APPENDIX F

Draft Essential Fish Habitat

(CSE 2006)

ENVIRONMENTAL REPORT

NAGS HEAD
EMERGENCY BEACH NOURISHMENT PROJECT

DRAFT ESSENTIAL FISH HABITAT ASSESSMENT

Submitted in Connection with the
National Environmental Policy Act and
Federal Review of Permit Application ID
(# to be assigned)

Submitted to:

US Army Corps of Engineers
PO Box 1890 Wilmington NC 28402-1890

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[CSE2203–EFH]
APRIL 2006

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1.0 INTRODUCTION

This report is prepared as a supplement to the Nags Head Beach restoration project Environmental Impact Statement. It presents a Draft Essential Fish Habitat (EFH) assessment of the Nags Head (NC) area following EFH Guidelines (50CFR 600.05-600.930) to assist the federal regulatory agencies in their review of the application.

1.1 Essential Fish Habitat and Habitat Areas of Particular Concern

The Fishery Management Plan amendments of the South Atlantic Fishery Management Council (SAFMC 1998) identify a number of Essential Fish Habitats (EFH) and Habitat Areas of Particular Concern (HAPC), which are listed in Table 1. Threatened and endangered species which also occur along North Carolina's coast are listed in Table 2. Fish species (under management of the Magnuson Stevens Act) that occur in the project area are listed in Appendix A. While all of the habitat categories occur in the southeastern United States, many are absent from the potential impact areas of the Nags Head emergency beach nourishment project. Those categories absent include estuarine scrub/shrub mangroves (which require a much more tropical environment) and several areas that are much removed from the impact areas associated with the project [including Hoyt Hills (32°00'N, 72°30'W) located on the Blake Plateau in water depths of 300–600 meters]. Impacts on habitat categories potentially present in the project area are addressed in Section 3.0 of this report.

TABLE 1. Categories of essential fish habitat and habitat areas of particular concern in the southeast states.

[*Areas shown are identified in Fishery Management Plan amendments of South Atlantic Fishery Management Council and are included in Essential Fish Habitat: New Marine Fish Habitat Mandate for Federal Agencies, February 1999 (rev. 08/04, Appendices 4 and 5)]

ESSENTIAL FISH HABITAT (EFH)	GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN (HAPC)
Estuarine Areas	**South Atlantic**
Aquatic beds	Hermatypic (reef forming) coral habitat & reefs
Estuarine emergent wetlands	Hoyt Hills
Estuarine scrub / shrub mangroves	Sargassum habitat
Estuarine water column	Hard bottoms
Intertidal flats	Submerged aquatic vegetation
Oyster reefs & shell banks	State-designated areas of importance to managed species
Palustrine emergent & forested wetlands	
Submerged aquatic vegetation (SAV)	Council designated artificial reef special management zones
Marine Areas	**North Carolina**
Artificial / Manmade Reefs	Big Rock
Coral & Coral Reefs	Bogue Sound
Live / Live Hard Bottoms	Capes Hatteras, Lookout, and Fear (sandy shoals)
Sargassum	New River
Water Column	Pamlico Sound at Hatteras/Ocracoke Islands
	The Point
	The Ten Fathom Ledge

TABLE 2. List of threatened (T) and endangered (E) species in North Carolina under the jurisdiction of NOAA/NMFS (EFH 2000).

* Green Sea Turtles are listed as threatened (T), except for breeding populations of Green Turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered (E).

** These are candidate species which are not protected under the Endangered Species Act, but concerns about their status indicate that they may warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.

Common Name	Scientific Name	Status
Fish		
Shortnose Sturgeon	*Acipenser brevirostrum*	E
Atlantic Sturgeon	*Acipenser oxyrhynchus oxyrhynchus*	**
Speckled Hind	*Epinphelus drummondhayi*	**
Warsaw Grouper	*Epinphelus nigritus*	**
Sea Turtles		
Kemp's ridley sea turtle	*Lepidochelys kempii*	E
Loggerhead sea turtle	*Caretta caretta*	T
Leatherback sea turtle	*Dermochelys coriacea*	E
Geen sea turtle	*Chelonia mydas*	T*
Hawksbill sea turtle	*Eretmochelys imbricata*	E
Marine Mammals		
West Indian Manatee	*Trichechus manatus*	E
Blue Whale	*Balaenoptera musculus*	E
Finback Whale	*Balaenoptera physalus*	E
Humpback Whale	*Megaptera novaeangliae*	E
Right Whale	*Eubaleana glacialis*	E
Sei Whale	*Balaenoptera borealis*	E
Sperm Whale	*Physeter macrocephalus*	E
Sharks		
Dusky Shark	Carcharhinus obscurus	**
Sand Tiger Shark	Odontaspis taurus	**
Night Shark	Carcharhinus signatus	**

Species proposed for listing:	None
Designated Critical Habitat:	None in the area of this project
Proposed Critical Habitat:	None in the area of this project

1.2 Project Description

The proposed activity is an emergency beach nourishment project along the oceanfront of Nags Head Dare County, North Carolina (Figs 1,2) between March and November 30, 2007. Work will include placement of up to 4,600,000 cubic yards (cy) of beach-quality sand along the oceanfront shoreline. The project is expected to encompass ~10 miles (out of ~11.2 miles) of Nags Head shoreline. No nourishment would be provided along the northernmost ~1.0 mile, consistent with the Dare County project EIS (USACE 2000). Some sections of Nags Head would receive greater volumes of nourishment than other sections because of variations in the existing beach condition and differences in erosion rates. Five reaches are defined in Figure 2 with Reach "0" being a no-work area and Reach "4" being a transition/taper area.

1.3 Summary of Native Beach Sediment Quality

CSE (2005) analyzed the quality of sediments on the native beach using draft sampling protocols of the NC Coastal Resource Commission (NCCRC 2005), as well as an alternate, more limited sampling across the active beach zone (CSE–recommended criteria for the present project). Based on 110 samples encompassing the length of Nags Head between the foredune and 15-foot (ft) depth contour, the following trends in sediment grain size were determined:

- There is a high degree of variation in mean grain size from station to station and from position to position across the profile.

- The mean grain size of dune samples (dune, toe dune) averages between 0.3 millimeter (mm) and 0.36 mm but individual samples exhibit a range of ~0.2 mm to >0.7 mm.

- The mean grain size of dry beach and swash zone samples [dry berm, mean high water (MHW), low-tide terrace (LTT)] average around 1.0 mm, but individual samples span a range from 0.27 mm to >3.5 mm.

- Underwater samples (trough, bar, outer) show mean grain sizes that average 0.19 mm to ~0.23 mm, with the range for individual samples between ~0.17 mm and >0.3 mm.

The alongshore and cross-shore trends in mean grain size are shown in Figure 3. The upper portion of Figure 3 shows the alongshore trend for three groups of samples:

- Dry beach to LTT (ie, the breaker and swash zone)
- Underwater (ie, trough, outer bar, and offshore)
- All samples combined (ie, dune to offshore)

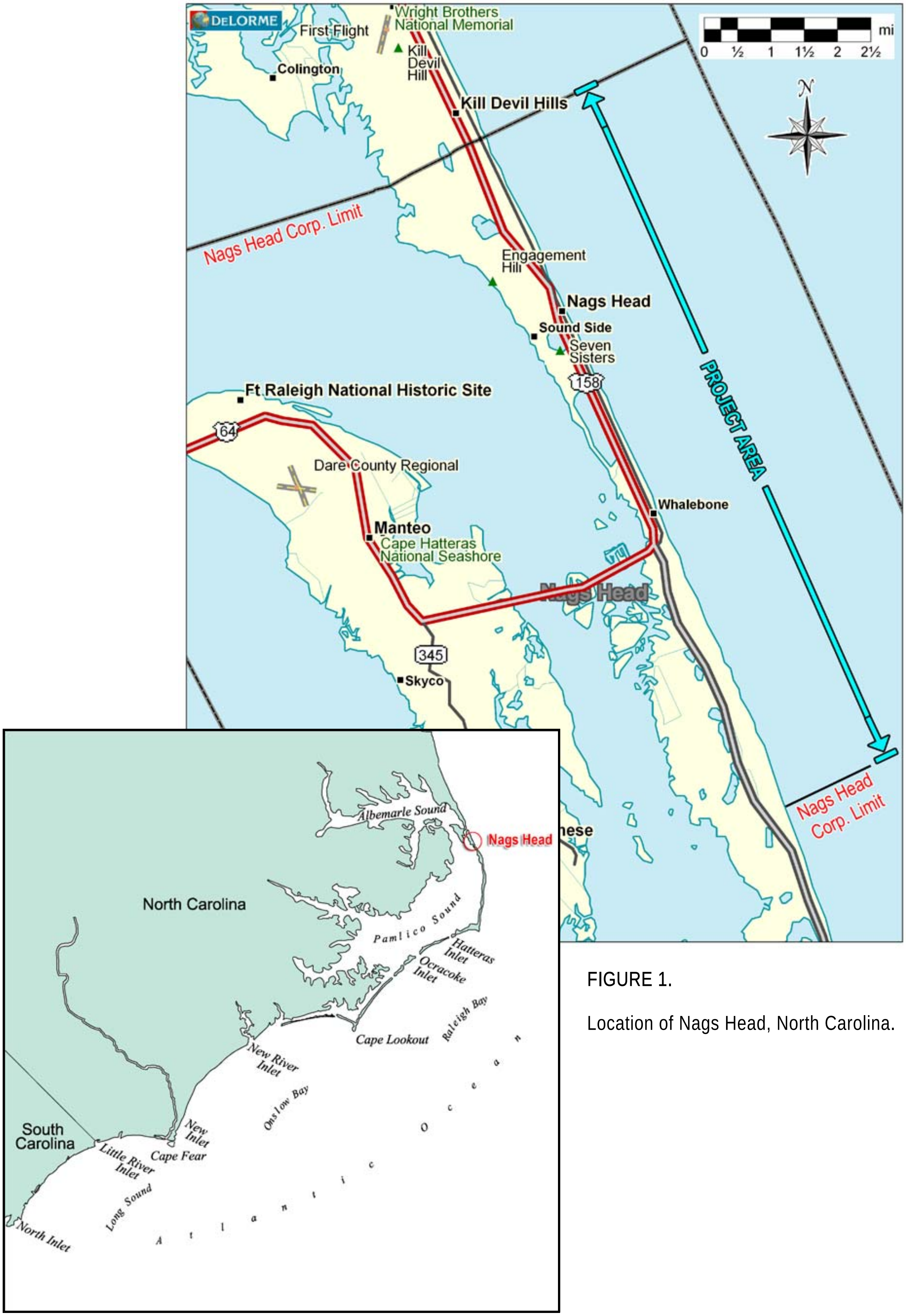


FIGURE 1.

Location of Nags Head, North Carolina.

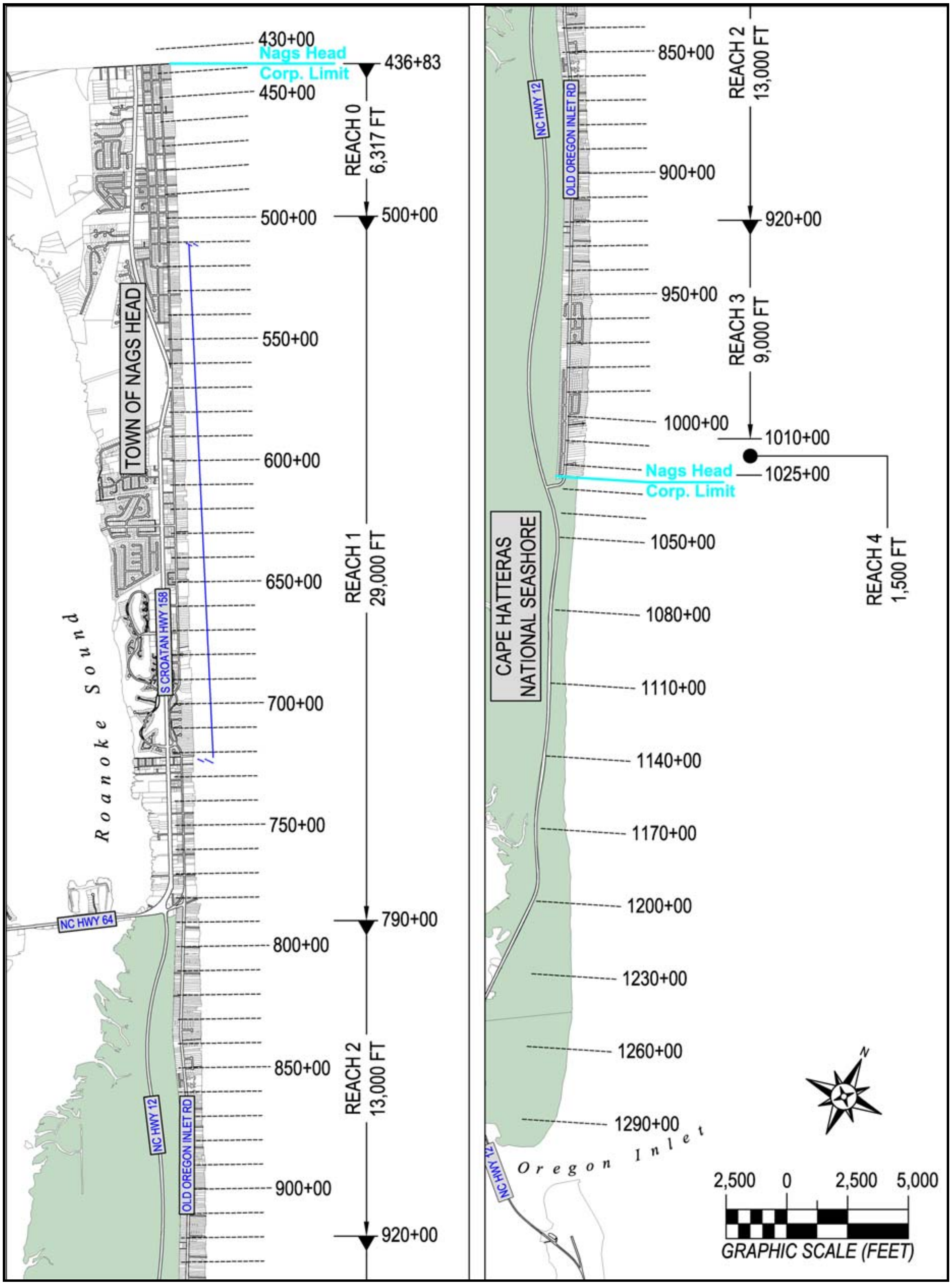
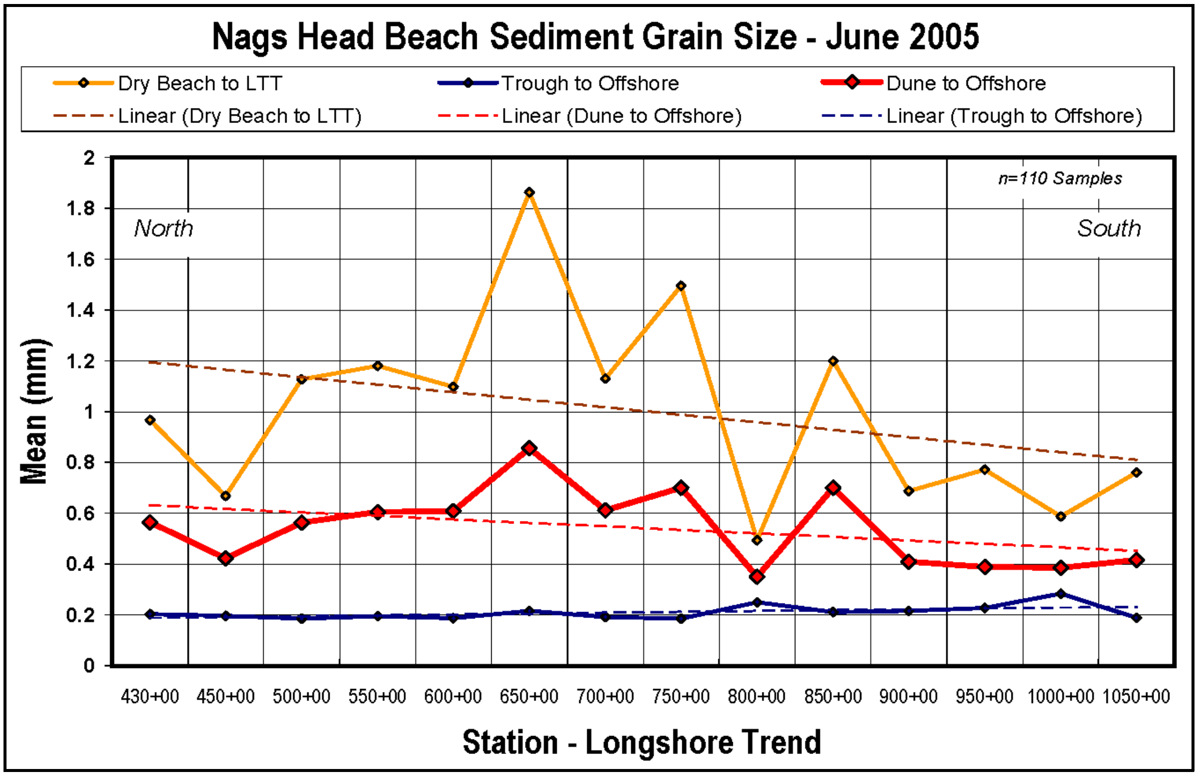


FIGURE 2. Location of project area, stationing by USACE, and five reaches considered. Total project length will be ~52,500 linear feet. Reach 0 is a “no-work” area.



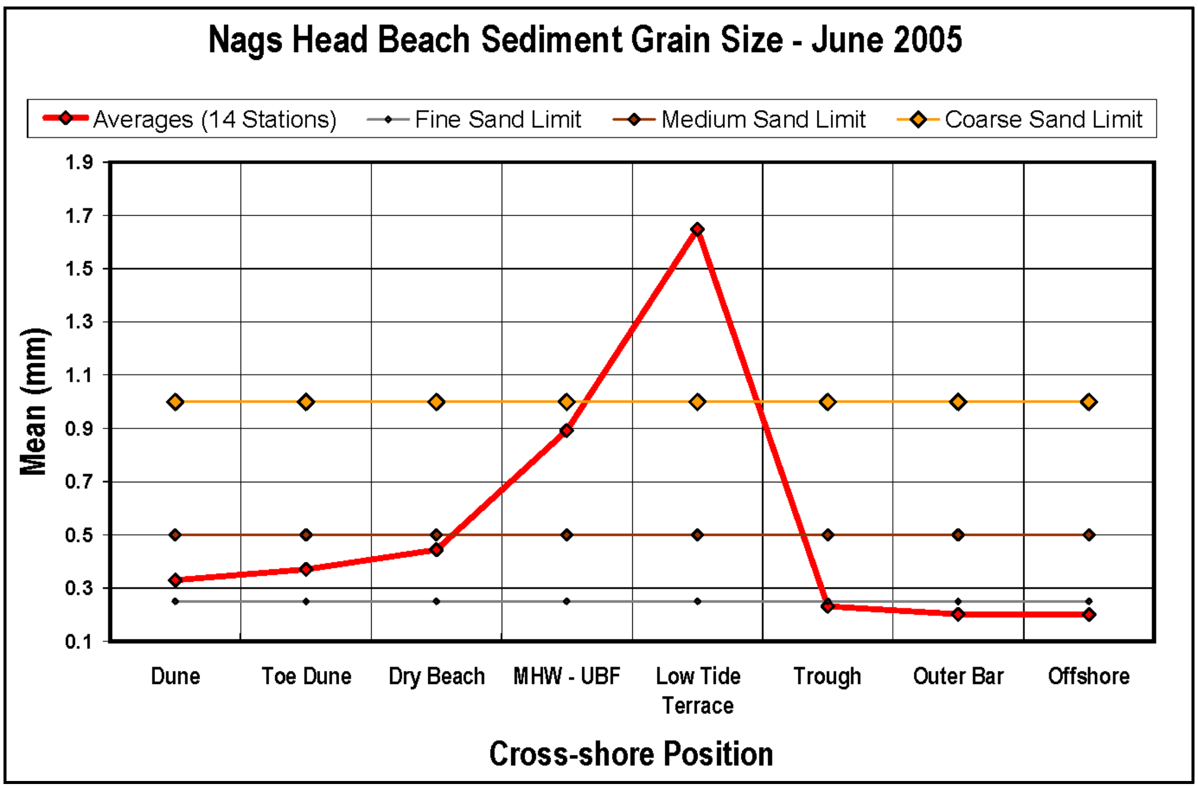
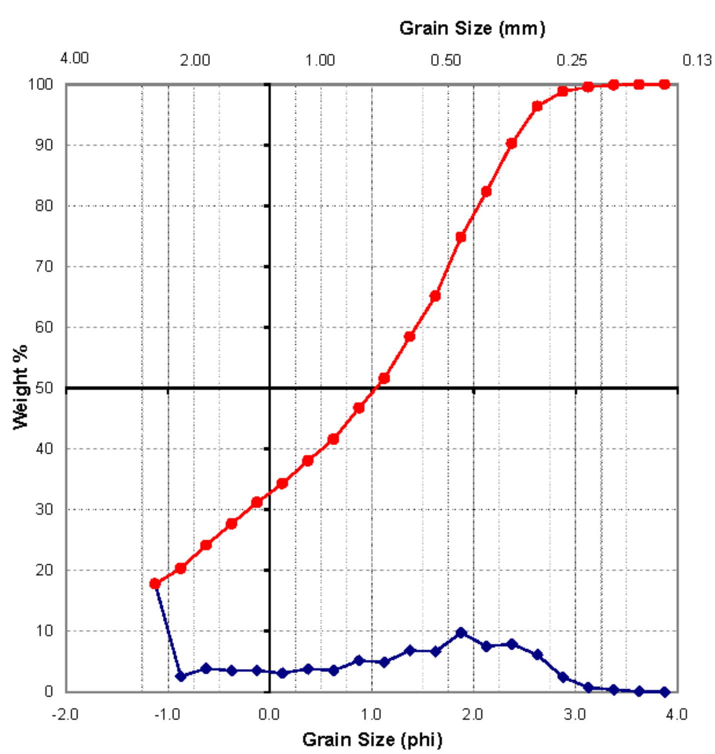


FIGURE 3. Overall trends in mean grain size by station and position across the profile. Red lines pool all samples. Trend line (dashed red line in upper graph) shows decrease in mean grain size from north to south. [From CSE 2005]

The results illustrate how coarse the swash zone samples are compared with the offshore samples. Offshore samples tend to be relatively uniform in mean grain size (around 0.2 mm). Swash zone samples, even when combined, still exhibit a wide range of grain sizes. Combining all samples (red line in Figure 3, upper) smooths the trend and suggests an (arithmetic) average range of mean grain sizes of the order ~0.45–0.65 mm. Mean sediment grain size tends to become finer toward the south, consistent with results given in the Dare County EIS (cf, USACE 2000).

Figure 3 (lower) shows the cross-shore trend in mean grain size, giving the average of all samples from a particular position along the profile. The cross-shore trend shows a characteristic coarsening from the dune to the low-tide terrace (near wave plunge point), then a rapid fining of sediment seaward of the inner breaker zone.

For purposes of project planning, CSE elected to adopt two "native beach" size distributions for Nags Head. Figure 4 shows the characteristic size distribution curves for the two composites. The top graph shows a composite native size distribution based on toe of dune, dry beach, MHW, LTT, and trough samples, consistent with CSE's prior practice. The lower graph shows a composite based on foredune to outer (offshore) samples, generally consistent with draft NCCRC (2005) sampling guidelines. Resulting mean grain sizes are 0.47 millimeters (mm) (CSE criteria) and 0.36 mm (NCCRC criteria).

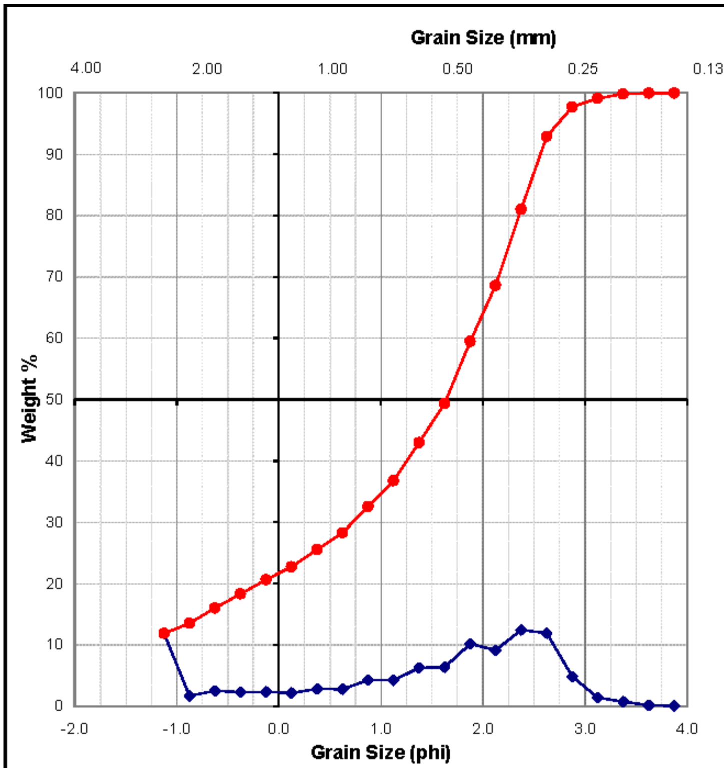


Nags Head '05
Beach Samples

Date	20-May-05
STA #	NH Comp
Location	ToeDune-Trough69
Mean	0.474 mm
Std. Deviation	0.471 mm
Skewness	-0.001

Sediment Type
COARSE SAND
Poorly Sorted
Strongly Coarse-Skewed
Platykurtic

Total weight (gram)	100.15
% finer than 4.00 phi	0.01
% coarser than -1.00 phi	17.77



Nags Head '05
Beach Samples

Date	19-May-05
STA #	NH Comp
Location	All110
Mean	0.362 mm
Std. Deviation	0.469 mm
Skewness	-0.225

Sediment Type
MEDIUM SAND
Poorly Sorted
Strongly Coarse-Skewed
Mesokurtic

Total weight (gram)	100.09
% finer than 4.00 phi	0.02
% coarser than -1.00 phi	11.84

FIGURE 4. Nags Head composite grain-size distributions for the "native beach" as adopted herein. The lower graph, based on ~110 samples, generally follows the draft NCCRC (2005) sampling protocols. The upper graph shows the result for a more limited zone of sampling between the toe of dune and trough.

2.0 NOURISHMENT PLAN

2.1 Borrow Areas

Two potential borrow areas for nourishment are considered for this project:

1) Offshore area "S1" as delineated by the USACE (2000) for the federal Dare County project (Fig 5).

2) Oregon Inlet channels and shoals.

Area S1 was chosen for investigation because of previous studies and recommendations by USACE (2000) as well as the fact that there is an existing EIS for the area which should facilitate review of the permit application.

The USACE (2000) first delineated the nearly ten-square-mile area S1 based on ~32 borings. The Corps estimated that S1 contains as much as 100 million cubic yards of beach-quality sand within the upper 10 ft of the bottom. CSE (2005) collected additional borings and further evaluated its sediment quality. In anticipation of an ~ 4 million cubic yard emergency project for Nags Head, only a small fraction of S1 would be required (Fig 5).

Oregon Inlet was considered as a potential borrow area for Nags Head because of on-going federal dredging of the channel and the possibility of piggy-backing on the federal project via Section 933, or some other funding means. Section 933 projects, under federal regulations, allow a local sponsor to obtain dredged material for the difference in the cost between what the federal government would pay for nearby disposal and what it costs to place the spoil on the local beach.

Oregon Inlet is dredged on a regular basis, and material is usually disposed along Pea Island about one-half mile downcast of the channel. Because of these ongoing activities and the fact that the inlet is situated less than 5 miles from Nags Head, it may provide an economic source of sand. CSE (2005) obtained sediment samples and short borings from sites in the inlet and on the Pea Island disposal area for purposes of evaluating sediment quality.

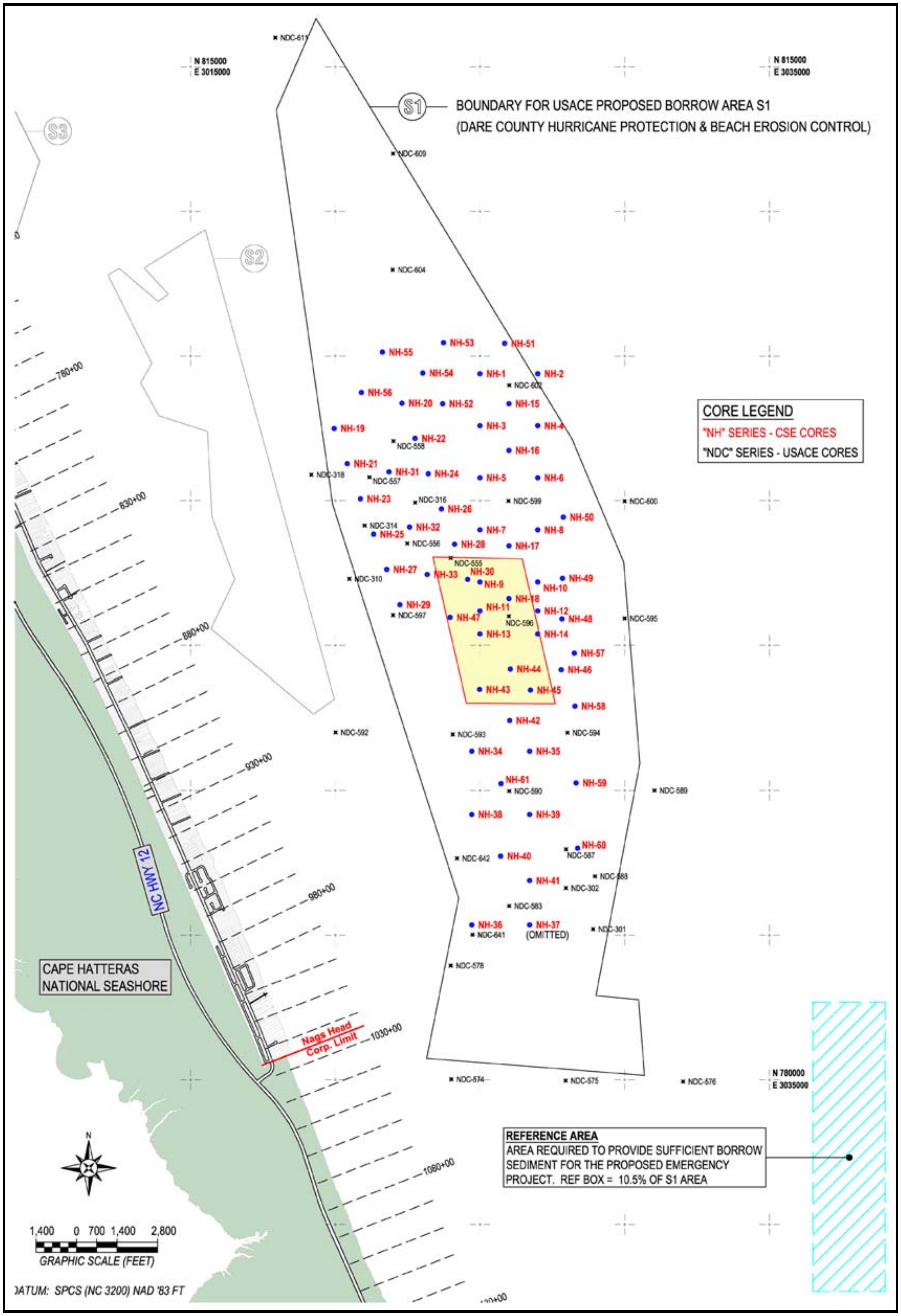


FIGURE 5. Location of offshore area S1 (delineated by USACE 2000) and various subareas being considered by USACE and CSE for initial borrow material. Based on cores available to CSE (2005), a reference area (box, diagonal blue lines) indicates the relative size of CSE's proposed borrow area for the emergency nourishment project assuming excavations average ~5 ft.

2.2 Comparison of Potential Borrow and Native Sediments

CSE (2005) analyzed about 150 sediment samples from offshore area S1 and Oregon Inlet for compatibility as nourishment material. Compatibility was evaluated by means of the overfill factor R_A (CERC 1984), which provides a measure of how a particular sediment will perform as beach nourishment. R_A's of less than 1.5 are generally preferred, with ideal being equal to 1.0. To apply the method, a native sediment size must be assumed. In this case, two possible native size distributions were applied:

1) “Composite 69" representing the sediments found between the toe of dune and trough along Nags Head.

2) “Composite 110" representing all available beach samples (dune to offshore) and generally following draft recommendations and criteria of the NCCRC (2005).

In the first case, the mean grain size (Mz) is 0.474 mm. In the second case, Mz=0.362 mm.

CSE subdivided ~125 samples from offshore area S1 into various subgroups meeting the following approximate criteria:

- Coarse sand (mean grain size ~0.5 mm or greater)
- Represents upper 2 ft or deeper substrate
- Similar sediment quality in adjacent cores

On the basis of various subgroups, CSE (2005) determined that portions of area S1 will yield highly favorable sediments comparing the two native distributions (Fig 6). Resulting R_A's were in the range 1.02–1.3 for certain subgroups. By comparison, R_A's for Oregon Inlet sediments average >7.0, meaning nearly seven times more Oregon Inlet sand would be required to equal the performance of S1 sand.

Based on results of the borrow area and native beach sediment analyses, CSE (2005) concluded the following:

- Portions of offshore area S1 have excellent beach-quality sediment, which offers a close match with those on the native beach. Further, area S1 contains ample sediment volumes to accomplish multiple nourishment project over a 50-year period under federal requirements (cf, USACE 2000, CSE 2005).

- Oregon Inlet are much finer than Nags Head native beach sediments and will not provide desirable performance or adequate volumes to restore and maintain the beach (CSE 2005).

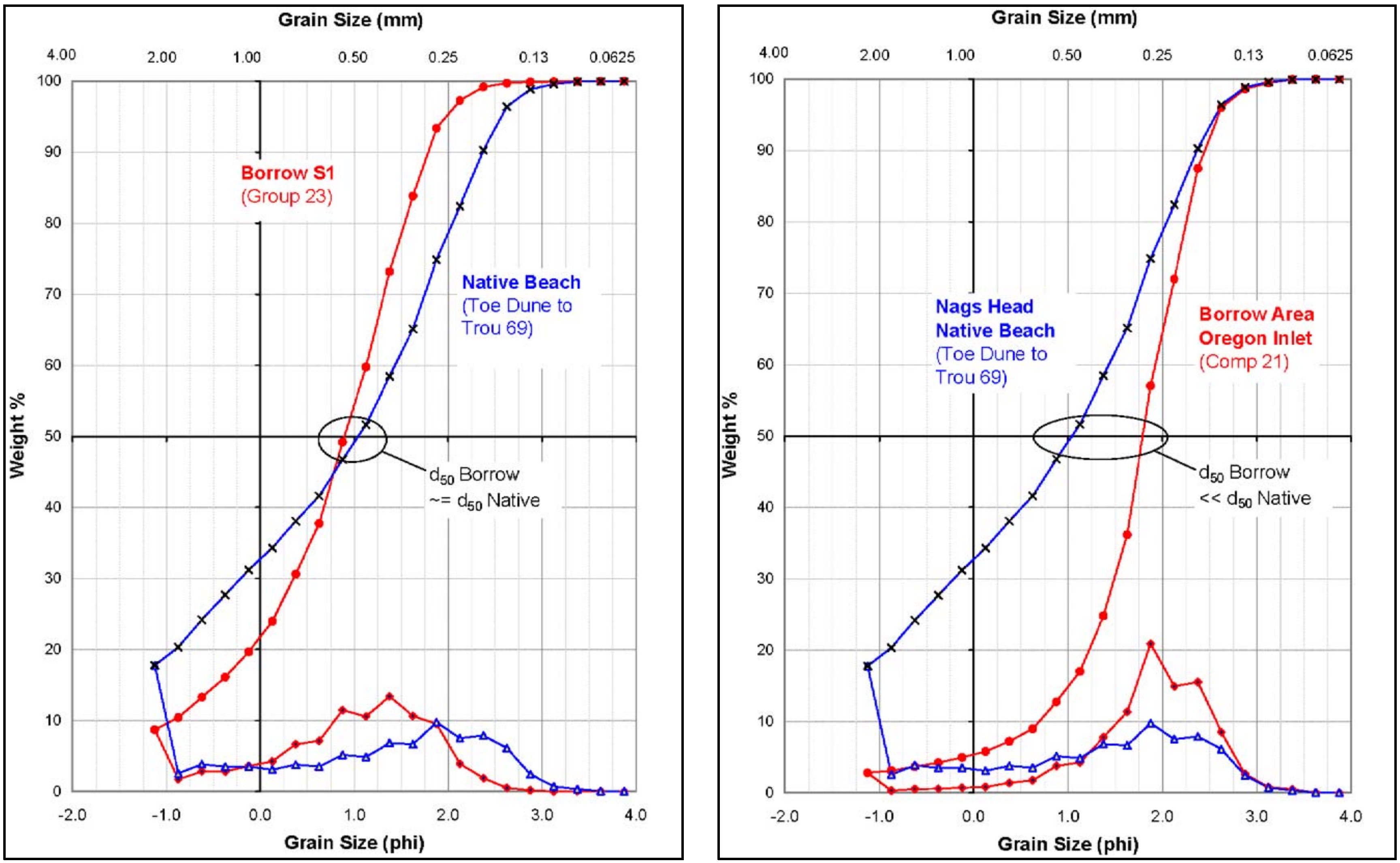


FIGURE 6. [LEFT] Comparison of borrow area S1 (subgroup 23) composite versus Nags Head native beach (Comp 69) (ie, CSE recommended criteria). [RIGHT] Comparison of Oregon Inlet sediments versus native (Comp 69) showing much finer texture (ie, unstable for use as nourishment sediment along Nags Head). [From CSE 2005]

2.3 Fill Placement

Permitting of a range of fill volumes generally from 60–130 cubic yards per linear foot (cy/ft) of beach is recommended. The extent of the construction will depend on bid prices and the funding available. Reaches for the beach fill are shown in Figure 2. Nourishment sand will be pumped from the selected borrow area (within the boundaries of S1) via hopper dredge to areas along Nags Head. The emergency project is based on the need to replace sand lost in recent years until such time as the federal Dare County project can be accomplished. The Town of Nags Head proposes to place up to 4.6 million cubic yards along the beach, which equals ~4–5 years of projected sand losses according to the federal project formulation under the Dare County EIS (USACE 2000). Figure 7 illustrates the estimated maximum nourishment volume by reach under the proposed emergency nourishment project.

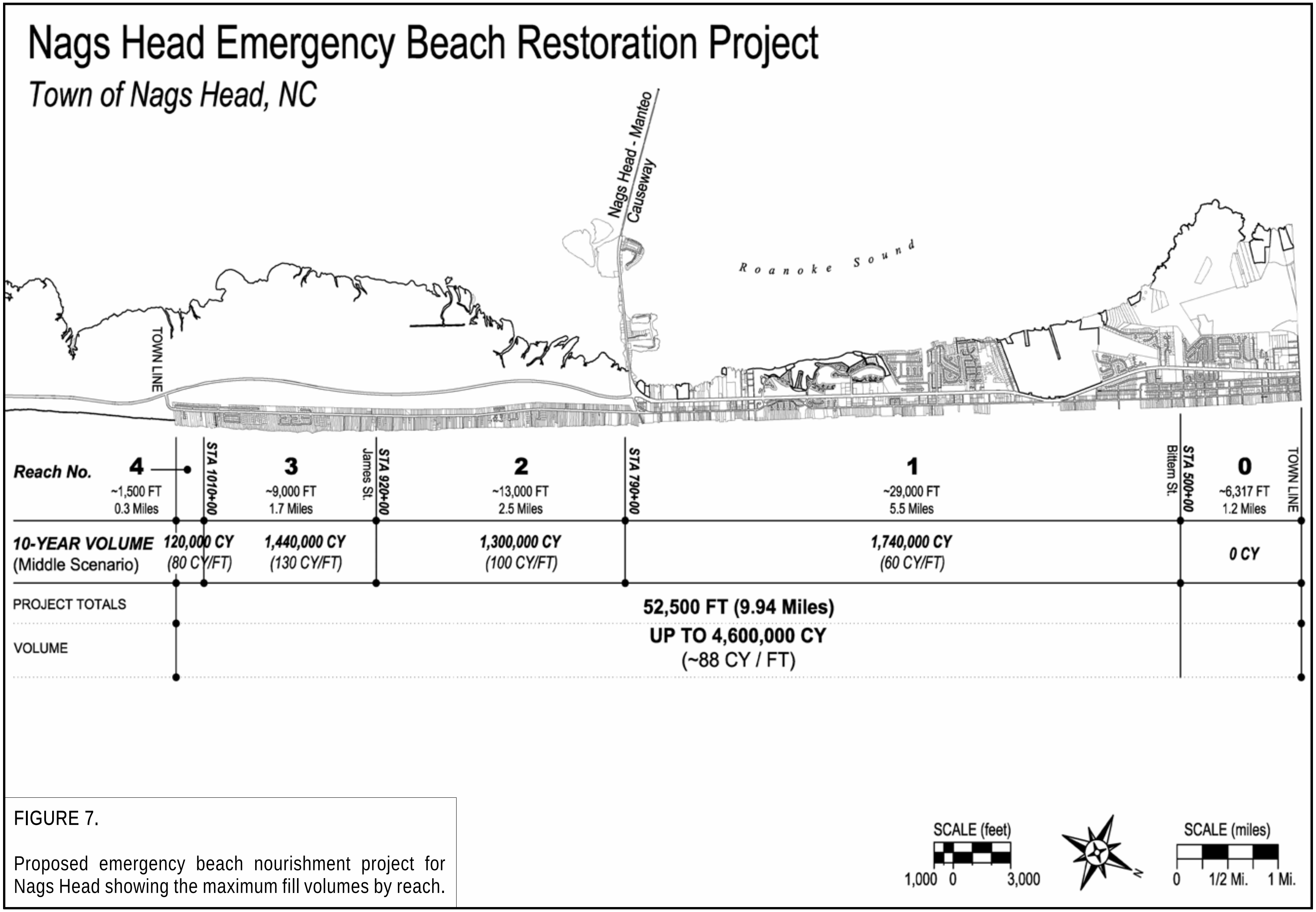


FIGURE 7.

Proposed emergency beach nourishment project for Nags Head showing the maximum fill volumes by reach.

3.0 IMPACTS TO HABITAT AREAS OF PARTICULAR CONCERN (HAPC) AND TO ESSENTIAL FISH HABITATS (EFH)

The essential fish habitats (EFH) and habitat areas of particular concern (HAPC) associated with this project are not expected to be impacted. The justification for the lack of impact is the EFHs and HPACs are for mobile animals, which are able to relocate themselves for the short term until the project is completed. Most spawning for concerned species occurs near inlets which are not in the immediate vicinity of the project. Species that spawn along beaches are not expected to be adversely impacted, because they will leave the vicinity of the project to spawn while construction activities are ongoing.

3.1 Impacts to Habitat Areas of Particular Concern (HAPC)

The following North Carolina sites, which are habitat areas of particular concern (HAPC), will not be impacted by the project:

Bogue Sound, the Big Rock, Cape Lookout Shoals, and Ten Fathom Ledge Off Cape Lookout – Located in the vicinity of the Cape Lookout area. The Big Rock, Bogue Sound, Cape Lookout Shoals, and Ten Fathom Ledge are all located ~100 miles south of the project area.

Cape Fear Shoals – This HAPC (including Frying Pan Shoals) is located south of Cape Fear over 175 miles from the project area.

Cape Hatteras Shoals – Located ~40 miles south of the project area along North Carolina's coastline, this HAPC includes Diamond Shoals.

The Point – Located east of Cape Hatteras close to the 200-meter contour, this HAPC is located well offshore and south of the project area.

Pamlico Sound at Hatteras/Ocracoke Islands – This HAPC is located ~5 miles southwest of Cape Hatteras and ~50 miles south of the project area.

New River – Located in Onslow County, this HAPC ~125 miles southwest of the project area.

3.2 Impacts on *Sargassum*

Sargassum is a pelagic brown algae which occurs in large floating mats in the waters of the continental shelf, in the Sargasso Sea, and in the Gulf Stream. It is a major source of biological productivity in nutrient-poor regions of the ocean. Masses of *Sargassum* provide extremely valuable habitat for a diverse assemblage of marine life including juvenile sea turtles, sea birds, and over 100 species of fish. Unregulated commercial harvest of *Sargassum* for fertilizer and livestock feed has prompted concerns over the potential loss of this important resource. There have been instances of relatively small masses of *Sargassum* washing ashore or into the project area under certain wind conditions. Since *Sargassum* occurs in the upper few feet of the water column and is not commonly found in the project area, it is not subject to impacts from dredging or disposal associated with the project.

3.3 Impacts to Artificial Reefs and Shipwrecks

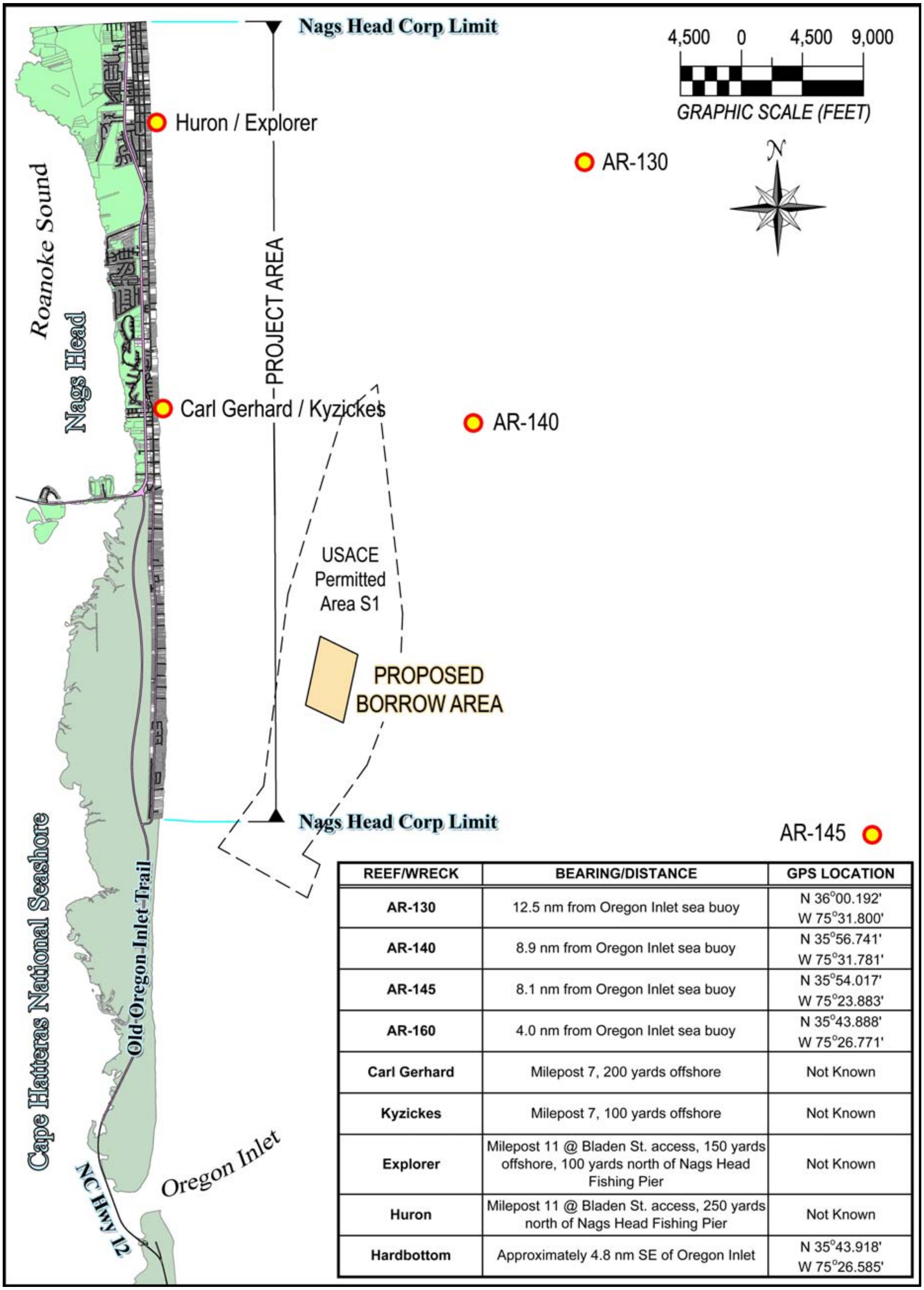
The North Carolina Department of Natural Resources (NCDNR) lists four artificial reefs and four shipwreck sites near the project area (Fig 8). Three of the artificial reef sites are located over 3 miles from the beach beyond the limits of borrow area S1. Reef AR-140 is located closest to the project area, 1 mile west of borrow site S-1 (Fig 8). Four wrecks (Carl Gerhard, Kyzickes, USS Huron, Tugboat Explorer) are located in the project area. All four wrecks are positioned within 250 yards of the shoreline in ~20–25 ft of water according to NCDNR.

No adverse impacts would be expected to the artificial reef or wreck areas, because dredging conducted as part of the project will not be performed in close proximity to these cultural resource features.

Disposal of the sand on the beaches of Nags Head will involve discharge of high quality sand material (sand content greater than 95 percent) onto the beach and in very shallow water with no affect on the artificial reefs. Direct sand placement is not expected to occur over the shipwrecks in the project area. Instead, nourishment sand will migrate into deeper water as the beach profile evolves under the influence of waves. Such sand migration will enhance the burial and preservation of the shipwrecks, making them less exposed at the surface substrate.

Elevated turbidity levels occur during the dredging of the borrow sites and disposal sites, but decrease rapidly as suspended sediments settle or disperse.

All reefs and wrecks located within two miles of the borrow area will be marked on project plans as sensitive areas to be avoided during anchoring. Pipeline corridors will be established in the project plans so as to avoid direct impacts on the shipwreck sites. Distribution sand along the beach will be via temporary land-based pipelines running along the dry beach well removed from cultural resource sites.



REEF/WRECK	BEARING/DISTANCE	GPS LOCATION
AR-130	12.5 nm from Oregon Inlet sea buoy	N 36°00.192' W 75°31.800'
AR-140	8.9 nm from Oregon Inlet sea buoy	N 35°56.741' W 75°31.781'
AR-145	8.1 nm from Oregon Inlet sea buoy	N 35°54.017' W 75°23.883'
AR-160	4.0 nm from Oregon Inlet sea buoy	N 35°43.888' W 75°26.771'
Carl Gerhard	Milepost 7, 200 yards offshore	Not Known
Kyzickes	Milepost 7, 100 yards offshore	Not Known
Explorer	Milepost 11 @ Bladen St. access, 150 yards offshore, 100 yards north of Nags Head Fishing Pier	Not Known
Huron	Milepost 11 @ Bladen St. access, 250 yards north of Nags Head Fishing Pier	Not Known
Hardbottom	Approximately 4.8 nm SE of Oregon Inlet	N 35°43.918' W 75°26.585'

FIGURE 8. Locations of known shipwrecks and artificial reefs in the vicinity of the proposed project. [Note: AR-160 and hard-bottom locations are not indicated. Coordinates (if known) are shown in the table.] [Source: NCDNR]

3.4 Impacts on Hard Bottom

Surveys of hard bottom areas, conducted by Southeast Monitoring & Assessment (SEAMAP 2001), revealed a hard bottom in the project vicinity (LAT 35.918N, LONG 75.585W), 4.8 miles or ~29,000 ft southeast of Oregon Inlet (Fig 8). Side-scan sonar surveys conducted for the Dare County EIS did not identify any hard bottoms within any of the potential borrow areas (USACE 2000).

The location of the hard bottoms, within ~3 miles of the project, will be shown on the project construction drawings so that the areas will be avoided and protected from physical impacts due to anchoring, submerged pipe, or equipment mobilization. Confirmed hard bottoms located greater than 3 miles from the project are not expected to be impacted.

3.5 Impacts on State-designated Areas Important for Managed Species

Primary nursery areas (PNAs) are designated by the North Carolina Marine Fisheries Commission. They are defined by the State of North Carolina as tidal saltwater which provides essential fish habitat for the early development of commercially important fish and shellfish (15 NC Administrative Code 3B. 1405). Many fish species go through post-larval development in these areas, which is vital to their survivability. This project will not impact PNAs.

3.6 Impacts to the Marine Water Column

Dredging and disposal activities conducted during project construction may cause impacts in the marine water column in the immediate areas of the borrow and deposition sites that could potentially impact nearshore and intertidal resources. These impacts may include minor and short-term sediment plumes (and related turbidity) as well as the release of trace constituents from the sediment. The impacts associated with this project may be similar, on a smaller scale, to the effects of storms. Storm effects may include increased turbidity and suspended sediment load in the water column and, in some cases, changes in fish community structure (Hackney et al 1996). Severe storms have been documented to create conditions of fish kills, but such situations are not associated with beach disposal of dredged sand.

Van Dolah et al (1994) assessed turbidity conditions associated with a beach nourishment project at Folly Beach (SC) and drew the following conclusion:

Although dredge effluent does increase turbidity levels in the immediate vicinity of the outfall, there are many other factors such as local weather and wave energy that will also produce this effect. The turbidity levels at Folly Beach during nourishment and the dispersal of the sediment plume were not considered unusual or severe relative to normal fluctuations and background levels.

In perhaps the most comprehensive monitoring of beach nourishment to date, Burlas et al (USACE 2001) found that certain fish species (eg, kingfish) were attracted to higher turbidity waters, whereas other species (eg, bluefish) avoided high turbidity water around the discharge pipe during a major nourishment project along the central New Jersey coast. This study suggests that fish have the ability to make choices regarding avoidance of locally turbid water associated with beach nourishment and that the presence of elevated turbidity can repel or attract certain species according to their particular adaptive behavior.

Beach disposal of dredged sediments can affect fishery resources and essential fish habitat through increases in turbidity and burial of beach resources. These impacts may create localized stressful habitat conditions and may result in the temporary displacement of fish and other biota. Given the high-energy offshore environment and the coarse sediment composition, the turbidity plume created is expected to be short-lived. Coarse sediments have much higher settling velocities than finer material (Table 3). Fine-grained sediments (such as silts and clays) produce greater and longer lasting turbidity plumes, which can impact large areas of the sea floor more than coarser, sand-sized material (USACE 2002).

3.7 Impacts to Benthic Habitat

There are several environmental issues relating to the benthic habitat and resources that arise in considering a beach nourishment project. The most significant include:

1) Impacts to and recovery of the benthic invertebrate community at the borrow sites.

2) Potential impacts to commercially or recreationally important demersal fishes and crustaceans in part because of these effects on their benthic invertebrate prey.

TABLE 3. Sediment settling velocities. [d_s- sieve diameter. d_v- volume sphere diameter. d_f- sedimentation diameter. *Wentworth Classification.]

d_s (mm)	d_v (mm)	d_f (mm)	@ 10°C (m/sec)	@ 20°C (m/sec)	*Sand Classification
0.089	0.10	0.1	0.005	0.007	vf
0.126	0.14	0.14	0.010	0.013	vf-f
0.147	0.17	0.16	0.013	0.016	f
0.208	0.22	0.22	0.023	0.028	f
0.25	0.25	0.25	0.028	0.033	f-m
0.29	0.30	0.29	0.033	0.039	m
0.42	0.46	0.40	0.05	0.058	m
0.59	0.64	0.55	0.077	0.084	c
0.76	0.80	0.70	0.100	0.110	c
1.25	1.40	1.00	0.15	0.160	vc
1.8	1.90	1.20	0.17	0.170	vc

3) Impacts to and recovery of the benthic invertebrate community on the intertidal and shallow subtidal beach.

4) Potential impacts to commercially and recreationally important fishes in the surf zone and/or shorebirds in large part because of the effects on their benthic invertebrate prey and because of enhanced turbidity along the shoreline.

3.7.1 Impacts to Offshore Vertebrates

Fish, plankton, and other mobile animals in the vicinity of the borrow area during dredging are least likely to be affected, because of their ability to avoid the disturbed areas. Fish species have been observed to leave the area temporarily during dredging operations and return when dredging ceases (Pullen and Naqvi 1983, USACE 2001). A study of near-shore borrow areas after dredging offshore of South Carolina revealed no long-term impacts to fisheries, both fish and planktonic organisms, as a result of dredging (Van Dolah et al 1992).

Creation of new habitat and the uncovering and suspension of food that attract fish during dredging have been attributed to dredging offshore borrow areas (Naqvi and Pullen 1982). Dredging of the bottom sediments in the borrow areas can be expected to attract fish (after the dredge leaves) as a result of suspension of bottom material. Burlas et al (USACE 2001) noticed there were two infaunal responses to the dredging of borrow pits: (1) rapid recovery (~1 year) or (2) development of a depauperate, soft bottom assem-blage. The former is more likely to be the case in the proposed project because the bor-row area will not be left as a deep hole (ie, not tens of feet deeper than the surrounding substrate) and the adjacent undisturbed sediments tend to be very coarse. Also high energy conditions tend to inhibit accumulation of fine-grained material in the S1 setting.

3.7.2 Impacts to Offshore Invertebrates

Benthic organisms in the immediate area being dredged will be dislocated or destroyed during dredging. However, initial recolonization of the dredged areas by opportunistic species is expected to occur soon after cessation of any dredging activities. Further recovery is expected by recolonization of migrating benthic organisms from adjacent areas and by larval transport. Monitoring studies of postdredging effects and recovery rates of borrow areas indicate that most borrow sites show significant recovery by benthic organisms in approximately one year (Naqvi and Pullen 1982, Bowen and Marsh 1988, Van Dolah et al 1992). Van Dolah et al (1998) noted ". . . slower infilling with muddy sediments, etc" for borrow sites that left deeper cuts and were surrounded by high concentrations of mud (eg, conditions typical of harbor channels). The Nags Head project is more likely to yield rapid recovery of offshore invertebrates.

3.7.3 Impacts to Nearshore Resources

Nourishment sediment will be placed on the upper part of the beach, but flow down into the surf zone region. Short term increases in turbidity are expected in the surf zone due to the nourishment discharge. An "Environmental Assessment, Hunting Island Ecosystem Restoration Study" (conducted by the USACE 2004) concluded that since animals associated with high-energy beaches are continually subjected to effects of erosion and accretion and to major physical changes resulting from storms and hurricanes, initial construction and any periodic nourishments will not unduly stress beach and intertidal animals beyond their adaptive capacities. Environmental monitoring of the Bogue Banks beach restoration project between 2001 and 2005 similarly demonstrates the ability of nourished beaches to regain healthy populations of benthic organisms very rapidly. All such studies tend to show that certain species are pioneers followed by others with longer life cycles. Thus, diversity lags behind initial recolonization.

There are three direct impacts from nourishment projects:

1) Very short-lived substantial increases in turbidity during the placement operation (ranging from a couple of hours to a few days at each location) alter the water column conditions sufficiently that mobile species tend to leave the area. Return tends to be rapid. A study conducted by Burlas et al (USACE 2001, for the Asbury Park to Manasquan section beach erosion project) revealed no differences in biomass/filled stomachs in project and control areas for any fish

species. Corps data did suggest that some fish were attracted to the active beach fill location during some sampling periods.

2) Burial of benthic organisms essentially destroys the existing community, but Van Dolah et al (1992) reported rapid recovery of benthic communities in the nearshore area, which was probably due to the similarity of fill material to existing sediments and the fact that nourishment material was placed high on the beach.

3) Alteration of sediment type necessarily results in changes in type and densities of species. Numerous monitoring studies recommend that the key to minimizing impact is to match the sediment types as closely as possible (Thompson 1973, Naqvi and Pullen 1982, and Van Dolah et al 1994, ACRE 1999).

3.7.4 Impacts to Intertidal Resources

During project construction, there will be an increase in the turbidity of the surf zone in the immediate area of sand deposition. Most of the fine-grained material in the beach fill is expected to be washed seaward into the surf during construction. This increase in fine material may cause the temporary displacement of various species of sport fish, causing a negative impact to surf fishing in the area of deposition. A study performed by the National Marine Fisheries Service (NMFS) on the effects of beach nourishment on nearshore macroinfauna concluded that beach nourishment projects using offshore dredged material have no harmful effects, provided that the sediments are similar to those of the native beach (Saloman and Naughton 1984).

Impacts to Intertidal Vertebrates – In view of the high mobility of fish, it is expected that fish will leave the areas under active construction. Impact on fishing resources in the intertidal zone will be minimized simply by the fact that sand-placement operations will take place at any one location for only a few days and then move further along the beach.

Impacts to Intertidal Invertebrates – Impacts on intertidal macrofauna in the immediate vicinity of the nourishment project are expected as a result of discharges of nourishment sediment on the beach. A study by Reilly and Bellis (1983) was conducted on Bogue Banks and is used as a seminal study on beach projects throughout the southeast U.S. "The Ecological Impact of Beach Nourishment with Dredged Materials on the Intertidal Zone at Bogue Banks, North Carolina" concluded that beach nourishment virtually destroys existing intertidal macrofauna, but that recovery is rapid once the pumping operation ceases. In most cases, recovery occurs within one or two seasons following the sediment placement. Reilly and Bellis (1983) state ". . . a speedy recovery largely depended on recruitment from pelagic larval stocks." Most species fell into this category. The few that did not (and recruited instead from neighboring beaches) were slower to recover.

3.7.5 Impacts to Beach and Terrestrial Resources

After construction, the beach sediment will be sampled and analyzed. The primary purpose will be to determine how much of the mud in the nourishment sediment still remains and did not decant off during the construction process.

Project construction will result in disturbance and removal of some of the existing vegetation along the seaward side of the island. The project is intended to widen the base of the beach face. Thus, replanting makes sense only for those areas where vegetation has been damaged. The Reilly and Bellis (1983) study that focused on the intertidal zone also encompassed dry-beach sampling. Most species, including all of the larger organisms such as ghost crabs, recruited from pelagic larvae and thus recovered rapidly (one or two seasons). This was also confirmed by CSA (2005) in a multi-year monitoring of the Bogue Banks nourishment project (multiple phases totaling ~8.5 million cubic yards through 2005).

Positive impacts from project construction will be an expected increase in nesting turtle populations. Other potential impacts are restoration and protection of shorebird habitat and maritime forest.

In an environmental report (ACRE 1999) on the use of federal offshore sand resources for beach and coastal restoration, the U.S. Department of the Interior–Minerals Management Service provided the following assessment of the potential impacts to beach fauna from beach disposal:

> *As with benthic organisms living in borrow areas, benthic organisms are significantly impacted by beach nourishment activities (Nelson 1985, Van Dolah et al 1992). These impacts, however, are considered shorter in duration than the impacts observed in offshore borrow areas. Because benthic organisms living in the beach habitats are adapted to high energy environments, they are able to quickly recover to original levels following beach nourishment events, sometimes in as little as three months (Van Dolah et al 1994, Levison and Van Dolah 1996). This is again attributed to the fact that intertidal organisms are living in high energy habitats where disturbances are more common. Because of lower diversity of species compared to other intertidal and shallow subtidal habitats (Hackney et al 1996), the vast majority of beach habitats are recolonized by the same species that existed before nourishment (Van Dolah et al 1992, Nelson 1985, Levison and Van Dolah 1996, Hackney et al 1998)*

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APPENDIX A. Project area fish managed under Magnuson-Stevens Fishery Conservation and Management Act.

Fish Species	Oregon Inlet	Atlantic Ocean North of Cape Hatteras	Atlantic Ocean Offshore North Carolina
Red Drum	E L J A	A	N/A
Bluefish	E L J A	J A	N/A
Summer flounder	L J A	E L J A	N/A
Gag grouper	J A	E L J A	N/A
Gray snapper	J A	E L J A	N/A
Dolphin	J A	E L J A	N/A
Cobia	E L J A	J A	N/A
King mackerel	L J A	E L J A	N/A
Spanish mackerel	L J A	E L J A	N/A
Black sea bass	L J A	E L J A	N/A
Spiny dogfish	E L J A	E L J A	N/A
Brown shrimp	E L J A	E L J A	N/A
Pink shrimp	E L J A	E L J A	N/A
White shrimp	E L J A	E L J A	N/A
Atlantic bigeye tuna	N/A	E L J A	N/A
Atlantic bluefin tuna	N/A	E L J A	N/A
Shortfin mako shark	N/A	J A	N/A
Blue shark	N/A	J A	N/A
Spinner shark	N/A	N/A	E L J A
Sword fish	N/A	E L J A	E L J A
Yellowfin tuna	N/A	E L J A	E L J A
Skipjack tuna	N/A	E L J A	E L J A
Longbill spearfish	N/A	E L J A	E L J A
Blue marlin	N/A	E L J A	E L J A
White marlin	N/A	E L J A	E L J A
Sail fish	N/A	E L J A	E L J A
Calico scallop	N/A	E L J A	E L J A
Scalloped	A	J A	J A
Hammerhead shark	N/A	N/A	N/A
Big nose shark	A	J A	J A
Black tip shark	A	J A	J A
Dusky shark	A	J A	J A
Night shark	A	J A	J A
Sandbar shark	A	J A	J A
Silky shark	A	J A	J A
Tiger shark	A	J A	J A
Atlantic sharpnose shark	A	J A	J A
Longfin mako shark	A	J A	J A
Whitetip shark	A	J A	J A
Yellow jack	N/A	N/A	E L J A
Blue runner	N/A	N/A	E L J A
Crevalle jack	N/A	N/A	E L J A
Bar jack	N/A	N/A	E L J A
Greater amberjack	N/A	N/A	E L J A
Almaco jack	N/A	N/A	E L J A

Banded rudderfish	N/A	N/A	E L J A
Spade fish	N/A	N/A	E L J A
White grunt	N/A	N/A	E L J A
Hogfish	N/A	N/A	E L J A
Puddingwife	N/A	N/A	E L J A
Threser shark	A	J A	J A
Gray triggerfish	N/A	N/A	E L J A
Blackfin snapper	N/A	N/A	E L J A
Red snapper	N/A	N/A	E L J A
Cubera snapper	N/A	N/A	E L J A
Silk snapper	N/A	N/A	E L J A
Vermillion snapper	N/A	N/A	E L J A
Blueline tilefish	N/A	N/A	E L J A
Sand tilefish	N/A	N/A	E L J A
Bank sea bass	N/A	N/A	E L J A
Rock sea bass	N/A	N/A	E L J A
Graysby	N/A	N/A	E L J A
Speckled hind	N/A	N/A	E L J A
Yellowedge grouper	N/A	N/A	E L J A
Coney	N/A	N/A	E L J A
Red hind	N/A	N/A	E L J A
Jewfish	N/A	N/A	E L J A
Red grouper	N/A	N/A	E L J A
Misty grouper	N/A	N/A	E L J A
Warsaw grouper	N/A	N/A	E L J A
Snowy grouper	N/A	N/A	E L J A
Yellowmouth grouper	N/A	N/A	E L J A
Scamp	N/A	N/A	E L J A
Sheepshead	J A	N/A	E L J A
Red porgy	N/A	N/A	E L J A
Longspine porgy	N/A	N/A	E L J A
Scup	N/A	E L J A	E L J A
Little tunny	N/A	N/A	E L J A
Notes: E-Eggs L-Larval J-Juvenile A-Adult N/A- Not Found			