this expansion, the concentration of the suspended sediments would decrease approximately three orders of magnitude to approximately 0.005 mg/L which is less than ambient concentrations, is far below concentrations shown to cause adverse impacts, and is even below laboratory detection limits.

Figure 4-1 and 4-2 show the surface plume after a period of four hours. The origin of the surface plume appears offset from the surface disposal zone in these figures due to the influence of prevailing currents after the initial disposal event has terminated.

During suspension and settling, changes in physical and chemical conditions may lead to the desorption of particulate-bound contaminants into the water column. Potential toxicity and bioaccumulation may result from biologically available, desorbed heavy metals and anthropogenic organics. Dissolved contaminants may in turn be sequestered from the water column by mechanisms such as the re-adsorption (onto sediment particles which eventually settle out of the water column), precipitation processes, redox transformations, uptake by aquatic life, degradation, and volatilization. The release of organic-rich sediments during disposal into environments adapted to low nutrient conditions can also result in eutrophication effects such as the localized confiscation of oxygen in the surrounding water column.

All material will be tested for the presence of contaminants as well as the potential for toxicity and bioaccumulation prior to dredging using national testing guidance (USEPA and USACE 1991). Numerical modeling using STFATE may be conducted using chemistry concentrations of proposed dredged material to determine the diluted concentration of potential contaminants in the water column. These modeled results will be compared to water quality criteria to determine suitability for ocean disposal. Only dredged material deemed suitable under these protocols would be permitted for disposal at an ODMDS. Screening of the dredged material will ensure that no significant effects to water quality would result from the ocean disposal of the dredged material at the ODMDS.

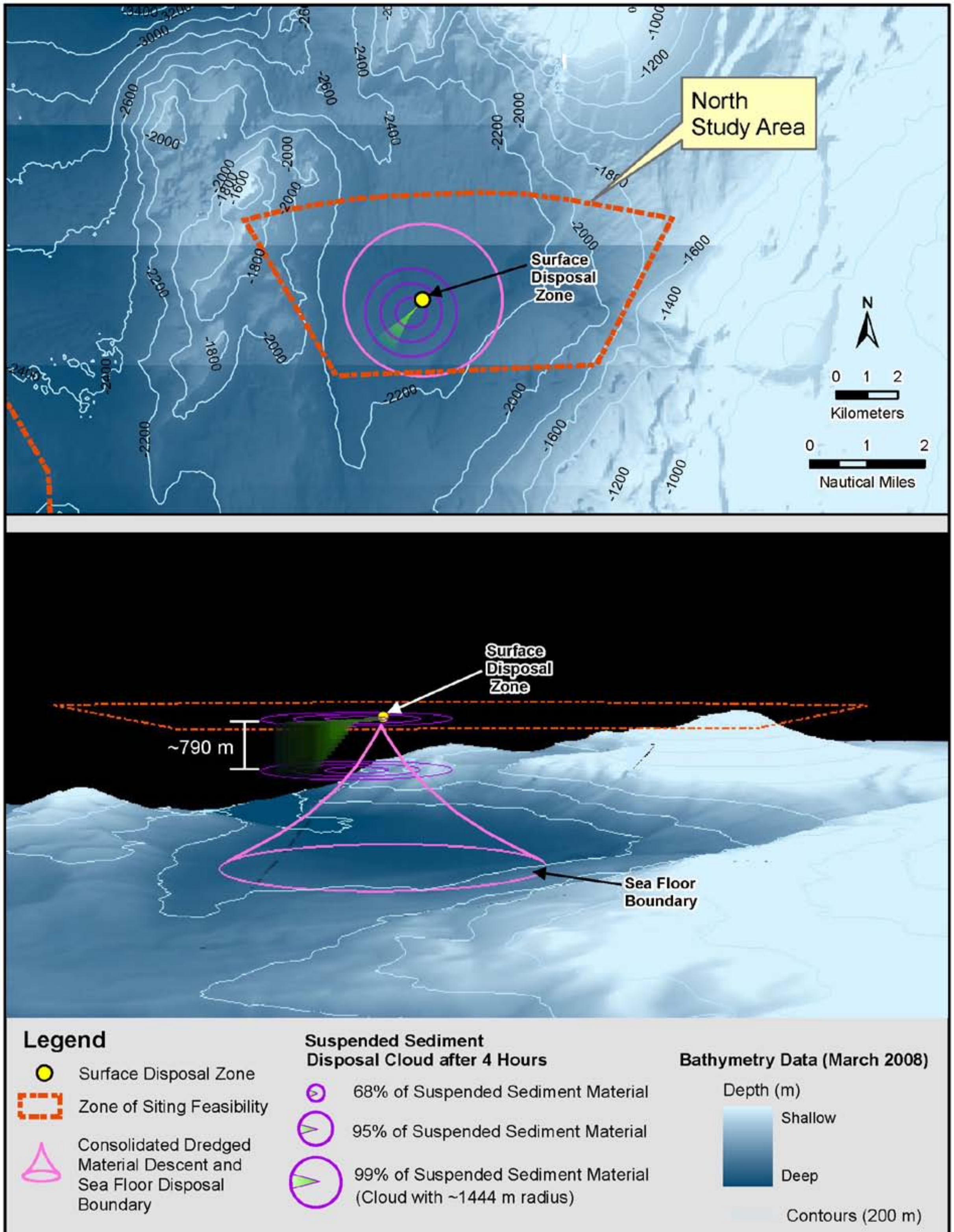

Figure 4-1.
Prospective View of Upper Water Column Sediment Dispersion in the North Study Area During La Niña Conditions

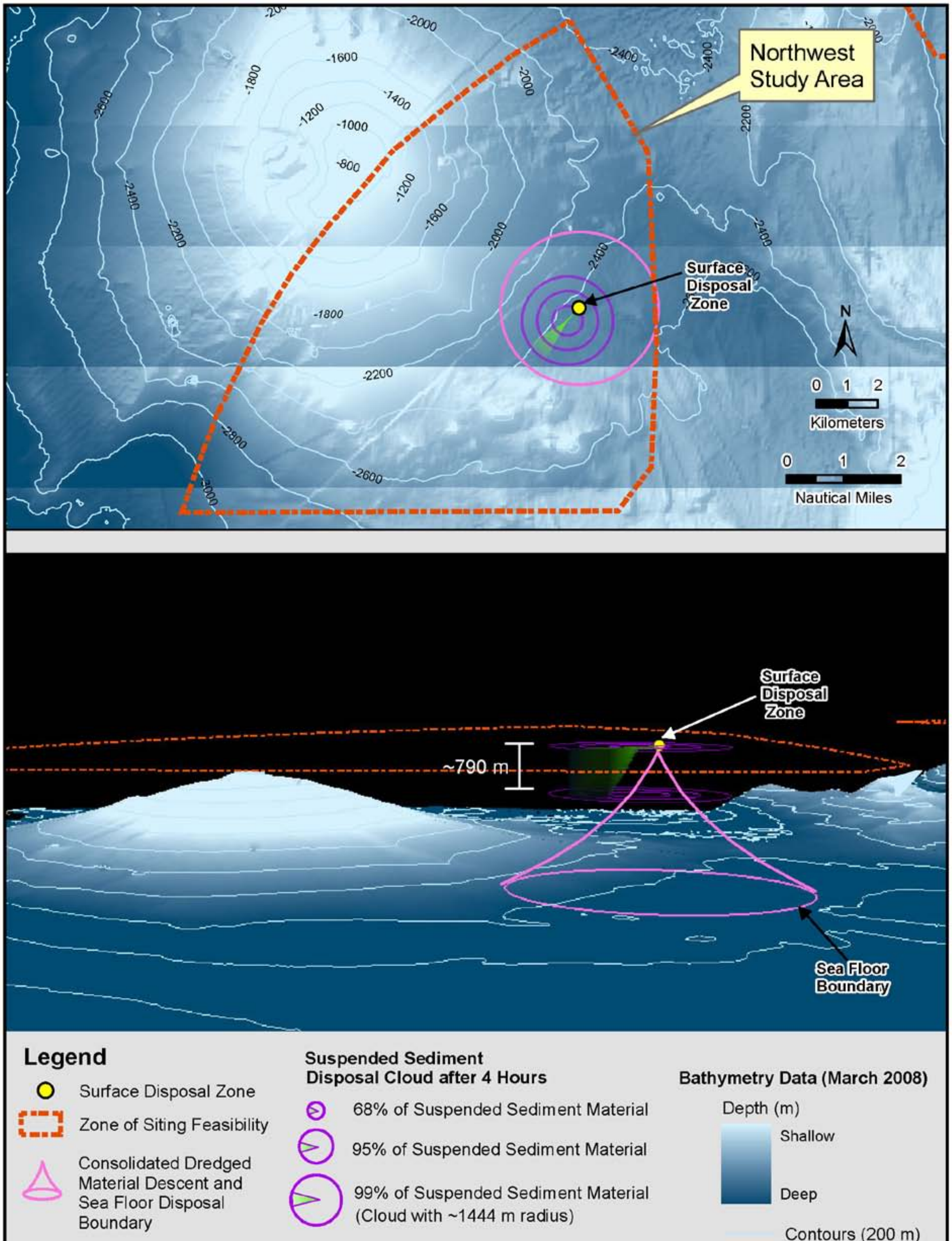

Figure 4-2.
Prospective View of Upper Water Column Sediment Dispersion in the Northwest Study Area During La Niña Conditions

Recent Tier III analysis and evaluation was performed for three construction dredging projects within the Apra Harbor Naval Complex which are expected to support new, deeper draft vessels based in Apra Harbor as well as larger vessels transiting through Guam. Two Inner Apra Harbor projects, P-436 and P-518 and an Outer Apra Harbor project, P-502, will ensure sufficient water depth to meet the Navy's operational requirements for future berthing and ship loading activities in these areas. Tier III analysis of the P-436 and P-518 area indicated that sediment from this area deemed suitable for ocean disposal was fine-grained (68.7% and 70.8%, respectively). Conversely, sediment from the P-502 area deemed suitable for ocean disposal was predominantly coarse-grained (95.1%). The Tier III assessment found that proposed dredged material from the entire P-518 and P-502 area was suitable for ocean disposal. Three of the five delineated areas within the P-436 project site were found suitable for ocean disposal. The remaining two areas showed toxicity in a SP tests and were deemed unsuitable for ocean disposal (Weston Solutions and Belt Collins 2007c). Because dredged material from Apra Harbor will likely be the primary source of materials disposed at the proposed ODMDS, environmental consequences caused by sediments from the P-436, P-518 and P-502 projects are considered throughout this section.

Sediment from the aforementioned projects was deemed appropriate for use in this evaluation because the material from these projects contained a range of grain size characteristics, from predominantly fine-grained to predominantly coarse-grained material. Finer-grained material (primarily silts and clays) tend to carry higher contaminant loads whereas coarser-grained material (primarily sands and gravels) tend to carry significantly less contaminant loads. Additionally, the majority of the sediment from these projects was collected along wharf faces where contaminant loads are expected to accumulate from industrial activities. The majority of the material evaluated for the three Navy projects was predominantly fine-grained. In the absence of chemical or fuel spills, future maintenance dredged material is expected to contain fewer contaminants, unlike those measured from sediment within the proposed P-436, P-518 and P-502 dredge footprints. The material proposed for dredging still need to pass Tier III testing to be determined suitable for ocean disposal and it is unlikely that the impact analysis would be significantly altered.

<u>North Alternative</u>

The discharge of dredged material could result in a temporary localized turbidity plume that would dissipate with distance from the disposal site. The increased turbidity may attenuate light within the plume causing a temporary decrease in transmissivity in the photic zone relative to ambient levels. Heavier sediments, such as coarse-grained particles characteristic of P-502 project sediments, would descend more rapidly than fine-grained sediments and therefore be expected to have an insignificant effect on water column characteristics in the North Alternative area. Finer sediments, such as silt and clay particles characteristic of P-436 and P-518 project sediments, would descend more slowly causing potentially significant impacts that would be attenuated by dispersal and dilution. Discontinuous disposal activity at the ODMDS can minimize these acute effects on water column characteristics. Chemical contaminants present within the plume may also result in temporary elevated levels of desorbed heavy metals and anthropogenic organics in the affected water column. The low TOC content of sediments from Areas P-436, P-518 and P-502 would avert eutrophication effects including the sequestering of dissolved oxygen in the surrounding water column.

Overall, potential impacts on water quality from suitable dredged material permitted for ocean disposal at the North Study Area are expected to be transient and localized (e.g., contained within the overall boundary of the disposal site) within four hours of the initial disposal activity. Significant dilution is expected to mitigate any potential impacts caused by sediments remaining in suspension beyond the boundary of the disposal site for longer than four hours. Therefore, there will be no unacceptable adverse impacts to water quality.

Northwest Alternative

Due to the homogeneity of water quality between the Northwest and North ODMDS Alternative areas, the potential impacts of dredged material disposal on the water column characteristics in the Northwest study area are expected to be similar to those outlined in the North Alternative area.

No Action Alternative

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. There would be no effect of the No Action Alternative on the water column.

4.1.4 Regional Geology

4.1.4.1 Significance Criteria

Geological impacts would be significant if the disposal of dredged material would: 1) alter the regional and site-specific bathymetry; 2) interfere with or change sediment transport processes; or 3) alter the existing characteristics of the seafloor (e.g., change the substrate from predominantly silty sand to gravel).

4.1.4.2 Impact Analysis

The disposal of dredged material at an ODMDS is not expected to have any measurable effect on the regional or site-specific bathymetric conditions or sediment transport processes, particularly outside of the site boundaries; however, dredged material is expected to accumulate within the proposed ODMDS boundary causing potential temporary impacts to substrate characteristics and benthic organisms. At the center of the disposal area, the maximum thickness of dredged material deposits was modeled to be approximately 2 ft (0.6 m) per year assuming a maximum possible disposal scenario of 1,000,000 cy (764,554 m^3) of coarse-grained material. STFATE, a model designed to assess the fate and transport of dredged material disposed in open ocean waters, was used to predict the horizontal and vertical extents of these dredged material accumulations on the seafloor. The potential for impacts to the benthic community are discussed in subsequent sections specific to biological resources (Section 4.2).

Results of monitoring conducted at the SF-DODS offshore of San Francisco, California indicates no evidence of major long-term physical changes [to the seafloor characteristics] and suggest no widespread or long-term impairments to the deep ocean biological communities (Germano & Associates 2008). The SF-DODS is similar to either of the proposed alternative ODMDS offshore of Guam in its location in extremely deep water (>8,200 ft [2,500 m]). Dredged material will disperse over a large spatial area during its descent through the water column and ultimately be deposited on the seafloor in relatively thin layers. Since its designation in 1994 as an ODMDS, the SF-DODS has received an annual average of approximately 1,000,000 cy (764,554 m^3) of dredged material. Over this almost 15 year period, the accumulated thickness of dredged material outside the site boundary is less than 4 in (10 cm). At the SF-DODS site, evidence suggests dredged material deposited on the seafloor is constantly being assimilated (e.g., mixed) into the underlying sediments by biological processes such as burrowing and foraging of benthic organisms.

Potential impacts to the regional geology, specifically the existing characteristics of the seafloor, are expected to be negligible.

Description of STFATE

The STFATE model was evaluated for its efficacy in modeling dredged material disposal events at a deep sea ODMDS, similar to the environment offshore of Guam. STFATE predicts the transport of disposed dredged material through the water column and ultimately the area and thickness of material deposition. STFATE is a module of the Automated Dredging and Disposal Alternatives Management System and was developed by the USACE. A detailed discussion of the model's capabilities and assumptions can be found in the Inland Testing Manual (USEPA and USACE 1998).

In general, STFATE models the transport of dredged material based on three phases of movement: convective descent, dynamic collapse and passive transport-dispersion. During convective descent, the consolidated dredged material falls vertically through the water column under the influence of gravity. Once the dredged material reaches a point of neutral buoyancy (dynamic collapse), vertical transport is replaced with horizontal spreading. Passive transport-dispersion occurs when ambient currents and turbulence dominates the movement of unconsolidated dredged material until the material is deposited (in a normal distribution) on the seafloor. The model assumes deposited material remains in place and is not transported due to erosion or bedload transport.

Model input and output is provided for a gridded area, scaled to represent the area of expected transport and deposition. The grid has cells of a user-specified size. Current velocity in the east-west (x) and north-south (y) direction for each of two vertical layers is applied to each cell. The model cannot account for site-specific bathymetry, and instead uses either a single disposal depth for each cell over the entire gridded area or a uniform slope.

Input parameters to the model include ambient environmental parameters such as time-invariant current velocity, density stratification and water depths, operational parameters such as barge position, speed, dimensions, draft and volume of dredged material to be disposed. Values representing entrainment, settling, drag, dissipation, apparent mass and density gradient differences can also be defined.

The primary limitation in using STFATE for this project is its inability to model multiple current patterns in both the horizontal as well as vertical directions. The model is restricted to only two discrete current patterns in the vertical direction. This constrains the model from accurate predictions in a deep sea environment which typically has a surface current attenuating with depth and multiple intermediate layer and bottom layer currents. Further, the model can only evaluate a maximum of 12 time-steps and is restricted in the lengths of each time-step. Due to the extreme depths of the disposal site and slow settling velocities of unconsolidated fine-grained material, the model would not run to completion (e.g., predict the deposition of all silts and clays).

STFATE model output provides results for a single disposal event of the total volume and associated deposit thickness for each particle size, as well as cumulative results for all disposed material, in each model grid cell. In addition, it provides results predicting the physical characteristics of the sediment cloud remaining in suspension at model termination. In the Ocean Current Study (Weston Solutions and Belt Collins 2007b), STFATE was used to model a single disposal event (3,000 cy [2,294 m^3]) and results were extrapolated to 333 disposal events over the course of year (1,000,000 cy [764,555 m^3]). Based on findings in the ZSF study (Weston Solutions and Belt Collins 2006), 1,000,000 cy (764,555 m^3) was chosen to represent a maximum dredged material volume for a given year associated with any specific construction dredge project. To be conservative, this assessment will focus on the disposal of 1,000,000 cy (764,555 m^3) to determine the maximum extent of the ODMDS boundary.

To extrapolate the deposit thickness for the dredged material volume scenarios of 1,000,000 cy (764,555 m^3), the deposit thickness from a single disposal event was multiplied by the total number of trips expected during each season (dry and wet), assuming a consistent, regular pattern of disposal throughout the year. For example, to dispose 1,000,000 cy (764,555 m^3) of dredged material using a scow having a capacity of 3,000 cy (2,294 m^3), would require 333 trips, 166.5 trips during each season. Two separate current structures were evaluated using *in situ* current data: dry season and wet season. For the purposes of the extrapolation, it was assumed that dredged material disposed at the potential ODMDS alternative sites would be exposed to dry season currents 50% of the time (50 trips) and wet season currents the remaining 50% of the time (50 trips). These calculations were input into a GIS and isopachs were developed for deposit thicknesses greater than 0.4 in (1 cm), 3.9 in (10 cm), 7.9 in (20 cm) and 19.7 in (50 cm), as appropriate.

This additive method is conservative in some aspects as it does not account for compaction of material over time or redistribution of sediment deposits due to physical processes such as bedload transport or biological processes such as bioturbation; therefore this method provides the greatest potential deposit thickness. This additive method is not conservative in other aspects as it assumes that each disposal event occurs at the same location within the target surface disposal area, rather than at multiple locations distributed throughout the target surface disposal area; therefore, the overall footprint on the seafloor is reduced. However, since the model grid cell size is only slightly smaller than the target surface disposal area and assuming a normal distribution of disposal events about the center of the target surface disposal area, variations in the predicted footprints are not anticipated to be significant.

As expected, coarser-grained material deposited more quickly than finer-grained material and the coarser-grained material did not disperse as far relative to finer-grained material. For example, gravel material settled within 16 hours of the disposal event and was not transported beyond the boundaries of the model grid cell in which the disposal event occurred (an area of approximately 0.11 sq. nm [0.37 km^2]). In contrast, only a small percentage of the silts and clays settled to the seafloor within the time limits of the model (192 hours) and these materials were transported over a much greater area with nearly all model grid cells within the bounds of the model limits (an area of approximately 219 sq. nm [752 km^2]) predicting some deposition, however minute, of these materials.

Table 4-4 lists the area of deposits for accumulations greater than 0.4 in (1 cm), 3.9 in (10 cm), 7.9 in (20 cm) and 19.7 in (50 cm) for each of the two scenarios (disposal of 1,000,000 cy [764,555 m^3] of coarse-grained material vs. fine-grained material) under the influence of currents measured from both the CM1 and CM2 moorings. Figures 4-3 through 4-10 illustrate these results. The largest footprint is associated with the disposal of 1,000,000 cy (764,555 m^3) of predominantly fine-grained material. Using current velocities from CM1 or CM2 did not influence the results. The deposit areas predicted using current velocities from CM1 or CM2 were similar to results obtained during the Ocean Current Study (Weston Solutions and Belt Collins 2007b).

The total thickness of new material deposited on the seafloor was much greater in the model grid cell directly below the disposal site than in all adjacent model grid cells. After 333 disposal events (the assumed maximum number of trips per year), new material in the grid cell directly below the disposal site was approximately 9.6 in (24.3 cm) for the disposal of predominantly fine-grained material and was approximately 25.6 in (64.9 cm) for the disposal of predominantly coarse-grained material at the North Alternative Area. For the disposal of material at the Northwest Alternative Area, new material in the grid cell directly below the disposal site was approximately 7.9 in (20.1 cm) for the disposal of predominantly fine-grained material and was approximately 24.2 in (61.4 cm) for the disposal of predominantly coarse-grained material.

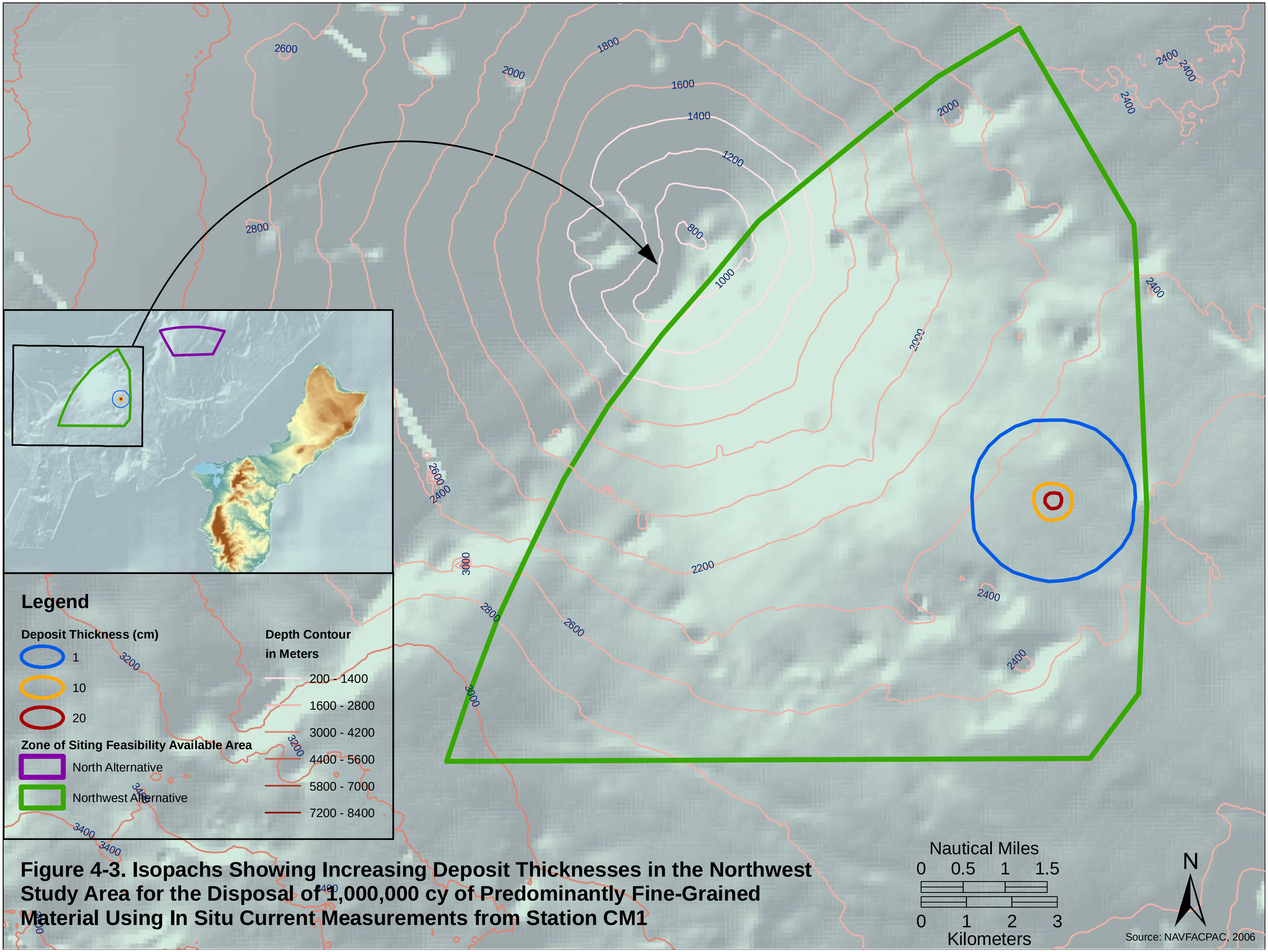

Figure 4-3. Isopachs Showing Increasing Deposit Thicknesses in the Northwest Study Area for the Disposal of 1,000,000 cy of Predominantly Fine-Grained Material Using In Situ Current Measurements from Station CM1

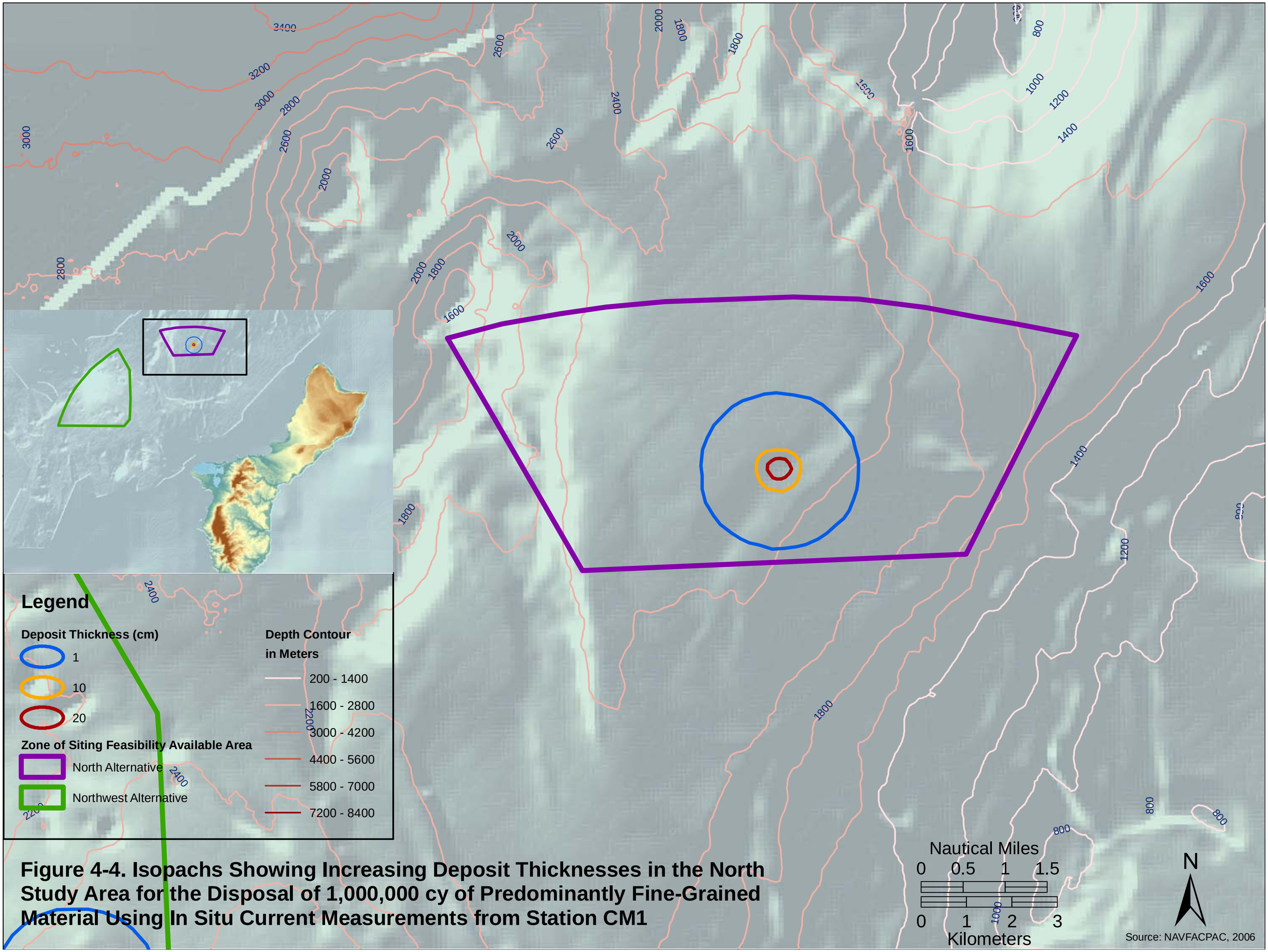

Figure 4-4. Isopachs Showing Increasing Deposit Thicknesses in the North Study Area for the Disposal of 1,000,000 cy of Predominantly Fine-Grained Material Using In Situ Current Measurements from Station CM1

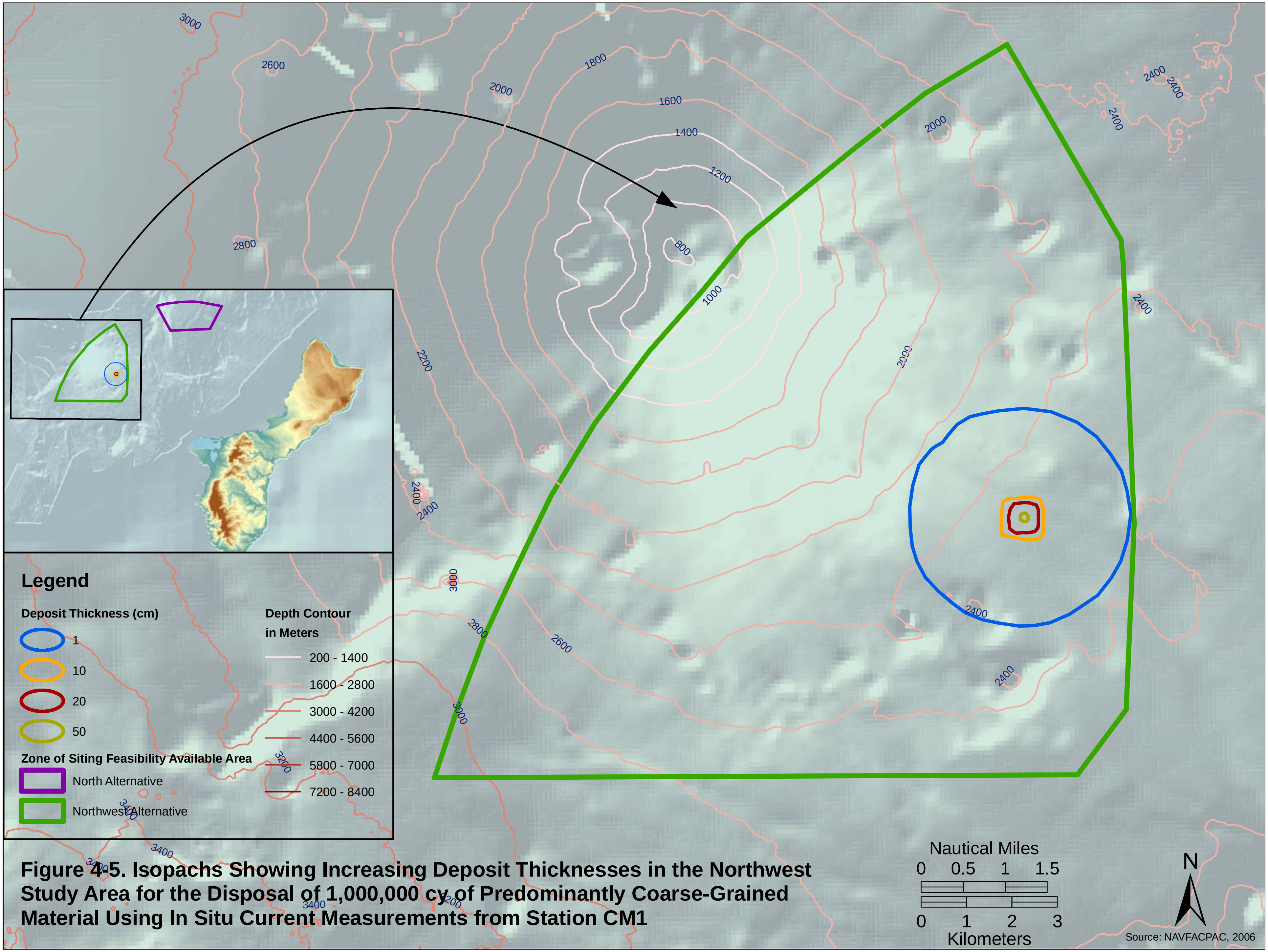

Figure 4-5. Isopachs Showing Increasing Deposit Thicknesses in the Northwest Study Area for the Disposal of 1,000,000 cy of Predominantly Coarse-Grained Material Using In Situ Current Measurements from Station CM1

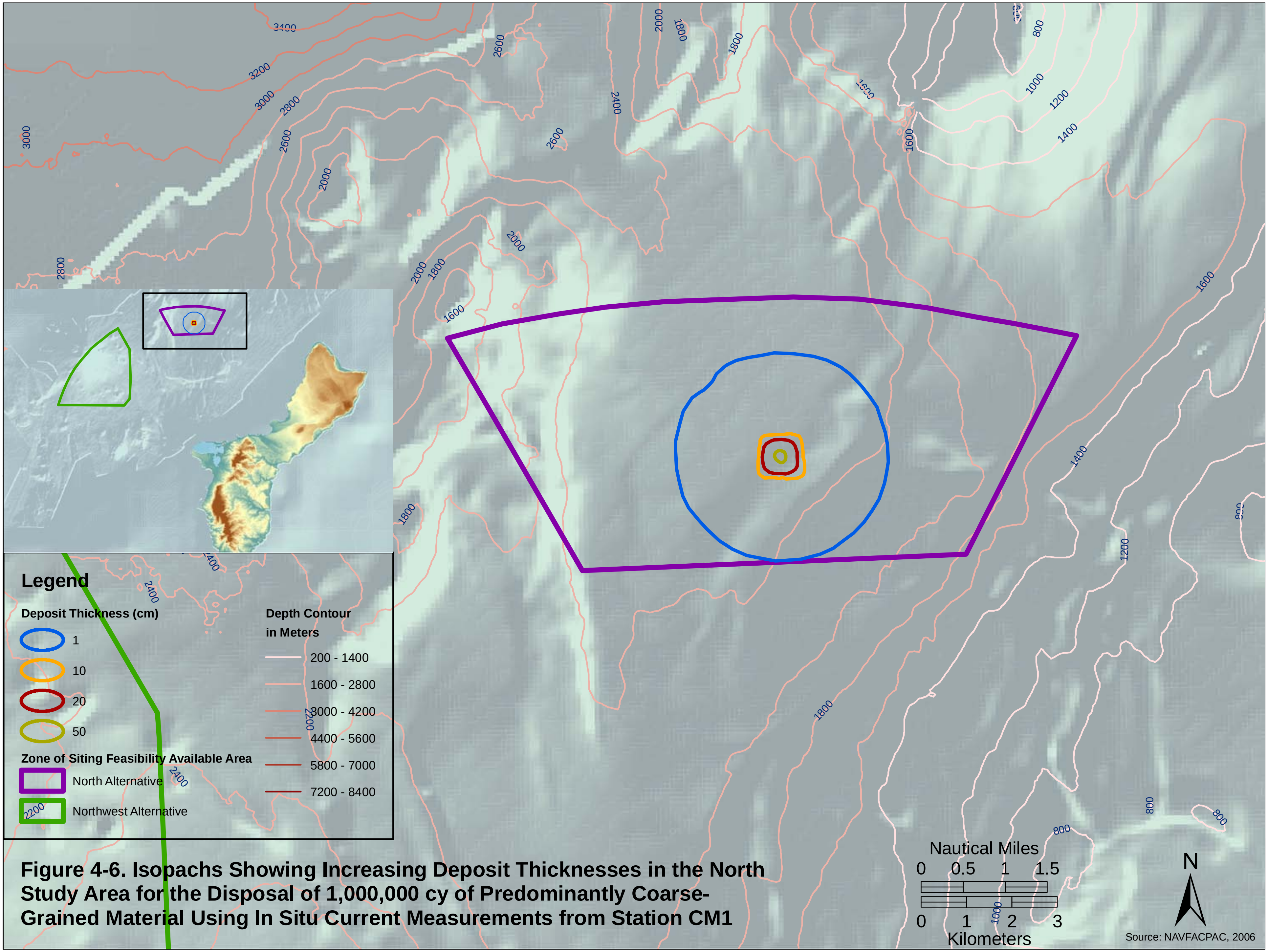

Figure 4-6. Isopachs Showing Increasing Deposit Thicknesses in the North Study Area for the Disposal of 1,000,000 cy of Predominantly Coarse-Grained Material Using In Situ Current Measurements from Station CM1

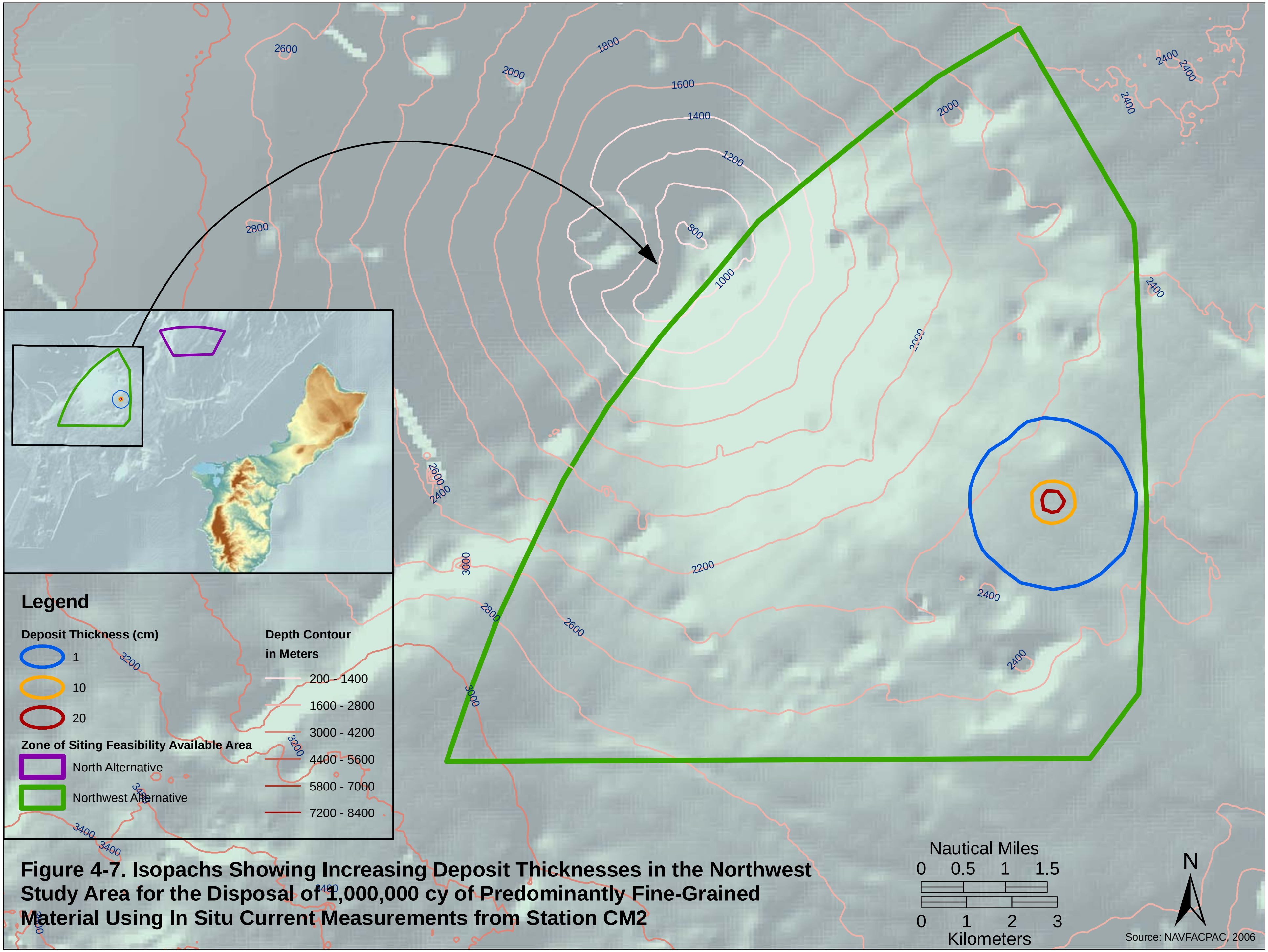

Figure 4-7. Isopachs Showing Increasing Deposit Thicknesses in the Northwest Study Area for the Disposal of 1,000,000 cy of Predominantly Fine-Grained Material Using In Situ Current Measurements from Station CM2

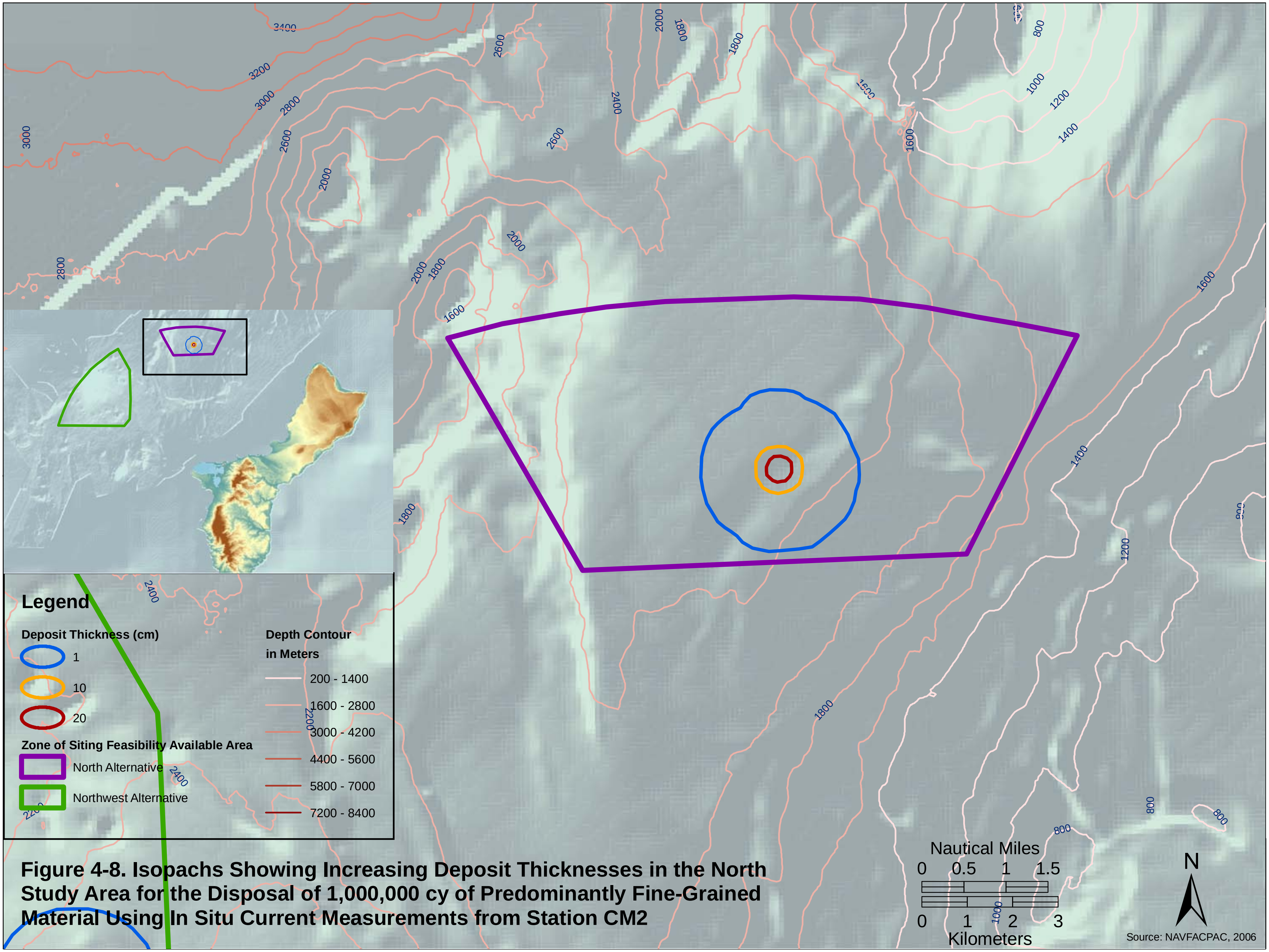

Figure 4-8. Isopachs Showing Increasing Deposit Thicknesses in the North Study Area for the Disposal of 1,000,000 cy of Predominantly Fine-Grained Material Using In Situ Current Measurements from Station CM2

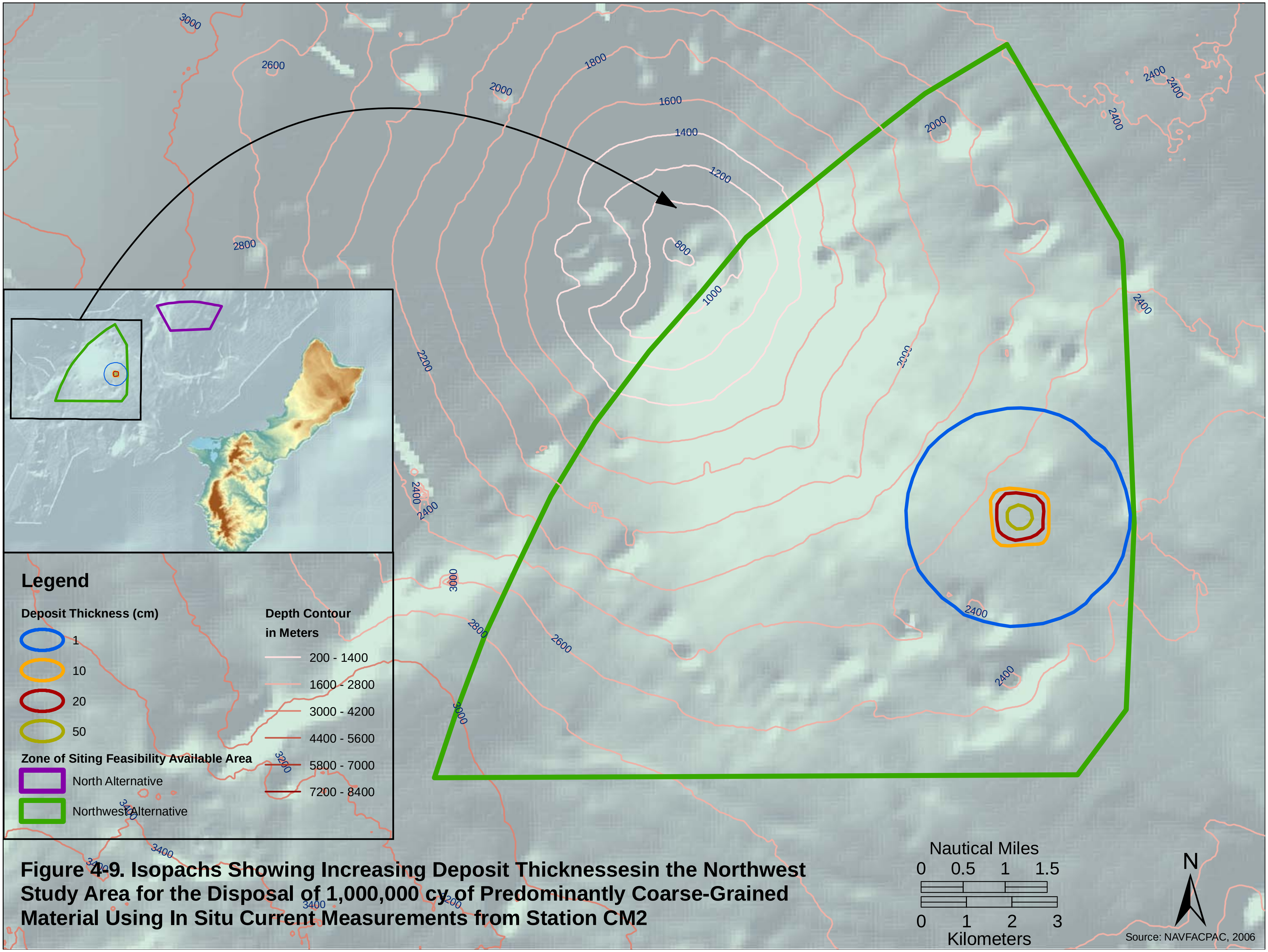

Figure 4-9. Isopachs Showing Increasing Deposit Thicknessesin the Northwest Study Area for the Disposal of 1,000,000 cy of Predominantly Coarse-Grained Material Using In Situ Current Measurements from Station CM2

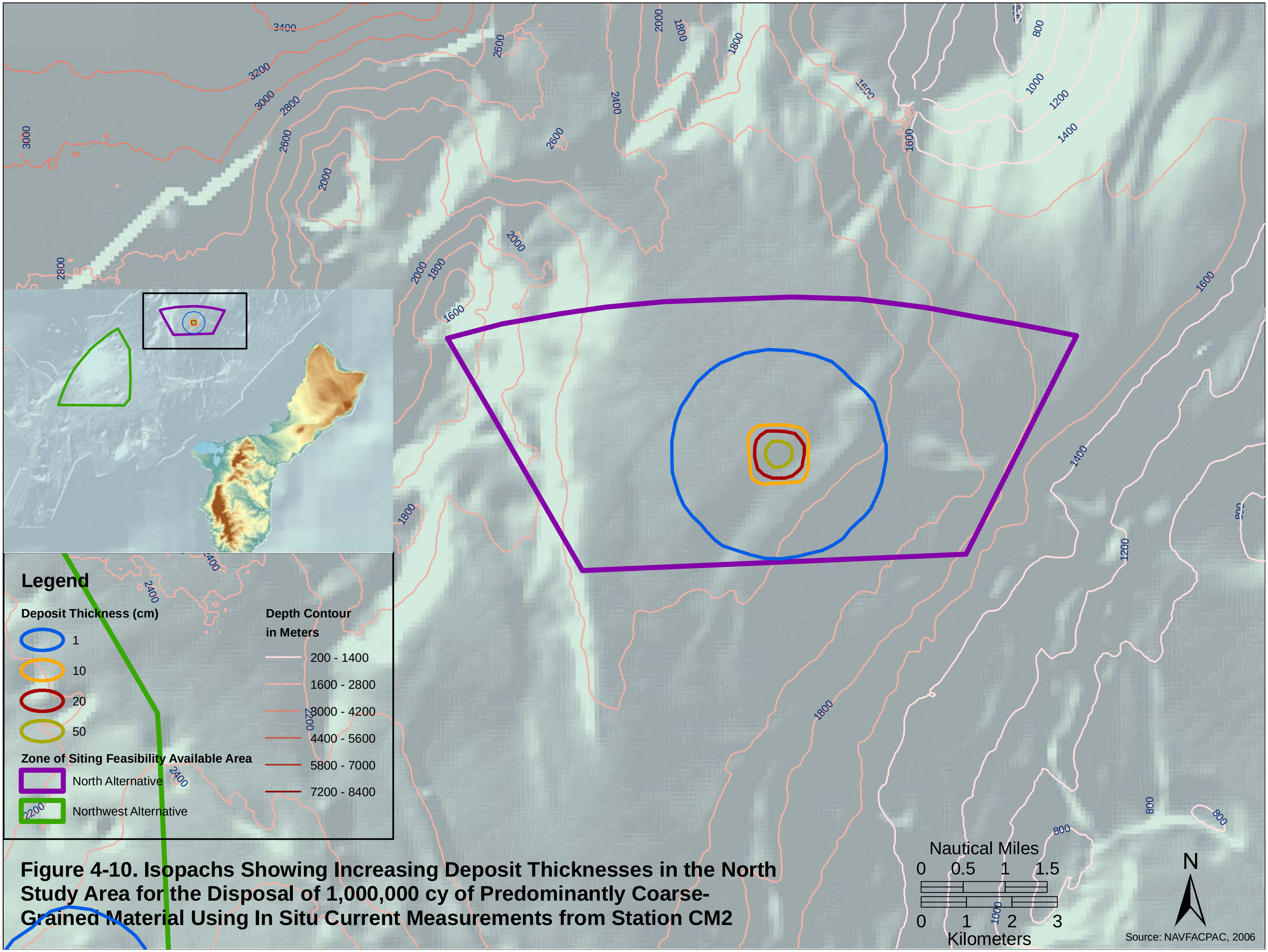

Figure 4-10. Isopachs Showing Increasing Deposit Thicknesses in the North Study Area for the Disposal of 1,000,000 cy of Predominantly Coarse-Grained Material Using In Situ Current Measurements from Station CM2

Table 4-4. Modeled Thickness and Area of Deposits for Disposal of 1,000,000 cy of Fine or Coarse-Grained Dredged Material

Scenario	Deposit Thickness (in [cm])	Diameter (mi [km])	Area of Deposits (mi^2 [km^2])	Maximum Deposit Thickness (in [cm])
North Alternative Fine-grained Material 1,000,000 cy CM1	>0.4 (>1.0)	2.13 (3.42)	3.55 (9.20)	9.6 (24.3)
	>3.9 (>10)	0.59 (0.94)	0.27 (0.70)	
	>7.9 (>20)	0.29 (0.47)	0.07 (0.18)	
	>19.7 (>50)			
North Alternative Coarse-grained Material 1,000,000 cy CM1	>0.4 (>1.0)	2.84 (4.57)	6.34 (16.4)	25.6 (64.9)
	>3.9 (>10)	0.66 (1.07)	0.35 (0.89)	
	>7.9 (>20)	0.49 (0.79)	0.19 (0.49)	
	>19.7 (>50)	0.16 (0.26)	0.02 (0.05)	
Northwest Alternative Fine-grained Material 1,000,000 cy CM1	>0.4 (>1.0)	2.21 (3.56)	3.85 (9.98)	7.9 (20.1)
	>3.9 (>10)	0.52 (0.84)	0.21 (0.56)	
	>7.9 (>20)	0.23 (0.37)	0.04 (0.11)	
	>19.7 (>50)			
Northwest Alternative Coarse-grained Material 1,000,000 cy CM1	>0.4 (>1.0)	2.97 (4.79)	6.95 (18.0)	24.2 (61.4)
	>3.9 (>10)	0.62 (0.99)	0.30 (0.77)	
	>7.9 (>20)	0.45 (0.72)	0.16 (0.40)	
	>19.7 (>50)	0.12 (0.19)	0.01 (0.03)	
North Alternative Fine-grained Material 1,000,000 cy CM2	>0.4 (>1.0)	2.14 (3.44)	3.58 (9.28)	9.6 (24.3)
	>3.9 (>10)	0.64 (1.03)	0.32 (0.83)	
	>7.9 (>20)	0.35 (0.56)	0.10 (0.25)	
	>19.7 (>50)			
North Alternative Coarse-grained Material 1,000,000 cy CM2	>0.4 (>1.0)	2.86 (4.61)	6.43 (16.7)	25.6 (64.9)
	>3.9 (>10)	0.86 (1.39)	0.58 (1.51)	
	>7.9 (>20)	0.68 (1.09)	0.36 (0.93)	
	>19.7 (>50)	0.36 (0.57)	0.10 (0.26)	
Northwest Alternative Fine-grained Material 1,000,000 cy CM2	>0.4 (>1.0)	2.25 (3.61)	3.96 (10.3)	7.9 (20.1)
	>3.9 (>10)	0.59 (0.94)	0.27 (0.70)	
	>7.9 (>20)	0.29 (0.46)	0.07 (0.17)	
	>19.7 (>50)			
Northwest Alternative Coarse-grained Material 1,000,000 cy CM2	>0.4 (>1.0)	2.98 (4.79)	6.96 (18.0)	24.2 (61.4)
	>3.9 (>10)	0.84 (1.36)	0.56 (1.45)	
	>7.9 (>20)	0.66 (1.06)	0.34 (0.89)	
	>19.7 (>50)	0.34 (0.55)	0.09 (0.24)	

The total thickness decreases at the Northwest Alternative Area due to its deeper depth (approximately 8,200 ft [2,500 m]) compared to the North Alternative Area (approximately 7,400 ft [2,255 m]) due to the greater horizontal transport of finer-grained material from the center of the disposal site. In all cases, the maximum deposit thickness in any of the immediately adjacent cells (a distance of approximately 3,000 ft (914 m) from the center of the disposal site) decreased by a factor of six. Therefore, within 3,000 ft (914 m) from the center of the disposal site, deposit thicknesses were reduced to approximately 1.6 in (4.1 cm) and 4.3 in (10.8 cm) for fine and coarse-grained material, respectively in the North Alternative Area and approximately 1.3 in (3.3 cm) and 4.0 in (10.2 cm) for fine and coarse-grained material, respectively in the Northwest Alternative Area.

The deposit thicknesses predicted using current velocities from CM1 or CM2 were similar to results obtained during the Ocean Current Study (Weston Solutions and Belt Collins 2007b).

Additional STFATE Modeling Simulating El Nino/La Nina Conditions

The STFATE model input parameters were modified to simulate likely changes in oceanographic conditions in response to atmospheric anomalies such as El Niño or La Niña.

Two separate scenarios were evaluated. In the first scenario surface current speeds were increased by a factor of four while the surface current directions remained normal, thereby simulating La Niña conditions (stronger than normal tradewinds). In the second scenario surface current speeds were increased by a factor of four and the surface current directions were reversed (e.g., towards Guam), thereby simulating a strong El Niño condition (weakening or reversal of tradewinds). In both scenarios no changes were made to the bottom current layers as these currents are driven by thermohaline circulation rather than atmospheric conditions. To satisfy constraints of the STFATE model the surface current layer is assumed to be uniform and extend down to a depth of 1,000 ft (328 m). This assumption is conservative as the effects of atmospheric conditions on the water column diminish with depth, and are typically much less significant below 656 ft (200 m). It should also be noted that on-shore current reversals towards Guam and stronger than normal current speeds were modeled for an entire year, but in reality would not be expected to last an entire year. These conservative input parameters were used to demonstrate the deposition pattern of disposed material during El Niño or La Niña events.

STFATE model results indicated minimal change to the deposition of material, even during maximum El Niño or La Niña conditions. Table 4-5 lists the area of deposits for accumulations greater than 0.4 in (1 cm), 3.9 in (10 cm), and 7.9 in (20 cm) under stronger than normal tradewinds (La Niña) and stronger than normal reversed tradewinds (El Niño) for the disposal of both coarse- and fine-grained material (Figures 4-11 through 4-14). The largest fine-grained material dispersal footprint is associated with disposal during El Niño conditions in the Northwest Alternative Area, where a 400% increase of surface current speed and reversal of tradewinds toward Guam only resulted in an approximately 4% increase in the area of dispersal. The largest coarse-grained material disposal footprint is associated with disposal during La Niña conditions also in the Northwest Alternative Area, where a 400% increase of surface current speed only resulted in an approximately 3% increase in the area of deposits.

The maximum deposit thicknesses of both predominantly fine-grained material and predominantly coarse-grained material were greatest in the North Alternative Area under stronger than normal reversed tradewinds (El Niño) at 1.7 in (4.3 cm) and 3.7 in (9.3 cm), respectively. Likewise, stronger than normal tradewind (La Niña) conditions in the North Alternative Area resulted in comparable maximum deposit thicknesses of 1.4 in (3.5 cm) for predominantly fine-grained material and 3.2 in (8.0 cm) for predominantly coarse-grained material. Conversely, the maximum deposit thicknesses were less in the Northwest Alternative Area under La Niña and El Niño conditions for both predominantly fine-grained material and predominantly coarse-grained material.

Table 4-5. Modeled Coarse- and Fine-Grained Material Accumulations Greater Than 0.4 in (1 cm), 3.9 in (10 cm), and 7.9 in (20 cm) Under Stronger Than Normal Tradewinds (La Niña) and Stronger Than Normal Reversed Tradewinds (El Niño)

Scenario	Deposit Thickness (in [cm])	Diameter (mi [km])	Area of Deposits (mi^2 [km^2])	Maximum Deposit Thickness (in [cm])
North Alternative Fine-grained Material La Niña Conditions	>0.4 (>1.0)	2.1 (3.41)	3.53 (9.13)	1.4 (3.5)
	>3.9 (>10)			
	>7.9 (>20)			
North Alternative Coarse-grained Material La Niña Conditions	>0.4 (>1.0)	2.85 (4.59)	6.39 (16.54)	3.2 (8.0)
	>3.9 (>10)			
	>7.9 (>20)			
North Alternative Fine-grained Material El Niño Conditions	>0.4 (>1.0)	2.15 (3.47)	3.66 (9.48)	1.7 (4.3)
	>3.9 (>10)			
	>7.9 (>20)			
North Alternative Coarse-grained Material El Niño Conditions	>0.4 (>1.0)	2.85 (4.58)	6.36 (16.47)	3.7 (9.3)
	>3.9 (>10)			
	>7.9 (>20)			
Northwest Alternative Fine-grained Material La Niña Conditions	>0.4 (>1.0)	2.22 (3.57)	3.87 (10.01)	0.6 (1.5)
	>3.9 (>10)			
	>7.9 (>20)			
Northwest Alternative Coarse-grained Material La Niña Conditions	>0.4 (>1.0)	3.02 (4.86)	7.17 (18.58)	1.4 (3.6)
	>3.9 (>10)			
	>7.9 (>20)			
Northwest Alternative Fine-grained Material El Niño Conditions	>0.4 (>1.0)	2.26 (3.64)	4.01 (10.39)	0.9 (2.3)
	>3.9 (>10)			
	>7.9 (>20)			
Northwest Alternative Coarse-grained Material El Niño Conditions	>0.4 (>1.0)	3.01 (4.85)	7.13 (18.47)	2.0 (5.0)
	>3.9 (>10)			
	>7.9 (>20)			

Note: Data are for 1,000,000 cy in a year, based on the assumption that the El Niño or La Niña conditions persist over the entire year.

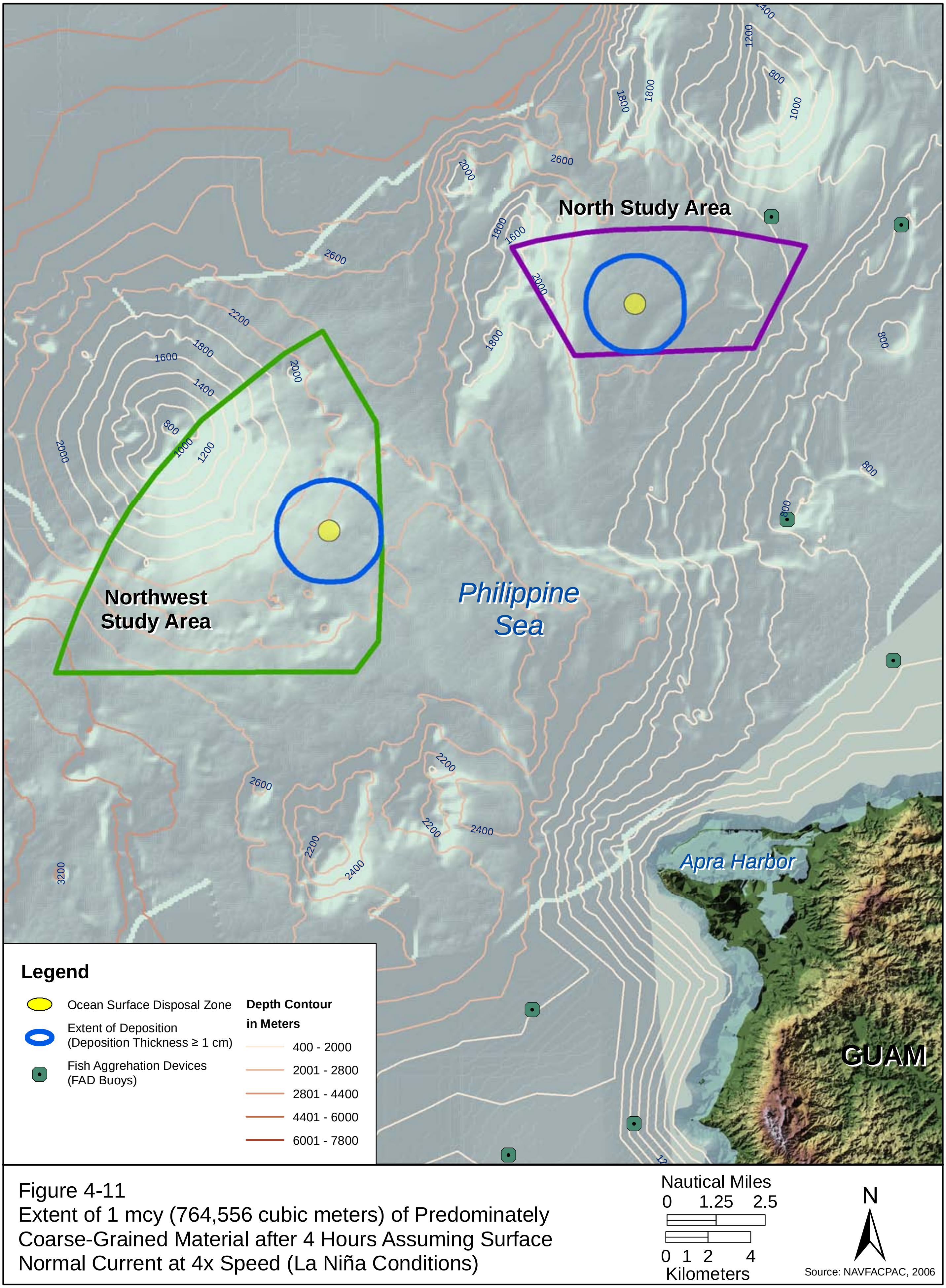

Figure 4-11
Extent of 1 mcy (764,556 cubic meters) of Predominately Coarse-Grained Material after 4 Hours Assuming Surface Normal Current at 4x Speed (La Niña Conditions)

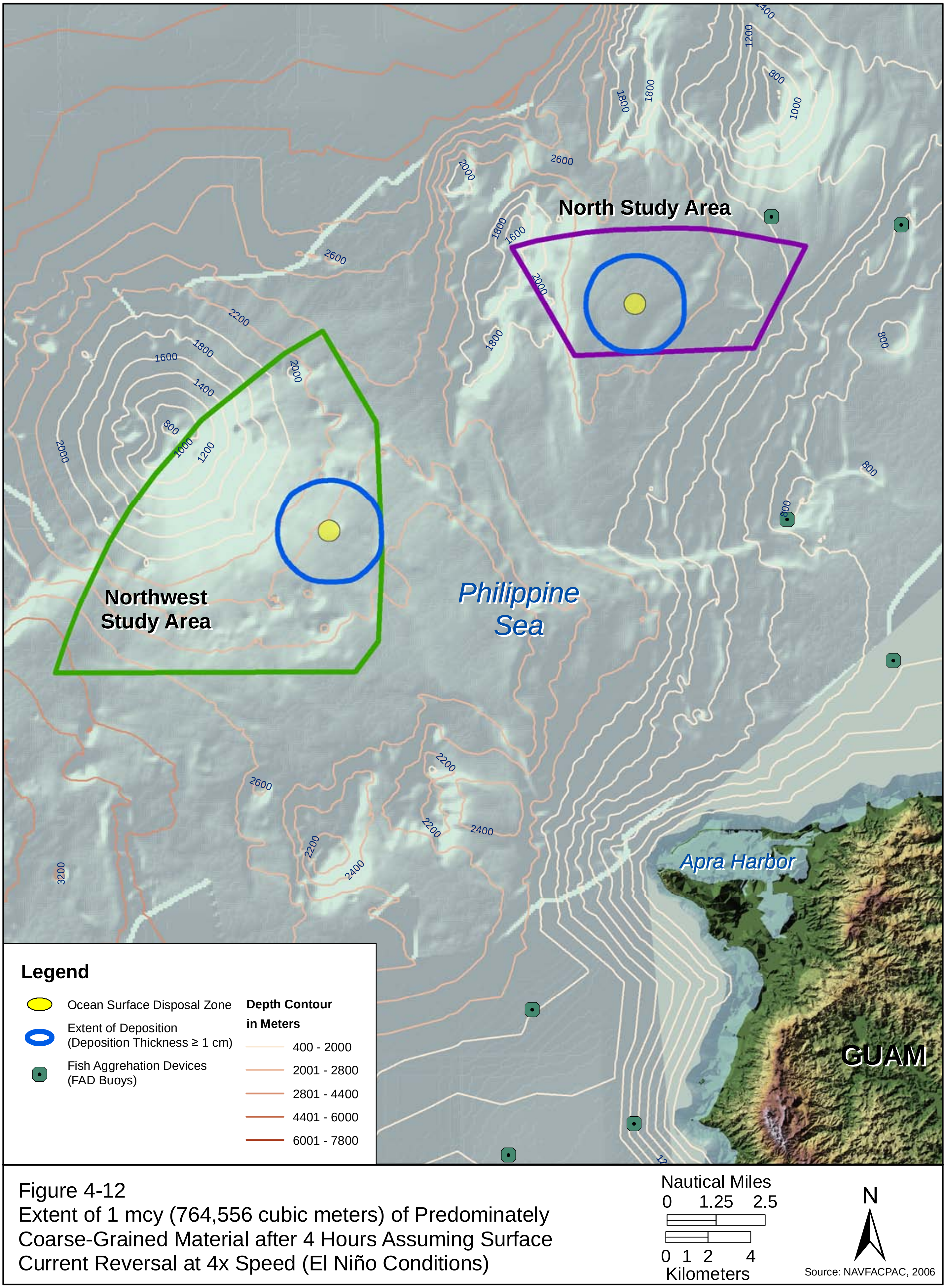

Figure 4-12
Extent of 1 mcy (764,556 cubic meters) of Predominately Coarse-Grained Material after 4 Hours Assuming Surface Current Reversal at 4x Speed (El Niño Conditions)

Source: NAVFACPAC, 2006

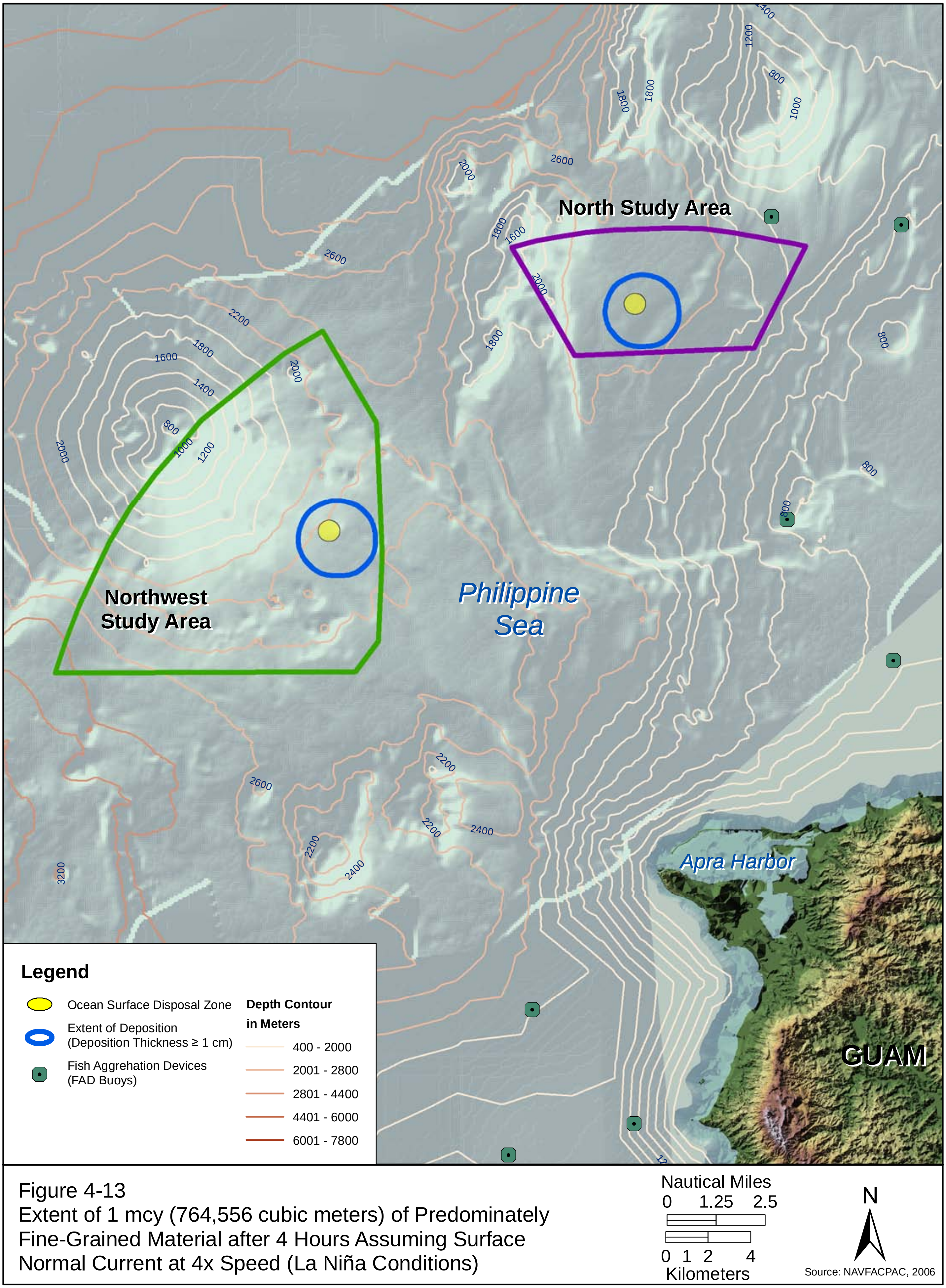

Figure 4-13
Extent of 1 mcy (764,556 cubic meters) of Predominately Fine-Grained Material after 4 Hours Assuming Surface Normal Current at 4x Speed (La Niña Conditions)

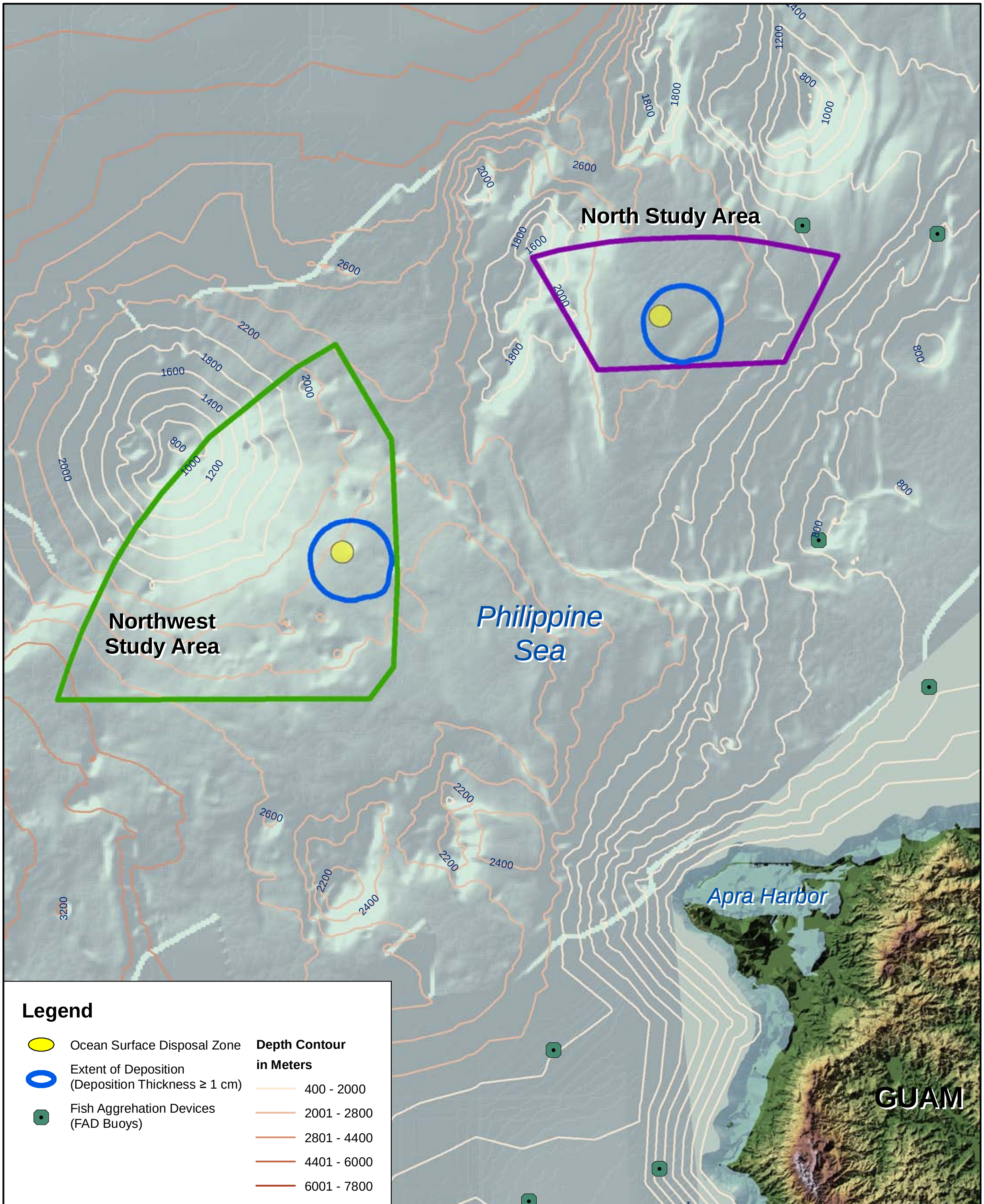

Figure 4-14
Extent of 1 mcy (764,556 cubic meters) of Predominately Fine-Grained Material after 4 Hours Assuming Surface Current Reversal at 4x Speed (El Niño Conditions)

Nautical Miles
0 1.25 2.5
0 1 2 4
Kilometers

N

Source: NAVFACPAC, 2006

4.1.5 Sediment Characteristics and Chemical Constituents

4.1.5.1 Significance Criteria

Sediment quality impacts would be significant if the sediments proposed for disposal at the proposed ODMDS were determined to not be suitable for ocean disposal (e.g., not meet the limiting permissible concentration [LPC] for the ocean disposal of dredged material as specified in 40 CFR 227). National testing guidance (USEPA and USACE 1991) sets forth procedures for comparative testing of sediments collected from proposed dredging areas and reference sites to ensure suitability for offshore disposal.

4.1.5.2 Impact Analysis

In general, the physical, conventional, chemical and radiological characteristics of sediments collected from stations located in the North and Northwest ODMDS study areas are similar with the exception of grain size and few trace metals. Sediment samples from stations located in the Northwest Study Area had greater proportion of fine-grained material with slightly higher mean concentrations of silver, arsenic, copper and lead than those from stations located in the North Study Area. Most persistent organic pollutants were non-detectable in all sampling locations.

Prior to dredging and ocean disposal, sediments must be evaluated and screened using national testing guidance (USEPA and USACE 1991) to ensure that chemical constituents are below biologically significant concentrations that have adverse ecologic effects on marine organisms. In addition to toxicity assessment using acute and chronic bioassays, material should be physically and chemically consistent with an ODMDS. Only dredged material deemed acceptable under these protocols would be approved for disposal at an ODMDS.

Recent Tier III analysis and evaluation was performed for three construction dredging projects within the Apra Harbor Naval Complex to support new, deeper draft vessels based in Apra Harbor as well as larger vessels transiting through Guam (Weston Solutions and Belt Collins 2007c). Two Inner Apra Harbor projects P-436 and P-518 and an Outer Apra Harbor project, P-502, are proposed to provide sufficient water depth to meet the Navy's operational requirements for future berthing and ship loading activities in these areas. Tier III assessment findings showed that proposed dredged material from the entire P-518 and P-502 project areas and three of the five P-436 project areas suggest this material would be considered suitable for ocean disposal based on the national testing guidance (e.g., Ocean Testing Manual [USEPA and USACE 1991). Because dredged material from Apra Harbor will likely be the main source of material disposed at the proposed ODMDS (e.g., sediment typical of the three aforementioned study areas), an evaluation of the potential environmental consequences caused by these typical sediment characteristics were considered throughout Section 4.1.5. A complete summary of sediment quality in Apra Harbor is provided in Volume 2, Chapter 4, of the Draft Guam and CNMI Military Relocation EIS/OEIS (NAVFACPAC 2009).

Sediment from the aforementioned projects was deemed appropriate for use in this evaluation because the material from these projects contained a range of grain size characteristics, from predominantly fine-grained to predominantly coarse-grained material. Finer-grained material (primarily silts and clays) tend to carry higher contaminant loads whereas coarser-grained material (primarily sands and gravels) tend to carry significantly less contaminant loads. Additionally, the majority of the sediment from these projects was collected along wharf faces where contaminant loads are expected to accumulate from industrial activities. The majority of the material evaluated for the three Navy projects was predominantly fine-grained. In the absence of chemical or fuel spills, future maintenance dredged material is expected to contain fewer contaminants, unlike those measured from sediment within the proposed P-436, P-518 and P-502 dredge footprints. The material proposed for dredging still need to pass Tier III testing to be determined suitable for ocean disposal and it is unlikely that the impact analysis would be significantly altered.

North Alternative

Grain size effects of disposal of dredged material from Apra Harbor within a disposal site located in the North Study Area represent significant or insignificant adverse impacts depending on the dredge area. This impact is expected to be localized and persist for the duration of disposal operations. Area P-436 and P-518 sediments are mostly fine-grained material, 68.7% and 70.8% respectively while the North Study Area averaged only 30.2%. Disposal of Area P-436 and P-518 sediments would result in a significant physical impact within disposal site boundaries. The largest footprint of sediment deposits greater than 0.4 in (1 cm) associated with the modeled disposal of 1 (million cubic yard (mcy) [764,556 m^3] of fine-grained material at Station 2, located in the North Study Area resulted in a 2.1 mi (3.4 km) diameter extended impact zone covering an area of 3.6 mi^2 (9.3 km^2) that is centered within a bathymetric depression with a dynamic periphery occurring in shallower areas of seamounts including Spoon Bank to the northwest and northeast and the island slope to the southeast. Sediment deposits less than 0.4 in (1 cm) would occur outside the site boundary of the disposal site. Sediment deposits less than 0.4 in (1 cm) occurring beyond the overall site boundary of the disposal site would be integrated (e.g., mixed) through physical and biological reworking processes thereby making any potential physical grain size changes indistinguishable from the existing substrate.

Unlike Area P-436 and P518, the 92,800 cy of material from Area P-502 is primarily sand (74.11%) with some gravel (20.97%) that can be considered relatively more homogenous to the North Study Area (69.82% sand, 0% gravel). Disposal of Area P-502 sediments would result in a locally insignificant physical impact. The largest footprint of sediment deposits greater than 0.4 in (1 cm) associated with the modeled disposal of 1 mcy (764,556 m^3) of coarse-grained material at Station 2, located in the North Study Area resulted in a 2.9 mi (4.6 km) diameter extended impact zone covering an area of 6.4 mi^2 (16.7 km^2) that is centered within a bathymetric depression with a dynamic periphery occurring in shallower areas of seamounts including Spoon Bank to the northwest and northeast and the island slope to the southeast. Sediment deposits less than 0.4 in (1 cm) would occur outside the site boundary of the disposal site. Sediment deposits less than 0.4 in (1 cm) occurring beyond the overall site boundary of the disposal site would be integrated (e.g., mixed) through physical and biological reworking processes thereby making any potential physical grain size changes indistinguishable from the existing substrate.

Only material that has been evaluated in accordance with USEPA and USACE protocols will be deemed suitable for ocean disposal (e.g., non-toxic); therefore, there would be no unacceptable adverse chemical or biological impacts outside the disposal site boundary (2.9 nm [4.6 km] in diameter).

Northwest Alternative

Grain size effects of disposal of dredged material from Apra Harbor within a disposal site located in the Northwest Study Area represent significant or insignificant impacts depending on the dredge area. The impacts are expected to be localized and would persist for the duration of disposal operations. Area P-502 sediments are primarily sand (74.11%) with some gravel (20.97%), while the Northwest Study Area averaged only 52.05 % sand and 0% gravel. Disposal of material from Area P-502 would result in a significant physical impact within the disposal site boundaries. The largest footprint of sediment deposits greater than 0.4 in (1 cm) associated with the modeled disposal of 1 mcy (764,556 m^3) of coarse-grained material at

Station 7, located in the Northwest Study Area resulted in a 3.0 mi (4.8 km) diameter extended impact zone covering an area of 7.0 mi^2 (18.0 km^2) that is centered on the flanks of a seamount with relatively gentle slopes. Sediment deposits less than 0.4 in (1 cm) would occur outside the site boundary of the disposal site. Sediment deposits less than 0.4 in (1 cm) occurring beyond the overall site boundary of the disposal site would be integrated (e.g., mixed) through physical and biological reworking processes thereby making any potential physical grain size changes indistinguishable from the existing substrate.

Unlike P-502, the material from Area P-436 and P518 are fine-grained, 68.7% and 70.8% respectively, and can be considered relatively more homogenous to the Northwest Study Area (47.95% fines). Disposal of dredged material from Areas P-436 and P518 would result in a locally insignificant physical impact. The largest footprint of sediment deposits greater than 0.4 in (1 cm) associated with the modeled disposal of 1 mcy (764,556 m^3) of fine-grained material at Station 7, located in the Northwest Study Area resulted in a 2.3 mi (3.6 km) diameter extended impact zone covering an area of 4.0 mi^2 (10.3 km^2) that is centered on the flanks of a seamount with relatively gentle slopes. Sediment deposits less than 0.4 in (1 cm) would occur outside the site boundary of the disposal site. Sediment deposits less than 0.4 in (1 cm) occurring beyond the overall site boundary of the disposal site would be integrated (e.g., mixed) through physical and biological reworking processes thereby making any potential physical grain size changes indistinguishable from the existing substrate.

Only material that has been evaluated in accordance with USEPA and USACE protocols will be deemed suitable for ocean disposal (e.g., non-toxic); therefore, there would be no unacceptable adverse chemical or biological impacts outside the disposal site boundary (3.0 nm [4.8 km] in diameter).

No Action Alternative

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. There would be no effect of the No Action Alternative on sediment characteristics.

4.2 BIOLOGICAL ENVIRONMENT

4.2.1 Significance Criteria

The proposed designation of a Guam ODMDS would be considered to have a significant impact on biological resources if they were to result in long-term or otherwise extensive adverse impacts to aquatic species or their habitats. Relevant statutory and regulatory protections include the ESA (protects listed species and their critical habitats); MMPA (protects all marine mammals); CWA (protects the Nation's waters, and in particular, Special Aquatic Sites such as wetlands, mudflats and vegetated shallows (including eelgrass); MSFCMA (protects Essential Fish Habitat); and the MBTA and EO 13186 (protect migratory birds and their habitats). Temporary impacts of limited extent would not normally be considered significant, provided applicable regulatory requirements are satisfied.

4.2.2 Impact Analysis

The following is an analysis of potential impacts to biological resources from the construction necessary within the project area, grouped by resource type.

4.2.2.1 Plankton Communities

Model analyses using USACE STFATE of a dredged material disposal event offshore of Guam indicated that coarse-grained material tend to settle more quickly within site boundaries and generally closer to the disposal site than fine-grained material which tended to stay in suspension longer and be deposited farther from the alternative disposal site (Weston Solutions and Belt Collins 2007b). Impacts of suspended particles from dredged material disposal on planktonic organisms are therefore expected to be minimal for the rapidly settling coarse-grained size fractions. Any potentially significant impacts would most likely involve contact with slower-settling silt and clay particles in the disposal plume and extended impact zone. Contact would be most probable in pycnocline regions where neutral buoyancy of fine-grained particles is caused by changes in water temperature and/or salinity. Dredged material disposal impacts could include the direct loss of entrained organisms in the discharge plume, temporary inhibition of phytoplankton photosynthesis due to the increased turbidity, physical interference of food ingestion by filter feeding organisms, and the uptake and potential bioaccumulation of particulate-bound contaminants (e.g., ingestion or filter feeding).

Turbid plumes associated with dredged material disposal can provisionally attenuate light penetration in the photic zone, thereby reducing primary production by as much as 50% prior to plume dissipation (Chan and Anderson 1981). Toxicity investigations have suggested that suspended red bauxite mud (clay-sized particles of Fe_2O_3) at concentrations above 6 mg/L reduced survival, reproductive success and development of the marine calanoid copepod, *Calanus helgolandicus* (Paffenhöfer 1972). Zooplankton often ingest clay and mineral particles that in turn take up space in the gut that might otherwise be occupied by food particles. Because suspended sediments impede the ingestion and assimilation of food particles, events that increase suspended sediment concentrations for even short periods of time, without otherwise altering food concentrations, could reduce growth or reproduction. Increased proportions of sediment in fecal pellets as measured in sediment concentrations greater than 1,000 mg/L have been correlated with decreased egg production by the copepod *Acartia tonsa* (White and Dagg 1989).

<u>North Alternative</u>

Disposal of mostly coarse-grained material, such as those from Area P-502, is expected to have an insignificant effect on plankton communities within a disposal site located in the North Study Area. Slower-settling silt and clay particles, such as those from Area P-436 and P-518, may have potentially significant temporary localized impacts on plankton communities. Potential adverse effects on planktonic organisms will likely occur during the first few hours following disposal, before mixing processes dilute the discharge. Discontinuous disposal activity at the ODMDS can minimize effects, since plankton communities are subject to high turnover rates. Even the complete loss of the plankton community within the disposal mixing zone would likely only produce a temporary impact, as populations can be rapidly reinstated. The major concern would be for mero- or holoplantonic egg and larval stages of benthic or nektonic marine species which can be affected during their presence in the plankton community. Even this potential impact can be considered minimal if the disposal site was significantly small relative to the size of the regional spawning grounds and larval transport routes; or if the time allocated to disposal operations represented only a short period in the entire breeding season (Alden and Young 1982). Rapid dilution of the suspended sediment plume with increasing time and distance from the point of discharge make it unlikely that there would be any unacceptable adverse impacts to the plankton communities outside of the disposal site boundaries. Due to these spatial and temporal impact constraints coupled with the rapid reproductive life history of zoo- and phytoplankton and its patchy distribution in pelagic environments, losses of entrained organisms due to contact with fine-grained material associated with the disposal plume of sediments from dredged areas like P-436 and P-518 would be less than significant.

Northwest Alternative

Due to the homogeneity of water quality between the Northwest and North ODMDS study areas, impact of ocean dredged material disposal on the planktonic community within a disposal site located in the Northwest Study Area is expected to be similar to those outlined in the North Study Area; therefore, less than significant.

No Action Alternative

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. The No Action Alternative would not have any effects on the planktonic communities at the ODMDS site. However, if an ODMDS is not designated, the planned volume of material to be dredged from Apra Harbor would still need to be managed. Under the no-action alternative scenario, material would likely be managed in an upland disposal site or beneficial use project. Managing material in an upland setting would likely result in biological impacts. These impacts may include loss of habitat (e.g., conversion of native forests or wetlands to confined disposal facilities), the potential loss of terrestrial flora and fauna intolerant to elevated dissolved salt concentrations in surface water or leachate runoff and other associated impacts. These impacts would need to be assessed and mitigated on a project-by-project basis, separate from this EIS.

4.2.2.2 Benthic Communities

Impacts of dredged material disposal to benthic organisms, including those that reside within the sediments (infauna) and on or directly above the bottom sediments (epifauna), are dependent on the species of organisms that comprise the community, the thickness of deposited material, frequency of burial events, the types of materials being disposed, and the physical parameters at the disposal site. Highly mobile epifaunal species have the potential to avoid areas subject to burial, while infaunal species are unlikely to avoid material as it is deposited. However, infaunal species tend to be more resistant to burial than epifaunal species, since the infauna have a greater ability to burrow through the sediments once buried.

For infauna, impacts from deposition can be negligible or may result in high levels of mortality, depending on the volume, and more importantly, the rate of deposition and subsequent deposit thickness. Additionally, the ability of benthic infauna, including both the macrofauna and the meiofauna, to recolonize a disposal site is dependent on the habitat suitability of the deposited materials (e.g., grain size and chemical composition and contamination) and the frequency of disposal events. When disturbances occur frequently, such as annually or more frequently, and with high enough volumes of dredged material, the infaunal community is likely to be dominated by disturbance-adapted species that have the potential to rapidly colonize. If disturbances tend to occur at intervals of at least a year or greater, and with low volumes of dredged material, then more mature communities have the potential to develop, including species that have longer life spans and are competitively dominant.

Estimates of critical burial depths are highly variable, ranging from 2.0 to 19.7 inches (50 to 500 mm), as determined by the depth of material from which infauna cannot burrow or excavate to reach the surface. For the purposes of this analysis, the critical burial depth above which impacts are considered to occur to the benthic community is 3.9 inches (100 mm). Therefore, areas of the potential disposal sites that receive materials that accumulate at depths greater than this threshold have the potential to be adversely impacted by dredged material disposal. Deposition depths used in this impact analysis are based on modeled deposit thicknesses as determined by the STFATE model outputs for the North and Northwest Study Areas presented in the *Ocean Current Study, Ocean Dredged Material Disposal Site, Apra Harbor, Guam* (Weston Solutions and Belt Collins 2007b). Deposition depths were modeled for fine- and coarse-grained materials assuming a disposal volume of 1 mcy (764,555 m^3).

North Alternative

Within the North Alternative area, deposited fine-grain material is modeled to accumulate to thicknesses in excess of 3.9 inches (100 mm) within a 0.1 mi^2 (0.3 km^2) area with a diameter of 0.3 nm (0.6 km). Coarse-grained material is anticipated to accumulate to a thickness greater than 3.9 inches (100 mm) over a larger area from the center of the disposal site, comprising a 1.0 mi^2 (2.6 km^2) area with a diameter of 1.9 km. Therefore, benthic infaunal and epifaunal species are expected to experience higher levels of mortality within a 0.5 nm (0.95 km) radius from the center of the disposal site. As stated in Section 2.3.4 (Identification of a Specific ODMDS Alternative Within Each ZSF Study Area), the overall boundary of the disposal site is approximately 3.1 nm (5.0 km) in diameter. This was defined as the area with a maximum sediment deposition of 0.4 in (1 cm) after 1,000,000 cy (760,555 m^3) is deposited over the course of one year. Deposit thicknesses greater than 3.9 in (10 cm) (e.g., those expected to potentially cause impacts to the benthic community) will be contained within the disposal site boundary. Deposit thickness beyond the site boundary (e.g., further than 1.55 nm [2.5 km) from the disposal point are expected to be less than 0.4 in (1 cm) (e.g., an order of magnitude less than what is expected to potentially cause unacceptable adverse impacts to the benthic community). This level of burial is considered to produce negligible impacts to the benthic community, since dredged material disposal is largely confined to a relatively small area that contains a benthic community that is largely similar to those of the surrounding area, as determined by the results of grab and trawl sampling within two alternative areas and reference area and are therefore expected to be less than significant.

Northwest Alternative

Due to the homogeneity of the invertebrate communities between the Northwest and North ODMDS study areas, impact of ocean dredged material disposal on the invertebrate community in the Northwest Study Area is expected to be similar to those outlined in the North Study Area, therefore less than significant.

No Action Alternative

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. The No Action Alternative would not have any effects on the invertebrate communities at the ODMDS site. However, if an ODMDS is not designated, the planned volume of material to be dredged from Apra Harbor would still need to be managed. Under this no-action alternative scenario, material would likely be managed in an upland disposal site or beneficial use project. Managing material in an upland setting would likely result in biological impacts. These impacts may include loss of habitat (e.g., conversion of native forests or wetlands to confined disposal facilities), the potential loss of terrestrial flora and fauna intolerant to elevated dissolved salt concentrations in surface water or leachate runoff and other associated impacts. These impacts would need to be assessed and mitigated on a project-by-project basis, separate from this EIS.

4.2.2.3 Fish Communities and Essential Fish Habitat (EFH)

The disposal of dredged material may have a variety of impacts to the demersal and pelagic fish communities and EFH. Burial of existing substrate may alter floral and faunal communities on which demersal fish rely for foraging. Changes in the water column may include increased turbidity and suspended solids, decreased light transmittance, and alterations to water quality variables such as DO, nutrients, salinity, temperature, pH and chemical contaminants (USEPA and USACE 2004). Potential impacts to the pelagic fish community and their prey due to changes in the water column are considered less than significant due to large dilution factors (USEPA and USACE 2004). Suspended sediment plumes having concentrations greater than 1 mg/L will be limited in size to a radius of 292 ft (89 m) and a duration of <4 hrs. The pelagic fishery is temporally and spatially dynamic with individual species having greater ranges than the area of the proposed disposal site, such that the relative percentage of the potentially impacted area in relation to the entire fishery (within an 18 nm [33 km] arc from Apra Harbor) is small (e.g., less than 1%). Furthermore, there were no uniquely distinguishable characteristics of the upper water column (e.g., shallower than 656 ft [200 m]) within or near the proposed disposal sites that would concentrate the pelagic fishery or their prey in these areas. Similarly, potential impacts to the pelagic life stages of coral reef organisms due to changes in the water column are considered less than significant. Both ODMDS alternatives are located in deep water and far from the shore that supports coral reef habitat. Any impact would likely be temporary and transitory, with the habitat returning to predisposal conditions within short periods. It should be noted that the addition of nutrients to the water column and substrate as a result of dredged material disposal may provide beneficial foraging opportunities to demersal and pelagic fish communities. Further, demersal and pelagic fishes would likely practice avoidance behavior as a result of dredged material disposal operations.

North Alternative

The pelagic fishery offshore of Guam consists of highly migratory species, including mahimahi, ono, tuna and marlin. These species are highly mobile and would likely avoid any suspended sediment plumes associated with dredged material disposal. Results of a laboratory investigation (Jokiel 1989) suggested that eggs and larvae of the pelagic fish, mahimahi (C. hippurus), were not sensitive to the increases in suspended sediment concentrations typical of ocean disposal activities. Matsumoto (1984) suggested similar results on other tuna and billfish species, indicating detrimental impacts of suspended sediments only occurred after prolonged exposure at high suspended sediment concentrations. Rapid embryonic and larval development in tuna, combined with the temporary and transitory nature of the suspended sediment plume associated with disposal at the Guam ODMDS suggest potential impacts to the pelagic fishery would be designated as insignificant.

The bottom fishery offshore of Guam is confined to water depths much shallower than the proposed alternative; therefore, these fisheries would not be impacted by dredged material disposal at the proposed alternative. Reef fishery habitat, including reef flats, reef slopes, and lagoons, are not located in the deep water environment near the North Alternative area; therefore, the coral reef fishery would not be impacted by dredged material disposal at the proposed alternative. Barges transporting dredged material to the proposed alternative may transit in close proximity to coral reef habitat while in Guam's harbors and nearshore waters. The SMMP specifies BMPs for the safe transport of dredged material to the ODMDS. The potential for accidental spillage, discharges, or groundings associated with barges are no greater than for any other vessels entering or leaving Apra Harbor. If considered necessary by local resource agencies, the potential for impacts to coral reefs by barges or other vessels passing in close proximity to the coral reef fishery could be evaluated on a project specific and case-by-case basis, separate from this EIS. The abundance and diversity of deep-sea fish species collected within the North Alternative area was very low. Suspended sediment plumes associated with an individual disposal event would likely be greatly diluted once reaching the substrate; nonetheless, it is likely the demersal fish species would practice avoidance behaviors. The highly mobile and migratory nature of many of the demersal and pelagic fishes, coupled with the temporary and transitory nature of suspended sediment plumes and other associated water quality impacts suggest potential impacts to the fish community in the North Alternative area would be expected to be insignificant. Impacts to fish communities outside of a disposal site located in the North Alternative area would also be expected to be insignificant. The impact of dredged material disposal barge traffic on pelagic and demersal fish EFH en route to the North Alternative would likely be insignificant relative to the vast majority of existing commercial and Navy ship traffic in Apra Harbor. This can be attributed to the constant roving behavior of pelagic fishes and the ability of both pelagic and demersal fish groups to employ avoidance behavior in response to an approaching dredged material vessel within EFH.

Connectivity between coral reefs is dependent on the dispersal of the pelagic life stage of many coral organisms. Although several studies have shown suspended sediments to negatively impact the survival and development of the early life stages of these organisms (Fabricius 2005, Gilmour 1999, and Te 1992), the distance between Guam's coral reefs and the ODMDS suggest the effects of dredged material disposal activities on connectivity mechanisms would be insignificant. The ODMDS is located greater than 13 nm (24 km) offshore of Guam, which is greater than recommended distances for the management of marine reserves with respect to connectivity concerns (Shanks et al. 2003).

<u>Northwest Alternative</u>

Due to the homogeneity of the pelagic and demersal fish communities between the Northwest and North ODMDS study areas, the impact of dredged material disposal on the fish communities in the Northwest Study Area is expected to be similar to those outlined in the North Study Area. Impacts would be temporary and minimal, and therefore less than significant. Impacts to fish communities outside of a disposal site located in the North Alternative area would also be expected to be insignificant. The impact of dredged material disposal barge traffic on pelagic and demersal fish EFH en route to the Northwest Alternative would also likely be insignificant.

<u>No Action Alternative</u>

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. The No Action Alternative would not have any effects on the fish communities and EFH at the ODMDS. However, if an ODMDS is not designated, the planned volume of material to be dredged from Apra Harbor would still need to be managed. Under this no-action alternative scenario, material would likely be managed in an upland disposal site or beneficial use project. Managing material in an upland setting would likely result in biological impacts. These impacts may include loss of habitat (e.g., conversion of native forests or wetlands to confined disposal facilities), the potential loss of terrestrial flora and fauna intolerant to elevated dissolved salt concentrations in surface water or leachate runoff and other associated impacts. These impacts would need to be assessed and mitigated on a project by project basis, separate from this EIS.

4.2.2.4 Marine Birds

Currently there is inadequate information on the potential influences of ocean dredged material disposal on local and transient bird populations, as no directed studies of impacts have been conducted. Potential impacts may include ship-following behavior, reductions in availability or accessibility of prey species, as well as decreased foraging behavior in the locality of the disposal plume. In addition, marine birds lured to positively buoyant fragments lingering at the surface subsequent to disposal may lead to an exhaustion of a considerable amount of energy with inadequate prey acquisition. These prospective effects are constrained to the duration of discrete disposal operations.

Many species of birds are known to frequently track ships, usually with the anticipation of feeding on galley scraps, bait or propeller chum. Others are known to exploit ships as a place to ground along their migratory crossing and rest before continuing their transit or migration. Species commonly known to pursue ships include frigate birds, boobies, tropicbirds, albatrosses, gulls, jaegers, procellarid petrels, and some storm-petrels (Spear and Ainley 1997). Of the eleven seabird species highlighted in Section 3.2.4, the brown booby (*Sula leucogaster*), red-footed booby (*Sula sula*) and Matsudaira's storm-petrel (*Oceanodroma matsudaira*) can be expected to follow dredged material disposal vessels. Following a disposal event, populations of important seabird prey species including krill, squid and tuna or other predatory fish schools may provisionally be reduced in the immediate locality. This can be attributed to the ability of many pelagic prey organisms to employ avoidance behavior in response to an approaching dredged material vessel and subsequent disposal of material. In response, the foraging success of marine birds may, in the interim, be reduced due to prey unavailability or inaccessibility following disposal activities.

The distribution of marine birds is thought to be affected by water clarity as a consequence of the potential effects on prey accessibility (Ainley 1977). Birds such as the short-tailed shearwater that dive from the water surface and follow submerged prey, known as pursuit divers, are considered to be attracted to turbid waters where prey are less apt to detect on-coming avian predators (Abrahams and Kattenfeld 1997). Birds such as the white tern, greater crested tern and brown noddy that swiftly thrust from the air into the water, known as plunge-divers, are considered to be attracted to clear waters where victims can be visually positioned from a distance. Recent studies show that most associations between the distribution of marine birds and water clarity were inconsistent, implying that the observed associations of some species with clearer or more turbid water may not be static. This weak effect of water clarity on distribution suggests that although some significant associations were observed, most species employ flexible foraging strategies (Henkel 2006).

<u>North Alternative</u>

The elicited ship-following behavior of marine birds by dredged material disposal vessels can be considered minor relative to the vast majority of existing commercial and Navy ship traffic in Apra Harbor. Model analyses using USACE STFATE of dredged material disposal offshore of Guam indicated gravel material settled within 16 hours of the disposal event. Conversely, only a small percentage of unconsolidated silts and clays settled to the seafloor within the time limits (192 hours) of the model (Weston Solutions and Belt Collins 2007b). Disposal of fine material characteristic of Areas P-436 and P-518 would therefore result in a greater temporary localized increase of water column turbidity relative to disposal of coarse grained material characteristic of Area P-502. This would consequently reduce the availability and/or accessibility of prey, along with potentially limiting the foraging efficiency of plunge- and pursuit-diving seabirds. Owing to the patchy allocation of these prey species near the ocean surface and the profusion of similar open-ocean foraging habitat, this effect on marine birds is considered localized as well as temporary.

Expended foraging energy with inadequate prey acquisition caused by the lure of some marine birds to floating material should be localized and of relatively short duration due to ocean dredged material disposal permit stipulations that suitable material contain negligible quantities of buoyant debris. Due to these spatial and temporal impact constraints coupled with the ability of marine birds and their prey to employ assorted escape behaviors, dredged material disposal impacts to marine birds would be less than significant in the North Study Area.

<u>Northwest Alternative</u>

As a result of the homogeneity of water quality and prey distribution between the Northwest and North ODMDS study areas, impact of ocean dredged material disposal on the marine birds in the Northwest Study Area is expected to be similar to those outlined in the North Study Area, and therefore less than significant. Any observed differences in disposal consequences to marine birds should be related primarily to differences in the relative abundance and diversity of these species within each site.

No Action Alternative

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. The No Action Alternative would not have any effects on marine birds at the ODMDS site. However, if an ODMDS is not designated, the planned volume of material to be dredged from Apra Harbor would still need to be managed. Under this no-action alternative scenario, material would likely be managed in an upland disposal site or beneficial use project. Managing material in an upland setting would likely result in biological impacts. These impacts may include loss of habitat (e.g., conversion of native forests or wetlands to confined disposal facilities), the potential loss of terrestrial flora and fauna intolerant to elevated dissolved salt concentrations in surface water or leachate runoff and other associated impacts. These impacts would need to be assessed and mitigated on a project-by-project basis, separate from this EIS.

4.2.2.5 Marine Mammals

The 2007 MISTCS report was used as a reference for marine mammals that potentially could be in the locality of a proposed ODMDS located in the North or Northwest Study Area. Between mid-January to mid-April, a total of 149 visual sightings of 13 species within 170,500 square nm surrounding the Marianas archipelago were reported. 148 of 149 sightings were of 12 cetacean species. The endangered sperm whale (*Physeter macrocephalus*) had the highest sighting, followed by the Bryde's whale (*Balaenoptera edeni/brydei*), and the endangered sei whale (*Balaenoptera borealis*). The survey revealed that the most frequently sighted delphinids were the Pantropical spotted dolphin (*Stenella attenuate),* followed by the false killer whale (*Pseudorca crassidens*) and striped dolphin (*Stenella coeruleoalba*). Potential ocean dredged material disposal impacts on marine mammals are expected to be analogous to those of marine birds. These potential impacts may include provisional impairment of foraging behavior as well as alteration of migratory passage routes ascribable to disposal noise disturbances, reductions in water clarity caused by the subsequent disposal plume, and the possible reduction in prey items. These prospective effects are constrained to the duration of discrete disposal operations.

As outlined by the MMPA, the term "harassment" in the case of a military readiness or scientific research activity conducted by or on behalf of the Federal Government, is defined as any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered.

Pollution can refer to chemical, physical, biological, thermal or noise contaminants with anthropogenic origin. Noise from commercial vessel traffic is considered the most dominant, continuous and ubiquitous source of anthropogenic noise in the ocean (Payne and Webb 1971). Most marine mammals are either attracted to or repelled by the occurrence of a ship, and many seek to avoid vessels at distances on the order of kilometers. Responses usually consist of moving toward the ship (some dolphins and porpoises), away from the ship (some dolphins, porpoise, and whales), or submerging (all marine mammals). Acoustic pollution is of special concern for cetaceans, which is known to be a very vocal taxonomic group dependent on sound for communicating, navigating, and foraging. Increased stress levels, abandonment of important habitat and the obscuring or interference of natural sounds, known as masking, are some of the ways populations may be threatened by noise (Weilgart 2007). Such population-level effects are, however, particularly difficult to detect in cetaceans because of a deficiency of accurate basal population estimates. Cetaceans have also exhibited short-term responses to human-produced reverberations including longer dive times, shorter surface intervals, evasive movements away from the sound source, attempts to shield young, increased swimming speed, changes in song note durations and departure from the area (Croll et al. 2001). Detection and avoidance of oil patches by bottlenose dolphins (*Tursiops truncates*) suggests that they are able to using echolocation, especially in the presence of air bubbles (Gerachi and St. Aubin 1987). This illustrates the possibility for cetaceans capable of detecting differences in water turbidity by echolocation to alter their route in avoidance of a disposal area. Disturbances from tugs towing the disposal barges would be limited in comparison to the overall vessel traffic in the area around Guam.

North Alternative

The contribution of acoustic pollution by dredged material disposal vessels can be considered minor in relation to the vast majority of existing commercial and Navy ship traffic in Apra Harbor. Impairment of foraging behavior as well as alteration of migratory passage routes ascribable to disposal noise disturbances can be considered provisional to the duration of disposal operations and constrained within the vicinity of the disposal plume. Model analyses using USACE STFATE of dredged material disposal offshore of Guam indicated gravel material settled within 16 hrs of the disposal event. Conversely, only a small percentage of unconsolidated silts and clays settled to the seafloor within the time limits (192 hrs) of the model (Weston Solutions and Belt Collins 2007b). Disposal of fine material characteristic of Areas P-436 and P-518 will therefore result in a greater temporary localized increase of water column turbidity relative to disposal of coarse grained material characteristic of Area P-502. This will consequently reduce the availability and accessibility of marine mammal prey such as krill, squid, small school fish, pelagic fish, and sharks. Owing to the patchy allocation of these prey species, this effect on marine mammals is considered localized as well as temporary. Due to these spatial and temporal impact constraints coupled with the ability of marine mammals to employ assorted avoidance behaviors, dredged material disposal impacts are designated as less than significant in the North Study Area. There would also be less than significant impacts to marine mammals as defined by the MMPA.

Northwest Alternative

As a result of the homogeneity of water quality and prey distribution between the Northwest and North ODMDS study areas, impact of ocean dredged disposal on the marine mammals in the Northwest Study Area is expected to be similar to those outlined in the North Study Area, and therefore less than significant. Any observed differences in disposal consequences to marine mammals should be related primarily to differences in the relative abundance and diversity of mammal species within each site.

No Action Alternative

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. The No Action Alternative would not have any effects on marine mammals at the ODMDS. However, if an ODMDS is not designated, the planned volume of material to be dredged from Apra Harbor would still need to be managed. Under this scenario, material would likely be managed in an upland disposal site or beneficial use project. Managing material in an upland setting would likely result in biological impacts. These impacts may include loss of habitat (e.g., conversion of native forests or wetlands to confined disposal facilities), the potential loss of terrestrial flora and fauna intolerant to elevated dissolved salt concentrations in surface water or leachate runoff and other associated impacts. These impacts would need to be assessed and mitigated on a project-by-project basis, separate from this EIS.

4.2.2.6 Threatened, Endangered and Special Status Species

Chapter 3, Table 3-11 presents Endangered, Threatened, and Special Status Marine Mammal Species and their prospective occurrence in the habitats of the general ODMDS study region. Three endangered species are known to occur frequently within the deep waters of the general study region. These endangered whales (humpback, sperm, and sei) are most likely to be observed during the winter months when they journey to warmer, tropical latitudes for breeding and calving. All three whale species were documented in the MISTCS occurring with calves, while the humpback and sperm whales additionally exhibited social behaviors allied with breeding grounds including tail-slapping, breaching, and chin-slapping. Three other endangered cetaceans (North Pacific Right Whale, Fin Whale and Blue Whale) are known to intermittently frequent the Guam study area. Three seabird species (brown noddy, black noddy, and white tern) that are most apt to be sighted in the study area are listed on the CNMI Species of Special Concern. Three other uncommon or irregular seabird visitors to the Guam study area, the wedge-tailed shearwater, brown booby, and red-footed booby, are also listed on the CNMI Species of Special Concern. These six special status seabirds are further protected by the MBTA. Five additional seabirds, the common visitor short-tailed shearwater and common or rare visitors black-naped tern, great crested tern, streaked shearwater and Matsudaira's storm-petrel are presently or will soon be protected by the MBTA.

Potential impacts of dredged material disposal on endangered marine mammals described in Section 3.2.6 may include provisional impairment of foraging behavior as well as alteration of migratory passage routes ascribable to disposal noise disturbances, reductions in water clarity caused by the subsequent disposal plume, and the possible reduction in prey items. Disturbances to special status seabirds may include ship-following behavior, reductions in availability and/or accessibility of prey species, decreased foraging behavior and exhausted foraging energy with inadequate prey acquisition caused by positively buoyant fragments in the locality of the disposal plume.

North Alternative

Due to the spatially localized and temporally limited nature of dredged material disposal activates, potential impacts on endangered cetacean and special status seabird species are designated as less than significant in the North Study Area.

Northwest Alternative

As a result of the homogeneity of water quality and prey distribution between the Northwest and North ODMDS study areas, impact of ocean dredged material disposal on endangered cetacean and special status seabird species in the Northwest Study Area is expected to be similar to those outlined in the North Study Area, and therefore less than significant. Any observed differences in disposal consequences to endangered and special status species should be related primarily to differences in the relative abundance and diversity of these species within each site.

No Action Alternative

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. The No Action Alternative would not have any effects on endangered, threatened and special status species at the ODMDS. However, if an ODMDS is not designated, the planned volume of material to be dredged from Apra Harbor would still need to be managed. Under this no-action alternative scenario, material would likely be managed in an upland disposal site or beneficial use project. Managing material in an upland setting would likely result in biological impacts. These impacts may include loss of habitat (e.g., conversion of native forests or wetlands to confined disposal facilities), the potential loss of terrestrial flora and fauna intolerant to elevated dissolved salt concentrations in surface water or leachate runoff and other associated impacts. These impacts would need to be assessed and mitigated on a project-by-project basis, separate from this EIS.

4.2.2.7 Marine Protected Areas (MPA)

According to the 2000 FR, MPAs are designated as any marine environment reserved by Federal, State, territorial, tribal or local laws/regulations with the intention of fortifying part or all of the natural and cultural resources therein. MPAs offer an effective means to conserve marine organisms and their habitat and serve as a unique approach to safeguard these organisms from the collective and synergistic impacts of anthropogenic stressors. In Guam, MPAs include a territorial seashore reserve, a national historic park and numerous ecological reserves and marine preserves that contain a variety of susceptible habitats and biological resources including endangered and special status species. A total of eight MPAs are 20 nm or less in proximity to the North or Northwest ODMDS study areas. Table 4-6 presents these eight MPAs located in Guam and their distance to each ODMDS study area. Proximity of the proposed barge transit route to each MPA is also outlined in Table 4-6.

Table 4-6. Relative Distance of Marine Protected Areas to North and Northwest Alternative Areas and Likely Planned Barge Transit Routes

Marine Protected Area	North ODMDS Study Area		Northwest ODMDS Study Area	
	Distance to:		Distance to:	
	Station 2 (nm)	Planned Barge Transit Route (nm)	Station 7 (nm)	Planned Barge Transit Route (nm)
Ecological Reserve Areas				
Orote Peninsula ERA	14.2	0.4	9.5	0.4
Haputo ERA	14.5	13.1	20	15.3
Marine Preserves				
Tumon Bay	14.5	9.8	17.1	10.9
Piti Bomb Holes	13.1	4.7	12.4	5.4
Sasa Bay	16.4	0.25	12.5	0.25
Territorial Seashore Reserve				
Guam Territorial Seashore	12.7	0.1	9.5	0.1
National Historic Park				
WAPA, Asan Beach	13.1	4	13.5	5.8
WAPA, Agat Beach	17.8	4	13.1	5.8

Although disposal of dredged material will not occur directly within MPA boundaries, proximity of transit to one or more MPAs is necessary in order to reach the designated ODMDS. Accidental spillage or overflow from disposal barges could result in the unintended release of dredged material within MPA boundaries. Volumes of inadvertently released dredged material during transport would likely be small relative to each barge load of approximately 3,000 cy (2,294 m^3). Dredged material unintentionally released within or immediately adjacent to a sensitive habitat and repeated discharges over time could result in more significant environmental impacts. These consequences would depend on immediacy of discharge to an MPA, velocity and course of plume dispersion and specific resources in the path of dispersing material.

North Alternative

Planned barge transit routes to the North ODMDS study area currently occur within 1 nm of three MPAs, including the Orote Peninsula ecological reserve, Sasa Bay marine preserve and Guam Territorial Seashore reserve. Significant environmental impacts related to the inadvertent release of dredged material immediately adjacent to these three MPAs, as well as cumulative discharges over time could be reduced or mitigated by specifying transit routes that maximize avoidance of these sensitive habitats, and would therefore lead to less than significant impacts.

Planned barge transit routes to the North Study Area would occur at least 4 nm from five other MPAs including Haputo ecological reserve, Tumon Bay- and Piti Bomb Holes marine preserve and WAPA National Historic Parks at Asan- and Agat Beach. Potential impacts to these five MPAs attributable to the isolated and/or cumulative release of dredged material en route to the North Study Area would therefore be considered less than significant.

Northwest Alternative

Due to similarities in planned barge transit proximity to MPAs, ecological impact of isolated and/or cumulative dredged material release en route to the Northwest Study Area is expected to be similar to those outlined in the North Study Area, and therefore less than significant.

No Action Alternative

Under the No Action Alternative the ODMDS would not be designated, and therefore conditions at the sites would not change. There would be no effect of the No Action Alternative on marine reserves.

4.3 SOCIOECONOMIC ENVIRONMENT

Direct and indirect impacts of the ODMDS alternatives on the socioeconomic environment of the region of influence would be significant if they adversely impacted commercial and recreational fishing, military uses, recreation and tourism, commercial shipping, historic resources or public health.

Significant impacts would include effects on fisheries or commercial fishing operations that resulted in a measurable loss of revenues to the Guam economy or resulted in failures of commercial fishing businesses. Significant impacts would be disruptions in the use of recreational fishing and water sports areas resulting in a loss in tourism participation and revenues related to these activities, or a measurable loss in traditional fishing practices of the local population.

The disruption of or interference with military operations or commercial shipping on a frequent basis would be a significant impact. Impacts to archaeological, historical or cultural resources would be significant if they resulted in damage to the resources or qualities that make a resource eligible for the NRHP. Significant impacts to the socioeconomic environment would include adverse effects on public health and welfare that might be caused by disposal of contaminated material, the creation of hazards to navigation, or impairment of important visual qualities.

Under the No Action Alternative, an ODMDS would not be designated and multiple upland disposal sites would be required to accommodate the dredging needs of projects anticipated in the reasonably foreseeable future (Figure 4-15). The potential impacts of this scenario on the socioeconomic environment were evaluated in Weston Solutions and TEC (2008a). Potential impacts associated with upland disposal include impacts to air quality, odor, noise, visual resources, loss of developable land, traffic and energy use.

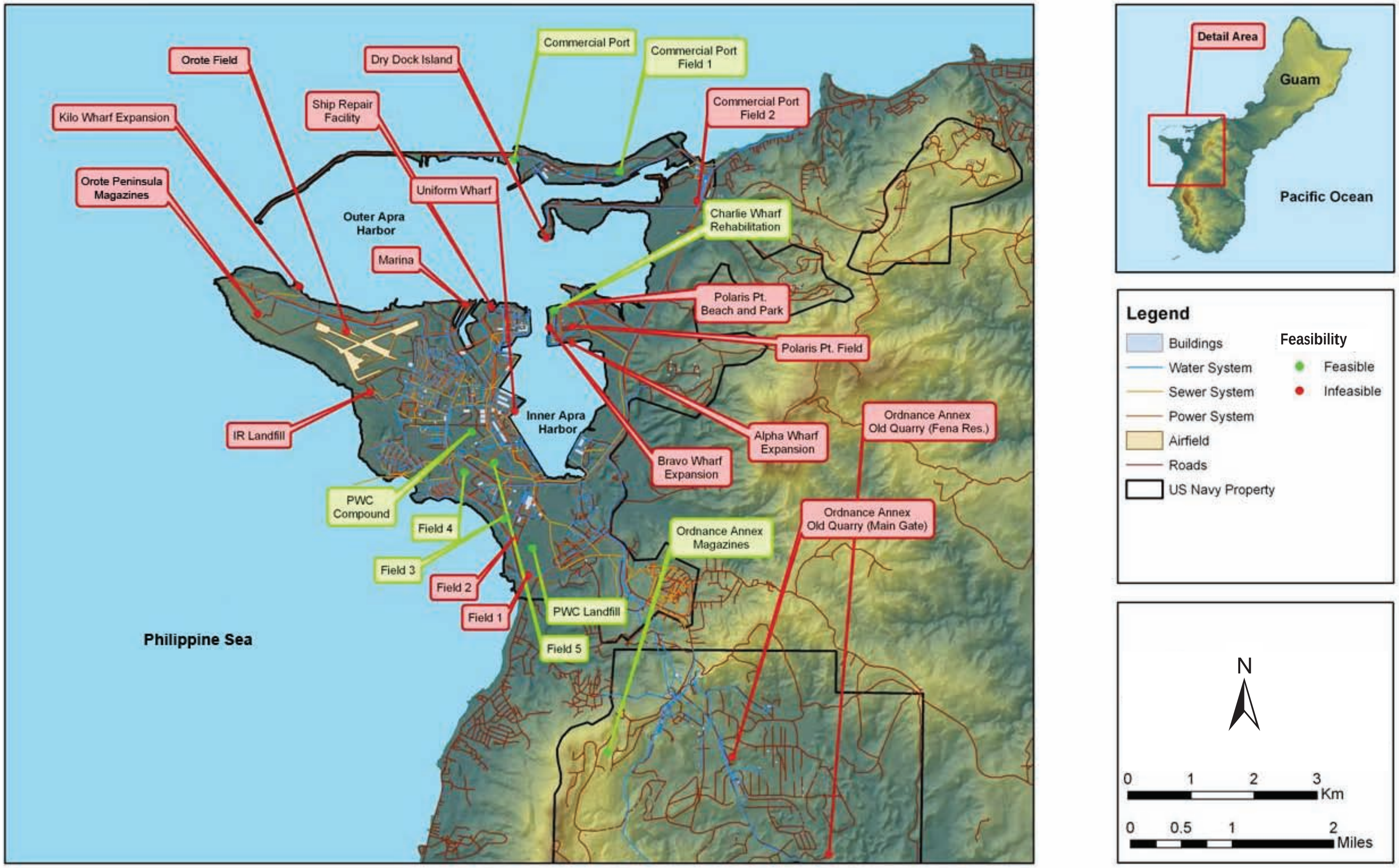

Figure 4-15. Overview Map of Potential Dewatering Facilities and Beneficial Use Alternatives, Apra Harbor Naval Complex, Guam

4.3.1 Commercial Fishing and Mariculture

4.3.1.1 North Alternative

The North Alternative site is located outside primary commercial fishing areas. Most commercial fishing takes place within 6 nm (11.1 km) of the shore in shallower water, near reefs and near FADs. The closest fishing area is a FAD located approximately 5 nm (9.2 km) from the site. Because of the restriction on longline fishing, there is relatively little commercial fishing occurring in deeper waters (>650 ft [200 m]). Although the pelagic fishery occurs throughout the waters offshore of Guam, it is not concentrated to the proposed disposal site. Furthermore, the pelagic fishery is temporally and spatially dynamic with individual species having greater ranges than the area of the disposal site, such that the relative percentage of the potentially impacted area in relation to the entire fishery (within an 18 nm [33 km] arc from Apra Harbor) is small (e.g., less than 1%). Suspended sediment plumes having concentrations greater than 1 mg/L will be limited in size to a radius of 292 ft (89 m) and a duration of <4 hrs.

Routes taken by tugboats pulling barges transporting dredged material to the site may come within 5 nm (9.2 km) of a FAD, which would not affect fishing in that area. Although it is possible that commercial fishing boats may occasionally encounter transiting barges leaving from or returning to Outer Apra Harbor, it would be similar to encounters with other ocean going vessel traffic and both vessels would be required to adhere to the navigation regulations.

The impact of the disposal of dredged material at the North Alternative ODMDS on the commercial fishing industry would be less than significant.

4.3.1.2 Northwest Alternative

The Northwest Alternative site is located outside primary commercial fishing areas and thus would have no effect on commercial fishing. There are no FADs or other fishing areas in proximity to the Northwest Alternative or the proposed transit routes of dredged material barges. Similar to the North Alternative, although the pelagic fishery occurs throughout the waters offshore of Guam, it is not concentrated to the proposed disposal site. Furthermore, the pelagic fishery is temporally and spatially dynamic with individual species having greater ranges than the area of the disposal site, such that the relative percentage of the potentially impacted area in relation to the entire fishery (within an 18 nm [33 km] arc from Apra Harbor) is small (e.g., less than 1%). Suspended sediment plumes having concentrations greater than 1 mg/L will be limited in size to a radius of 292 ft (89 m) and a duration of <4 hrs. Commercial fishing boats may occasionally encounter transiting barges leaving from or returning to Outer Apra Harbor. The Northwest Alternative would have a less than significant on the commercial fishing industry.

4.3.1.3 No Action Alternative

The No Action Alternative would not affect fishing areas and thus would not impact commercial fishing.

4.3.2 Military Use

4.3.2.1 North Alternative

The North Alternative ODMDS is located outside areas of military use; therefore, disposal operations would have no affect on military operations. Military vessels may occasionally encounter barges transporting dredged material between Apra Harbor and the ODMDS. These encounters would be similar to those with other ship traffic operating in accordance with navigation regulations and are not expected to impact military operations. The North Alternative would have no impacts on military uses.

4.3.2.2 Northwest Alternative

Because of a similar location relative to military use areas, the impacts of the Northwest Alternative would be the same as those described for the North Alternative.

4.3.2.3 No Action Alternative

The No Action Alternative would have adverse impacts on military uses if dredging projects needed to facilitate those operations are delayed or become infeasible, either if an upland site with adequate capacity is not available, or if a dredged material disposal site is not available.

4.3.3 Recreational Use

4.3.3.1 North Alternative

The North Alternative site is located outside of primary recreational fishing areas. Similar to commercial fishing, recreational fishing off the western coast of Guam takes place within 6 nm (11.1 km) of the shore in shallower water, near reefs and near FADs and also at the offshore banks. The closest fishing area to the ODMDS alternative site is a FAD located approximately 5 nm (9.2 km) from the site; therefore, disposal operations at the North Alternative ODMDS would have no effect on recreational fishing.

Routes taken by tugboats pulling barges transporting dredged material to the site may come within 5 nm (9.2 km) of a FAD, which would affect fishing in that area. Although it is possible that recreational fishing boats may occasionally encounter transiting barges leaving from or returning to Outer Apra Harbor, it would be similar to encounters with other ocean going vessel traffic and both vessels would be required to adhere to the navigation regulations. The impact of transiting barges is therefore expected to be negligible. The impact of the disposal of dredged material at the North Alternative ODMDS on the recreational fishing industry would be insignificant.

Because water sports and diving activities occur near the shore they would not be affected by disposal at the ODMDS alternative site. However, routes taken by barges through Apra Harbor may come within less than 1 nm of dive sites in the harbor. Inadvertent release of dredged material from a transiting barge immediately adjacent to these dive sites may result in temporary impacts to visibility at the dive sites. Because these impacts would be temporary and may be reduced or mitigated by the use of transit routes that maximize avoidance of dive sites, impacts of the North Alternative on recreational water sports and diving would be less than significant.

4.3.3.2 Northwest Alternative

The Northwest Alternative site is also located outside primary recreational fishing areas. There are no FADs or other fishing areas in proximity to the Northwest Alternative or the proposed transit routes of dredged material barges. Similar to the North Alternative, recreational fishing boats may occasionally encounter transiting barges leaving from or returning to Outer Apra Harbor, similar to encounters with other ocean going vessel traffic and both vessels would be required to adhere to the navigation regulations. The Northwest Alternative would have no effect on the recreational fishing industry.

Impacts to recreational water sports and diving under the Northwest Alternative would be the same as described for the North Alternative and would result in a less than significant impact.

4.3.3.3 No Action Alternative

The No Action Alternative would have no effect on water-based recreational uses in the region of influence.

4.3.4 Commercial Shipping

4.3.4.1 North Alternative

The North Alternative ODMDS is situated between but outside two shipping lanes and thus disposal of dredged material would have no effect on commercial shipping. The shipping lanes would be used by tugboats pulled barges transporting dredged material to the ODMDS; therefore, commercial vessels would encounter transiting barges. Based on the maximum dredged material volume of 1,000,000 million cy per year, and 24-hour operations, it is estimated that barges would be transiting for an average total of 30 days per year. Because of the relatively limited period of time transiting barges would be present and given that tugboats pulling barges would be required to operate in accordance with navigation regulations, a less than significant impacts to commercial vessels is anticipated.

4.3.4.2 Northwest Alternative

Similar to the North Alternative, the Northwest Alternative ODMDS is also located between but outside two shipping lanes. The impacts of the Northwest Alternative would be the same as described for the North Alternative, resulting in a less than significant impact.

4.3.4.3 No Action Alternative

The No Action Alternative would have significant impacts on commercial shipping if dredging projects needed to facilitate those operations are delayed or become infeasible if a dredged material disposal site is not available.

4.3.5 Oil and Natural Gas Development

No oil or other mineral extraction platforms were identified offshore of Guam; therefore, none of the alternatives would affect oil and gas development.

4.3.6 Archaeological, Historical, and Cultural Resources

4.3.6.1 North Alternative

Planned barge transit routes to the North Study Area would occur at least 4 nm from the WAPA National Historic Parks at Asan and Agat Beach. Potential impacts to this cultural resource attributable to the isolated and/or cumulative release of dredged material en route to the North Study Area could therefore be considered less than significant.

If cultural resources are identified in the study area during the examination of the high resolution images produced for this site designation, they will be avoided by adjusting barge transit routes and/or selecting and ODMDS within the North Alternative. Therefore there will be no adverse impact to cultural resources.

4.3.6.2 Northwest Alternative

Due to similarities in planned barge transit proximity to the WAPA National Historic Parks, environmental impact of isolated and/or cumulative dredged material release en route to the Northwest Study Area is expected to be similar to those outlined in the North Study Area.

If cultural resources are identified in the study area during the examination of the high resolution images produced for this site designation, they will be avoided by adjusting barge transit routes and/or selecting and ODMDS within the North Alternative. Therefore, there will be no adverse impact to cultural resources.

4.3.6.3 No Action Alternative

The No Action Alternative would have no effect on archaeological, historical or cultural resources in the region of influence; however, the need for new upland disposal sites would increase the potential for adverse impacts to resources on the shoreline or on land.

4.3.7 Public Health and Welfare

4.3.7.1 North Alternative

Health and welfare concerns for the population of Guam relative to the proposed designation of an ODMDS near Guam involve the potential release of toxic substances, increases in ciguatoxin outbreaks, hazards to navigation, conflicts between marine traffic and disposal operations equipment, and visual effects. The potential impacts of the North Alternative on public health and welfare were determined to be less than significant.

All material to be dredged would be tested according to testing criteria (40 CFR Parts 225 and 227) for the presence of contaminants as well as the potential for toxicity and bioaccumulation prior to dredging using federally regulated procedures of USEPA and USACE. Should the testing indicate that the accumulation of contaminants in the disposal area(s) represents an unacceptable risk to the marine environment or to human health, management actions would be taken to reduce or mitigate these impacts. This could include determining that dredged material is unsuitable for ocean disposal.

Ciguatoxin is closely associated with microalgae in coral reef environments and may affect tropical reef fish. Ciguateric fish have been collected from Guam's nearshore waters. Coral reefs located around Guam occur within 1 nm (1.9 km) of shore. Although the disposal of dredged material at the North Alternative (approximately 13.7 nm [25.4 km] offshore) will not occur directly within or adjacent to coral reef habitat, barges destined for the designated ODMDS would transit through coastal areas suitable as coral reef habitat. Accidental spillage or overflow from disposal barges could result in the unintended release of dredged material within coral reef habitat. Volumes of inadvertently released dredged material during transport would likely be small relative to each barge load of approximately 3,000 cy (2,294 m^3). Dredged material unintentionally released to coral reef habitat and repeated discharges over time could degrade the coral reef habitat and subsequently provide opportunistic growth of ciguatoxin. Significant environmental impacts related to the inadvertent release of dredged material in coral reef habitats could be reduced or mitigated by specifying transit routes that maximize avoidance of these sensitive habitats. Therefore, impacts of the North Alternative on the public health due to ingestion of ciguateric fish would be less than significant.

The disposal of dredged material would not result in a navigation hazard, although there is a potential for tugboats pulling disposal barges within the shipping lanes to encounter other marine traffic during transit to and from the disposal site. Because transiting barges are only expected to be present an average of 30 days each year, and given that tugboats pulling barges would be required to operate in accordance with navigation regulations, less than significant impacts to other marine vessels would be expected.

Visual impacts would be considered adverse if the quality of important scenic vistas were to be impaired by the dredged material disposal operations. Line of sight evaluations were performed during the site constraint analysis and critical view areas were avoided (see Figure 2-3). However, persons standing at Two Lovers Point would be able to see a tugboat and barge 28.6 nm (53.0 km) away. Although barges transiting to the North Alternative ODMDS may be visible in the distance from viewpoints at higher elevations, they would look the same as other ship traffic and the impact would be less than significant.

4.3.7.2 Northwest Alternative

Potential impacts of the Northwest Alternative would be the same as those described for the North Alternative, except that barges transiting to this ODMDS would not be visible from Two Lovers Point on the north side of Guam's west coast.

4.3.7.3 No Action Alternative

The need for new upland disposal sites would create the potential for significant impacts on public health and welfare if the only available upland disposal sites are in proximity to neighborhoods or areas of scenic quality.

4.4 CUMULATIVE IMPACTS

Federal regulations implementing NEPA (42 U.S.C. 4321 et seq.) and DON procedures for Implementing NEPA (32 CFR 775) require that the cumulative impacts of a Proposed Action be assessed. CEQ regulations implementing the procedural provisions of NEPA define cumulative impacts as:

> *The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7).*

A cumulative impact may be additive or interactive. Interactive effects may be either countervailing (where the net adverse cumulative effect is less than the sum of individual effects) or synergistic (where the net adverse cumulative effect is greater than the sum of the individual effects). Cumulative impacts can result from individually minor but collectively significant actions that take place over time. Accordingly, a cumulative impact analysis identifies and defines the scope of other actions and their interrelationship with the alternatives if there is an overlap in space and time. Cumulative impacts are most likely to occur when there is an overlapping geographic location and a coincident or sequential timing of events. Because the environmental analysis required under NEPA is forward-looking, the aggregate effect of past actions is analyzed to the extent relevant and useful in analyzing whether the reasonably foreseeable effects of a proposed action may have a continuing, additive and significant relationship to those effects.

In order to analyze cumulative impacts, a cumulative impacts geographic region must be identified for which impacts of the Proposed Action and other past, present, and reasonably foreseeable future actions would be cumulatively recorded or experienced. The true geographic range of an action's effect may not be limited to an arbitrary political or administrative boundary. Within the geographic study area for each resource area, no past, present, or future actions having the potential for additive and/or interactive effects were identified.

4.4.1 Physical

Impacts from an ODMDS that occur at the disposal area itself are unique in that sediments are released in to the water column far offshore. No other projects in the study region result in a disposal of sediments to the seafloor at great depths. As no other ODMDS occurs in waters surrounding Guam, impacts from the designation of an ODMDS would be confined to the proposed action (e.g., ocean disposal of suitable dredged material) on the physical ocean properties located directly at an ODMDS designated at either the North or Northwest Study Area. No other actions impact the physical resource areas offshore of Guam in a similar fashion to the proposed ocean disposal of dredged material; therefore, there would be no cumulative impacts from the proposed action.

4.4.2 Biological

As no other active ODMDS exists in the waters surrounding Guam, impacts from the designation of an ODMDS would be confined to a location within with the North or Northwest study area for organisms residing in, migrating through, or foraging in the area. This would include the following groups of organisms: plankton, marine invertebrates, demersal fishes, and marine birds. For organisms residing near to or en route from land to the ODMDS, vessel traffic associated with ODMDS operations may contribute to disturbances from other actions occurring in waters surrounding Guam. As directed in USACE permits and the SMMP (Appendix C), peak coral spawning period avoidance can be practiced by dredge and vessel operators in compliance with determinations made by local agencies during each project-specific permit application, which will be evaluated separately from this EIS. Vessel traffic may contribute to disturbances of the following resources: fisheries and EFH, marine birds, marine mammals, sea turtles, and marine reserves. Other commercial and recreational vessels may operate without restrictions along the same route as the tugs and barges operating during a disposal project. No other projects or actions occur along the same route as the ODMDS vessels would operate.

4.4.3 Socioeconomic

Socioeconomic resources analyzed in this EIS that have the potential to be affected by the cumulative effects of the proposed site designation of an ODMDS and dredged material disposal include: commercial fishing, military and recreational uses, commercial shipping, submerged cultural resources, and public health and welfare. The geographic region considered in the analysis of cumulative impacts includes Apra Harbor and the waters of the Philippine Sea between the western shore of Guam and the ODMDS site designation study areas.

The alternative disposal sites would not directly impact socioeconomic resources and thus would not contribute to cumulative socioeconomic impacts. However, the transport of dredged material through Apra Harbor to the ODMDS alternative locations may result in minor navigation-related impacts to vessels engaged in commercial fishing, military transport, recreation, and commercial shipping. Future foreseeable dredging projects, undertaken by the Port of Guam and the military in Apra Harbor that would be facilitated by the designation of an ODMDS, may enable the arrival of larger ships and/or a greater number of ships that would travel in the shipping lanes and through Apra Harbor. The cumulative impact of the proposed action and this foreseeable action on commercial fishing, military transport, recreation, and commercial shipping would be the potential for an increase in navigation-related conflicts in or near the harbor. However, because marine traffic is expected to operate in accordance with navigation regulations and transit through and near Apra Harbor is only a minor part of each activity, the cumulative impacts on existing vessel traffic would not be expected to adversely impact these socioeconomic resources.

These cumulative impacts should have no effect on commercial and recreational fishing activities. Although the pelagic fishery occurs throughout the waters offshore of Guam, the primary commercial and recreational fishing areas are located nearer to shore or at offshore banks located in shallower water (e.g., less than 650 ft [200 m]). Furthermore, the pelagic fishery is temporally and spatially dynamic with individual species having greater ranges than the area of the proposed disposal site, such that the relative percentage of the potentially impacted area in relation to the entire fishery (within an 18 nm [33 km] arc from Apra Harbor) is small (e.g., less than 1%).

It is reasonably foreseeable that the designation of an ODMDS would be beneficial for future dredging projects at military facilities and the Port of Guam in Apra Harbor. Future dredging projects may enable the arrival of larger ships and/or a greater number of ships that would utilize military facilities and the commercial port in Apra Harbor. The cumulative economic impact of this scenario would be beneficial to the island's economy.

There is also the potential for transiting barges to inadvertently release small amounts of dredged material during transport that could cause temporary water turbidity impacts at reef dive sites and cultural resources sites in Apra Harbor. The cumulative effect of this impact may be minor compared to the cumulative impact of any increase in the amount of ship traffic transiting through the harbor on the quality of diving at reefs or submerged cultural resources in Apra Harbor.

The effect of dredged material transport barges transiting to the ODMDS alternatives combined with a potential increase in large vessel traffic has the potential for cumulative visual impacts. The shipping lanes used for the North Alternative are visible from scenic overlooks on the northwest shore of Guam, which is an important tourist destination. It is likely; however, that the increase would not be discernible or objectionable to the casual observer and the impact would be minor.

No significant cumulative impacts to socioeconomic resources are identified.

4.5 RELATIONSHIP BETWEEN SHORT-TERM AND LONG-TERM RESOURCE USES

NEPA requires consideration of the relationship between short-term use of the environment and the impacts that such use could have on the maintenance and enhancement of long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. Such impacts include the possibility that choosing an alternative could reduce future flexibility to pursue other alternatives, or that choosing a certain use could eliminate the possibility of other uses at the site.

The proposed site designation is not expected to produce significant, long-term adverse impacts to resources including the physical, biological, and socioeconomic environments within the study region. Localized physical impacts are expected to persist as long as the sites continue to be used for dredged material disposal; however, impacts outside of the site boundaries are expected to be minimal and insignificant. If disposal operations were discontinued at these sites, there would be a gradual recovery of the benthic communities over time within site boundaries.

Use of either of the two proposed sites areas as ODMDSs is not expected to interfere with the long-term use of any resource in the area. No significant effects to commercial fishing or sportfishing are expected to occur because the sites represent a small percentage of total fishing grounds around the island of Guam. In addition, new oil and gas developments are not expected in the area and if they do occur it is feasible that recovery of these resources can be realized without significantly interfering with disposal activities. Therefore, no adverse impact to utilization of these resources is expected.

The only effect to resources on-site expected as a result of the dredged material disposal operations is a minor reduction in biological productivity at the disposal site due to physical impacts from deposition of suitable sediments on the ambient seabed. The benefits of dredging include maintaining and expanding the channels and waterways in the area for recreational, commercial and military traffic.

4.6 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

NEPA (42 USC § 4332 Section 102(2)(C)(v) as implemented by CEQ regulation 40 CFR 1502.16) requires an analysis of significant, irreversible effects resulting from implementation of a Proposed Action. Resources that are irreversibly or irretrievably committed to a project are those that are typically used on a long-term or permanent basis; however, those used on a short-term basis that cannot be recovered (e.g., non-renewable resources such as metal, wood, fuel, paper, and other natural or cultural resources) also are irretrievable. Human labor is also considered an irretrievable resource. All such resources are irretrievable in that they are used for a project and thus become unavailable for other purposes. An impact that falls under the category of the irreversible or irretrievable commitment of resources is the destruction of natural resources that could limit the range of potential uses of that resource.

Implementation of the Proposed Action would result in an irreversible commitment of energy and resources used to dredge, transport, and dispose of the material; economic costs associated with ocean disposal activities; temporarily limited physical benthic resource within the disposal site associated with the deposition of dredged material on the ambient seabed; and human labor associated with these dredging and disposal activities. Energy (electricity and natural gas) and water consumption, as well as demand for services, would not increase significantly as a result of the implementation of the proposed dredging activities. The commitment of these resources is undertaken in a regular and authorized manner, and does not present significant impacts within this EIS.

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