FINAL PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

WALLOPS FLIGHT FACILITY SHORELINE RESTORATION AND INFRASTRUCTURE PROTECTION PROGRAM

VOLUME II OF II

Prepared for

National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

In cooperation with

U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement and
U.S. Army Corps of Engineers

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Prepared by

URS

URS Group, Inc.
200 Orchard Ridge Drive, Suite 101
Gaithersburg, MD 20878
15301785

Storm Damage Reduction Project Design for Wallops Island, Virginia

David B. King Jr., Donald L. Ward
Coastal and Hydraulics Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Greggory G. Williams, and Mark H. Hudgins
U.S. Army Engineer District, Norfolk
803 Front Street
Norfolk, VA 23510-1096

Prepared for:
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

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Contents

1 Introduction

The National Aeronautics and Space Administration's (NASA's) Goddard Space Flight Center's Wallops Flight Facility (WFF), located on Virginia's eastern shore, was established in 1945 and is NASA's principal facility for managing and implementing suborbital research programs. The facility is divided into two parts: a main base, located on the Delmarva Peninsula, and Wallops Island, a coastal barrier island that houses a series of launch facilities and support buildings. Almost all the facilities and rocket launch pads on the island occupy a sandy strip of land less than 1000 ft (300 m) from the Atlantic Ocean, with most less than half that distance. The current replacement value of the infrastructure on the island is approximately $800 million. Separating Wallops Island from the mainland is a series of open bays and coastal salt marsh roughly 2 miles (3 kilometers) wide, which is a southern extension of Chincoteague Bay.

The shoreline at Wallops Island has experienced chronic erosion for at least the last 150 years. At present, a rock seawall protects much of the facility. Most of the seawall has no exposed beach fronting it, and several sections of the seawall are in a deteriorated condition.

Study Objectives

The US Army Engineer Research and Development Center's (ERDC) Coastal and Hydraulics Laboratory (CHL) has been working with the US Army Engineer District, Norfolk (CENAO) to develop a comprehensive solution to the shoreline erosion problem that will provide substantial storm damage protection to the infrastructure on Wallops Island and at the same time avoid any significant negative impacts to Assawoman Island, the shoreline immediately south of Wallops Island. This report documents the data collection, numerical modeling, and technical analysis undertaken to support the design of storm damage reduction project alternatives for the site.

2 Description of the Study Area

Location

Wallops Island, Virginia is a barrier island located on the Atlantic coast of the Delmarva Peninsula about 90 km north of the mouth of Chesapeake Bay., as shown in Figures 2-1 and 2-2.

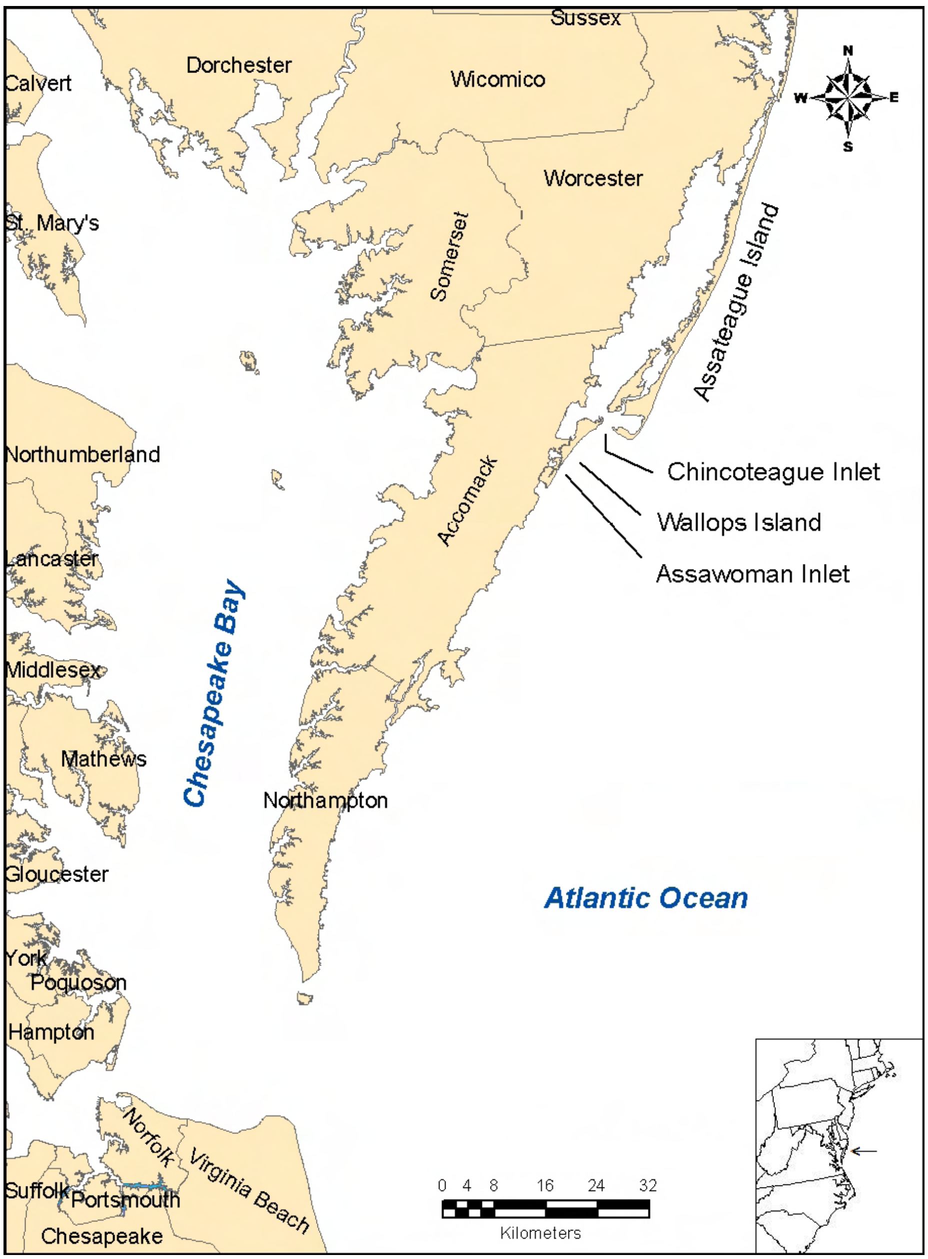

Figure 2-1. Location of Wallops Island on the Virginia eastern shore of the Delmarva Peninsula.

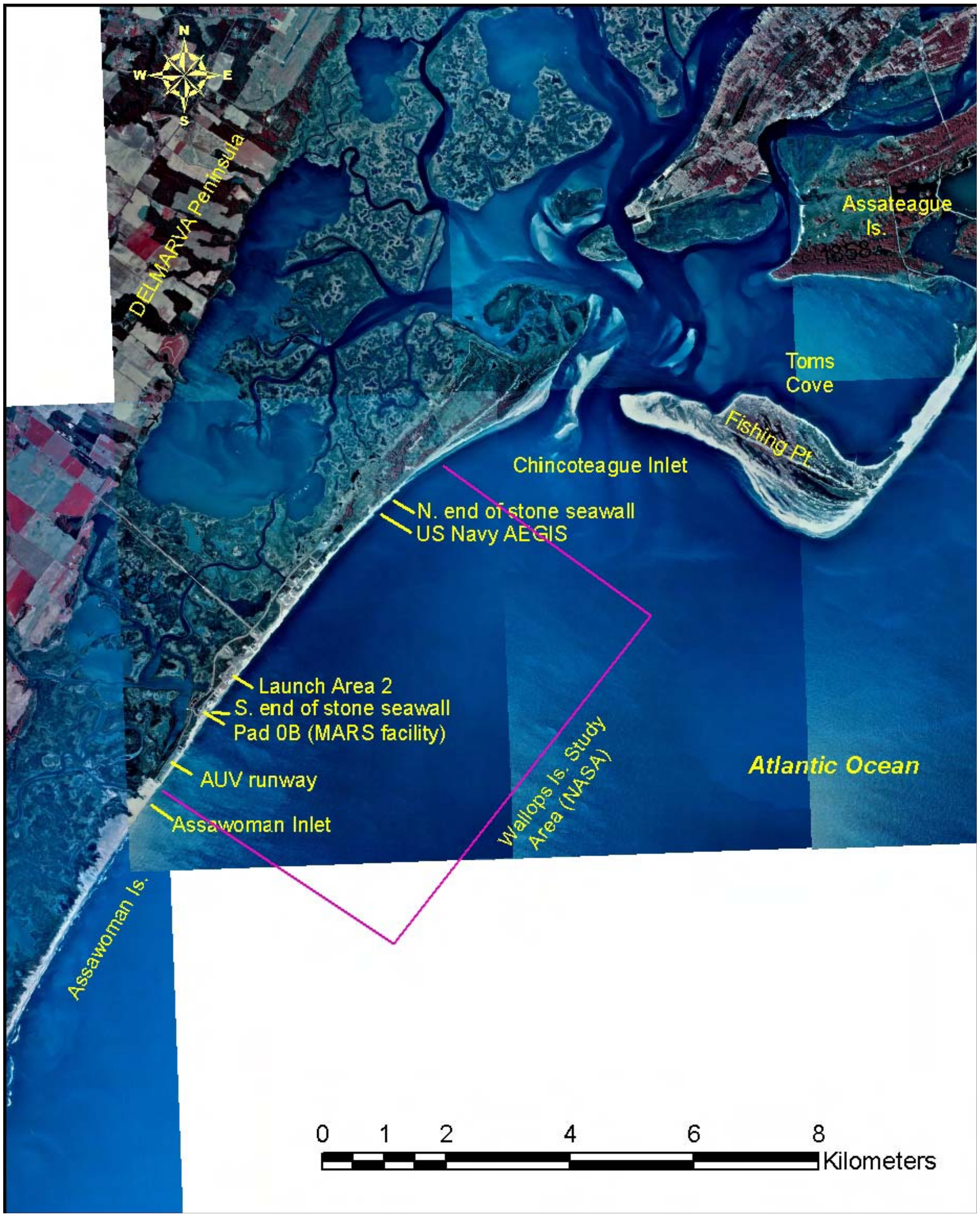

Figure 2-2. Wallops Island, VA study site.

Wallops Island is bounded on the east and southeast by the Atlantic Ocean. To the northeast is Fishing Point, a recurved spit which forms the southern end of Assateague Island. To the north are Chincoteague Inlet, Chincoteague Bay, the town of Chincoteague, VA, and the mainland base for WFF. To the west, Wallops Island is separated from the mainland by a series of marshes and tidal creeks which are a southern extension of Chincoteague Bay. The mainland in the vicinity is comprised mainly of rural farmland. South of Wallops Island is Assawoman Inlet (now closed) and Assawoman Island, a National Wildlife Refuge managed by the US Fish and Wildlife Service. A string of undeveloped barrier islands extend further south, down the coast to the mouth of Chesapeake Bay. Virginia's Atlantic coast shoreline on the Delmarva Peninsula is one of the longest stretches of undeveloped shoreline on the east coast of the U.S. The only public road access to the entire Virginia shoreline is at the Assateague Island National Seashore located east of the town of Chincoteague.

History of Shoreline Change along Wallops Island

1940's and 1950's

In 1945, the National Advisory Committee on Aeronautics (NACA, the precursor to NASA) began using Wallops Island, VA as a launch site for experimental rocket research. This research mission at Wallops Island continues to the present.

Due to concern about storm damage to facilities being constructed on the island, a seawall was first erected in 1945-1946. The original seawall was made of interlocking 18 ft sections of sheet pile, driven approximately 12 feet into the ground. The Beach Erosion Board of the USACE first studied the problem of beach erosion at Wallops Island in April-May 1946. They documented that the shoreline had receded 500 ft since 1851 and recommended that a groin field be installed when the high water line came within 50 feet of the seawall. Figure 2-3 shows the Wallops Island shoreline in January 1946 looking north. Assawoman Inlet is at the extreme bottom of the photograph.

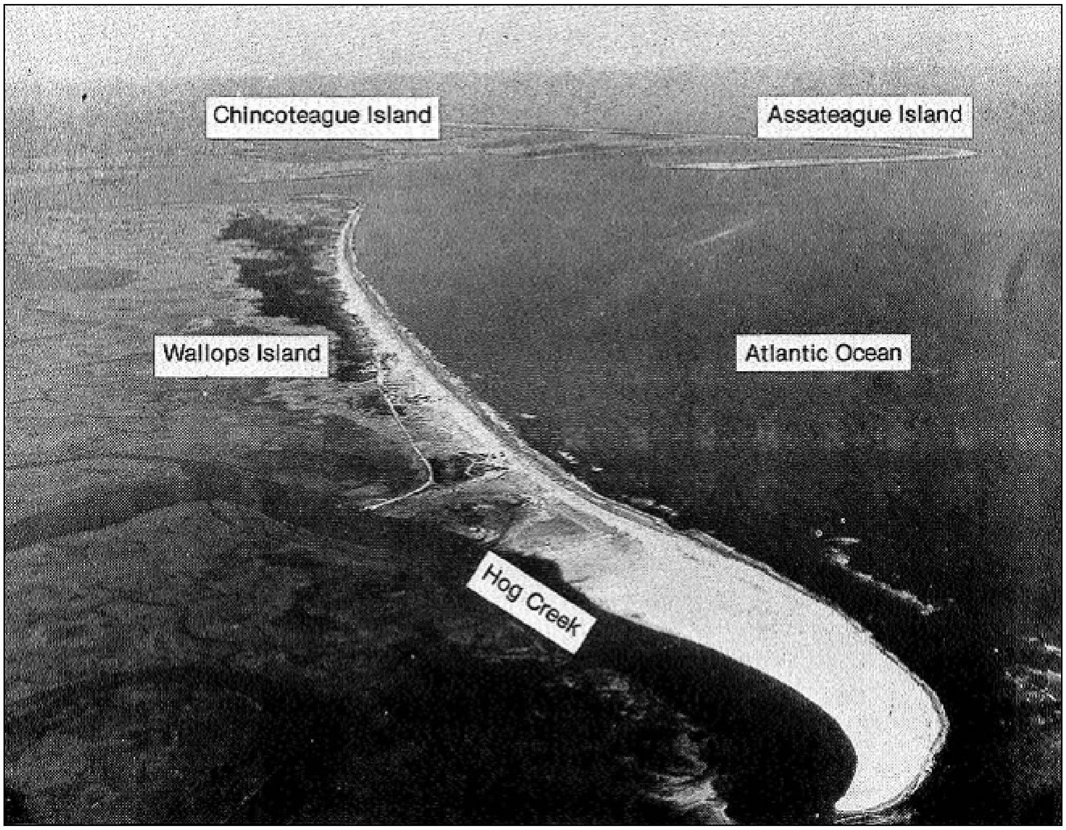

Figure 2-3. Wallops Island shoreline, January 1946.

Figure 2-4 shows the erosion and storm damage to the Wallops Island Association Clubhouse at the north end of the island in May 1949. Figure 2-5, taken in October 1956, shows a portion of the exposed seawall. In May, 1956, the Beach Erosion Board again inspected the beach at Wallops Island and recommended that 8 groins be installed at 400 ft intervals along 2,800 feet of beach. These groins are seen in Figure 2-6, which was taken in December 1959. This figure also shows the causeway connecting Wallops Island to the mainland, which was constructed in 1959. The seawall was extended further to the north in 1960. The above information and Figures 2-3 through 2-7 are from Shortal, 1978.

Figure 2-4. Wallops Island north end erosion damage, May 1949.

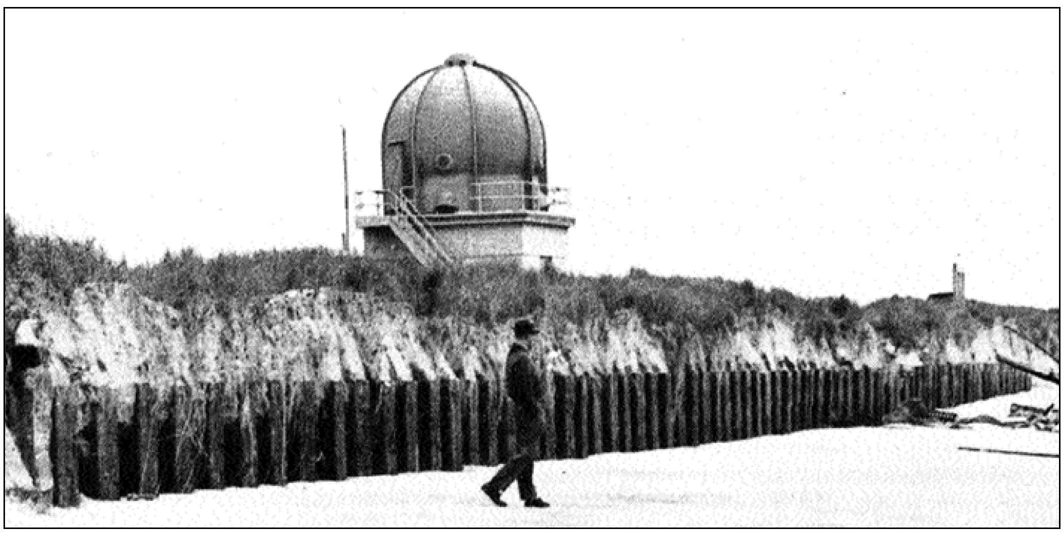

Figure 2-5. Wallops Island seawall, October 1956.

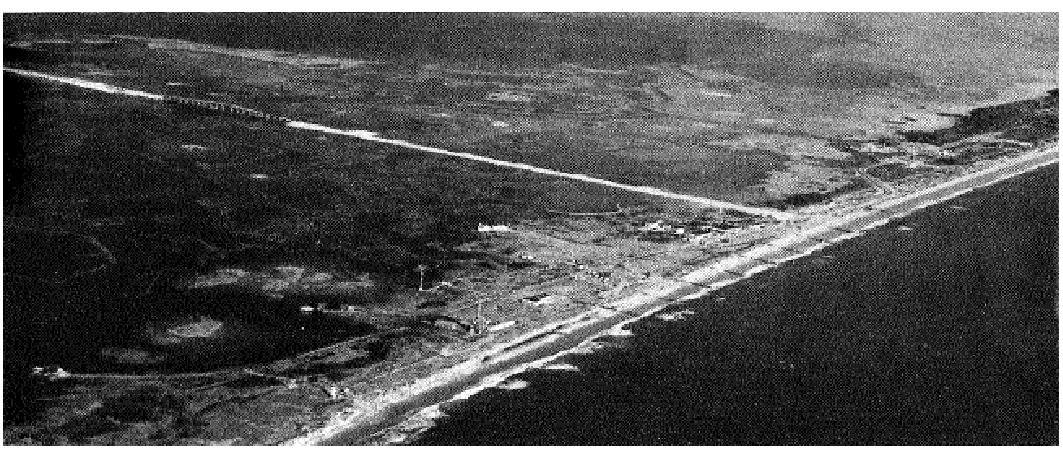

Figure 2-6. Wallops Island, December 1959, showing groin field extending southward from the newly built causeway.

1960's through 1980's

Figure 2-7 shows failed sections of the sheet pile seawall following the Ash Wednesday storm of March 6-8, 1962. This Nor'easter caused extensive damage along the eastern seaboard from New York to North Carolina and is considered one of the ten worst storms in the United States in the 20th century. The damage at Wallops Island was estimated at $1,000,000.

The storm also breached the south end of the island at the location of the present UAV runway and connected Hog Creek (Figure 2-3) directly with the ocean. This breach was mechanically closed with a large rectangular fill as shown in the 1965 photo, Figure 2-8. The southern edge of this fill section is the location of the present day South Camera Stand.

A total of 47 groins had been built along the Wallops Island shoreline by 1972 (Morang, Williams, and Swean, 2006). The groins were constructed of wood as illustrated in the Shore Protection Manual, 1984 and Basco, 2006 (Figure 2-9). Most of the groins ranged in length from 120 ft (30 m) to 400 feet (120 m) and the spacing between them varied from 200 to 650 ft (60 to 200 m) (Table 2 in Moffatt and Nichol, 1986). In the 1960's and early 1970's the groins functioned well, as shown in Figure 2-10, and were considered a success.

The seawall was extended, augmented, and repaired several times in the 1950s through the 1980s (Table 1 in Moffatt and Nichol, 1986). In addition to the steel sheet pile, portions of the seawall were constructed using wooden bulkheads, concrete aprons, and rock rubble mounds. There is little evidence that the groins were regularly maintained, and there is no record of any beach nourishment being placed in the groin field. By the 1980s, the groins showed signs of serious deterioration, as shown in Figure 2-11. Moffatt and Nichol (1998) concluded that the lack of periodic nourishment was the principal reason for the failure of the groins.

Assawoman Inlet was formerly a small, natural inlet at the southern tip of Wallops Island (Slingerland 1983). Most photos and shorelines through the early 1980's show a small, but open, inlet. However, photos and shorelines from the 1990's on show the inlet as closed. Today, the inlet's former location is marked by a series of overwash fans.

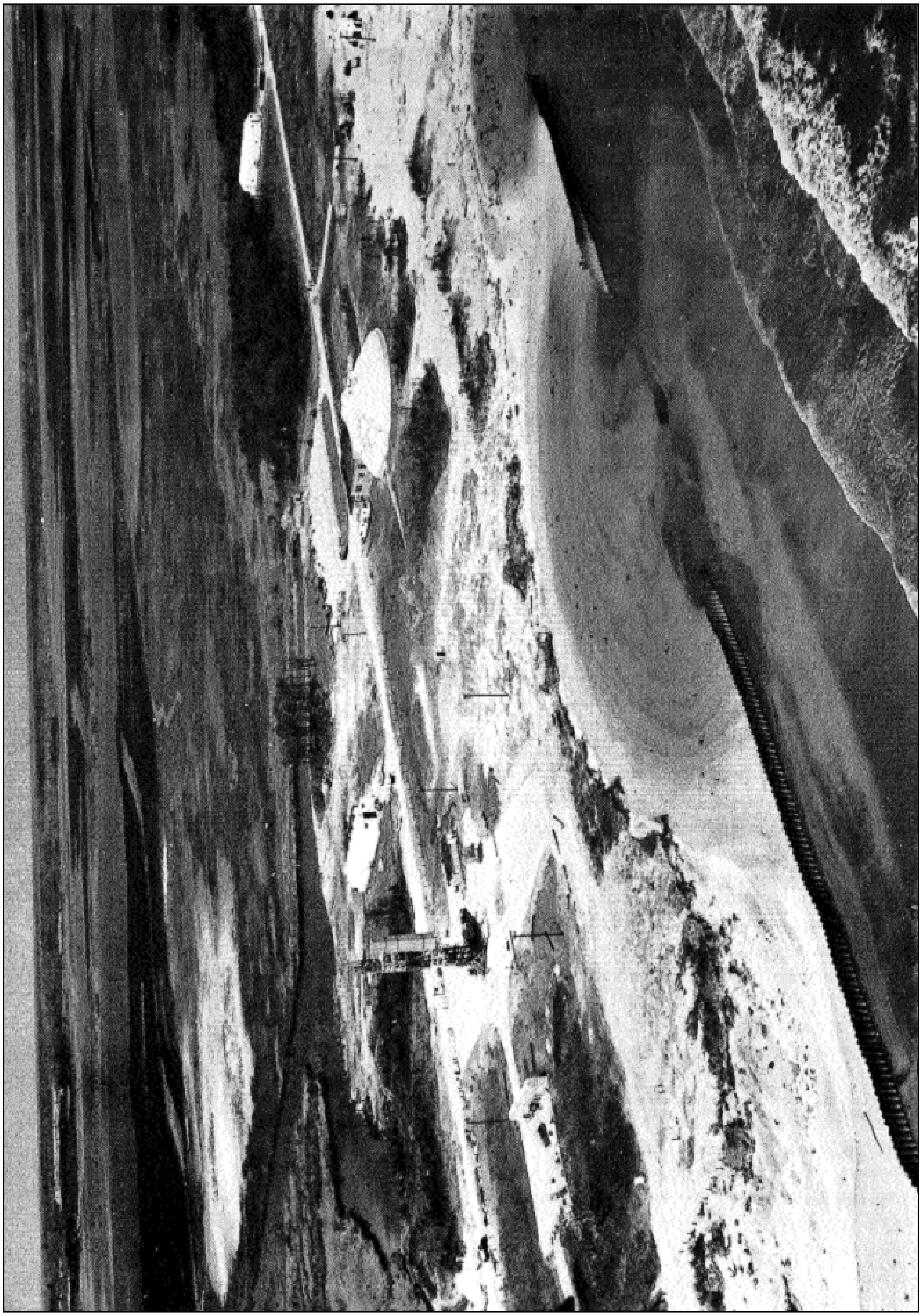

Figure 2-7. Seawall damage from Ash Wednesday Storm of April 1962.

Figure 2-8. Mechanically filled section of the south end of Wallops Island following an Ash Wednesday Storm breach.

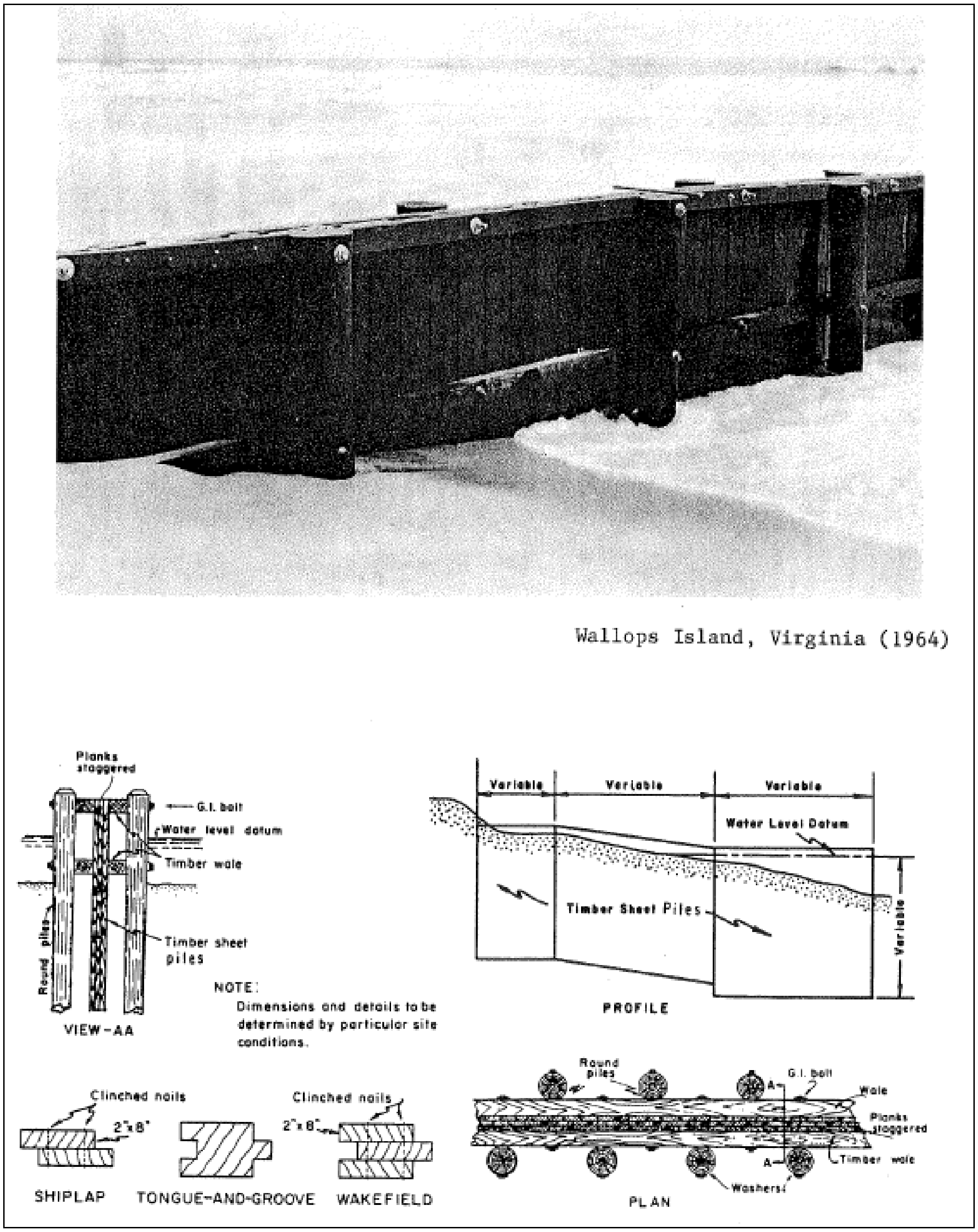

Figure 2-9. Wallops Island wooden groins, from SPM, pg 6-77.

Figure 2-10. Wallops Island groin field in 1969.

Figure 2-11. Condition of groins and seawall in 1983.

WFF attempted several different measures to control the shoreline erosion, including two experimental beach barrier projects, which were initiated in the mid 1980s. Moffatt and Nichol (1989) evaluated these and concluded that both types of experimental shore protection structures failed to provide any significant protection. Figure 2-12 (from Morang, et al, 2006) shows “Beach Prism” sand retention units that are badly misaligned following an April 1988 storm.

Figure 2-12. Experimental beach protection barriers.

1990's to Present

In the mid 1990s NASA built the current rock seawall generally in the same location as the previous seawalls (Figures 2-13 and 2-14). The wooden groins were mostly removed at approximately the same time, though several short sections of wooden pilings still remain in place. Photos from the 1990's generally show a small section of beach remaining in front of the seawall. This rock seawall has substantially halted the shoreline retreat, although the sub-aerial beach has disappeared, except at the northern end. Further, the sub-aqueous beach seaward of the seawall has continued to erode, as discussed in Chapter 6. The rock seawall has suffered damage by undermining and stone displacement. Because the wall is porous, storm waves frequently penetrate it, causing flooding and eroding sand on the landward side. See further discussion of the rock seawall in Chapter 3. Figure 2-15 shows waves from Hurricane Dennis overtopping the rock seawall in September 1999. NASA has made frequent repairs to the seawall since the mid 1990's (Morang, Williams, and Swean, 2006). In 2006, NASA placed a temporary geotextile tube along the beach south of the seawall, as shown in Figures 2-14 and 2-16. Large waves have occasionally damaged portions of this tube. In mid November 2009 a substantial Nor'easter caused island flooding and substantial damage to the geotextile tube (Figure 2-17).

Figure 2-13. Remnants of wooden, steel sheet pile, and concrete seawalls can all be found within and adjacent to the rock seawall in the vicinity of building Y35B.

Figure 2-14. Rock seawall in 2007 looking north along Wallops Island.

Figure 2-15. Rock seawall during Hurricane Dennis, September 1999.

Figure 2-16. 2007 oblique aerial photo looking south from near the south end of Wallops Island, Va. From bottom to top the shoreline shows the geotextile tube and the overwash area that was previously Assawoman Inlet.

Figure 2-17. Damage to the south end of Wallops Island caused by the November 2009 Nor'easter.

Shoreline Change

Like most of the Atlantic coast beaches on the southern Delmarva peninsula (Richardson and McBride, 2007), the beach at Wallops Island has been in a state of chronic erosion for at least the last 150 years, as evidenced by an analysis of a series of measured shorelines. These shorelines are shown in Figure 2-18. The 1849, 1857/1858, 1909/1911, 1933, and 1983 shorelines are taken from the US Coast and Geodetic Survey charts. The 1994 shoreline was digitized from a rectified aerial photograph. The 1996 and 2005 shorelines were obtained from LIDAR surveys.

On Figure 2-18, distances are in miles. The figure has the same orientation and origin as the GENESIS grid discussed in Chapter 5. The origin is located near the Dynamic Balance Facility Building on Wallops Island. In this figure, Wallops Island extends horizontally from -1½ miles to +4 miles. The dominant direction of wave approach for this section of coastline is from the northeast (left) and sediment transport is generally to the south (right), though a significant transport reversal occurs on Wallops Island (discussed below and in Chapter 5).

Panel A of Figure 2-18 shows the 1849 and 1857/1858 shorelines. At this time the shoreline was much straighter as Fishing Point spit had not formed. The inlet shown in the 1849, which is now called Assateague Channel, has shifted to the southwest in the 1857 shoreline, suggesting that the main direction of longshore sediment transport was to the south.

By 1909/1911, Figure 2-18, Panel B, Fishing Point had started to form. Assateague Channel had shifted further to the southwest. The Wallops Island shoreline had retreated by approximately 75 meters (250 ft). By 1933, Fishing Point had formed a distinct hook, but it had not grown enough to redefine the mouth of Chincoteague Inlet.

By 1983, Figure 2-18, Panel C, substantial changes had occurred. Fishing Point had grown to the extent that the tip of it and the northern shoulder of Wallops Island had started to re-define the location of the throat section of Chincoteague Inlet. Some aerial photographs from the 1980s show the existence of an emergent ebb shoal. However, these points were still well over a mile apart.

The northern end of Wallops Island was now sheltered enough by Fishing Point that it had started to accrete, which was a change from earlier decades as shown in panel C (see also Figure 2-4). Because the mouth of Chincoteague Inlet was still so wide, it is likely that a substantial portion of the accretion at the northern tip of Wallops Island was due to a transport reversal on Wallops Island, caused by Fishing Point blocking waves from the northeast. The rest of Wallops Island and Assawoman Island were still experiencing substantial erosion.

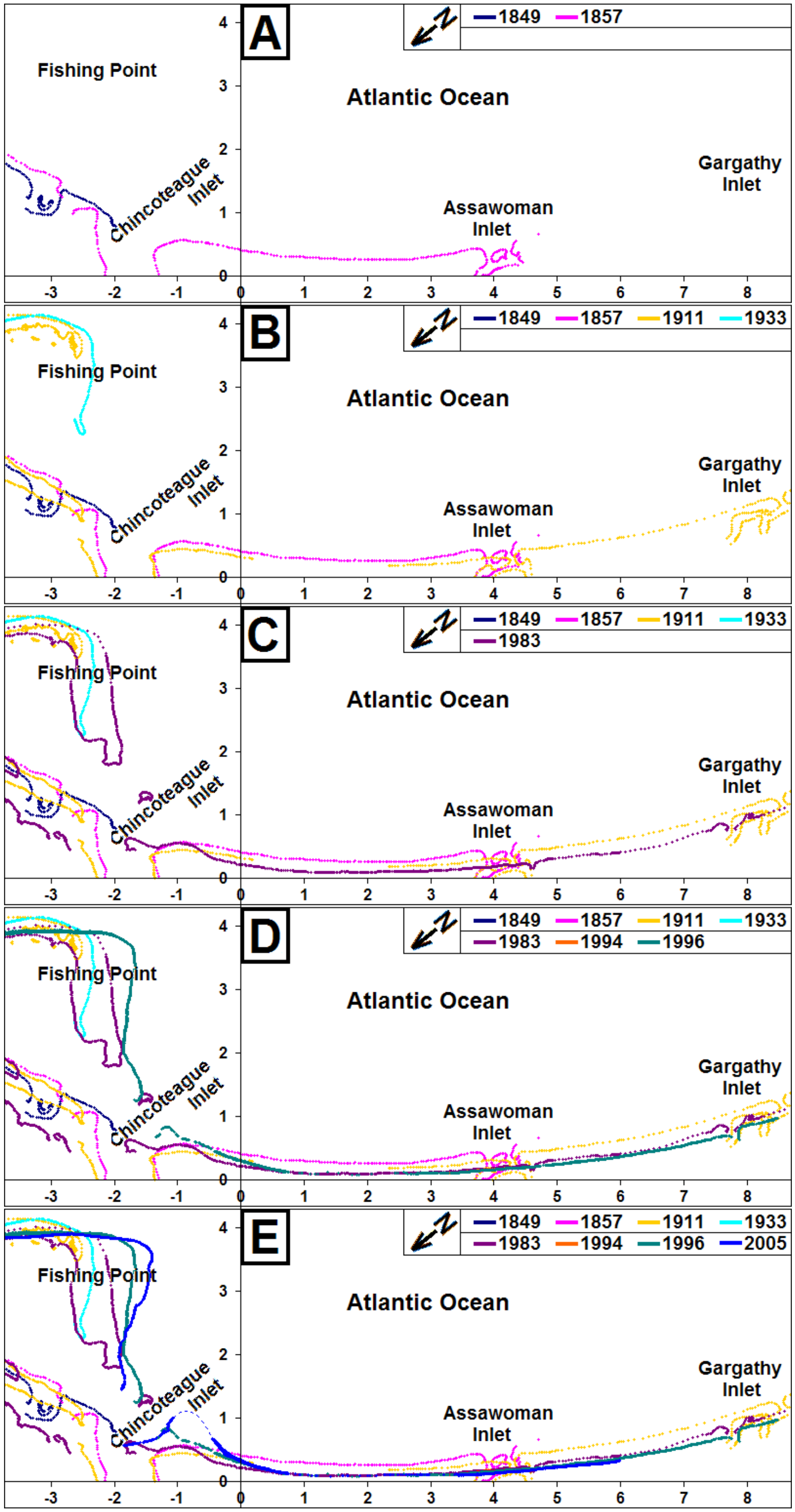

Figure 2-18. Wallops Island shoreline changes between 1849 and 2005.

By 1996, Figure 2-18, Panel D, Fishing Point and the northeastern shoulder of Wallops Island had both grown enough that the mouth of Chincoteague Inlet was less than a half mile wide, and substantial inlet bypassing (from Fishing Point to Wallops Island) had started to occur. This is supported by the fact that CENAO began dredging Chincoteague Inlet in 1995. Subsequent dredging of the inlet channel has been required at intervals ranging from one to three years (Morang, Williams, and Swean, 2006). On Wallops Island, the area of accretion at the northern tip had extended further to the south; though the southern part of the island continued to erode.

Figure 2-18, Panel E shows the 2005 shoreline. The dashed portion of this shoreline at the northern end of Wallops Island was not covered in the LIDAR survey. Instead, this shoreline is inferred from limited GPS readings taken in 2007. The northern end of Wallops Island has continued to strongly accrete, both as a result of sediment bypassing of Chincoteague Inlet and northward net transport along the northern end of the island. Today, the beach at the northern tip of Wallops Island contains a series of trapped shallow sloughs. These are the result of ebb shoal bar bypassing and welding to the inlet's downdrift shoreline. These shoals form in the channel and migrate westward, where they weld onto the northern tip of Wallops Island.

Future Shoreline Trends

The discussion in this section is an extrapolation of present shoreline behavior into the future. It is not intended to be an exact quantitative prediction of rates or timelines for future events, but rather a regional framework which can provide context to help interpret the results of the numerical modeling effort presented in later chapters.

As shown by the growth of Fishing Point in Figure 2-16 and the closure of Assawoman Inlet, the shoreline in the vicinity of Wallops Island is dynamic, and substantial changes will likely continue to occur on decadal time scales, as compared with more typical beaches.

Growth of the Southern Tip of Fishing Point

The development and growth of the cape called Fishing Point over the last 100+ years has captured sand that would have otherwise been available to nourish Wallops Island and the islands further south along the Virginia eastern shore. This is a dominant reason why these shorelines are all experiencing substantial erosion. The shoreline at Fishing Point is continuing to evolve. Figure 2-19, from the National Parks Service website: http://www.nps.gov/asis/planyourvisit/upload/historicseashore.pdf, shows the growth of the tip of the island through 2002. This growth has not slowed in recent years. The National Park Service has measured the Assateague Island shoreline multiple times yearly since 1997. Figure 2-20 shows their shoreline location data through the spring of 2009 for the very southern tip of Assateague Island and shows that the tip of the island is continuing to grow to the southwest at a rate of approximately 150 ft (50 meters) per year. If this trend continues over the 50-year life of the shore protection project on Wallops Island, the tip will grow to the southwest by about 1.5 miles (2.3 km). This will more strongly shelter the Wallops Island shoreline from ocean waves approaching from the northeast, and will shift the transport divergent nodal point which is currently on the north end of Assawoman Island to the south by roughly that amount. The nodal point and the Wallops Island sediment budget are discussed in Chapter 5.

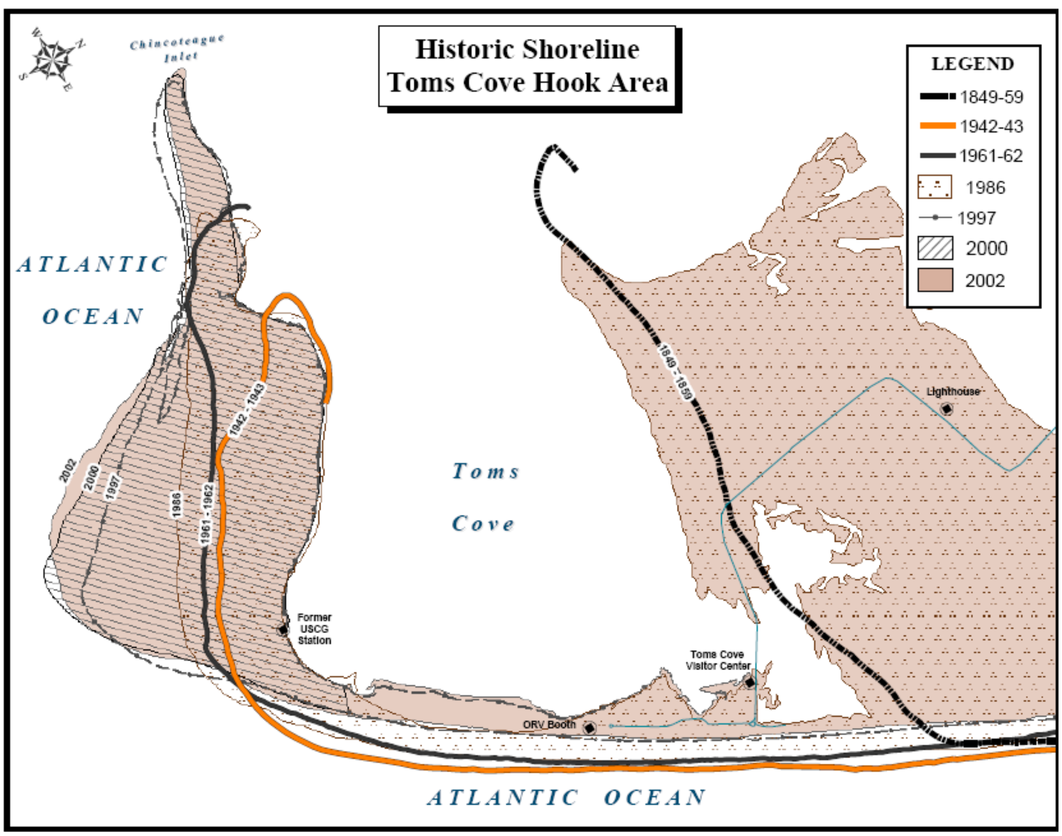

Figure 2-19. Shoreline Changes at the southern end of Assateague Island.

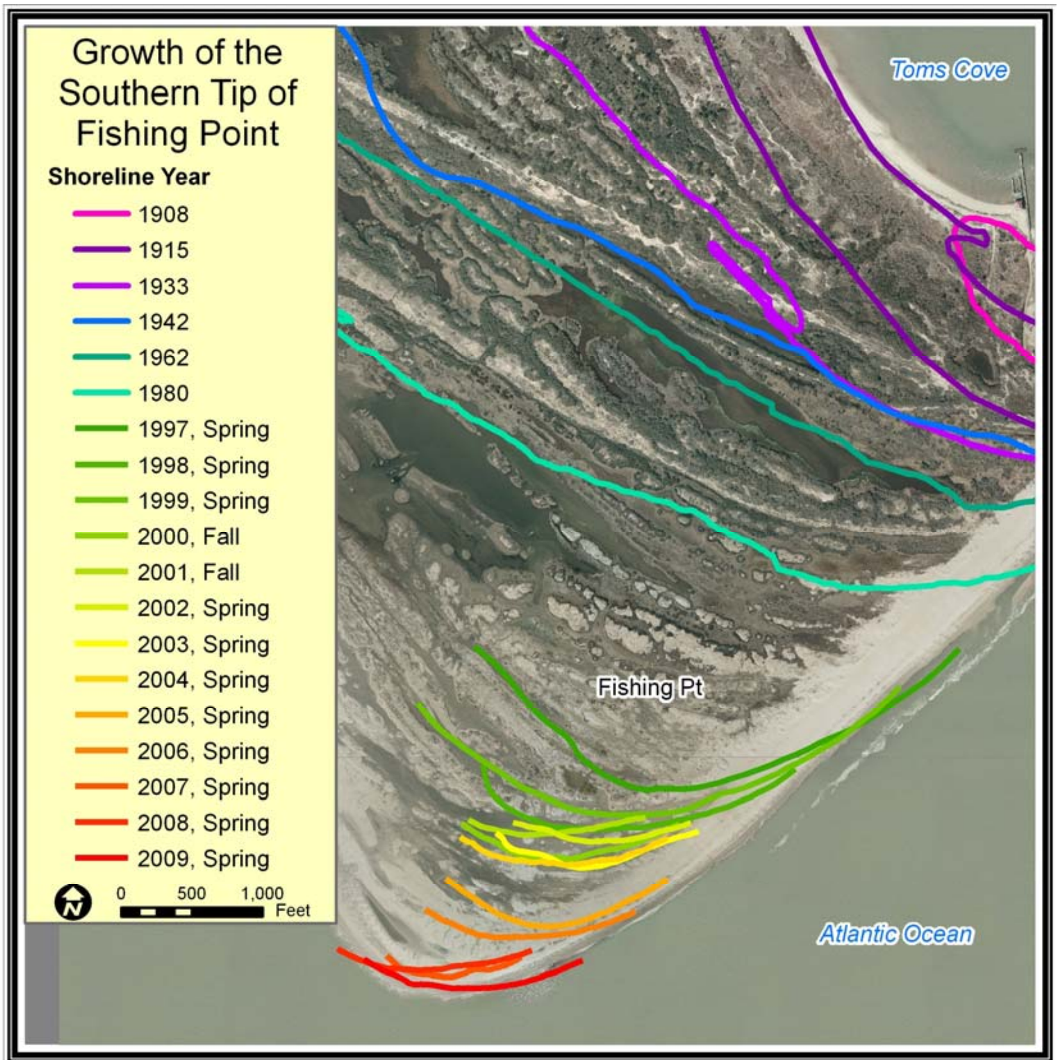

Figure 2-20. Changes in shoreline position at the very southern tip of Assateague Island (Fishing Point) between 1908 and 2009.

Narrowing of the Tom's Cove Isthmus

Another shoreline change feature shown in Figure 2-19 is a narrowing strip of land separating Tom's Cove from the Atlantic. The rate at which the isthmus is narrowing makes it likely that there will be numerous storm-induced breakthroughs between Tom's Cove and the Atlantic during the 50-year lifetime of this project. The first breach in this area occurred as a result of a November 2009 Nor'easter (Figure 2-21). These breaches may close rapidly or they may cause a permanent or semi-permanent inlet(s) to form. Any new inlet would compete with Chincoteague Inlet for the tidal prism of Chincoteague Bay.

The beach fill project on Wallops Island will mine sand offshore of the south end of Assateague Island to obtain fill material. It is critical that this mining operation be done in a way that will have minimal impact on the sediment transport rate along this portion of the Assateague Island shoreline, so that it does not exacerbate the breaching potential. Mining of the offshore shoals is discussed in Chapter 8.

Figure 2-21. Looking south along Assateague Island at breach into Tom's Cove caused by November 2009 Nor'easter.

Sea Level Rise

Sea level rise is currently occurring on a world-wide basis, and current USACE guidance (USACE, 2009a) projects it to continue to occur at an increasing rate, though there is large uncertainty in what future rates will be. By the Bruun rule, (Bruun, 1962) small changes in sea level can be expected to have dramatic effects on shoreline position, with increasing sea levels causing shoreline retreat.

The shoreline at Wallops Island will certainly experience the effects of future sea level rise, and in this report we have followed current USACE policy to account for its impacts. This has primarily been done by providing an additional sediment volume during each renourishment event that would raise the level of the entire beach fill by an amount necessary to keep pace with the projected rise rate (Chapter 6).

Concerning the shoreline change trends discussed above, sea level rise will work to reduce the rate of southwesterly growth of Fishing Point and the accretion on the north end of Wallops Island (Bruun rule). It will increase the frequency of shoreline breaches in the Tom's Cove area. However, while sea level rise may be the most dominant mechanism affecting shoreline change on many beaches world-wide in the coming decades, at Wallops Island it may not have as great an impact as some of the other effects discussed above.

3 Field Investigations

This section of the report includes a discussion of several recent field investigations in the Wallops Island area that have provided needed data for this study. Most of these investigations were performed in support of the present storm damage reduction project.

Beach Profile Measurements

Beach profile data (wading plus fathometer) were collected for this project by the Norfolk District in 2007. These profiles consisted of 25 long lines and 67 intervening short lines as shown in Figure 3-1.

Profile lines were spaced at 500 foot intervals. For most lines, rod and transect data collection started approximately 100 feet to the west of the existing rock seawall and terminated at the seaward foot of the seawall. Bathymetric data were collected utilizing a survey vessel equipped with an Innerspace Technology depth finder and extended seaward to approximately 1000 feet east of the seawall with every fourth survey line being extended to approximately the 30 foot contour.

Onshore and Nearshore Sediment Survey

Norfolk District personnel collected a total of 170 grab samples from the subaerial and subaqueous portions of the active beach. On the beach at Wallops Island five samples were taken on each of seven transects between the top of the berm and the mean low water elevation. Four transects were taken at the north end of Wallops Island and the remaining three were taken at the south end, near the former Assawoman Inlet. The remaining samples were taken along twenty five hydrographic survey lines that ran perpendicular to the shoreline. Sampling was performed at minus 5, 10, 15, 20, 25, and 30 feet depth where practical. These samples were analyzed, and the native beach composite mean diameter was determined to be between 0.20 and 0.21 mm. A D_{50} value of 0.20 mm was applied to characterize the native beach material in the modeling effort.

Additional sediment samples were obtained from 16 cores taken at the north end of Wallops Island in 2009 (USACE, 2009b) at the locations shown in Figure 3-2. Surface samples were extracted from all 16 cores. In addition, samples were extracted at a 2 ft depth for eight of the cores and at a 4 ft depth for the remaining eight cores. These were sieved using standard methodology.

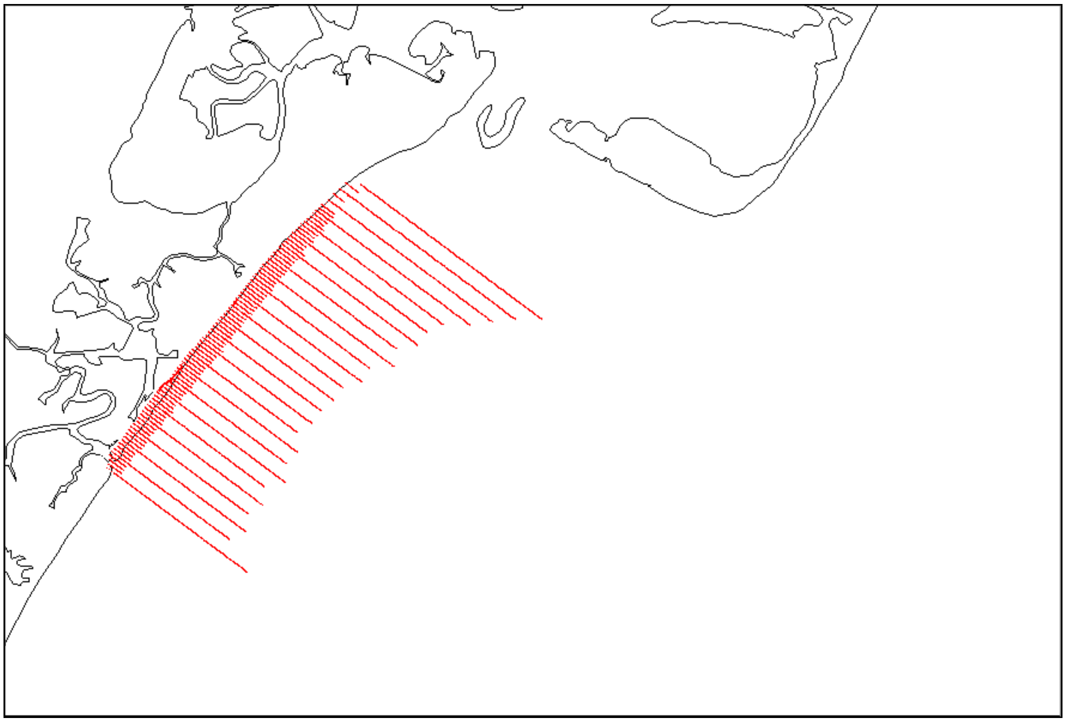

Figure 3-1. Locations of Measured Profiles.

The sieve results were then mathematically combined to obtain average sand distributions at 0, 2, and 4 ft depths, and these were further combined to produce a composite distribution (Figure 3-3). From these distributions, median, mean, and standard deviation values were calculated using the Folk method (Table 3-1). This additional analysis fully supported the characterization of the native sediment material on Wallops Island as having a 0.2 mm median grain size.

Table 3-1. Grain Size Data for Combined Samples, Wallops Island North End

Depth (ft)	Median $D_{(\phi 50)}$	Mean $M_{(\phi 50)}$	Median D_{50}	Mean M_{50}	St Dev σ_ϕ
	Phi units	Phi units	mm	mm	Phi units
0	2.358	2.358	0.195	0.195	0.468
2	2.375	2.375	0.193	0.193	0.529
4	2.266	2.160	0.208	0.224	0.591
Composite	2.342	2.337	0.197	0.198	0.505

Figure 3-2. Locations of 2009 North Wallops Island Sediment Cores.

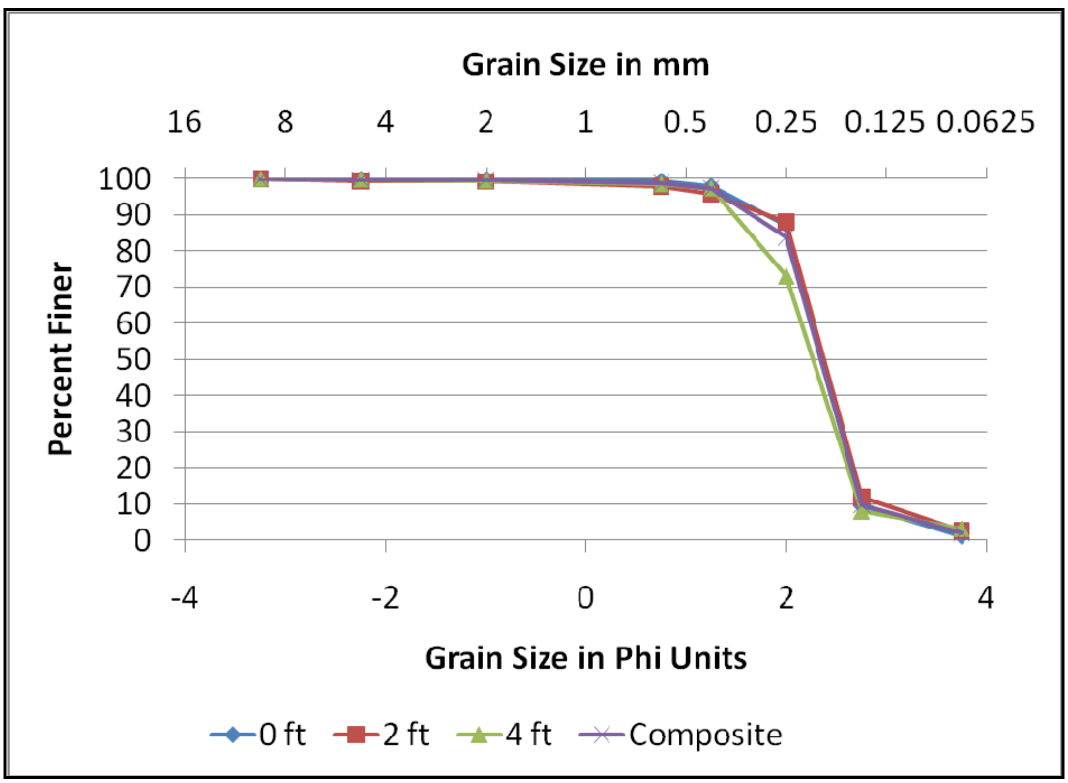

Figure 3-3. Average grain size distributions from 2009 north Wallops Island Sediment Cores.

Offshore Borrow Site Survey and Sediment Characteristics

In May 2007 and December 2007, the Norfolk District supervised subsurface investigations offshore of Wallops Island, Virginia. The purpose of the investigations was to determine if suitable sand size materials were located offshore that could be mined economically and transported to the shoreline on the Wallops Flight Facility. The work was performed in two phases with the first exploration program examining an area covering approximately 230 nautical miles immediately offshore of the project area and possible sites to both the north and south of the project area. The second program was a more detailed examination of potential areas found from the first program attempting to define vertical and lateral extent of potential borrows areas. Details of the surveys and sediment analysis are discussed in Alpine Ocean Seismic Survey (2007 and 2008).

May 2007 Survey

During May 2007, forty vibracores were taken immediately offshore of Wallops Island, Virginia. The purpose of this exploration program was to identify any areas that may contain suitable beach quality materials which may be located near the project area. The program initially concentrated on areas in close proximity to Wallops Island. However, borings collected immediately offshore of the project area generally contained sediments that were unsuitable for beach fill. There was substantial scatter in the median grain size of these sediments, but most had a $D_{50} < 0.20$ mm.

This survey also investigated Porpoise Banks, located southeast of Wallops Island. Six borings performed in this area indicated that this area lacked suitable borrow material.

Four shoals located northeast of Wallops Island off the southern end of Assateague Island were also investigated. These included Chincoteague Shoal, Blackfish Bank, and two unnamed shoals, referred to as Site A and Site B. All four of these shoals were found to contain beach quality sediments.

December 2007 Survey

Chincoteague Shoal lies within the three-nautical-mile jurisdiction of the Commonwealth of Virginia and additional time and cost would be involved in obtaining permits for the mining of its resources. Since suitable nearby sites were found outside the three-mile limit, Chincoteague shoal was not further investigated in the December 2007 survey. Rather, in December, forty one borings were concentrated on Blackfish Shoal, and on Sites A and B. These potential borrow sites are shown in Figure 3-4.

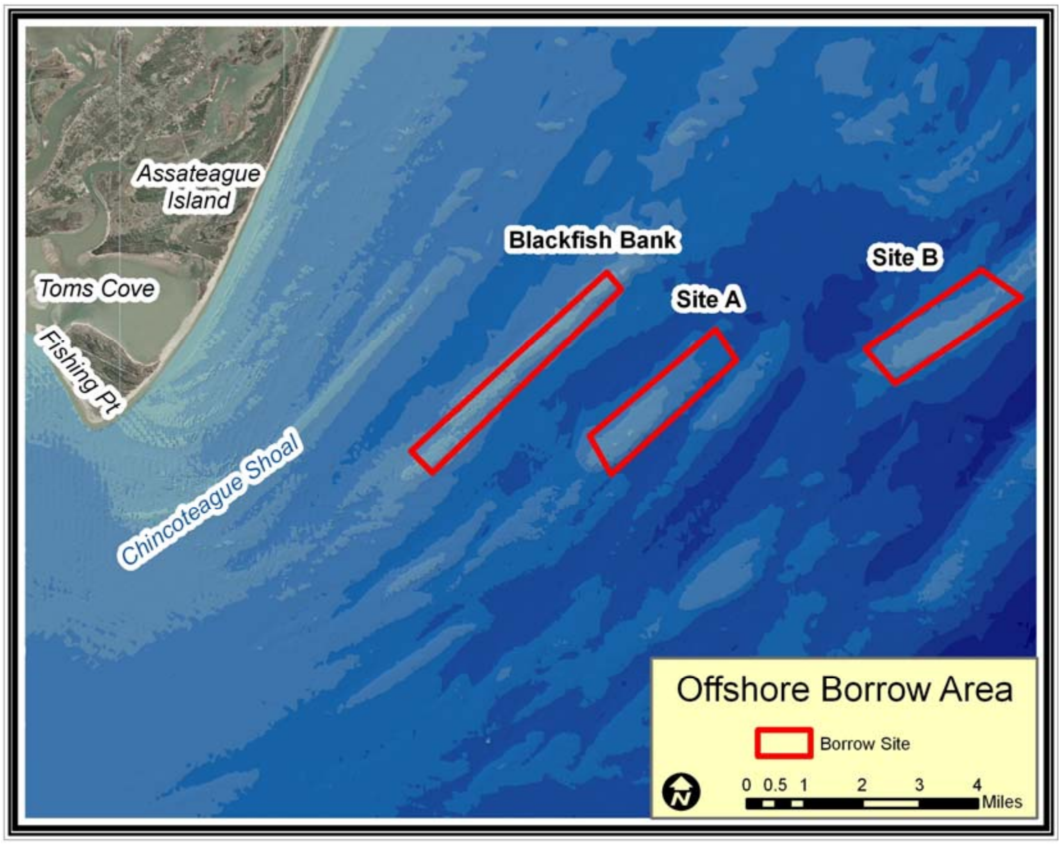

Figure 3-4. Location of potential offshore borrow sites.

Vibracore Sediment Analysis

In the laboratory, the vibracores were split and then photographed, described and the major sandy sediment units were delineated. An example core is shown in Appendix A. The sediments were then analyzed using standard methodology. Two (upper and lower) or three (upper, mid, and lower) sediment samples were obtained from each core. In addition, a composite sediment sample was obtained from the entire length of each core. These samples were sieved with a RoTap type machine and the results were plotted. The plotted sieve results were used to obtain mean, median, and standard deviation values using the Folk method.

Analysis of the vibracores collected at Blackfish Bank indicates that the Bank holds at least 25 million cubic yards of beach quality material having a median sediment diameter of about 0.35 mm. However, there is opposition to the use of this site by local fishermen. In addition, the analysis described in Chapter 8 of this report indicates that mining this shoal would have greater shoreline impacts than mining either Offshore Site A or B. Therefore, this site has been removed from further consideration.

Volumetric analysis indicates that Site A contains approximately 68 million cubic yards, and site B contains approximately 132 million cubic yards of material. These volumes are substantially in excess of the estimated 10 million cubic yards of fill material needed over the lifetime of the project. Mean, median, and standard deviation values of the sediment from the cores obtained at these two sites, along with the locations of these cores, are listed in Appendix A of this report.

The average depth for the upper core sections is 5.5 ft, and for the composite core sections is 12.2 ft. Since the depth to which these shoals might be mined is not known and is expected to vary over the shoal, both the upper and the composite core data were considered in developing a median grain size for the fill material which is a needed parameter in the numerical modeling work. The median grain sizes were ranked from smallest to largest as shown in the histogram (Figure 3-5). This figure shows the data separated by site and depth as well as the four data sets combined. The median values for these curves range from D_{50}= 0.29 mm to 0.34 mm.

In addition, the sieved core results were mathematically combined to produce average upper and average composite curves for Site A and Site B. The statistics for these average curves are given in Table 3-2, and the sediment distribution curves are shown in Figure 3-6.

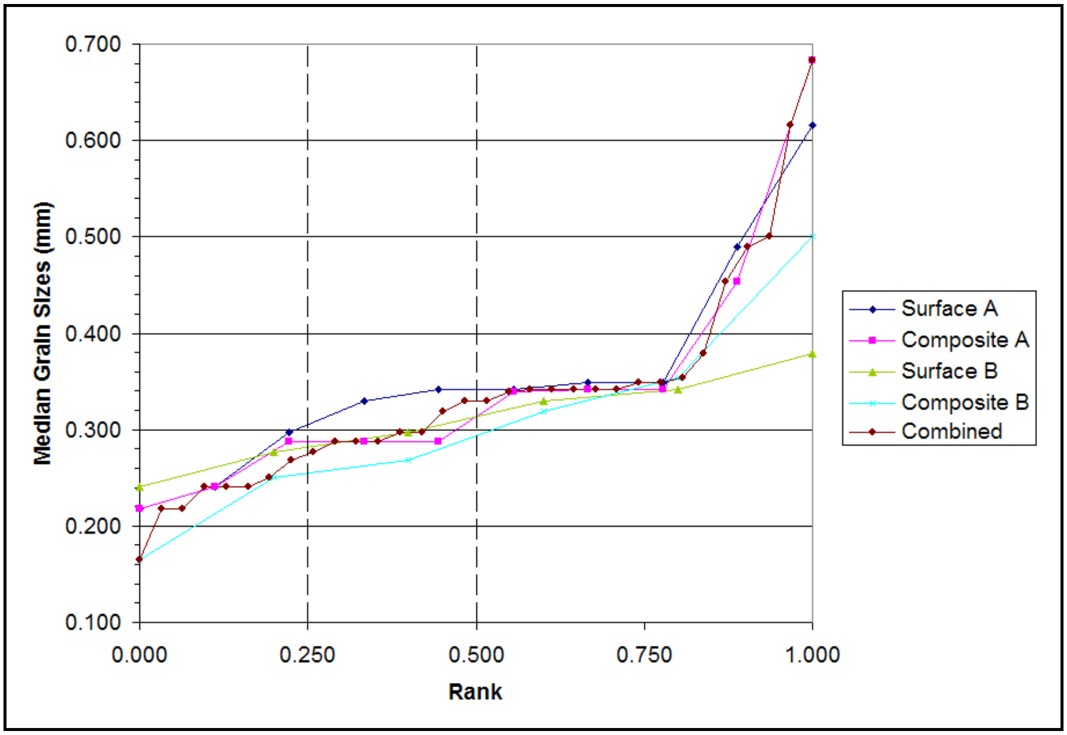

Figure 3-5. Distribution of Median grain sizes from offshore samples.

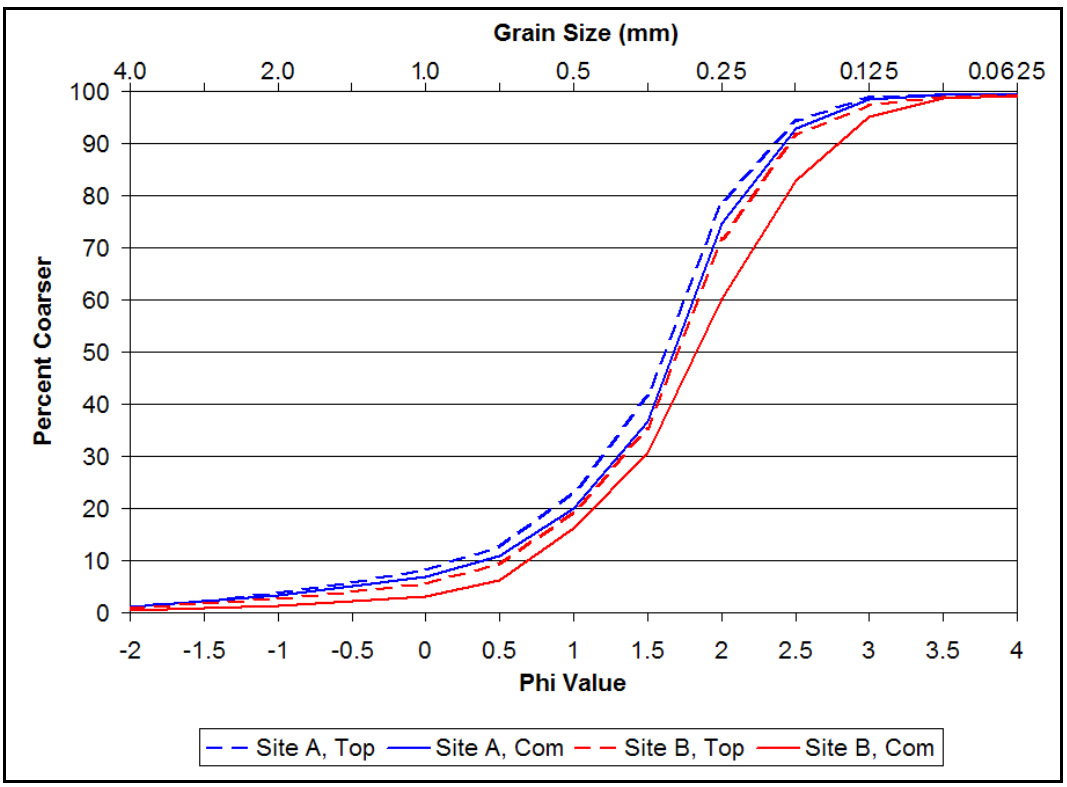

Figure 3-6. Grain Size Distributions of Combined Cores.

Table 3-2. Grain Size Data for Combined Samples, Offshore Borrow Sites						
Borrow Location	**Depth**	**Median** $D_{(\phi 50)}$	**Mean** $M_{(\phi 50)}$	**Median** D_{50}	**Mean** M_{50}	**St Dev** σ_ϕ
		Phi units	**Phi units**	**mm**	**mm**	**Phi units**
Site A	Upper	1.615	1.411	0.326	0.376	0.926
	Composite	1.675	1.517	0.313	0.349	0.903
Site B	Upper	1.703	1.573	0.307	0.336	0.862
	Composite	1.825	1.765	0.282	0.294	0.838

Table 3-2 shows that the average median grain diameter for Site A, the preferred location, is about 0.32 mm. Table A1 lists the median grain diameters for the "upper" and "composite" samples for Site A. These 20 D_{50}'s range from a minimum of 0.218 mm to a maximum of 0.683 mm, and have a mid value of 0.34 mm. Thus, the most likely median grain diameter for the sediment on Unnamed Shoal A is in the range of 0.32 mm to 0.34 mm. However, there are relatively few cores available to characterize the sediment in this two mile^2 area, and an underestimate of this value would lead to an underestimate of the volume of initial fill material needed for the project. The consequences of this are discussed in Chapter 6. Therefore, to be conservative, a smaller median grain diameter, 0.29 mm was chosen for modeling purposes. Fully ¾· of the median grain diameters (Table A1) are this value or larger. The statistical likelihood that the true median grain diameter of the material on Shoal A being less than 0.29 mm decreases rapidly with decreasing grain size. However, an additional margin of safety was incorporated into the Overfill volume (Chapter 6) to allow for the D_{50} of the fill material to be as low as 0.27 mm.

Condition Survey of the Rock Seawall

This section has been extracted from a site visit report to Wallops Island, VA on 28 October, 2008. The purpose of the site visit was to determine if the existing seawall provided sufficient protection to the facility until such time as the nourishment project is completed, to determine if and how the seawall should be included as a component in the storm damage reduction project, and to determine necessary repairs to the seawall. A previous 1999 USACE site visit report is provided in Appendix B of this study.

Geotube™ section at south end of seawall

Although the Geotube™ was partially exposed along its entire length, the Geotube™ section appeared to be in good shape. (See Figures 2-14 and 2-16 for Geotube™ location.) At the extreme southern end the top half of the tube was exposed where there was some flanking around the end, but more typically about 25 percent of the tube was exposed along the southern portion of the tube (Figure 3-7). The amount of exposed Geotube™ increased in the northern portion to one-third to one-half of the tube's height (Figure 3-8). The front face of the bag was exposed down to the scour apron at the northern end of the tube on both the seaside and the landward side (Figure 3-9) but no scouring beneath the apron was observed. A repair to the Geotube™ was evident near the northern end. Here, a second section of Geotube™ was lying adjacent to the main barrier and gave the appearance that the two bags had been stacked and the upper bag pushed off the top to landward (Figure 3-10). There was substantial washout in this section behind the Geotube™, but the tube itself is stable.

Along the crest of the Geotube™ for its entire length, the sand was hard packed (comparable to concrete) without any give. There were several areas where the tube was not completely full leaving a depression in the sand within the tube and the fabric stretched tautly over the top of the depression. These depressions were typically not more than a foot or two across and did not appear to be a problem. No significant rips or tears in the fabric were noted.

Figure 3-7. Looking north from southern portion of Geotube™.

Figure 3-8. Near the middle of the Geotube™ section, looking north.

Figure 3-9. Scour apron exposed on landward side of Geotube™ at northern end of structure.

Figure 3-10. Short Geotube™ behind the north end of main tube.

Seawall Condition

The northern end of the seawall is in an area of sand accretion and is fronted by a wide beach. This portion of the seawall is in good condition. The rest of the seawall is considered to be in a failed condition along much of its length due to reduced crest elevation (Figure 3-11) and/or an overly steepened seaward face. Point measurements taken during the site visit indicated the crest elevation in the undamaged areas was about 14 ft, with a seaside face estimated to have a slope of 1:2 (vertical: horizontal). Crest elevations in damaged areas were as low as 8 ft, and in some areas the seaward face was steeper than 1:1 (Figure 3-12). By comparison, the seawall designed by Moffatt and Nichol (1998) (referenced in Morang, Williams, and Swean, 2006) had a 14 ft (MSL) crest elevation and a seaside face with 1:3 slope.

Figure 3-11. Area of decreased crest elevation on seawall.

Figure 3-12. Steep seaside face on seawall.

North of radar gun tower Y-110 is a large area of washout behind the seawall. Material has washed out from under a concrete apron causing the concrete to crack with rocks sliding seaward (Figure 3-13).

Figure 3-13. Washout under the concrete apron causing cracking and tilting.

In some areas the remains of earlier seawalls constructed of timber piles (Figure 3-14) or steel sheet pile (Figure 3-15) were seen within or adjacent to the rubble-mound seawall. In sections, wave action moves freely through the seawall causing scour on the landward side (Figure 3-16). Large scour areas behind the seawall were found along approximately 50% of the length of the seawall, with the scour areas as much as 6 ft below the surrounding land area. Some of these scour holes have been filled with rubble, and the rubble repairs are working effectively at halting the localized scour (Figure 3-17).

Figure 3-14. Remnants of concrete apron and timber pile wall.

Figure 3-15. Remnants of concrete apron with steel sheet pile wall.

Figure 3-16. Water flowing through seawall by wave action.

Figure 3-17. Rubble pile behind seawall, presumably to fill scour hole.

Structure Stability

Morang, Williams, and Swean (2006) state that the seawall was constructed with 60 percent 2- to 3-ton stone. If a median stone weight of 2.5 ton is assumed, the Hudson equation (see sample equation in Appendix C for equation and assumptions) indicates a 1:2 slope should be stable against an 8 ft incident wave height or 7 ft wave height if the slope is 1:1.5. The Hudson equation is not intended for slopes steeper than 1:1.5. In places, the seaward face of the seawall is even steeper, appearing to be less than 1:1. It is therefore assumed that waves as small as 6 ft may cause localized damage to the seawall, while waves larger than 8 ft may cause damage along much of the structure. According to the Wave Information Study (WIS) hindcast (available online at http://chl.erdc.usace.army.mil/chl.aspx?p=s&a=DATA;1) for station 179 (37.75 N -75.33 W, depth 18 m), waves greater than 3m (10 ft) have been hindcasted during every year of the data base (1980-1999). The seawall designed by Moffatt and Nichol (1998) called for 3.5-ton stone on a 1:3 slope which should be stable against wave heights of 10 ft.

Structure Runup

Wave runup on a structure is commonly given in terms of either maximum runup (R_{max}) or 2% runup ($Ru_{2\%}$, the elevation that is exceeded by 2 percent of the waves). From a practical standpoint, the two may be used interchangeably. Runup on this seawall is difficult to estimate because the structure has no core or underlayer and water running up the face of the structure will pass through the seawall. Some general comments may be made by making a few assumptions. Looking at the WIS hindcasts for Station 179, most waves of 6- to 8-ft wave height have peak wave period of 7 to 9 sec. Using the example calculation given Appendix C, an 8 ft wave height with an 8 sec peak period will have a 2% runup of 13.2 ft above the swl for a typical seawall. Mean high water is at +2.7 ft. Assuming two feet of storm surge, the seawall would have to have a core elevation of +18 ft to prevent runup from overtopping the seawall during a fairly moderate storm.

Seawall Repair Assessment

An analysis was conducted of the stone requirements for a minimal seawall repair to raise low portions of the wall to +10 ft and to provide a 1:1.5 seaward slope. Additional analyses were undertaken to determine the stone requirements needed to raise the seawall to +12 and +14 ft and provide a 1:12 seaward slope. Details of the present seawall condition were obtained from a 2005 LIDAR survey of the Wallops Island shoreline collected by the Joint Airborne LIDAR Bathymetry Technical Center of Expertise (http://shoals.sam.usace.army.mil/).

Analysis for +10 ft crest elevation

Two-foot interval contour lines along the seawall were generated from the LIDAR data. Determining areas of low crest elevation was accomplished simply by panning along the image of the structure and visually identifying gaps in the contour lines. Similarly, areas with a steep seaside face were visually identified by noting where the contour lines became close together. Figures 3-18 through 3-26 identify the locations of the areas identified with low crest elevation and the areas with steep seaside face.

Crest elevations over much of the structure were at +14 ft or higher. Areas where the crest was less than +10 ft were identified. Small localized areas of reduced crest elevation were ignored. Although no specific criteria were applied when selecting areas sufficiently long to be of concern, the final areas selected were 30 ft or more along the crest. Table 3-3 lists the areas of reduced crest elevation, identifying the beginning and end of the section where the crest is below + 10 ft. Table 3-3 also lists the length (measured along the crest) of each section and the range of elevations within that section.

Table 3-3. Areas of concern due to low crest elevation.

Area No.	Crest Elev. Range (ft)	Length (ft)	Tons of Rock to Raise Elevation to +10 ft	VA State Plane 4502, meters			
				South End		North End	
				Easting	Northing	Easting	Northing
1	6-10	39	39	3765516.5	1171170.7	3765524.7	1171179.3
2	8-10	30	15	3765675.6	1171364.9	3765681.7	1171371.9
3	8-10	47	23	3765714	1171413.7	3765722.8	1171424.9
4	8-10	107	53	3766849.4	1172853.5	3766869.8	1172878.8
5	6-10	557	552	3767198.1	1173284.5	3767311.5	1173411
Total		780	682				

Normally, raising the crest of an existing structure involves not only raising the crest but recovering the entire seaward and landward sides in order to maintain the desired slopes. Because the areas with the lowest crest elevation on this seawall were flattened from a higher crest elevation, there is sufficient width on the existing crest that the crest can be raised at least to +10 ft without having to extend the raised crest out to the landside and seaside toes. The amount of stone to raise each of these areas to +10 ft was estimated by assuming the existing crest elevation is the middle of the crest elevation range shown in Table 3-4, using a 10-ft crest width, assuming a unit weight of stone of 165 pounds per cubic foot, and estimating a structure porosity of 40 percent. Total weight required for all five areas is estimated at 680 tons.

Analysis for Steep Seaward Face

There were many areas where the contour lines indicated seaside slopes steeper than 1:1.5. If the seawall were to remain as the primary means of protecting the infrastructure, the seaside slopes should be flattened at least to 1:2. However, guidelines for this analysis were that a new beach fill would act as the primary means of defense in about 3 yrs, and the goal of this analysis was to identify areas that could potentially suffer major damage within the next 3 yrs.

After repeated examination of the contour data, 13 areas were selected as primary "areas of concern." Each area showed a vertical drop of at least 6 ft (4 contour lines) with a slope of 1:1 or steeper over a length of more than 10 ft along the crest. Table 3-4 lists the areas of concern including their length, their upper and lower critical elevations, the width of the steep slope areas, crest length of the area of concern, the front face slope, state plane coordinates of the southern and northern ends of each area, and the volume of rock needed for repair. Because the steepness of the structure face varies along the face of the structure within each area, the slope listed in Table 3-4 is considered representative of the steep areas. In some areas, only portions of the area are excessively steep; Table 3-4 therefore lists the percentage of the length of the area for which the slope is unacceptably steep.

The amount of stone required to improve each section is also included in Table 3-4. The amount of stone listed is considered a minimum, and is intended only to flatten the slope below +10 ft to 1:1.5. The calculations assume the slope will only be flattened to elevation +10 ft, and assume that there is a stone base below the lower contour line on which the flatter slope can be built, rather than extending the slope down to the toe. For example, if Table 3-4 shows a reach where the +12 ft contour line is separated from the +2 ft contour line by 5 ft (1:0.5 slope), a rock base is assumed at +2 ft sufficient to support a 1:1.5 slope up to +10 ft, and the difference between a 1:0.5 slope and a 1:1.5 slope up to +10 ft is calculated. Stone weight calculations assume a unit weight of 165 pounds per cubic foot and a 40 percent porosity.

Areas 3 and 4 are only 20 and 25 ft in length, respectively, but both areas indicate an 8 ft drop in elevation at a slope of 1:0.5 over the entire length of each area. These appear to be the most critical areas. A portion of Area 5 also shows a slope of 1:0.5, but slope is above +8 ft and therefore of less concern than Areas 3 and 4.

The total weight of stone required for all areas in Table 3-4 is estimated at 285 tons. The total weight of stone required to both adjust the seaward slope and to raise the low crests is 960 tons.

Table 3-4. Areas of concern due to excessively steep seaside slope.

Area No.	Length (ft)	Upper Contour (ft)	Lower Contour (ft)	Slope Width (ft)	Percent of Area	Slope	VA State Plane 4502, meters				Area for 1:1.5 slope to +10	Tons of Rock Needed for Repair
							South End		North End			
							Easting	Northing	Easting	Northing		
1	25	12	2	6	33	0.6	3765313	1170910	3765318	1170916	28.8	11.8
2	14	12	4	5	75	0.63	3765408	1171029	3765410	1171032	15.75	8.2
3	20	12	4	4	100	0.5	3765453	1171085	3765457	1171090	18	17.8
4	25	10	2	4	100	0.5	3765759	1171470	3765764	1171476	32	39.6
5*	290						3766462	1172363	3766516	1172433		
5a		14	4	6	12	0.6					16.2	27.9
5b		14	4	8	12	0.8					12.6	21.7
5c		14	4	6	12	0.6					16.2	27.9
5d		14	8	3	12	0.5					2	3.4
5e		14	8	4	12	0.67					1.67	2.9
6	18	12	4	6	100	0.75	3766550	1172474	3766554	1172477	13.5	12
7	50	12	2	7	50	0.7	3766625	1172571	3766635	1172583	25.6	31.7
8	27	12	4	6	100	0.75	3766671	1172631	3766677	1172637	13.5	18
9	26	12	6	5	25	0.83	3766698	1172663	3766703	1172669	5.33	1.7
10	21	14	6	6	100	0.75	3766765	1172748	3766770	1172753	6	6.2
11	35	12	4	8	100	1	3766785	1172772	3766792	1172780	9	15.6
12	13	12	4	5	100	0.63	3766937	1172966	3766939	1172969	15.75	10.1
13	34	10	2	8	100	1	3766962	1172993	3766968	1173002	16	26.9
Total	598											283.4

Note: Multiple cross-sections were taken of Area 5. Total area of concern was 60 percent of length, evenly divided among cross-sections.

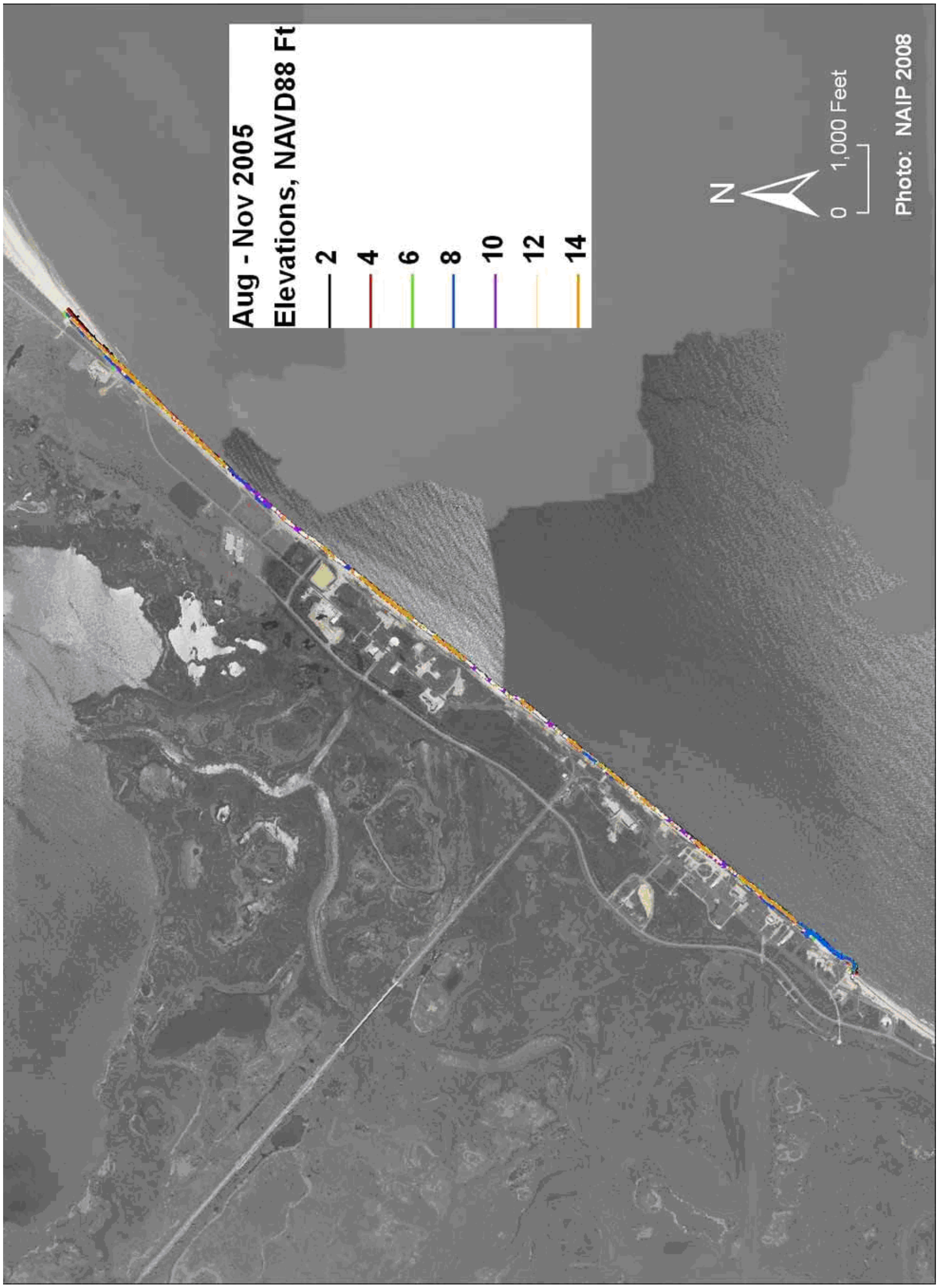

Figure 3-18. Overview of seawall on Wallops Island.

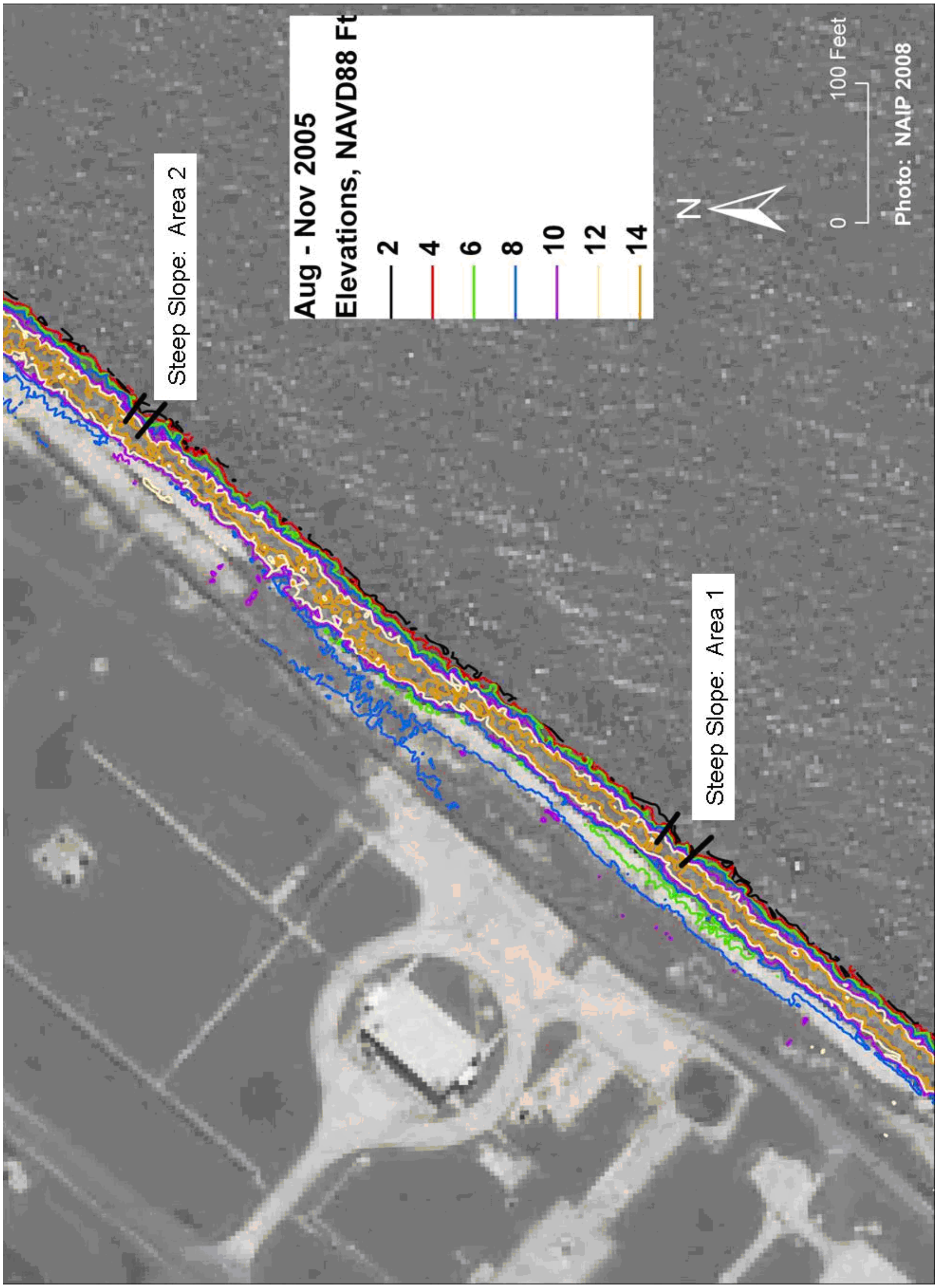

Figure 3-19. Steep slope areas 1 and 2.

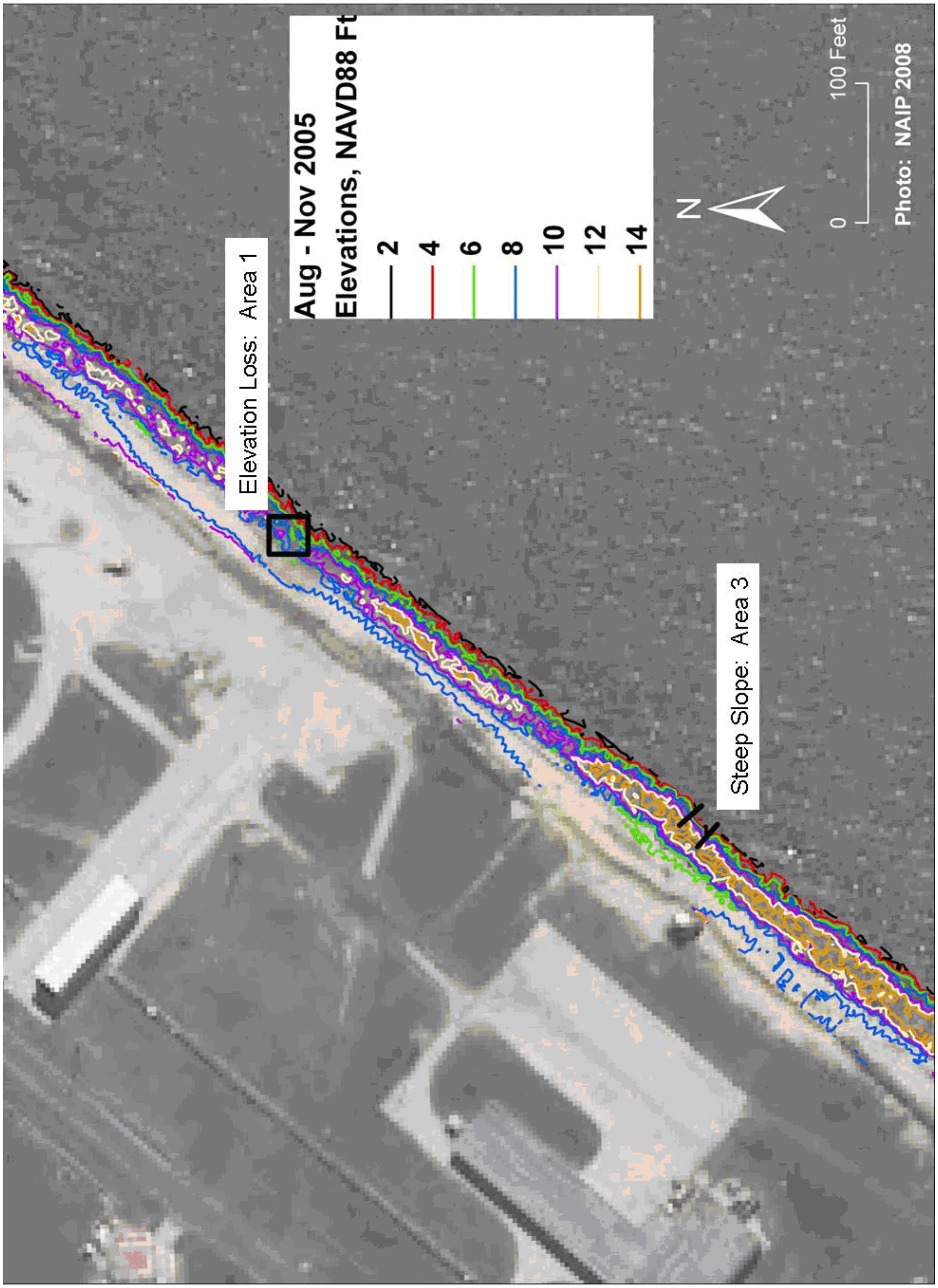

Figure 3-20. Steep slope area 3 and elevation loss area 1.

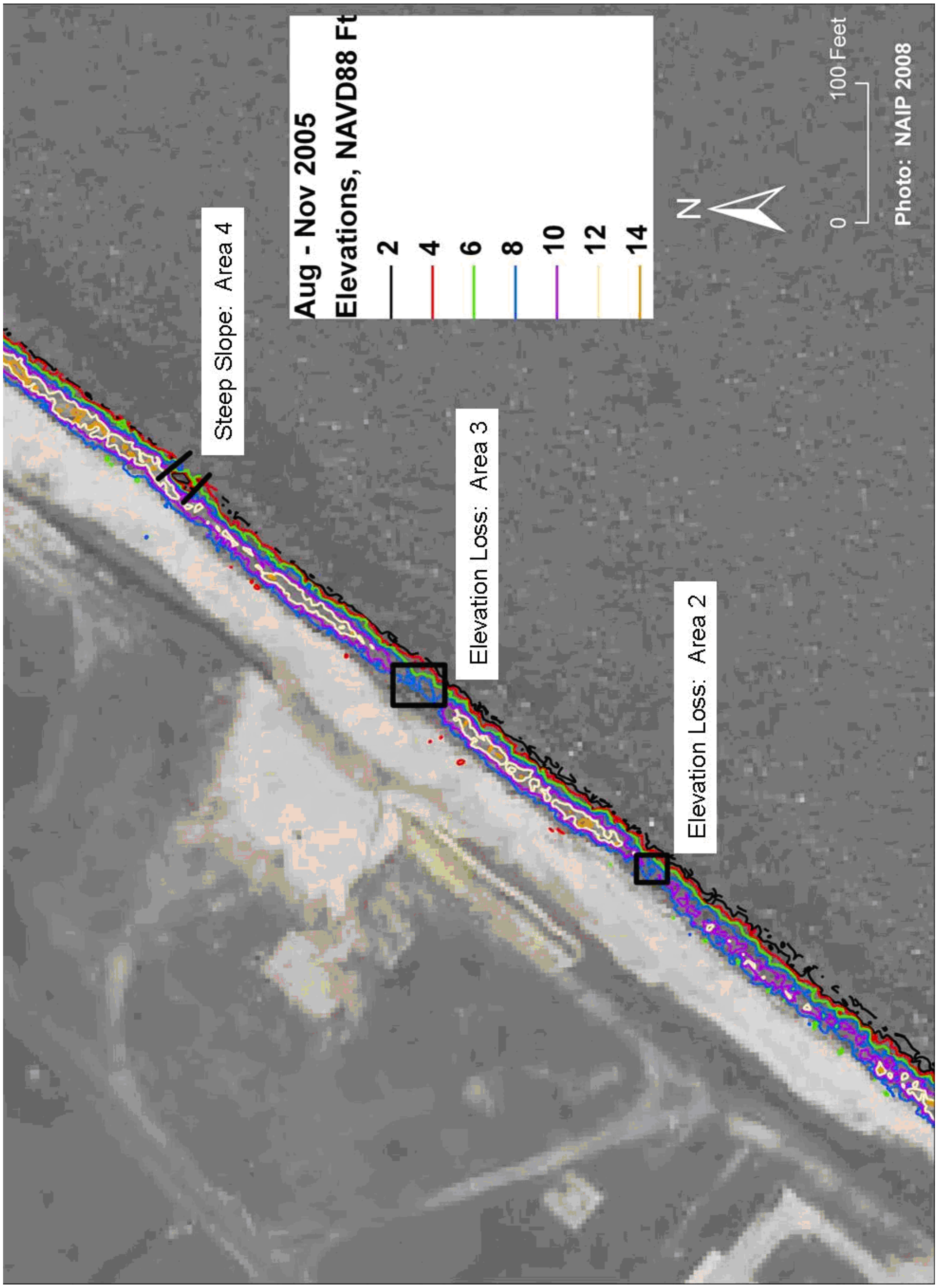

Figure 3-21. Elevation loss areas 2 and 3 and steep slope area 4.

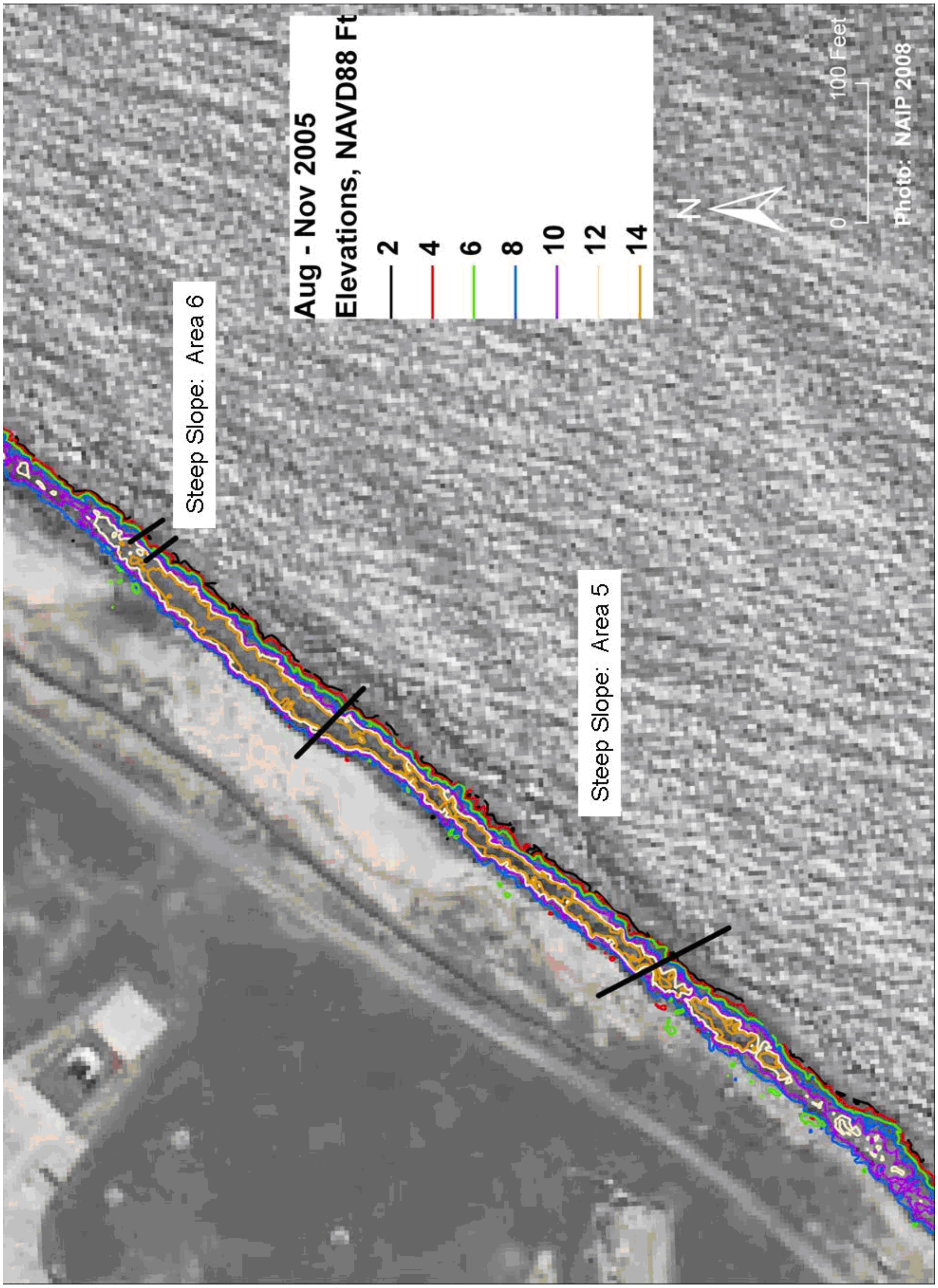

Figure 3-22. Steep slope areas 5 and 6.

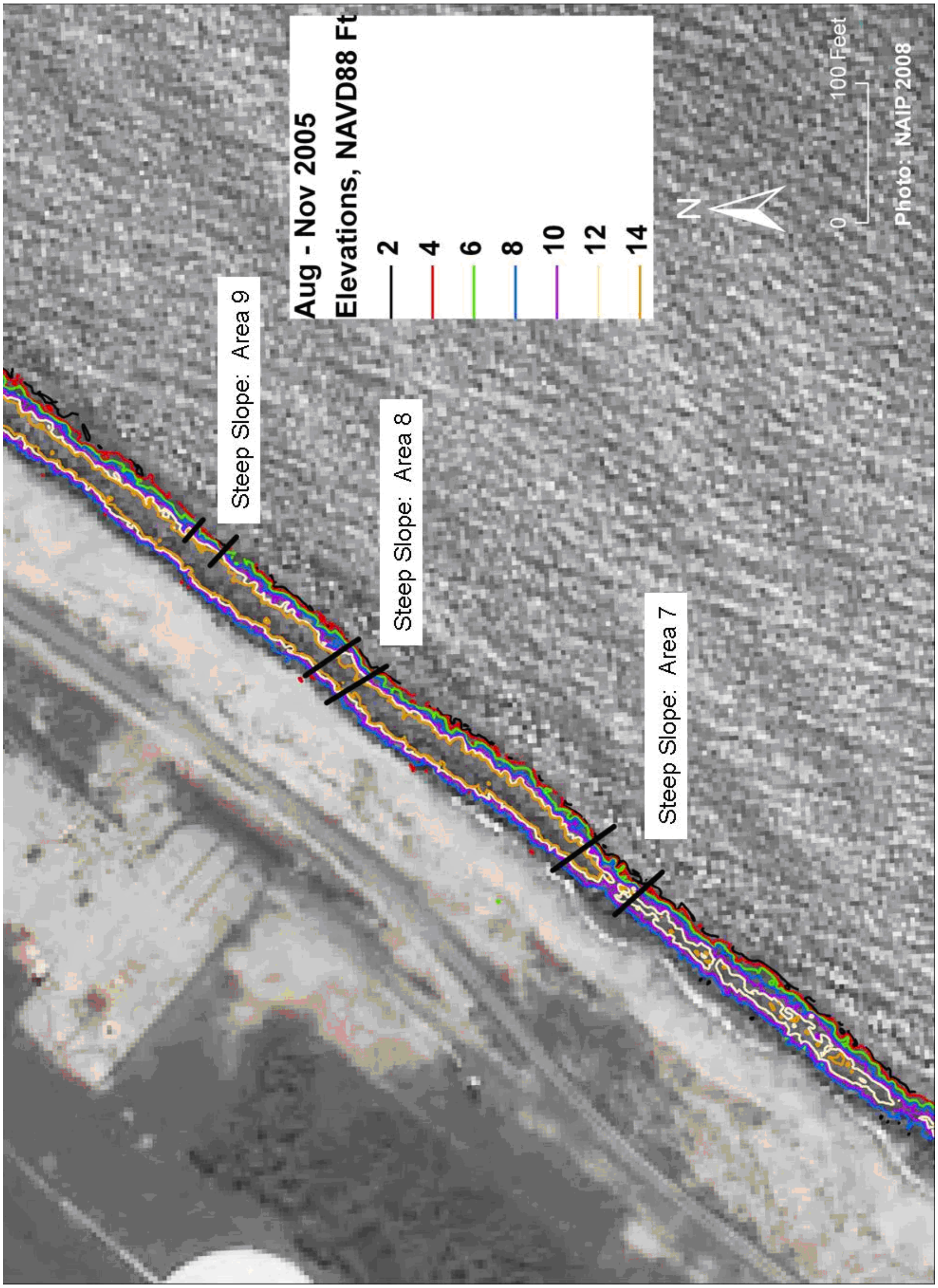

Figure 3-23. Steep slope areas 7, 8, and 9.

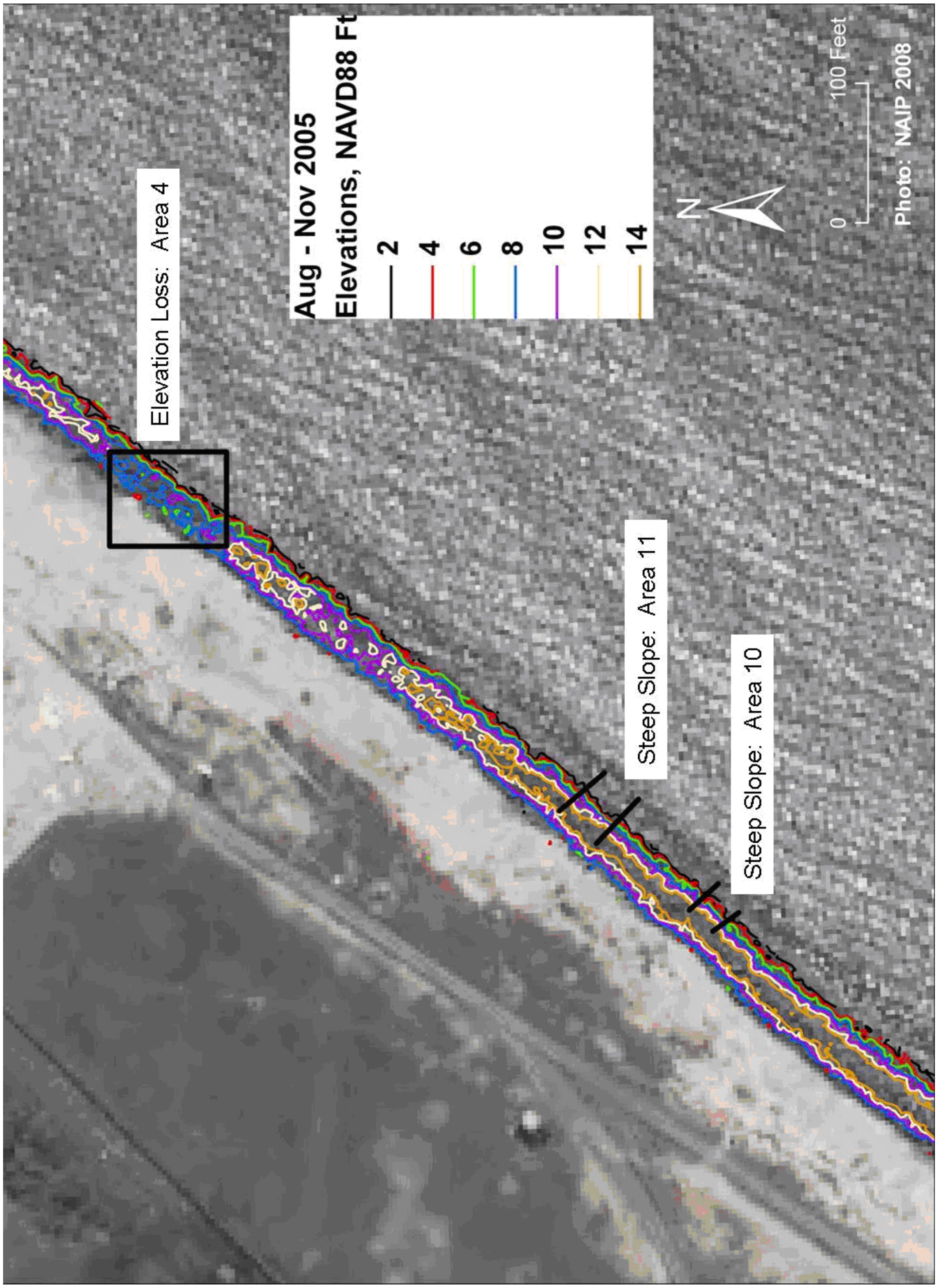

Figure 3-24. Steep slope areas 10 and 11 and elevation loss area 4.

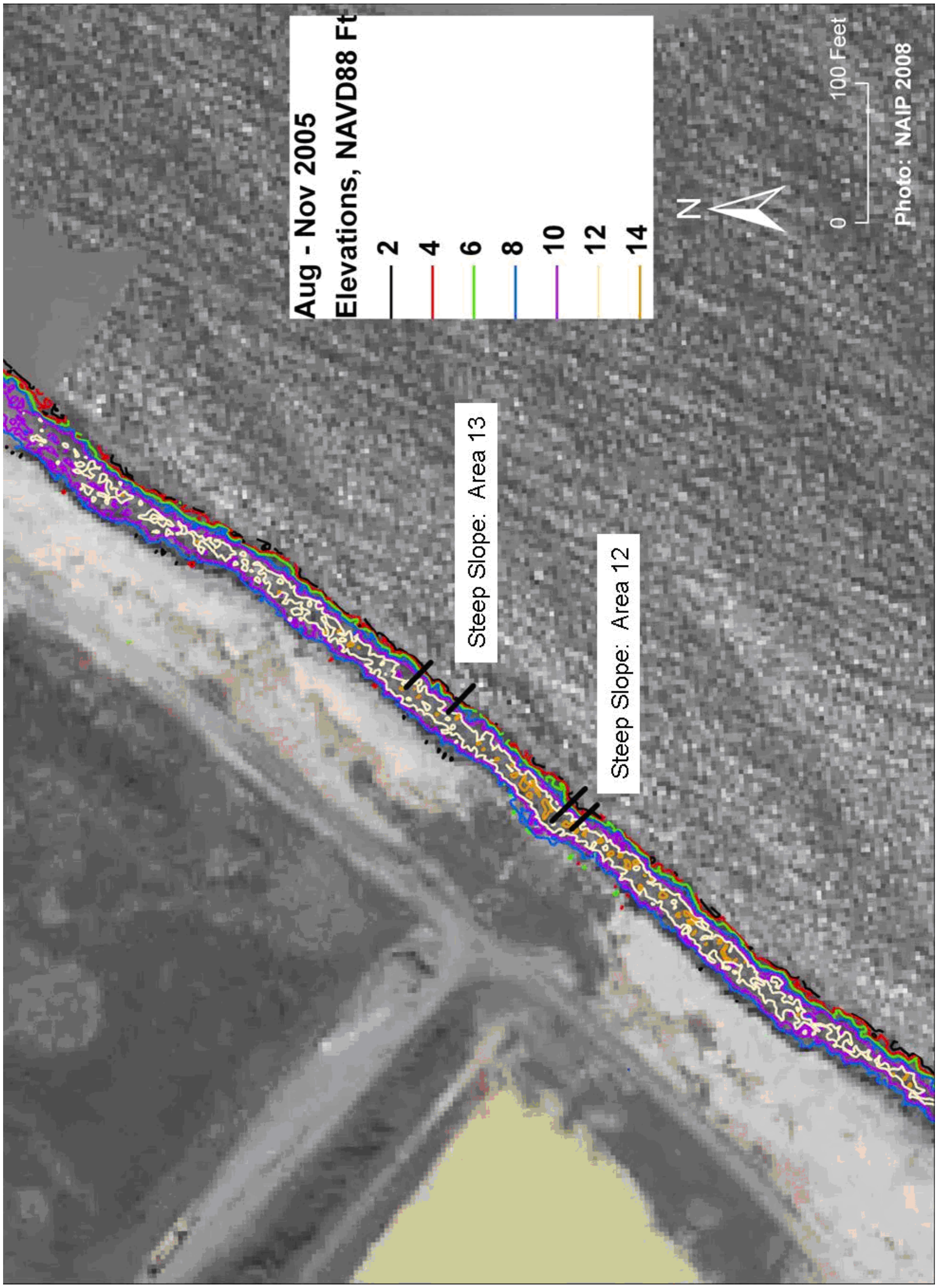

Figure 3-25. Steep slope areas 12 and 13.

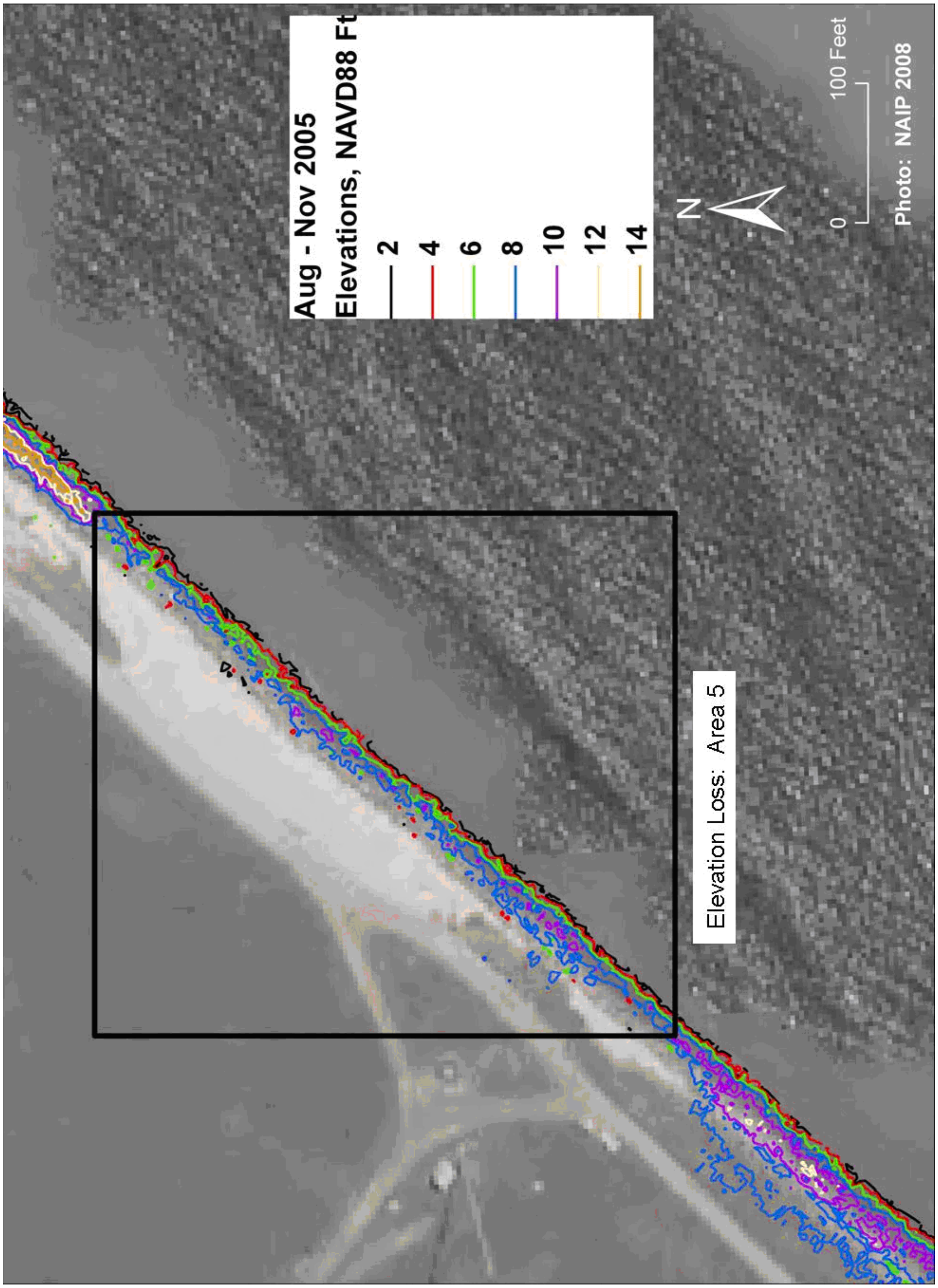

Figure 3-26. Elevation loss area 5

Analysis for +12 ft and + 14 ft crest elevation

Unlike the analysis for a crest elevation of +10 ft, which consisted of simply filling in low areas along the crest, raising the crest to +12 ft or +14 ft would require re-shaping the seawall side slopes to obtain a stable structure. Thus, for the +12 ft and +14 ft crest elevation analyses, the stone requirements were estimated by comparing a design profile to the existing profile at selected cross-sections along the seawall. This type of analysis accounted for both low elevation and steep seaward face seawall repairs.

A design profile for the Wallops Island seawall was selected with crest width of 10 ft at crest elevation either +12 ft or +14 ft. The landward side slope was 1:1.5. On the seaward side, a 1:2 slope was used from the crest down to elevation +6 ft. Normally, the 1:2 slope would continue to the seabed or to a toe berm, or the lower slope might be flattened to 1:2.5 or 1:3. However, because the proposed project will have a sand berm at elevation +6 ft and the lower slope should never be exposed, the design slope was steepened to 1:1.5 below elevation +6 ft.

Sixteen seawall profiles were taken from the LIDAR data at 1,000 ft intervals along the seawall. Locations of these seawall cross-sections are shown in Figure 3-27. The same cross-sections were used for the +12 ft and +14 ft analyses. +12 ft and +14 ft design profiles were overlain on each of these existing cross-sections and the deficits for each were calculated. Where the existing profile exceeded the design profile negative volumes were also calculated.

The +12 ft results indicated that 19,600 cu yds of stone would be needed to raise the existing profile to the +12 ft design profile. However, this analysis also indicated that the seawall currently has 15,600 cu yds of rock that is above the design profile. Assuming stone weight of 165 pcf and a porosity of 40%, yields the results that 26,200 tons of rock are required to raise the existing profile to the design, and 20,900 tons of rock are in the existing profile above the design profile. In other words, the 26,200 tons required to meet the design profile could be met by adding just 5,300 tons new stone and taking the remaining 20,900 tons from the seawall in areas where the existing profile is higher than the design profile. These quantities are shown in Table 3-5.

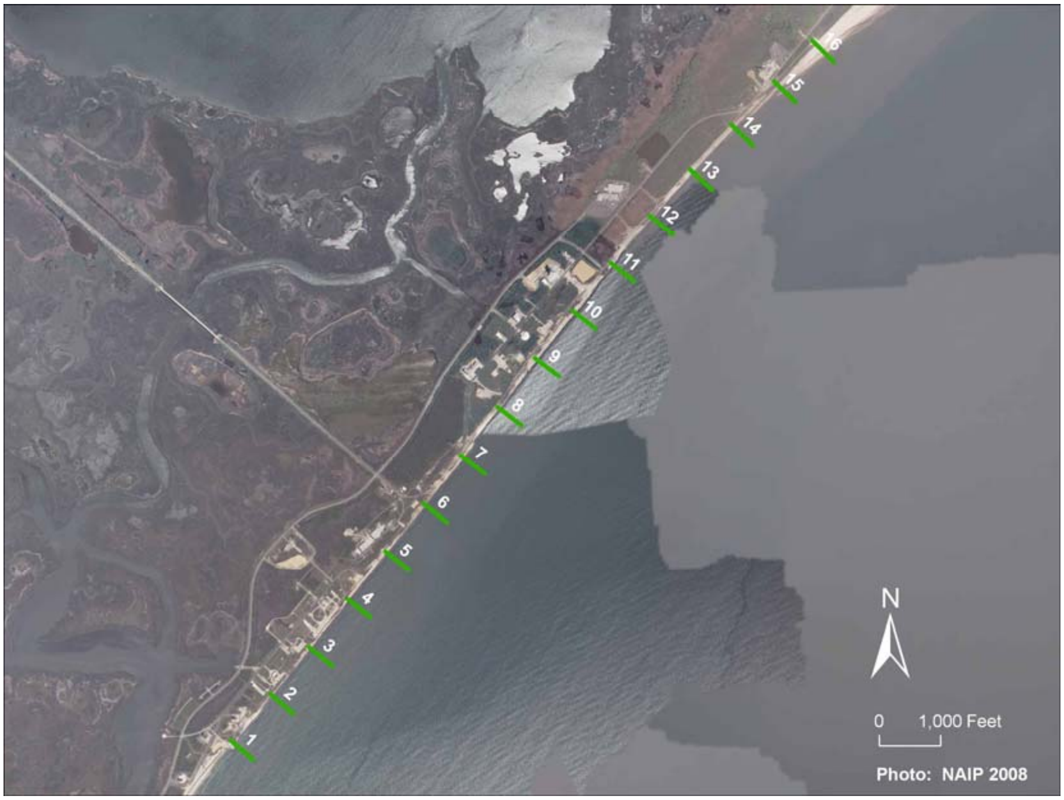

Figure 3-27. Locations of analysis cross-sections for seawall repair to +12 and +14 ft.

The +14 ft analysis showed that 26,300 cu yds of stone would be required to raise the existing profile to the design profile, and there are 3,900 cu yds available where the existing profile is higher than the design profile. Converted to tonnage, that is approximately 35,100 tons of stone required with 5,200 tons on the seawall above the design profile.

Table 3-5. Stone requirements for +12 and +14 ft seawall repair

Crest Elevation (ft)	Stone Required (cu yds)	Stone Available (cu yds)	Difference (cu yds)	Stone Required (tons)	Stone Available (tons)	Difference (tons)
12	19,600	15,600	4,000	26,200	20,900	5,300
14	26,300	3,900	22,400	35,100	5,200	29,900

Experimental Placement of Chincoteague Inlet Dredge Material on Wallops Island Shoreline

The Norfolk District has been dredging Chincoteague Inlet since the mid-1990's, placing the material in an offshore disposal site that is approximately 4,000 feet offshore of Wallops Island. The disposal site, having an area of 1,000 feet by 3,000 feet, is shown in Figure 3-28. The amount of material dredged is shown in Table 3-6 (Morang, Williams, and Swean 2006).

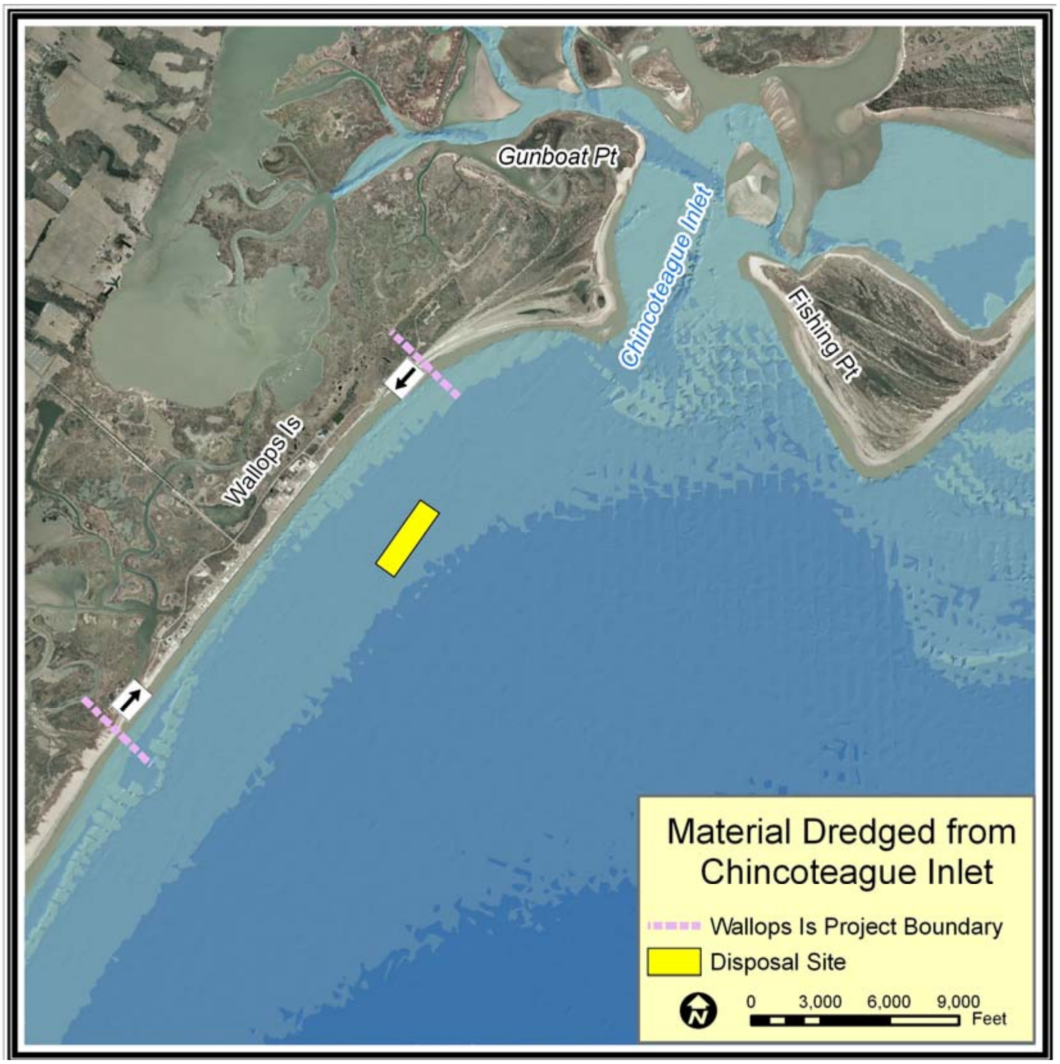

Figure 3-28. Offshore disposal site for Chincoteague Inlet dredge material.

In 2002, the District partnered with NASA to place dredge material from the inlet channel along the Wallops Island shoreline (Figure 3-29.) rather than in the offshore disposal site. The material was taken from the ocean bar portion of the project which lies just south of the westward tip of Assateague Island. The intent was to demonstrate the ability to place material along the shoreline from a hopper dredge, to determine the behavior of the material once placed along the shoreline, and to determine if this placement scenario could be a long term alternative.

Table 3-6. Chincoteague Inlet Dredging History

Date	Dredge	Dredge Days	Yardage (yd3)	Price Per Yard	Mob and Demob	Beach Work	Total Cost	Total Cost Per Yard
Mar-06	Atchafalaya		70,000	$4.99	$234,817		$584,117	$8.34
Mar-05	Currituck	10	12,455				$102,505	$8.23
Oct-02	Northerly Island	26	91,292	$14.32	$163,260	$592,226	$2,062,787	$22.60
Dec-99	Atchafalaya	13	85,000	$4.50	$210,000		$592,500	$6.97
Aug-98	Mermentau	17	72,592	$3.15	$120,000		$348,665	$4.80
Nov-97	Mermentau	34	122,889	$3.87	$275,000		$750,580	$6.11
Jul-96	Mermentau	30	120,079	$3.58	$150,000		$579,883	$4.83
Apr-95	Mermentau	22	120,835	$3.72	$270,000		$719,506	$5.95

Notes: All operations by hopper dredge.

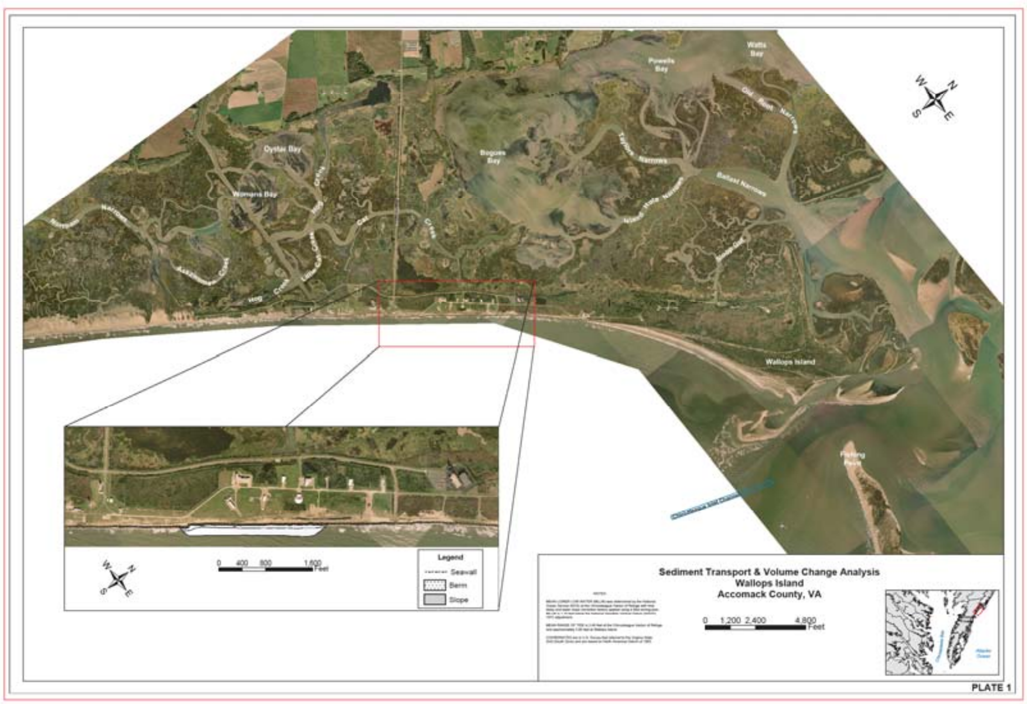

Figure 3-29. Site location map for experimental dredge placement.

For the project, the estimated nodal point along Wallops Island was the outfall for the dredge pipe running from the mooring and pump out buoy. Contract DACW65-02-C-0042 was awarded to B+B Dredging for the maintenance of the project and placement of material along the shoreline. The project was constructed during the period of September 22, 2002 to

October 23, 2002 for a final cost of $2,054,260.44. The volume of material removed, as calculated from bathymetric surveys, was 91,292 cubic yards.

The material from the project consisted mainly of fine sand. The outfall of the dredge pipeline was originally submerged at the start of the project and attached at the estimated nodal point to the toe of the seawall. Surveys and observation showed several feet of scour directly adjacent to the toe of the seawall. During the course of construction, a small beach head was created but not enough dry beach area was created to necessitate movement of the pipe outfall nor was there need for any equipment to spread the material.

Three surveys were performed along the Wallops Island shoreline to detect the placement and movement of material in the area. A before placement survey was performed in September 2002, an after placement survey was performed in November 2002, and a monitoring survey was performed in April 2003.

Comparison of the before placement survey and the after placement surveys generally showed that initial material was distributed along the seawall face and likely filled in a portion of the scour area that had been previously created in front of the seawall out to about 300 ft offshore (Figure 3-30). Comparison of the after placement survey and the monitoring survey (Figure 3-31) generally show that the material had moved away from the seawall face and joined nearshore bars along with generally diffusing throughout the area. Due to the high cost and modest benefits, the process has not been repeated during more recent inlet dredging events.

Figure 3-30. Comparison of pre- and post-placement surveys.

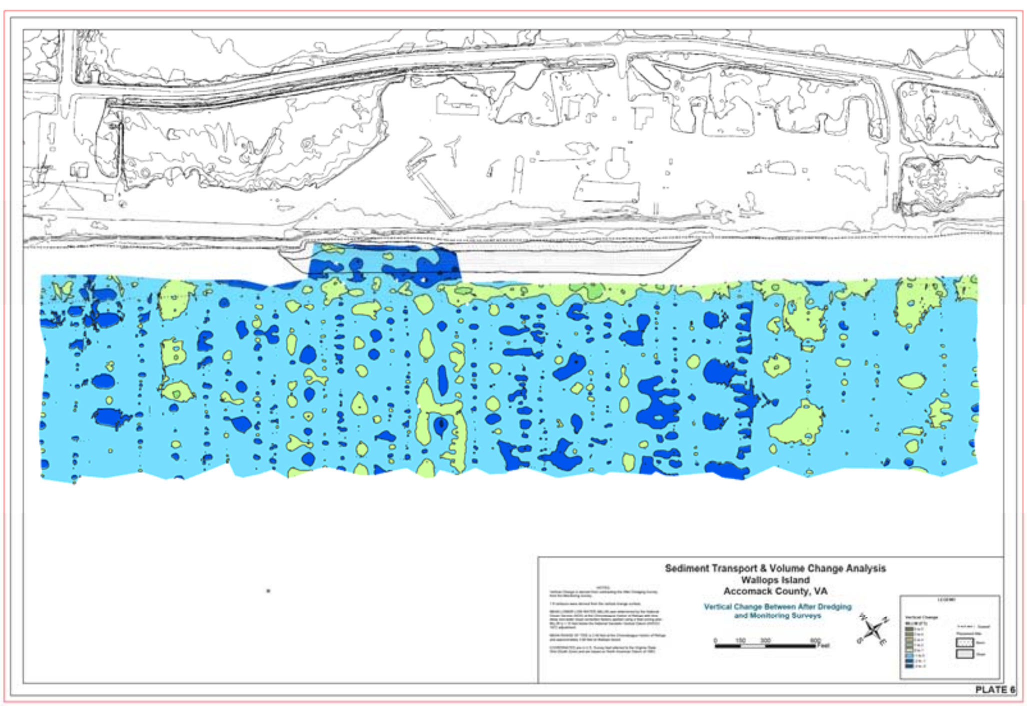

Figure 3-31. Comparison of post-placement surveys.

4 SBEACH / EST Modeling and Levels of Storm Damage Protection

Application of SBEACH and GENESIS Modeling

Following the methodology described in the Coastal Engineering Manual (CEM, Part 5, Chapter 4; Gravens, et al., 2006), the procedure applied in this project has been to develop a target beach profile along the shoreline that would provide an appropriate level of erosion, flooding, and storm damage protection to the facilities on Wallops Island, and then to augment this profile with sufficient advanced nourishment so that, at a minimum, the target profile would be maintained throughout the renourishment cycle. The computer models SBEACH and EST, which are discussed in this chapter, were applied to relate profile characteristics to levels of protection from storm damage. The computer models STWAVE and GENESIS, which are discussed in later chapters, provided estimates of longshore sediment transport rates throughout the study area and determined the volumes of advanced nourishment necessary to maintain the target profile through the end of the renourishment interval.

All SBEACH / EST and the STWAVE / GENESIS modeling work was performed at CHL on PC's using the CEDAS (version 4.03) package of models. A description of this software package can be found at the website: <http://www.veritechinc.com>.

SBEACH Setup

Model Description and Approach

SBEACH (Storm-induced BEAch CHange) is an empirically based numerical model for simulating two-dimensional cross-shore beach change (Larson and Kraus 1989, 1991, 1995; Larson, Kraus, and Byrnes 1990; Wise, Smith, and Larson 1996). The model's intended purpose is for predicting short-term profile response to storms. A fundamental assumption of SBEACH is that profile change is produced solely by cross-shore processes, resulting in a redistribution of sediment across the profile with no lateral gain or loss of material by longshore transport.

When a storm erodes a beach, the sand is usually not lost to the system. Rather, it is moved offshore, frequently into one or more bars. Low wave conditions after the storm will slowly move this material back onshore, rebuilding the berm. The discussion in this chapter addresses the question of how much sand must be placed in a berm and dune to provide adequate protection from storms.

Prior to running the model, input data in the form of representative nourished beach profiles and time series of storm waves and water levels were developed. Other input data included sediment grain size, depth of closure, and default model configuration parameters. The primary SBEACH output was a final (post-storm) profile for each input profile for each storm variant. These profiles are the basis for inputs to EST.

Storm Events

Forty-one hurricanes and tropical storms that impacted the study area between 1856 and 2003 were selected for the historical storm database. Thirty-nine extra-tropical storms (Nor'easters) that occurred between 1954 and 2003 were also included. These storms, listed in Tables 4-1 and 4-2, were culled from a dataset that was developed to analyze shoreline responses to a project in Chesapeake Bay (Melby, et al, 2005). Eleven Hurricanes and four Nor'easters were removed from the Chesapeake Bay dataset because they were found to have negligible impact at Wallops Island.

Table 4-1. Hurricanes and Tropical Storms Database

HURDAT Number	Storm Name	Reference Name	Year	SBEACH Start Date:time	SBEACH End Date:time	Max Wind speed (mph)
0031	unnamed	H-0031_	1856	8/19:0000	8/21:1200	50
0064	unnamed	H-0064_	1861	9/26:1800	9/29:0600	70
0067	unnamed	H-0067_	1861	11/01:1200	11/04:0000	70
0078	unnamed	H-0078_	1863	9/17:0600	9/19:1800	60
0165	unnamed	H-0165_	1876	9/17:0000	9/19:1200	80
0172	unnamed	H-0172_	1877	10/03:0000	10/05:1200	100
0187	unnamed	H-0187_	1878	10/22:0600	10/24:1800	90
0190	unnamed	H-0190_	1879	8/17:1200	8/20:0000	100
0202	unnamed	H-0202_	1880	9/08:0600	9/10:1800	70
0269	unnamed	H-0269_	1888	10/10:1800	10/13:0600	85
0302	unnamed	H-0302_	1893	6/15:1800	6/18:0600	85
0310	unnamed	H-0310_	1893	10/12:1200	10/15:0000	105
0312	unnamed	H-0312_	1893	10/21:1800	10/24:0600	50

0316	unnamed	H-0316_	1894	9/26:1800	9/30:1800	105
0317	unnamed	H-0317_	1894	10/08:1800	10/11:0600	105
0336	unnamed	H-0336_	1897	10/24:0000	10/28:0000	55
0347	unnamed	H-0347_	1899	8/14:1800	8/20:0600	105
0351	unnamed	H-0351_	1899	10/30:0000	11/02:0000	85
0384	unnamed	H-0384_	1904	9/13:1200	9/16:0000	85
0409	unnamed	H-0409_	1908	7/29:1200	8/02:0000	85
0492	unnamed	H-0492_	1923	10/22:0000	10/25:0000	60
0562	unnamed	H-0562_	1933	8/20:1800	8/24:1800	105
0567	unnamed	H-0567_	1933	9/14:1800	9/17:1800	105
0588	unnamed	H-0588_	1935	9/04:1200	9/07:0000	140
0605	unnamed	H-0605_	1936	9/17:0000	9/19:1200	105
0671	unnamed	H-0671_	1944	9/13:0600	9/15:1800	120
0755	BARBARA	H-0755B	1953	8/13:0000	8/16:0000	95
0776	HAZEL	H-0776H	1954	10/14:0600	10/16:1800	120
0780	CONNIE	H-0780C	1955	8/10:0600	8/14:0600	125
0787	IONE	H-0787I	1955	9/18:1200	9/21:0000	105
0830	BRENDA	H-0830B	1960	7/28:1800	7/31:0600	50
0832	DONNA	H-0832D	1960	9/10:1800	9/13:0600	140
0937	DORIA	H-0937D	1971	8/26:1800	8/29:0600	55
1030	BRET	H-1030B	1981	6/29:1200	7/02:0000	60
1070	GLORIA	H-1070G	1985	9/25:1200	9/28:0000	125
1077	CHARLEY	H-1077C	1986	8/15:0000	8/19:0000	70
1175	BERTHA	H-1175B	1996	7/11:1800	7/14:0600	100
1179	FRAN	H-1179F	1996	9/04:1200	9/08:1200	105
1196	BONNIE	H-1196B	1998	8/26:0000	8/30:0000	100
1214	FLOYD	H-1214F	1999	9/15:0000	9/17:1200	135
1264	ISABEL	H-1264I	2003	9/17:0600	9/21:0600	140

Table 4-2. Nor'easters Database

Reference Name	Year	SBEACH Start date:time	SBEACH End Date:time	Maximum Wind speed (m/s)
N540121	1954	1/21:1200	1/24:0000	18.4
N561024	1956	10/24:0600	10/30:1800	14.3
N571002	1957	10/02:0600	10/06:1800	13.7
N581019	1958	10/19:1200	10/22:1200	16.7
N620305	1962	3/05:0600	3/08:1800	16.3
N621126	1962	11/26:0000	12/05:1200	14.5
N660126	1966	1/26:0600	2/01:0600	15.8
N690119	1969	1/19:1800	1/22:1800	12.5
N720524	1972	5/24:0000	5/28:0000	14.0
N721004	1972	10/04:0600	10/08:1800	13.0
N741130	1974	11/30:1800	12/05:0600	14.6
N750628	1975	6/28:1800	7/02:0600	14.8
N771029	1977	10/29:0000	11/03:0000	12.4

N780426	1978	4/26:0000	4/28:1200	14.7
N801226	1980	12/26:1800	12/31:1800	13.2
N810819	1981	8/19:0000	8/23:1200	12.3
N830210	1983	2/10:1800	2/15:1800	13.4
N840328	1984	3/28:1200	3/31:1200	15.8
N840926	1984	9/26:1200	10/03:0000	13.1
N841010	1984	10/10:1200	10/15:0000	14.8
N851028	1985	10/28:1200	11/06:1200	13.6
N861129	1986	11/29:1800	12/04:0600	12.8
N880411	1988	4/11:1200	4/14:1200	14.8
N890307	1989	3/07:0600	3/11:0600	13.6
N910107	1991	1/07:0000	1/12:0000	13.4
N910418	1991	4/18:0000	4/21:1200	14.4
N911028	1991	10/28:0000	11/01:0000	14.6
N911108	1991	11/08:0000	11/10:1200	18.2
N930312	1993	3/12:1200	3/15:1200	13.8
N941012	1994	10/12:0000	10/16:1200	13.1
N961003	1996	10/03:1200	10/10:0000	12.4
N970601	1997	6/01:0000	6/08:0000	12.0
N971014	1997	10/14:0600	10/21:0600	12.1
N980510	1998	5/10:1200	5/15:0000	12.2
N990428	1999	4/28:1200	5/04:1200	12.5
N990829	1999	8/29:1200	9/07:0000	14.2
N000528	2000	5/28:1200	6/01:0000	15.0
N030408	2003	4/08:0000	4/12:1200	12.1
N030908	2003	9/08:0600	9/12:1800	13.9

Characterization of Storm Water Levels

The storm-induced water elevations were calculated with the ADCIRC model as described in Melby et al. (2005). The ADCIRC grid covered the eastern seaboard from North Carolina to New Jersey and included Chesapeake and Delaware Bays. Water elevation data were obtained from the ADCIRC output (node 7566), just offshore of Wallops Island.

The ADCIRC storm surge results included the historical astronomical tide in the water level time series. Since future storms will strike the coast at random times relative to the tide cycle, the historical tide was removed and replaced with 12 different tidal curves to make 12 variants for each storm. The historical astronomical tidal data was obtained from the website: <http://tbone.biol.sc.edu/tide/>.

The 12 tidal variants were generated with a 12 hour period (semi-diurnal) sine wave with three different amplitudes and four phases. Amplitudes were designated S (= spring), I (= intermediate), and N (= neap). Values applied were a spring amplitude of 0.714 m (2.34 ft), an intermediate amplitude of 0.535 m (1.76 ft), and a neap amplitude of 0.363 m (1.19 ft). See Appendix D for tidal and datum information. Tidal phases were randomized by synchronizing the peak of the tide with the peak of the storm surge and by then shifting the peak of the tide phase by 90, 180, and 270 degrees (designated 1, 2, 3, and 4, respectively).

An example of these tide plus storm surge curves for storm N801226 are shown in Figure 4-1. This figure shows the ADCIRC generated storm surge in panel A with the historical astronomical tide removed. Panels B through E show the four storm surge plus spring tide curve storm variants (S1 through S4, respectively).

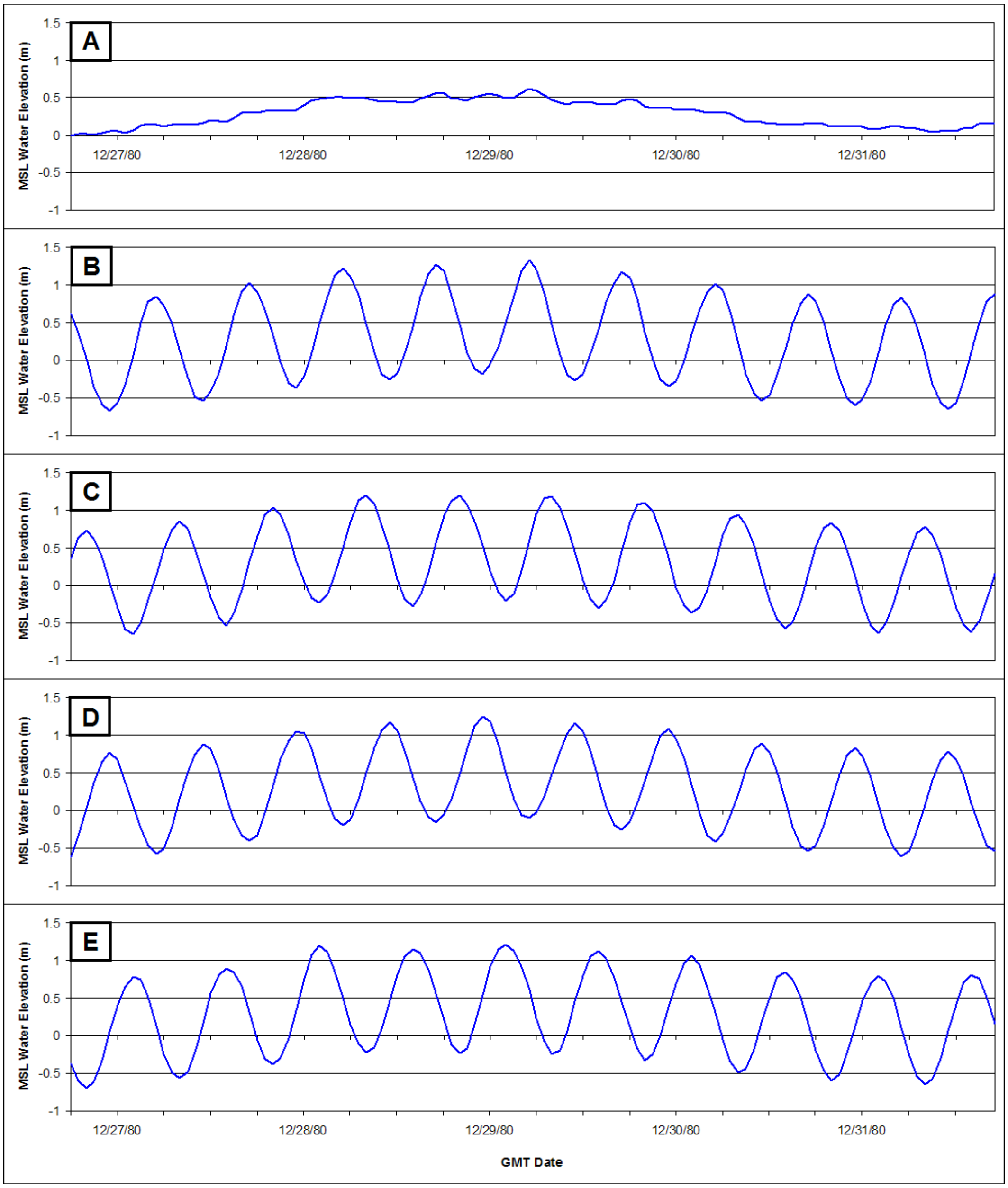

Figure 4-1. Example Spring tide plus surge water level curves for Nor'easter N801226.

Characterization of Storm Waves

Wave data at Wallops Island were available for all storms from 1980-1999 in the form of WIS hindcasts from WIS Atlantic station 178 (see: <http://frf.usace.army.mil/cgi-bin/wis/atl/atl_main.html>). These data were transformed to 6 meters of water depth using the Phase3 transformation routine within CEDAS. Wave data for the other storms used surrogate data from the storm wave data that were available. Wave data were matched to storms having similar maximum water levels and then time shifted so the maximum wave height occurred at the peak of the storm surge.

An example of the Phase 3 transformed wave height and wave period data for storm N801226 is shown in Figure 4-2. Each of the 12 water level variants for a storm used the same wave data.

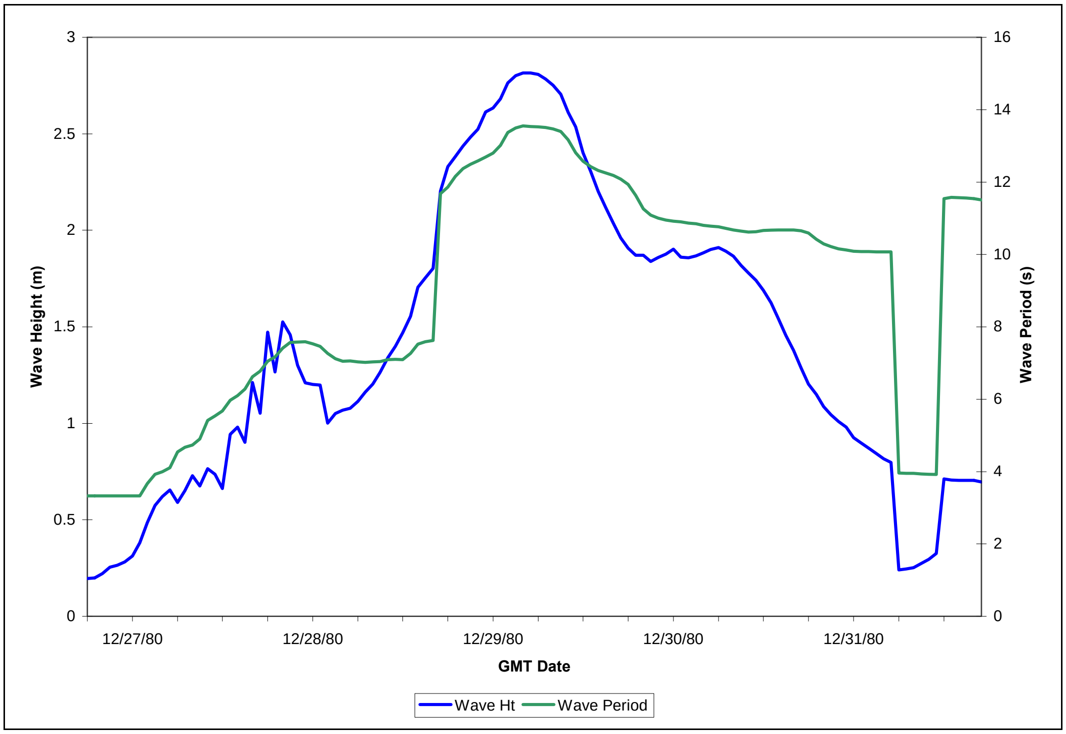

Figure 4-2. Example wave height and wave period for storm N801226.

Characterization of the Beach Profile

There is no exposed beach along much of the seawall (the southern part). However, by comparing profiles north and south of the seawall (primary comparison parameters were berm height, foreshore beach slope, subaerial profile volume, and subaqueous profile shape), it was determined that a single idealized profile could represent the nourished profile along the 3.7 mile (6.0 km) length of the project.

The beach profiles described in chapter 3 were analyzed along with initial SBEACH modeling results to develop three idealized "potential" nourished profiles that were used in the SBEACH modeling effort (Figure 4-3). The three profiles differ in the width of the berm and the presence and size of the dune. The three profile alternatives were designed to be placed adjacent to the seaward face of the rock seawall (the rock seawall extends landward (to the left) from Distance zero in Figure 4-3). However, the rock seawall (non-eroding surface) was not modeled.

- The B030 profile represents a modest project with no dune and a 30 ft berm width. Since this profile lacks a dune, it does not provide flood protection.
- For the B070 profile, the seaward sloping face of the dune rests against the seawall. The distance from the seawall to the seaward shoulder of the berm is 70 ft, of which 40 ft is under the dune and 30 ft is exposed berm width.
- The B100 profile has a 20 ft dune crest plus the seaward sloping dune face. The distance from the seawall to the berm shoulder is 100 ft, of which 60 ft is under the dune and 40 feet is exposed berm width.

For the idealized profiles, the upland elevation (based upon profile data) is set at 7 ft. (All elevations in this discussion are relative to MSL, see Appendix D). The dune elevation of 14 ft is based upon initial modeling results (of storm surge elevations and amount of erosion of dune crest), and is the design elevation of the rock seawall. The dune slope (1:5) is a fairly common choice for a stable engineered dune. The berm height (+6 ft) and foreshore slope ($0.073{:}1=\tan(4.17°)$) are based upon measured beach profiles. Below MSL an actual long profile from the south end of the project (profile 4) was applied. A full profile is shown in Figure 4-4.

The differences in these three profiles are largely necessitated by differences in the dune. The B030 profile represents a minimal fill project without a dune. The B070 profile has the same amount of exposed berm width (30 ft) as the B030 profile, and represents a minimal fill project that includes a dune. The dune in the B070 profile is only a partial dune (the seaward face of a dune) as it rests against and is supported by the seawall. The B100 profile has a somewhat wider exposed berm (40 ft) in addition to the seaward face and central portion of a dune. However, this B100 dune is still incomplete as it lacks rear slope. Instead, support is supplied by the seawall.

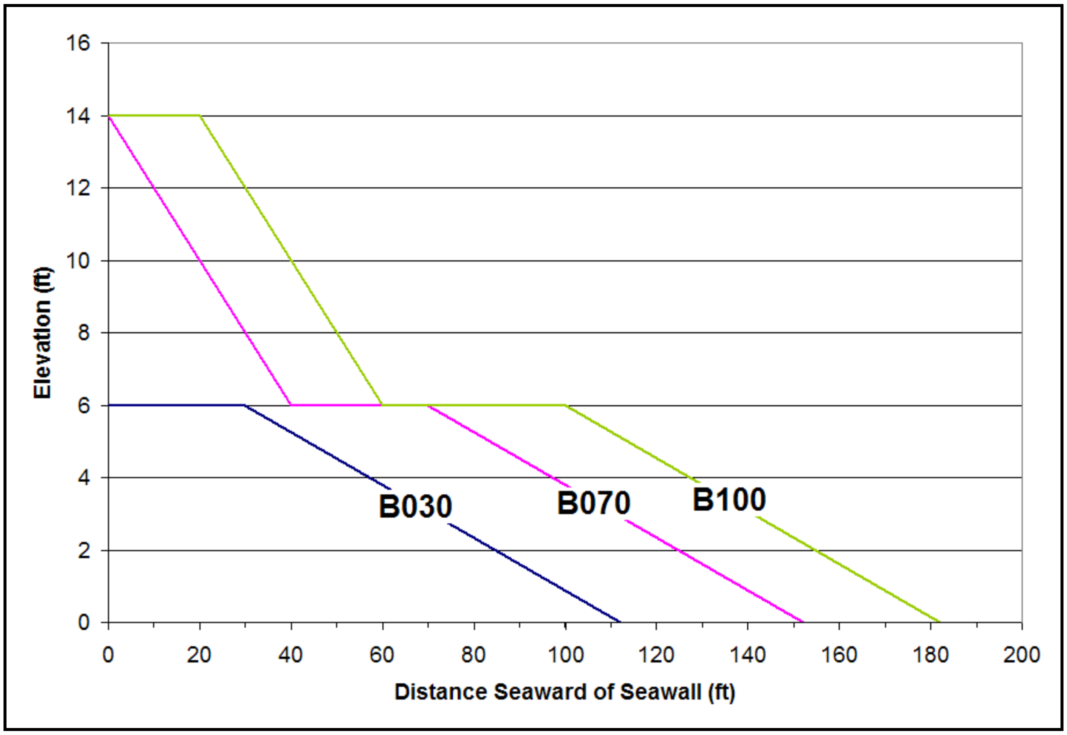

Figure 4-3. Sub-aerial profiles for Alternatives considered.

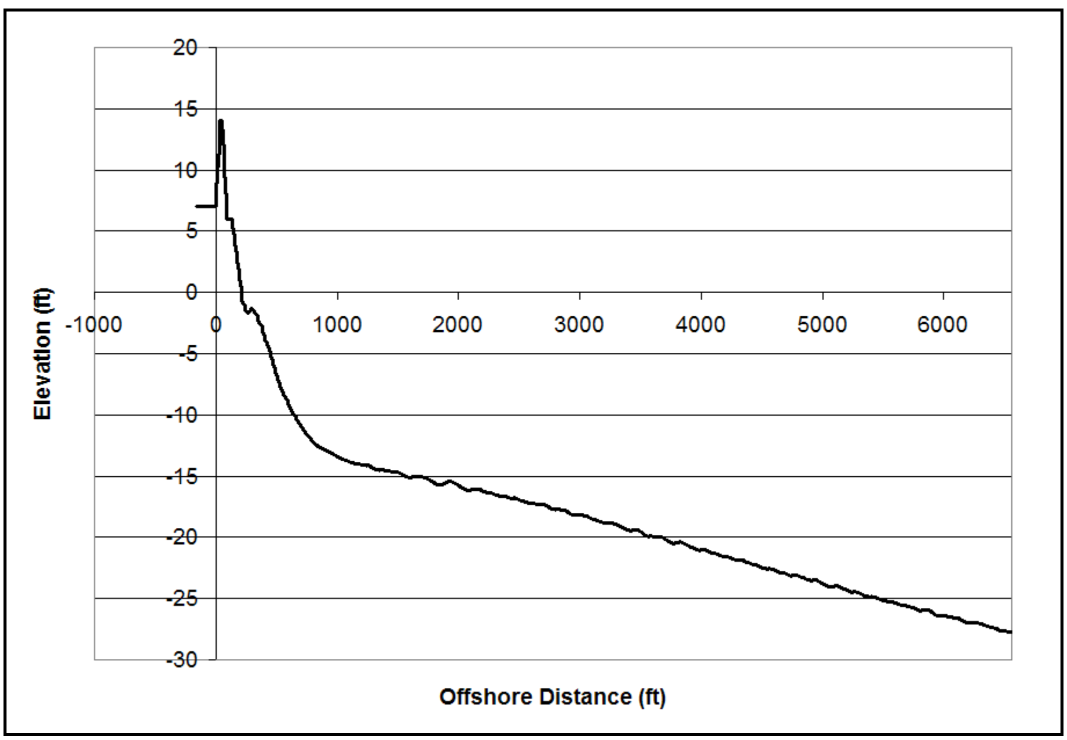

Figure 4-4. Representative Profile.

Characterization of the Depth of Closure

Multiple beach profile datasets were not available to determine a "pinch-out" depth for the depth of closure. Rather, a Closure Depth of 13 ft (4 m) was determined largely upon profile shape information. The profiles all start to become much more nearly flat at this depth and begin to diverge substantially from an equilibrium profile, as shown in Figure 4-5. The GEN Cell 17, 50, and 87 Profiles are representative of the northern, central, and southern portions of the project site. As the Wallops Island shoreline has been experiencing chronic erosion for many decades, a reasonable interpretation for the flatness in the profiles is that this is the depth to which the erosion has cut. In addition, this Depth of Closure value is not greatly different from estimates obtained using the formulas of Hallermeier (1983) or Ahrens (2000). On the 0.29 mm equilibrium profile, this depth of closure is 600 ft (183 m) seaward of the shoreline.

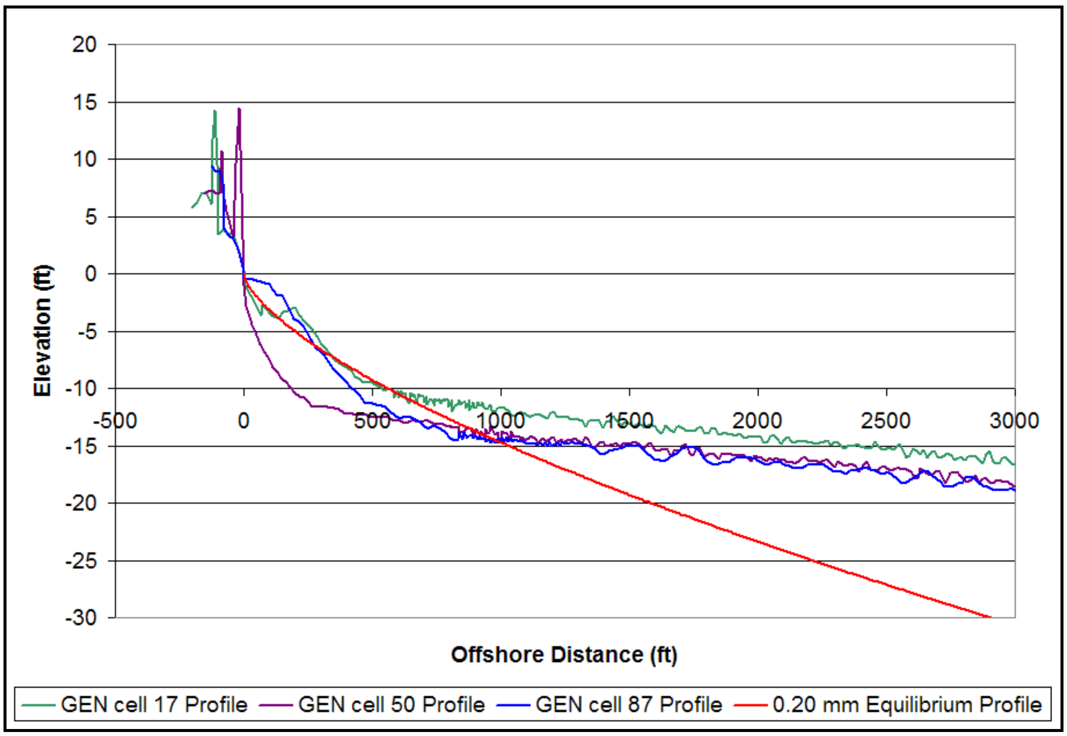

Figure 4.5. Divergence of Wallops Island profiles from an equilibrium profile for depths greater than 4 meters (13 feet).

This depth of closure is substantially less than the value (-28 ft) given in Morang, Williams, and Swean (2006). However, the value given in that report was not calculated for Wallops Island, but taken from the closest site available where the calculation had previously been made, in this case

Sandbridge, VA. In discussions with the senior author of that report, he concurred with the methodology presented here.

While this value appears reasonable, it is recognized that it is shallower than many other U.S. east coast values. An underestimate of this value can lead to an underestimate in the required amount of beach fill material. Uncertainty in this value is discussed in Chapter 6 and additional material is included in the fill estimates specifically to compensate for uncertainties in this and other quantities.

SBEACH Model Runs

The SBEACH model was not calibrated for the Wallops Island site prior to data runs being made, because the appropriate pre- and post-storm profiles were not available for the site. Instead, the default model parameters were applied. This was considered justified as one of the primary sites used to develop the SBEACH default parameters was on Assateague Island, which is immediately north of the project site (Wise, Smith, and Larson, 1996). All of the configuration values for this model are listed in Table E-1 of Appendix E.

Initial model runs indicated that the B070 profile provided optimal storm protection. As discussed below, the beach is only one component of the defenses in this storm damage reduction project (the other two being the rock seawall and interior flood barriers). The philosophy of this tiered approach is that the beach fill alone will provide protection against smaller, more frequent storms, leaving the seawall intact to protect against the largest storms expected over the life of the project.

The B030 profile lacks a dune and initial model results showed that storm waves would impact the seawall at intervals more frequent than the renourishment events. Thus, potential damage to the seawall would be an ongoing issue. The B100 profile provided superior storm damage protection as compared to the B070 profile, but at greater expense, and the additional protection would be, in essence, provided by the rock seawall. At an estimated cost of $10/yd^3, the B100 design condition would add an additional $5.3 million dollars to the cost of the initial fill placement beyond the cost of the B070 design condition. Based upon this initial screening, only a limited amount of modeling was conducted using the B030 and B100 profiles.

EST Setup

EST (Empirical Simulation Technique) is a statistical numerical analysis procedure designed to simulate multiple life-cycle sequences of a non-deterministic multi-parameter system to determine frequency of occurrence relationships (Borgman, et al, 1992, Scheffner, et al, 1996, Scheffner, et al, 1999). The program generates frequency response information for each output parameter.

The model requires input vectors that describe the process forcing functions (the storms), output vectors that define the parameters to be modeled (the post storm profile responses), and configuration parameters. The following standard nine EST input vectors were developed for each of the 960 storm variants.

1. The peak of the storm surge.
2. The duration of storm surge (length of time the storm surge exceeded 0.3 m).
3. The average value of surge over the storm's duration.
4. The tidal amplitude (spring, average, or neap).
5. The tidal phase at peak surge (high, mid, or low tide).
6. The slope of tide at peak surge.
7. The peak wave height.
8. The duration of storm waves (length of time the wave height exceeded 1 m).
9. The average value of wave height over the storm's duration.

A FORTRAN program extracted a variety of response vectors from the suite of SBEACH post-storm profiles, which were directly imported into EST. EST model configuration parameters are listed in Appendix E.

Profile Responses to Hurricanes and Nor'easters

While there is a great deal of similarity, Nor'easters and Hurricanes can impact the beach profile differently because of differences in these types of storms. Hurricanes that occur at the latitude of Wallops Island are typically fast moving storms, usually producing substantial coastal impacts for something on the order of a day or less. However, because of the low central pressures and high wind speeds, they can generate large storm surges (substantially elevated water levels). In contrast, Nor'easters can cause impacts over longer time scales (several tidal cycles), but usually do not produce extremely high storm surges. These trends are shown in Figures 4-6 and 4-7, which use data taken from the historical storm sets listed in Tables 4-1 and 4-2. Figure 4-6 shows the storm surge heights (with tides removed) with the data ranked from highest surge height to lowest, for Hurricanes (black) and Nor'easters (red). Figure 4-7 shows the distribution of storm times, as defined by the hours that the surge height exceeded 0.3 m for each of the 12 variants for each storm. The average Hurricane storm time was 23 hours; the average Nor'easter storm time was 48 hours.

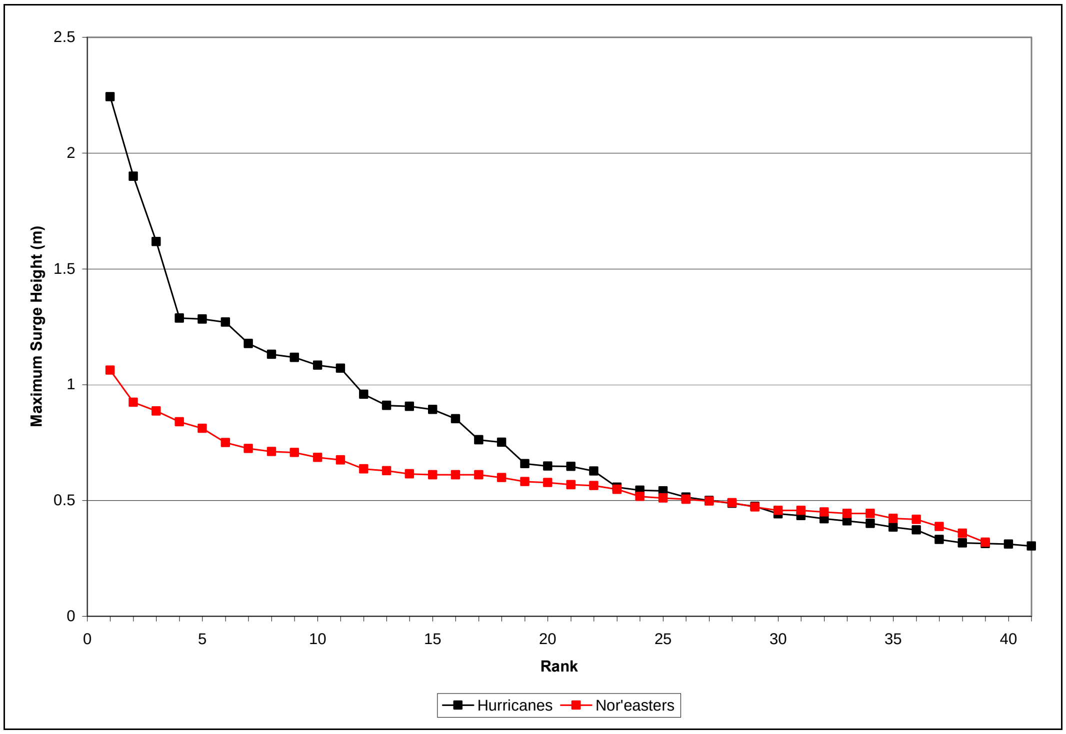

Figure 4-6. Maximum storm surge height for Hurricanes and Nor'easters, ranked from highest to lowest for the storms in the dataset.

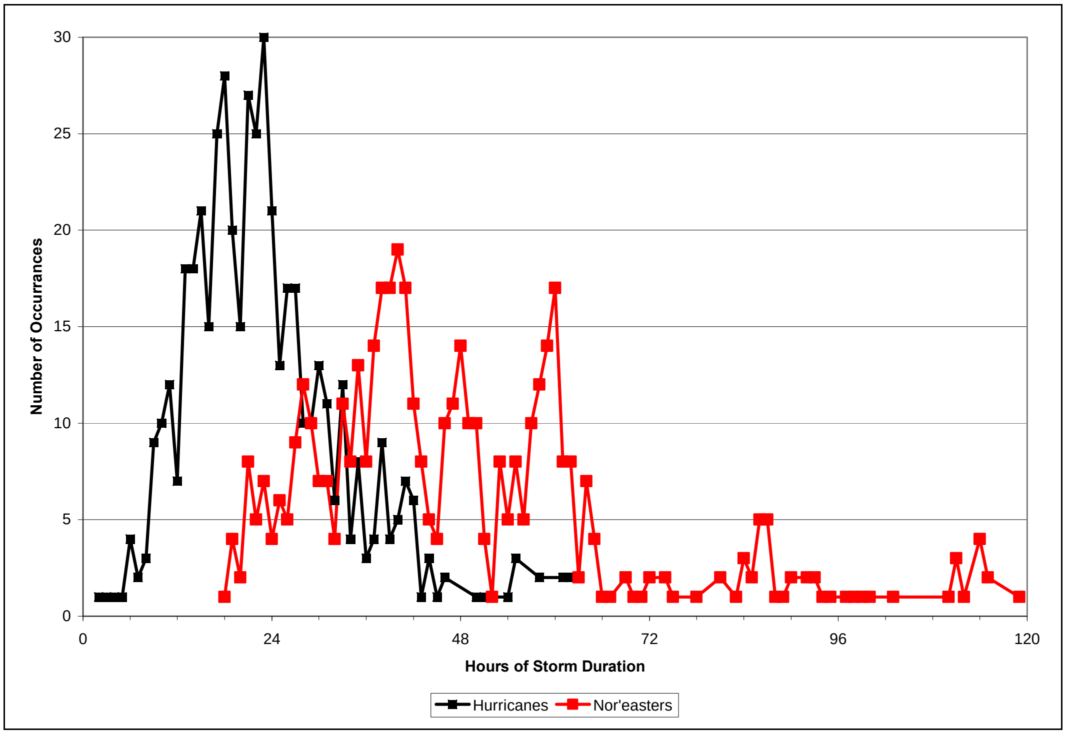

Figure 4-7. Distribution of storm surge durations for Hurricanes and Nor'easters.

These differences affect the way the storms impact the beach profile. Nor'easters, with their lower water levels but longer durations, can produce considerable berm erosion while leaving the dune relatively intact. Conversely, a hurricane can have less impact on the berm, but a greater impact on the dune. Examples of these differences are shown in Figures 4-8 and 4-9. These figures are SBEACH pre (black) and post (red) storm profiles. The pre-storm profiles were model inputs; the post-storm profiles are model predictions. Figure 4-8 shows a Nor'easter that has severely eroded the berm, but has left the dune essentially untouched. Figure 4-9 shows a hurricane that has done less damage to the berm but has started to erode the dune. Where there is no change in the profile only the final (red) profile line is visible.

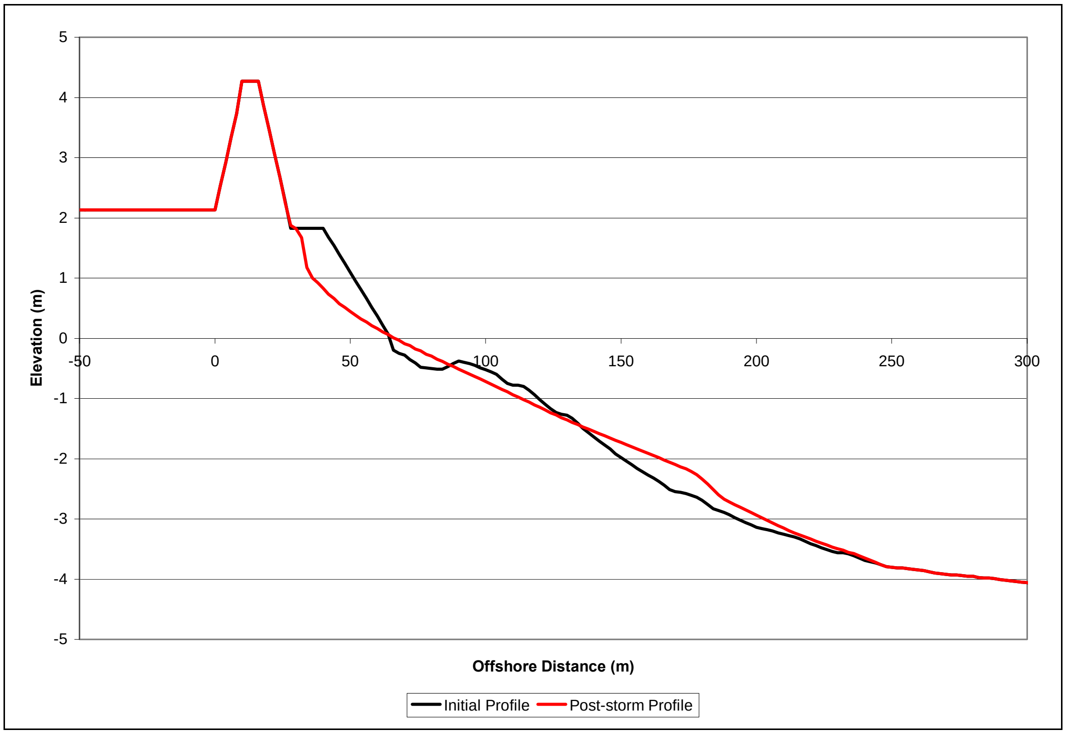

Figure 4-8. SBEACH Profile Response for Storm N621126S3 (Nor'Easter).

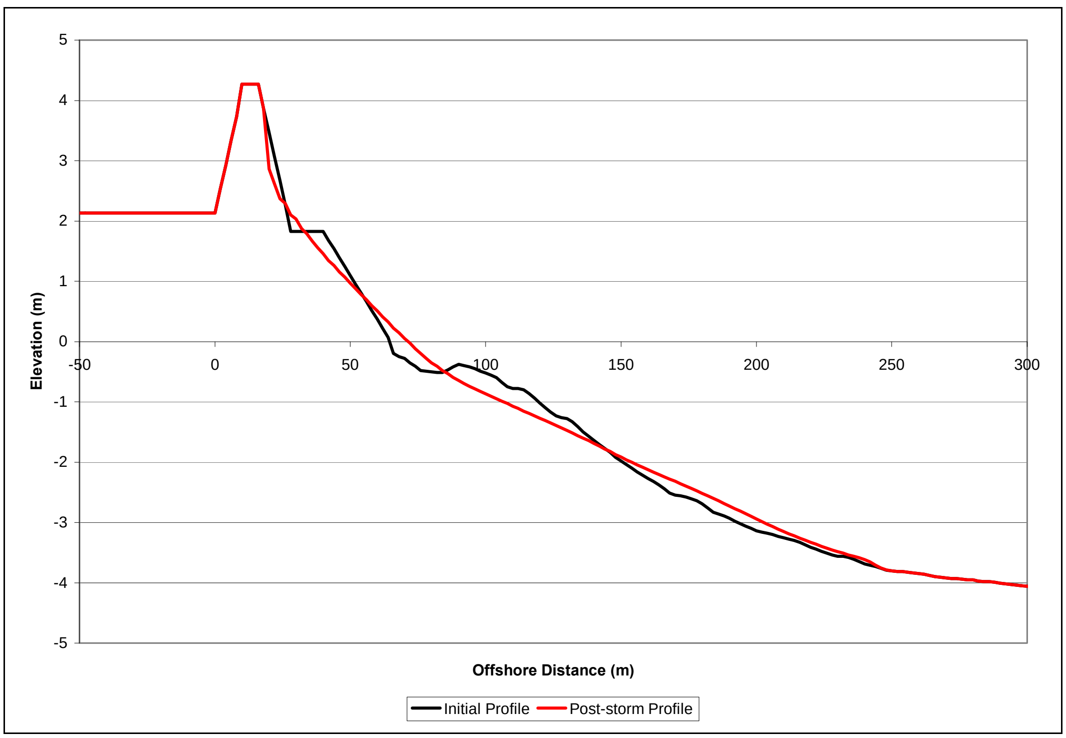

Figure 4-9. SBEACH Profile Response for Storm H-190_S1. (Hurricane).

B070 Profile Response to Storms

Figures 4-10 through 4-14 are EST frequency response plots that show the predicted response of the B070 profile to the suite of storms that are based upon the combined historical data set of Hurricanes and Nor'easters.

Berm Response

Figure 4-10 shows the return period intervals for storm-induced berm recession. This plot shows the landward distance that the berm crest elevation will be reduced by 1 foot. This is equivalent to the recession distance of the 5 ft contour, since the modeled berm crest is flat. This plot shows that a storm that produces 30 ft of berm cutback can be expected to occur with a return period on the order of 8 years. A storm producing 40 ft of horizontal berm erosion has an estimated return period of 40-50 years. The entire seaward face of the berm shows approximately the same behavior. The return period for the recession of the 2 ft contour is shown in Figure 4-11.

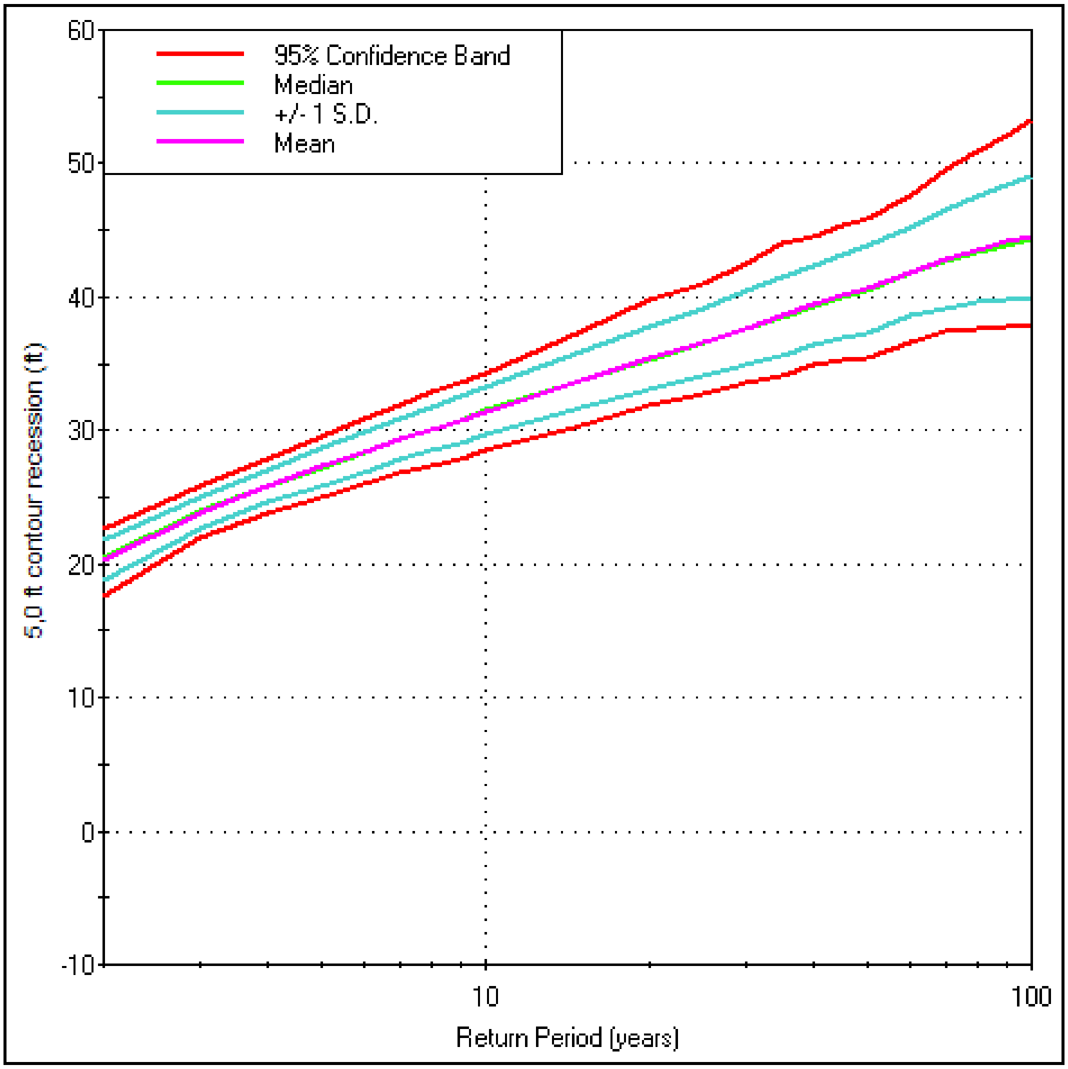

Figure 4-10. Return period of berm recession.

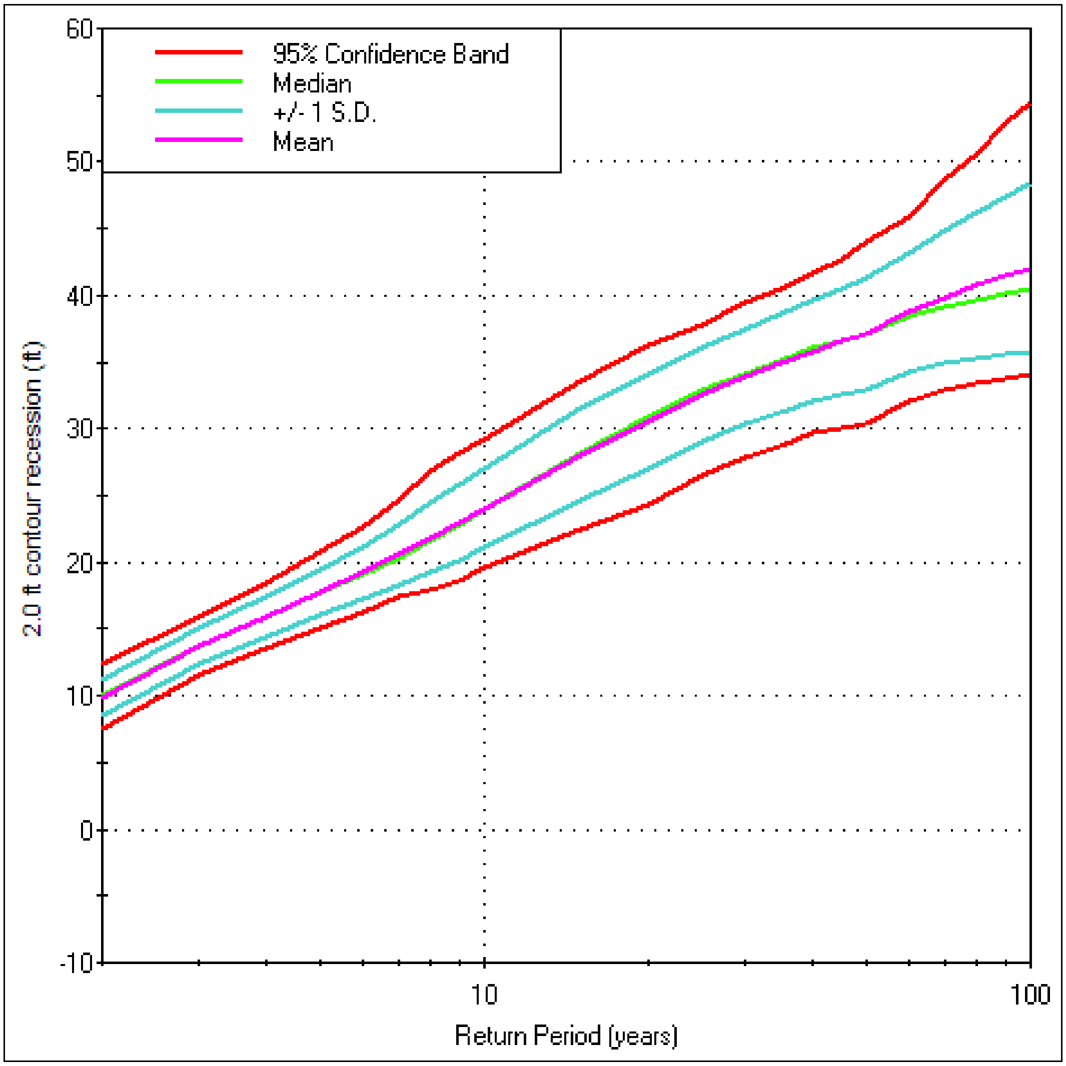

Figure 4-11. Return period for recession of the +2 ft contour.

Dune Response

Figure 4-12 shows the frequency response for dune lowering. This figure shows that storms that are less than 30-40 year return interval events do not impact the +14 ft dune crest.

Unlike a berm, the dune is not expected to recover following storm damage, at least not on the time scales of typical renourishment cycles. Rather it is expected that such damage will require mechanical repair at the time of the next renourishment. Therefore, damage to the dune should be an infrequent event. Figure 4-13 shows the frequency response for recession of the 9 ft contour. This elevation is a little less than half way up the dune face. Figure 4-13 shows that storms that start to cause dune erosion can be expected to have a 20-30 year return interval.

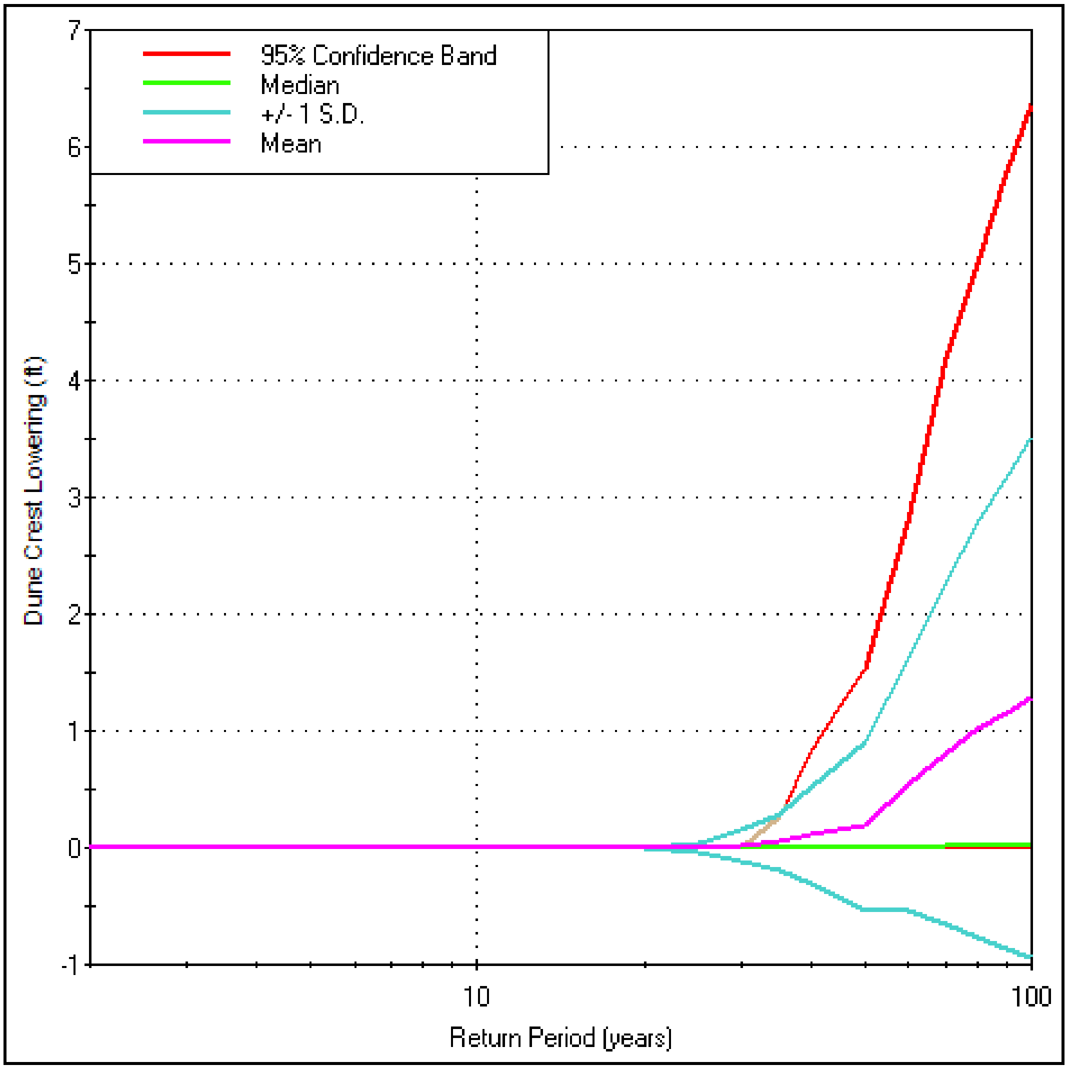

Figure 4-12. Return period for dune crest lowering.

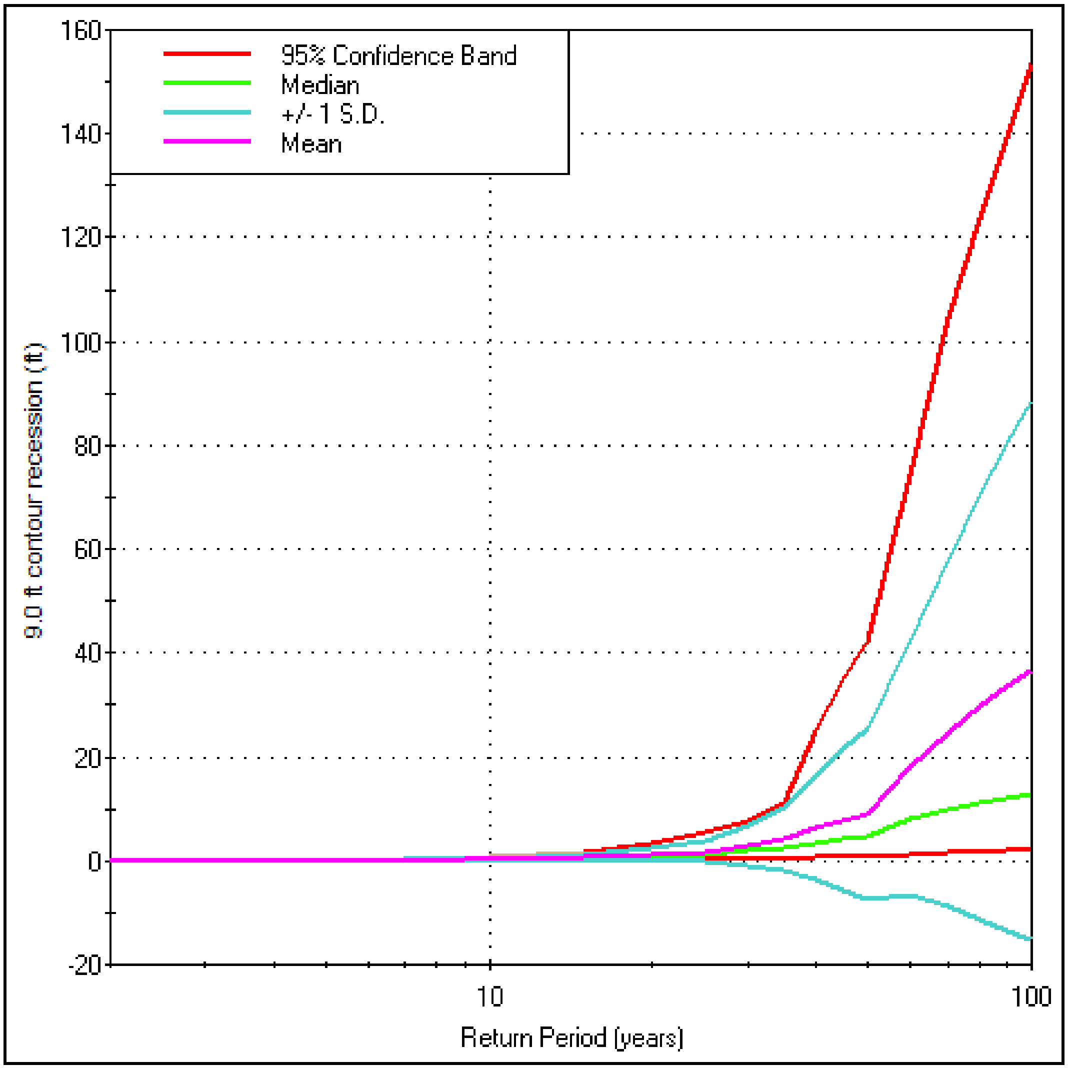

Figure 4-13. Return period for recession of the 9 ft contour.

Storm Surge

Figure 4-14 shows return periods for upland flooding in the absence of a dune. These elevations can be thought of as the mean water elevations at the height of a storm. Wave crest elevations would be on top of these elevations. Assuming that upland elevations at Wallops Island are of the order of +7 ft (MSL), in the absence of a sand dune, storms with return periods on the order of 15 years can be expected to produce flooding. Note that the rock seawall has a design height of +14 ft and can be expected to significantly reduce wave heights; however, it will do little to reduce flooding because of its porosity.

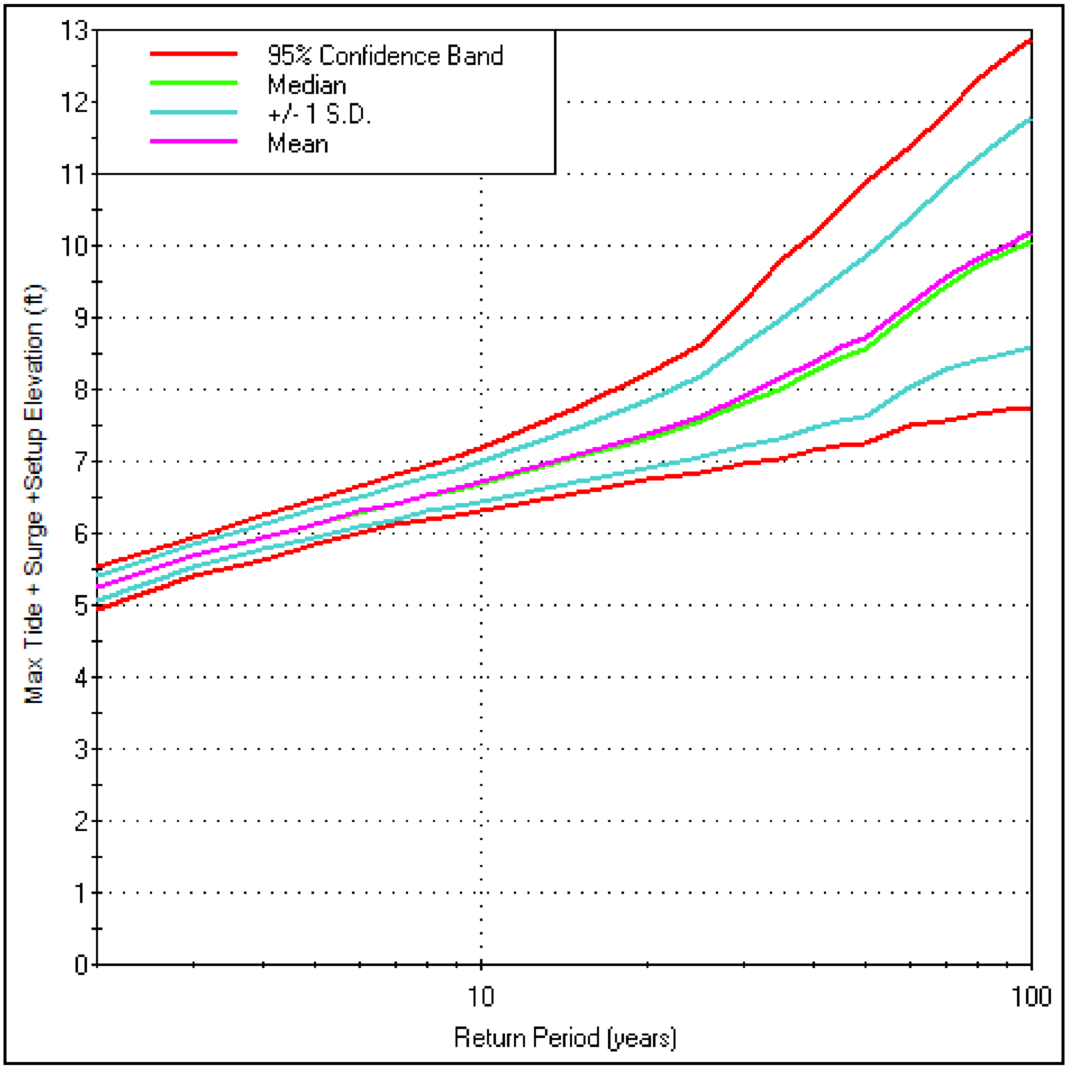

Figure 4-14. Storm surge return period.

Storm Damage Reduction Level of Protection

Following discussions with NASA personnel, a storm damage reduction project that provided significant defense against a design target of a 100-year return interval event was agreed upon. The project consists of three principal components. These include the beach fill project, the rock seawall, and flood barriers and/or other flood protection schemes for individual buildings on the island.

The beachfill project is intended to be the first line of defense. Based upon the analysis presented above, a fill project based upon the B070 profile and a 5-year renourishment interval will, by itself, provide damage protection from a storm that, on average, is likely to occur only once every 30 years.

Though the dune and berm portion of the beach fill will be substantially degraded during a 100-year return interval storm event, the fill will remain largely in place and provide a shallow water surface for storm waves to break upon, thus reducing wave energy at the seawall. Provided that degraded portions of the rock seawall are repaired with a seaward slope of at least 1 on 1.5, the seawall will be able to withstand waves up to 7 ft in height (see Chapter 3). As a 7-ft wave will typically break in a depth of about 9 ft, the limited depth over the berm will cause waves of that height to first break seaward of the seawall. The seawall should therefore survive a 100 year storm event with minimal damage.

In the presence of a 100-year storm event, the largest incident waves will break offshore, smaller waves will break on the remaining portions of the beach fill, and most of the remaining wave energy will be dissipated at the rock seawall. Although wave runup will carry over the structure, waves generated by the runup will be minimal and the primary potential damage to infrastructure landward of the seawall will be from flooding rather than from direct wave impacts.

As shown by Figure 4-13, during a 100-year storm event, the mean water elevation at the seawall will be approximately +10 ft. Infrastructure is vulnerable to flooding from water coming through the seawall, from water flanking the ends of the project, and from flooding from the bay. Wave heights on the landward side of the seawall are expected to be on the order of a foot. All of the recently constructed facilities on Wallops Island have been designed to accommodate flooding elevations of +12 ft. As part of this project, NASA officials will continue to routinely monitor all structures on the island to make sure that each maintains its +12 ft flood protection strategy.

To protect existing and future proposed facilities on Wallops Island, the length of the project needs to extend from the northern end of the rock seawall (3767988.32 Easting, 1174124.21 Northing) to the south end of the geotextile tube at the south camera stand (3764244.61 Easting, 1169509.68 Northing), a distance of 19680 ft (5998 m).

5 STWAVE/GENESIS Setup and Model Calibration

STWAVE

The longshore sediment transport formula used in GENESIS requires wave height, period, and direction information at the seaward edge of the surf zone (the breaker line.) Wave data for this study were available in the form of WIS hindcasts several miles offshore in nominal 20 meters water depth. The numerical model, STWAVE, (STeady-state spectral WAVE model) was used to transform representative offshore waves to a near-breaking depth, where the shoaled wave data were handed off to GENESIS.

The STWAVE model described in this chapter was applied in conjunction with GENESIS to simulate the sediment transport and shoreline evolution along Wallops Island. STWAVE was also used to evaluate the wave refraction effects of mining offshore shoals to supply sediment for the beach fill. This application is discussed in Chapter 8. The STWAVE grid domain used in this chapter is named the Wallops Island domain. The two STWAVE grid domains used to examine the offshore borrow sites (Chapter 8) are termed the Fishing Point Coarse Grid and the Fishing Point Fine Grid domains.

Model Description

STWAVE is a computationally intense, half plane, steady state spectral wave model that requires a two-dimensional uniform rectilinear grid to transform waves from the offshore region to a near-breaking depth (Resio 1987, 1988a, 1988b; Smith 2001). It solves the complete radiative transfer equation (Jonsson 1990) that includes both propagation effects (refraction, shoaling, diffraction, and wave-current interactions) and source-term effects (wave breaking, wind inputs, and nonlinear wave-wave interactions). As input, the model requires some basic configuration data, a uniform rectilinear bathymetry grid, directional wave spectra at the seaward boundary of the grid, and optionally, wind and current data. Wind and current data were not used in this application.

Model Grid

The required bathymetry data were obtained from the National Ocean Survey (NOS) hydrographic surveys that are available in electronic format from the Geophysical Data System (GEODAS, version 4.0) developed by the National Geophysical Data Center. GEODAS is an interactive database management system for use in the assimilation, storage, and retrieval of geophysical data. Bathymetric surveys collected in the 1960's through the 1990's were used where available, with earlier survey data used to fill gaps in the more recent bathymetry coverage.

The STWAVE grid is shown in Figure 5-1. This figure is oriented so that land (bright green) is at the bottom and offshore is at the top. The elevation scale on the right-hand side of the figure is in meters. The shoreline is the white line running from A to B. C shows the location of Fishing Point and D is at Chincoteague Inlet. (The gap in the shoreline representing Chincoteague Inlet is not modeled.) The black grid running from E to F along Wallops Island shows the location of the GENESIS X-axis within the STWAVE grid. The STWAVE save stations are shown by the light blue line in shallow water offshore of the GENESIS grid. This grid was used to propagate waves from the nominal 20 meter depth to the save stations.

The grid runs for 10 miles (16 km) along shore from about the middle of Tom's Cove in the north (at A) to the middle of Assawoman Island in the south (at B) and runs 12 miles (19 km) offshore to approximately the 20 meter contour. Grid cells were 240 ft (73.152 m) on a side. The bathymetry offshore of Wallops Island varies from being nearly featureless immediately offshore to a complex set of shoals offshore of Fishing Point. These shoals are also shown in Figure 3-2. The STWAVE model domain was extended sufficiently far to the north to insure that these shoals were included in the analysis. Datums for this bathymetry are discussed in Appendix D. The necessary set of bathymetry grid parameters are listed in Appendix E.

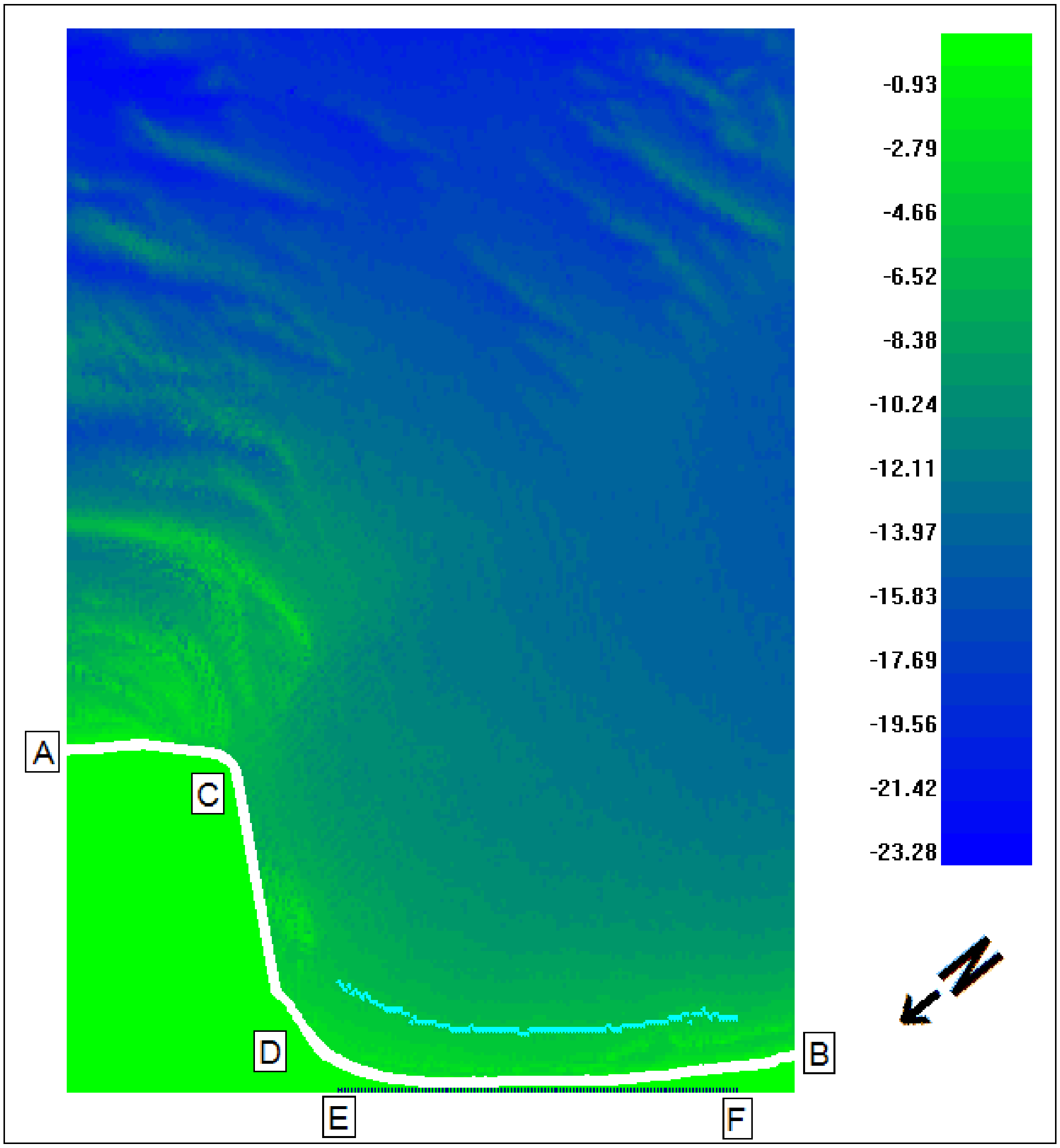

Figure 5-1. STWAVE grid for Wallops Island, VA.

Wave Climatology

Waves are the dominant driving mechanism in longshore sediment transport and are a primary environmental forcing input to STWAVE and GENESIS. A 20-year hourly hindcast (1980-1999) of wave heights, periods, and directions was obtained from <http://frf.usace.army.mil/cgi-bin/wis/atl/atl_main.html> for WIS station 178, located at 37.75° N, 75.25° W, in 20 meters of water depth near the offshore boundary of the STWAVE grid. Comparisons between the WIS hindcast data and measured wave data can be found at the above website and in Tracy (2002) and Tracy and Cialone (2004). Wave direction data from this WIS station were referenced to the local shore normal direction of 129 deg azimuth as shown in Figure 5-2. Positive wave angles are those approaching the coast from the northeast (from the left for a person standing on the beach looking offshore).

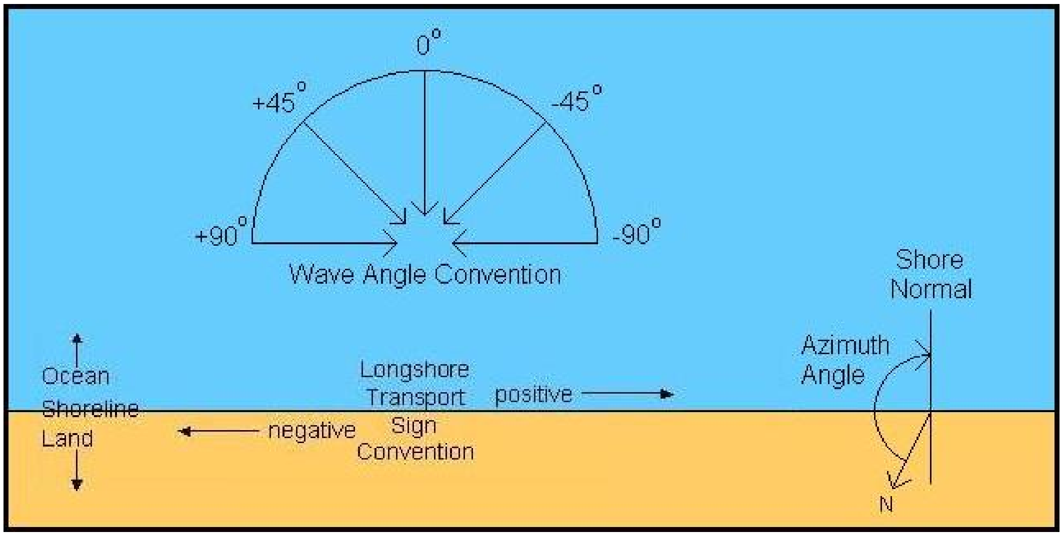

Figure 5-2. Angle and sign convention definition sketch.

Following a phase3 transformation to remove offshore directed wave energy, the 20-year WIS wave hindcast (175,320 hourly wave records) was characterized by binning the data into nine significant wave height bins, eight peak spectral wave period bins, and twelve vector mean wave directions at the peak spectral frequency bins, as shown in Figure 5-3. This figure is a histogram of WIS station 178 wave heights, periods, and directions shown as percent occurrence (the numbers above each bin). The numbers below the bins are the average bin values and the bin boundaries. Bright blue bins indicate those occurring most frequently and gray, least frequently. Figure 5-4 is the corresponding block diagram of wave height versus wave direction. These figures show that average wave heights are around 0.8 meter, average wave periods are 6-7 seconds and the predominant direction of wave approach is from the left of shore normal (from a northeasterly direction).

Of the 864 possible bin combinations (12 wave angles * 8 wave periods * 9 wave heights), the 20-year WIS hindcast populated 661 of the bins with at least an hour of data. STWAVE was run to transform the wave data in these 661 bin combinations from a 20 meter water depth to a near breaking depth. Model wave parameters are listed in Appendix E.

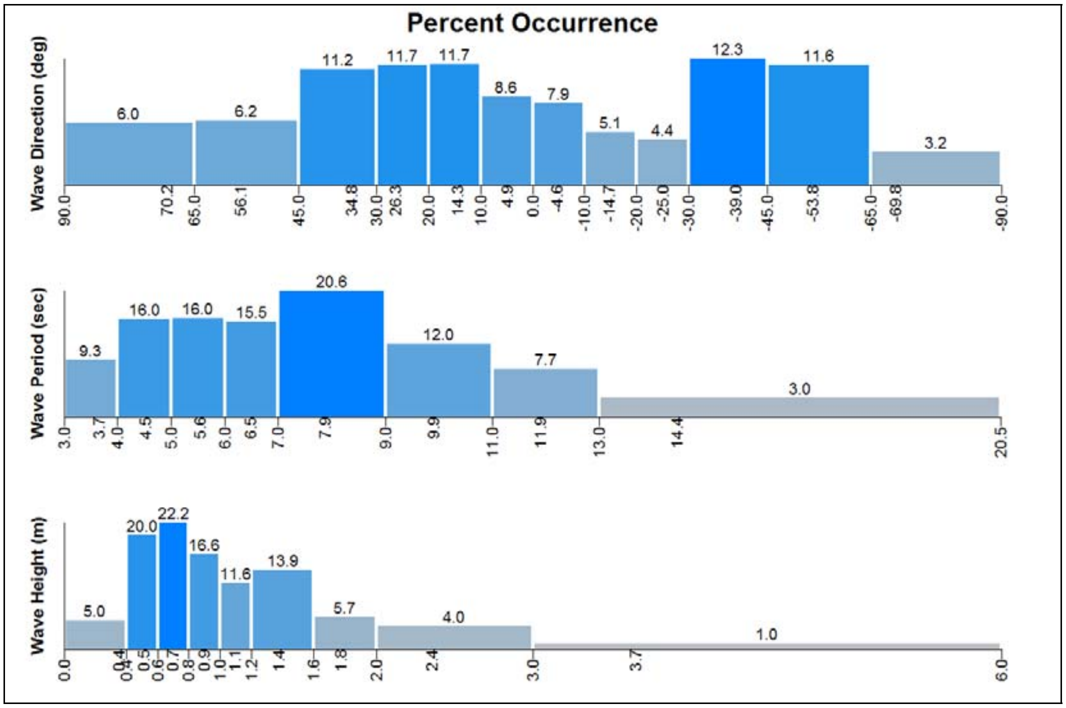

Figure 5-3. STWAVE Wave Height, Period, and Angle bins.

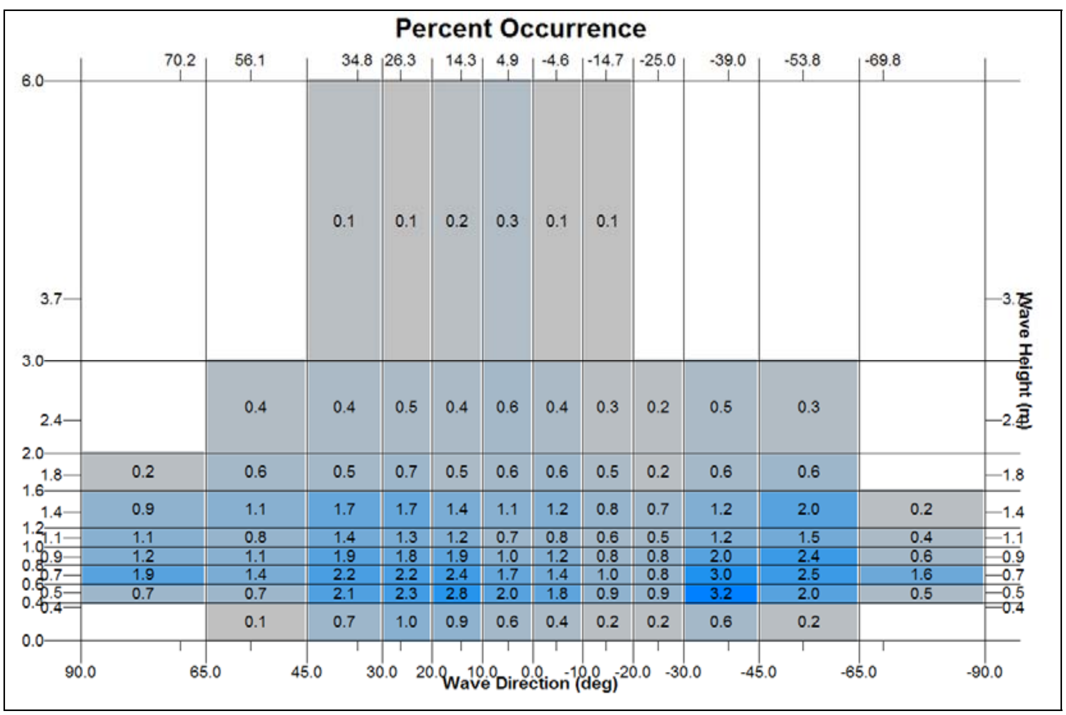

Figure 5-4. STWAVE block diagram of wave height vs. wave angle.

GENESIS

Model Description

GENESIS (GENEralized model for SImulating Shoreline change) is a shoreline change model that simulates longshore sand transport and the resulting change in shoreline position (Hanson 1987; Hanson and Kraus 1989; Gravens, Kraus, and Hanson 1991). One of the GENESIS assumptions is that when erosion or accretion occurs, the entire profile shifts landward or seaward, without changing profile shape, so that only one cross-shore point at each grid cell needs to be tracked. Thus, it belongs to a class of models known as one-line models, and the grid is one-dimensional, running the length of the shoreline in the study area. At each alongshore grid cell, the model applies the transformed wave data supplied by STWAVE to calculate breaking wave heights and angles, and applies this information to calculate the temporally and spatially varying local longshore sediment transport rate. Other inputs include configuration data, shoreline positions, and structure locations. GENESIS can predict shoreline change in a diverse variety of situations involving almost arbitrary numbers, locations, and combinations of groins, jetties, detached breakwaters, seawalls, and beach fills.

Model Grid

A GENESIS grid was laid out as shown in Figure 5-5. For ease of interpretation, Table 5-1 shows the location of several prominent shoreline features referenced to the GENESIS grid. The grid origin is located at 3768396.5200 Easting, 1174969.9500 Northing (in STWAVE cell (264, 83)), which is 3120 feet (951 meters) north of the north end of the rock seawall (and in the front yard of building V50). This location is south of the main shoals of Chincoteague Inlet, though not completely away from the inlet's influence. It is on the accreting part of the beach, to the north of any expected project beach fill or sand retention structure. The grid runs southward along an azimuth of 219^{o} for 29,040 feet (8851.392 meters), ending about a mile (1.6 km) south of Assawoman inlet. This location is south of the expected project construction and far enough south to model project impacts along the north end of Assawoman Island. The grid contains 121 cells, each 240 feet (73.152 m) long; the same cell length as the STWAVE grid. A complete list of grid parameters is given in Appendix E.

Figure 5-5. Layout of GENESIS grid.

Figure 5-6 covers the extent of the grid, and shows the land (green) / water (blue) boundary along with the rock seawall and geotextile tube indicated as hard features (yellow line).

To model the behavior of the detached breakwater, a second finer resolution grid, was set up. Each of the cells in the original grid was divided into four cells, so the fine resolution grid had a total of 484 cells, each 60 ft (18.288 m) long. The smaller cell width necessitated the use of a shorter model time step, so for this grid, a 15 minute, rather than a 1 hour time step was used. The grid origin and orientation remained the same as for the regular grid. These parameters are listed in Appendix E.

Table 5-1. Infrastructure Location along GENESIS baseline

Feature	Building #	Approximate location on GENESIS baseline: Cell Wall #	feet	meters
GENESIS Grid origin; NASA Dynamic Balance Facility, Center Bldg	V50	1	0	0
NASA Dynamic Balance Facility, South Bldg	V045	3	480	146
Unpaved road access to beach		6	1200	366
North end of Seawall; North end of beach fill project		14	3120	951
Navy Surface Combat Systems Center, SSD Facility	V024	17	3840	1170
Navy Aegis Engineering and Training Complex	V021	31	7200	2195
Water Tower	W055	36	8400	2560
Navy Surface Combat Systems Center WIETC Facility	V003	37	8640	2633
Raised Viewing Stand	W036	39	9120	2780
Blockhouse 3	W020	42	9840	2999
Vehicle Assembly North Building	W065	46	10800	3292
Raised Viewing Stand	W115	49	11520	3511
Tower	X080	50	11760	3584
Flagpole at seaward end of Causeway		56	13200	4023
Camera Stand	X065	57	13440	4097
MRL Launcher Facility	Y039	64	15120	4609
Blockhouse 2	Y030	65	15360	4682
Arc Launcher Facility	Y035B	66	15600	4755
Red and white Tower	Y085	67	15840	4828
Vehicle Assembly South Bldg	Y015	68	16080	4901
Blockhouse	Z065	70	16560	5047
50K Launcher Facility	Z071	72	17040	5194
Prior site of Launch Pad 0A		74	17520	5340
Camera Stand, South End of Rock Seawall	Z040	76	18000	5486
Pad 0B, MARS launch facility		80	18960	5779
UAV Runway		89	21120	6437
South Camera Stand; South End of beach fill project		95	22560	6876
Approx middle of Assawoman Inlet (closed)		100	23760	7242
South end of future possible NASA development on Assawoman Island		104	24720	7535
South end of GENESIS Grid		122	29040	8851

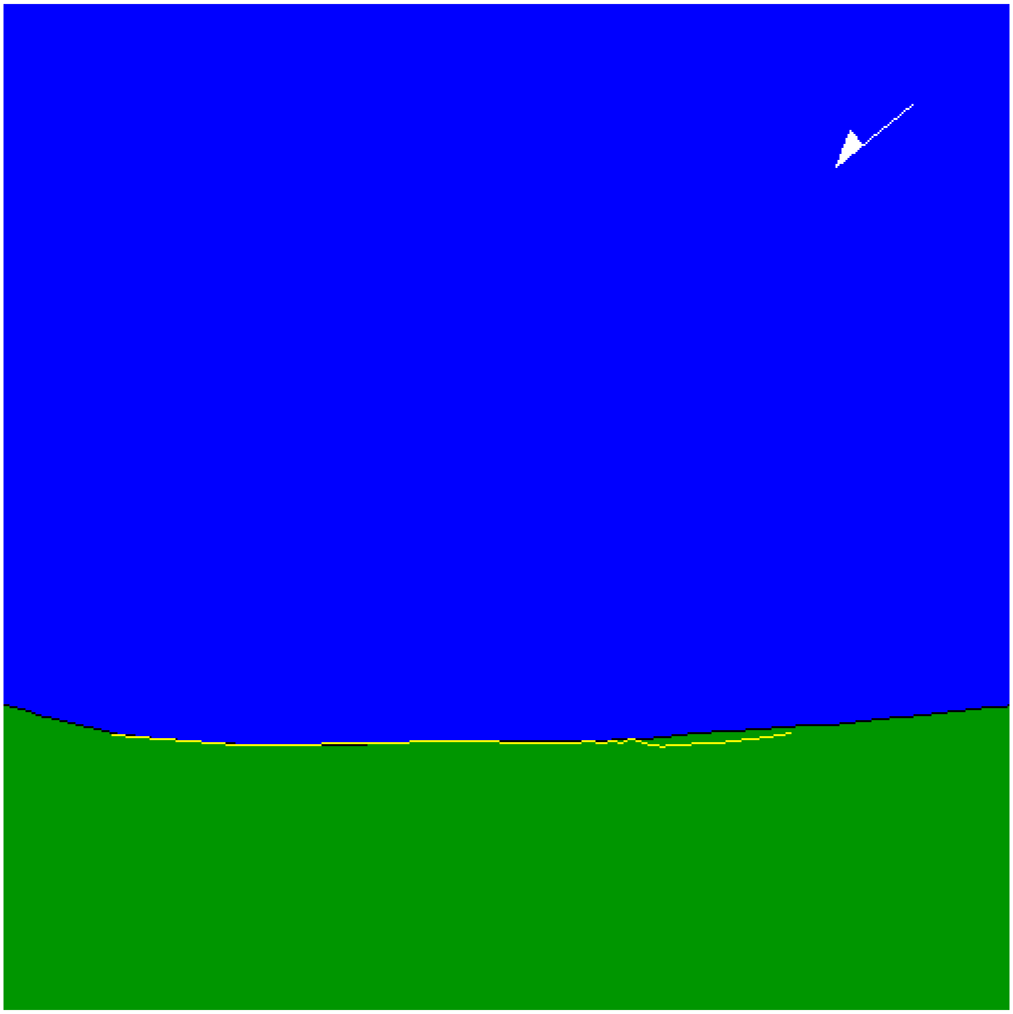

Figure 5-6. GENESIS grid showing Rock Seawall and Geotextile Tube. The 1996 and 2005 shorelines touch most of the seawall but not the geotextile tube.

GENESIS Calibration

Calibration of the GENESIS model consisted of initiating the model with a measured shoreline, and during a run having it evolve the shoreline to approximate a second measured shoreline which was collected at a later date. The 1996 and 2005 measured shorelines were selected for calibration. The results of this calibration are shown graphically in Figure5-7. Note that there is about a 10:1 distortion in offshore to alongshore distance scales which exaggerates the differences in the model comparison, but allows it to be seen. Figure 5-8 shows the difference in the 2005 measured and the final model shoreline (measured minus modeled) and the average yearly difference. The model reproduced the change rate in the 1996 to 2005 shorelines to an accuracy of better than three ft (1 meter) per year at all locations.

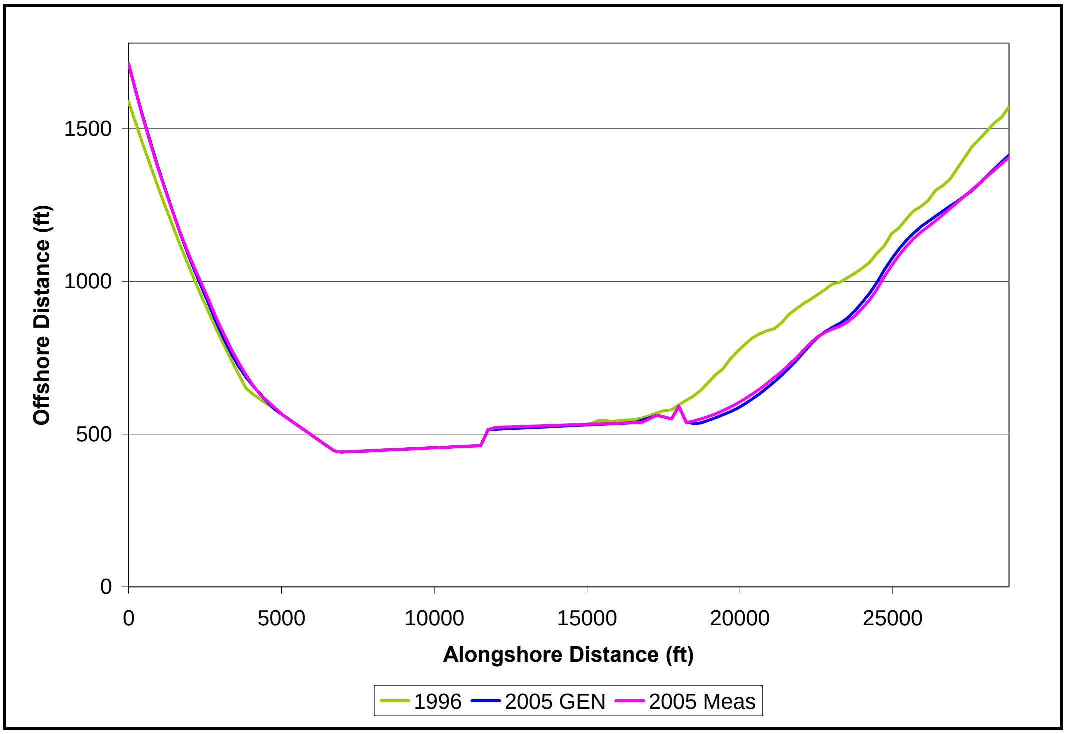

Figure 5-7. GENESIS calibration showing Initial (1996), Final (2005 GENESIS), and Measured (2005) shorelines.

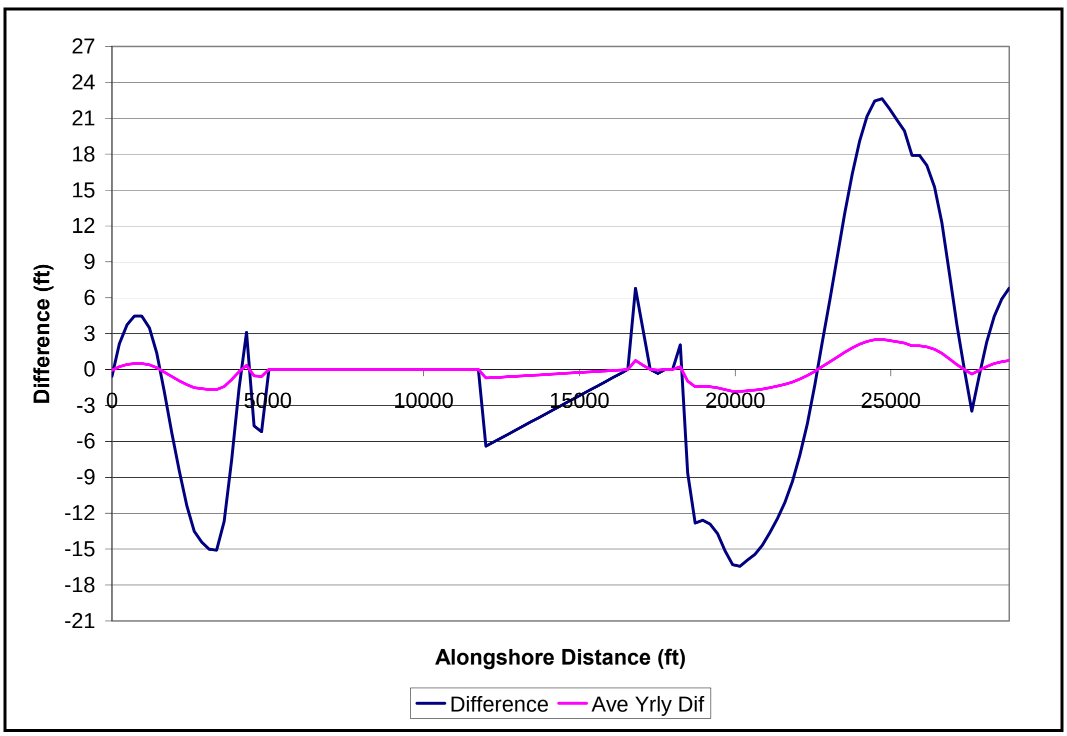

Figure 5-8. Difference in 2005 Measured and GENESIS modeled shoreline.

During calibration, various values for the K1 and K2 constants were tried, however, the default values were found to give satisfactory results and were adopted. Lateral boundary conditions were based upon shoreline change rates obtained from the 1996 and 2005 profiles. For calibration and most model runs, the waves used to drive the model were a 5-year set of average wave conditions. These are described further in the sensitivity section below. The use of a regional contour was found to improve the comparison between the final model and final measured shorelines. Figure 5-9 shows the 5 meter contour obtained from the bathymetry, the 5 meter contour obtained from the beach profiles, the 2005 shoreline (shifted 700 meters seaward) along with the Regional Contour which was applied (shown in blue). This contour was obtained by iteration. It is similar to the other contours shown in Figure 5-9, but is smoother and more flattened on the ends. A complete set of model configuration parameters are given in Appendix E.

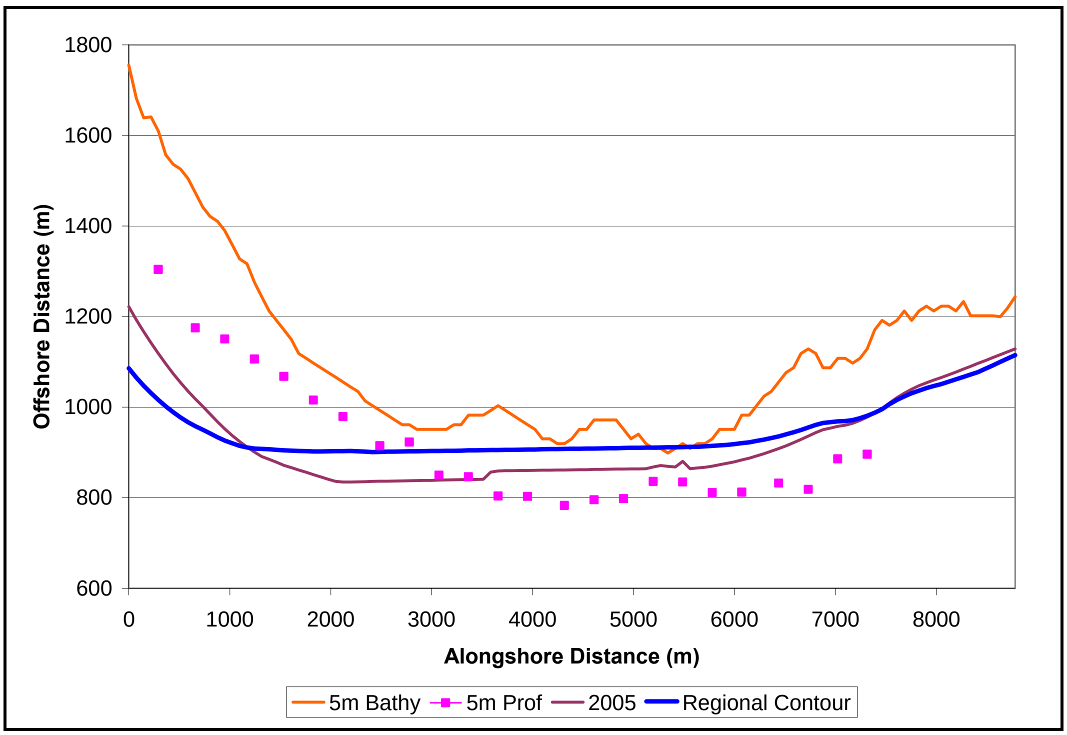

Figure 5-9. Wallops Island Regional Contour. (5:1 vertical to horizontal distortion)

Sensitivity

The 20 years of WIS data for station Atl-178 were analyzed on a year-by-year basis to determine simple sediment transport rates using the method described in Gravens, 1989. Wave data were assembled in 5 year blocks using the following criteria: Ave - the 5 years whose net sediment transport rates were nearest to the 20 year average net rate. Max - the five years with the maximum gross transport rates. Min - the five years with the minimum gross sediment transport rate, N - the 5 years with the maximum net amounts of northerly transport, and S - the five years with the maximum net amounts of southerly transport. The years selected for each 5-year block are shown in Table 5-2.

These five different wave data blocks were used to drive the GENESIS model. The calibration results presented above (along with much of the modeling discussed below and in the next chapter) were produced using the Ave wave block. GENESIS results using the other four wave blocks, along with the measured 2005 shoreline are shown below in Figure 5-10.

There are not large differences using these different driving conditions. The largest is for the Southward wave set showing additional erosion just south of the seawall. This would not be unexpected. It is noted that the 2005 measured shoreline falls within the envelope of these four modeled shorelines.

Table 5-2.

Year	Ave	Max	Min	N	S
1980					
1981	X				
1982					
1983		X			X*
1984					
1985	X		X		
1986			X		
1987	X		X*		
1988			X*	X*	
1989				X	
1990			X	X*	
1991					X
1992		X*			X*
1993	X				
1994					X
1995	X	X			
1996		X*		X	
1997				X	
1998					
1999		X			X

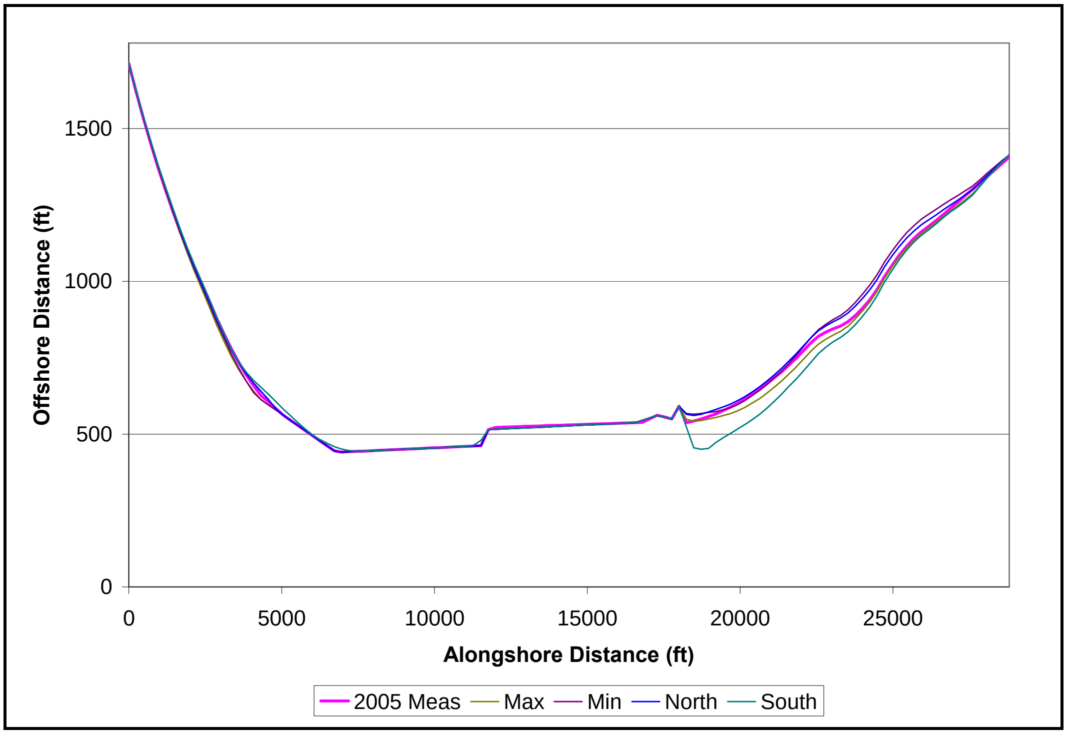

Figure 5-10. Comparison of the 2005 measured shoreline with GENESIS shorelines driven with the Max, Min, North, and South wave blocks.

Verification

Once the GENESIS model was calibrated, it was verified by running the model using a second set of measured profiles. Since the 2007 shoreline was the only other available recent shoreline, for verification, the 2005 shoreline was used as the initial shoreline and the 2007 shoreline was used as the final target shoreline were used for verification. The 2007 shoreline does not extend over the complete GENESIS grid, so the comparison, shown in Figure 5-11 is truncated at both ends. The 2007 measured shoreline (pink) does not agree as well with the 2007 GENESIS verification shoreline (blue) as in the calibration (Figure 5-7). However, the 2007 measured shoreline does fall almost completely within the envelope of the Max, Min, North, and South shorelines that were run using the 2005 shoreline as the initial shoreline. Since these runs were only two years long, two year wave blocks containing the maximum value years were used to drive the model. The years used are shown by asterisks in Table 5-2.

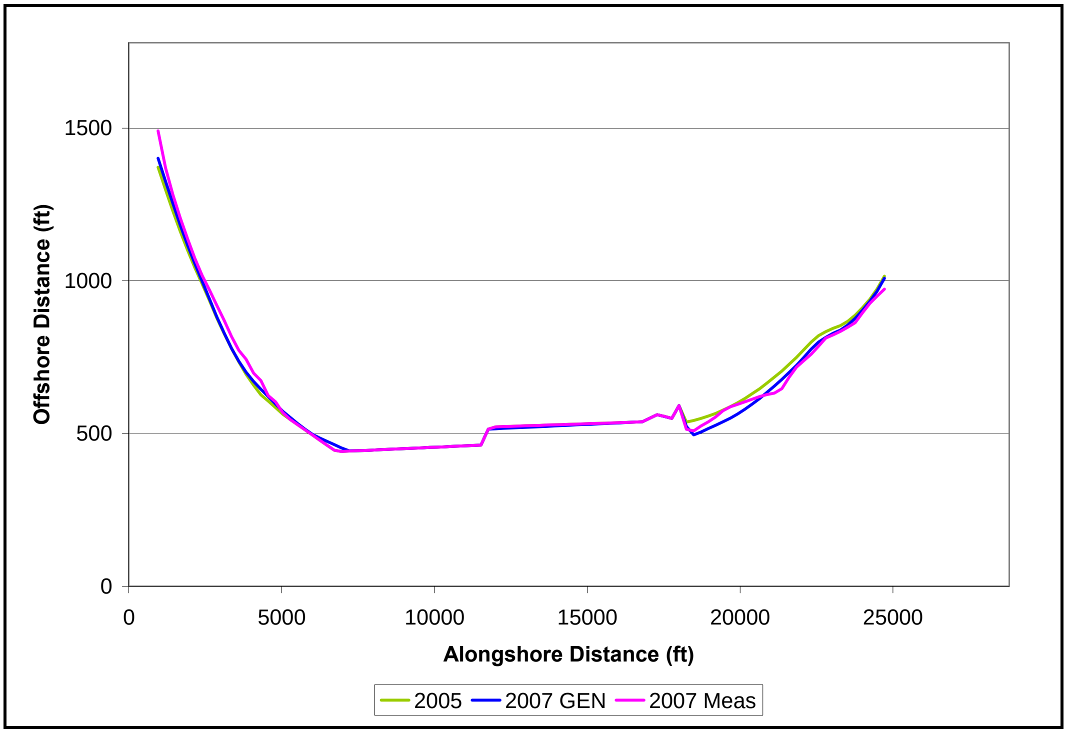

Figure 5-11. Comparison of Initial (2005), Final (GENESIS modeled) and Meas (2007) Shorelines, showing only the portion of the shoreline where there is 2007 data.

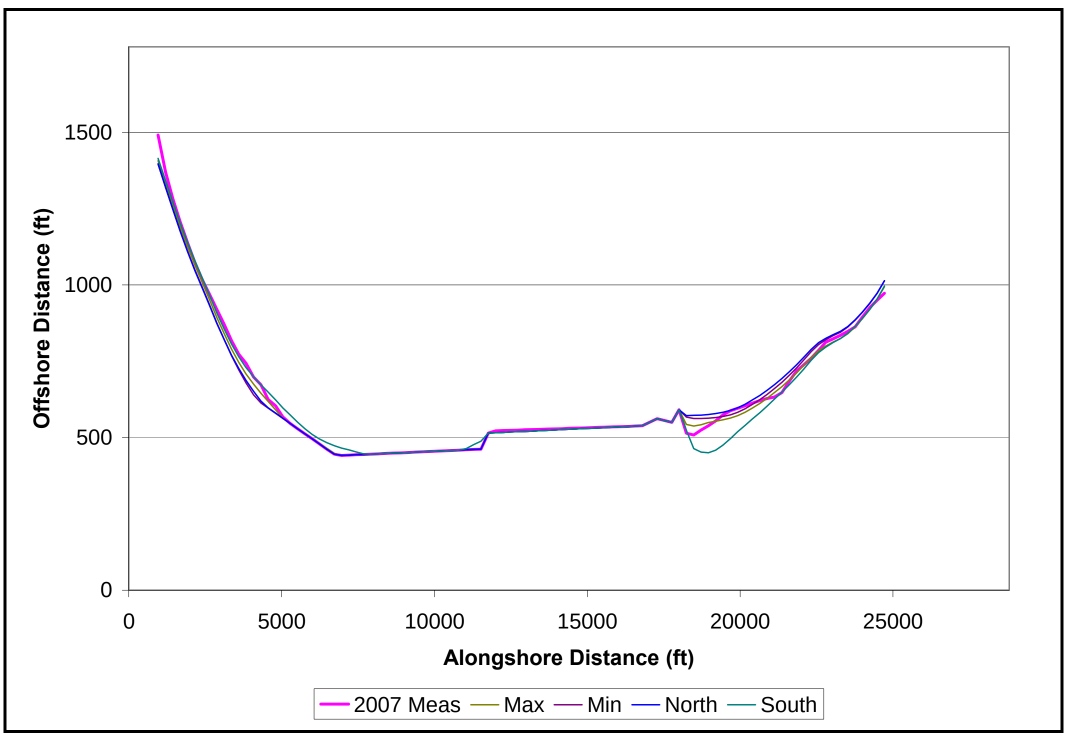

Figure 5-12. Comparison of the 2007 measured shoreline with GENESIS shorelines driven with the Max, Min, North, and South wave blocks.

STWAVE Results

The presence of Fishing Point greatly affects the wave patterns seen on the shore at Wallops Island. Wave energy coming from the northeast is largely blocked by Fishing Point, whereas wave energy coming from the southeast arrives at the beach with little change (see Figures 1-2, 5-1, e.g.). An example of this is shown in the STWAVE output given in Figure 5-13. This figure shows the near breaking wave heights that occur along the beach at Wallops Island for a 4 second, unit height offshore wave that approached the coast from a variety of angles. Positive angles are those coming from left of shore normal (the northeast); negative angles are those coming from the southeast (see Figure 5-2). Waves coming from the southeast have roughly the same height everywhere along the shoreline, but waves coming from the northeast have dramatically decreasing height (and thus energy) the further north they are along the shoreline. This means that they have less ability to transport sand to the south. This wave sheltering from Fishing Point and the offshore shoals is the primary reason that there is a transport reversal on Wallops Island.

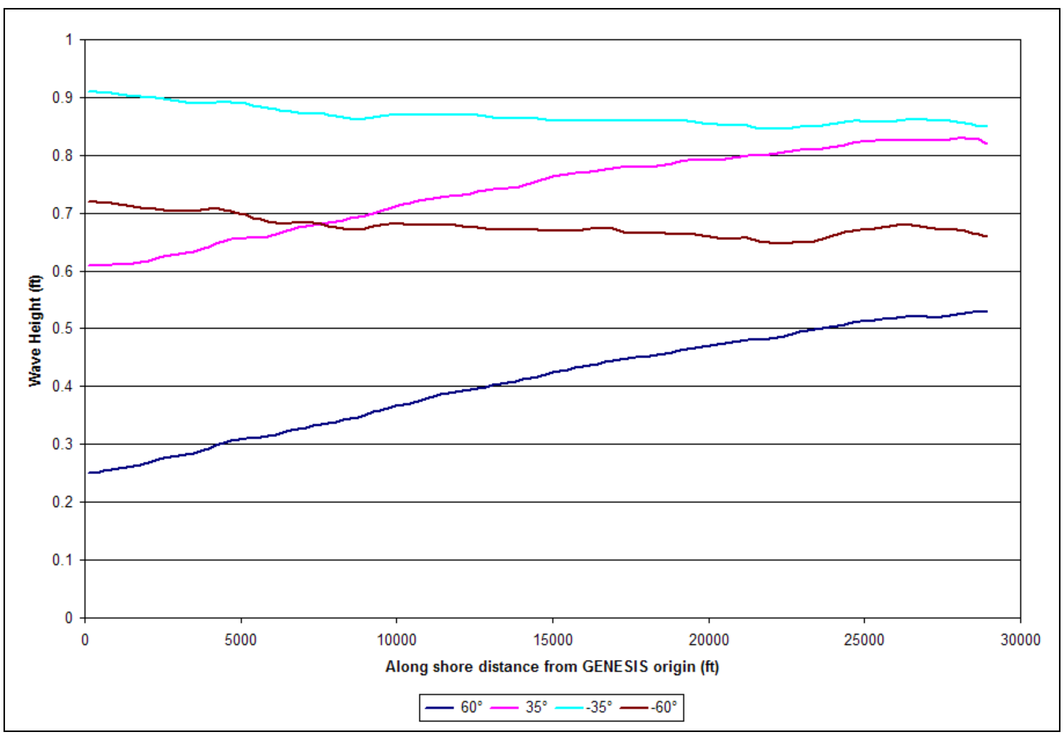

Figure 5-13. Example of nearshore wave heights along the beach at Wallops Island.

The point is further illustrated in Figure 5-14. This figure shows wave heights everywhere within the STWAVE grid for one of the four cases shown in Figure 5-13, the case for a unit high, 4 second, wave having an deep water (pre-refracted) angle of +60°. The offshore direction of this wave is shown by the black insert arrow at the top of the figure. Colors on the figure and scale are referenced to an offshore wave height of 1 unit. The lines on the figure are lines of constant wave height. Seaward of the shoals in the vicinity of Fishing Point, there is little change in wave height. However, near shore along Wallops Island there is a strong gradient in the wave height, with the height decreasing to the north.

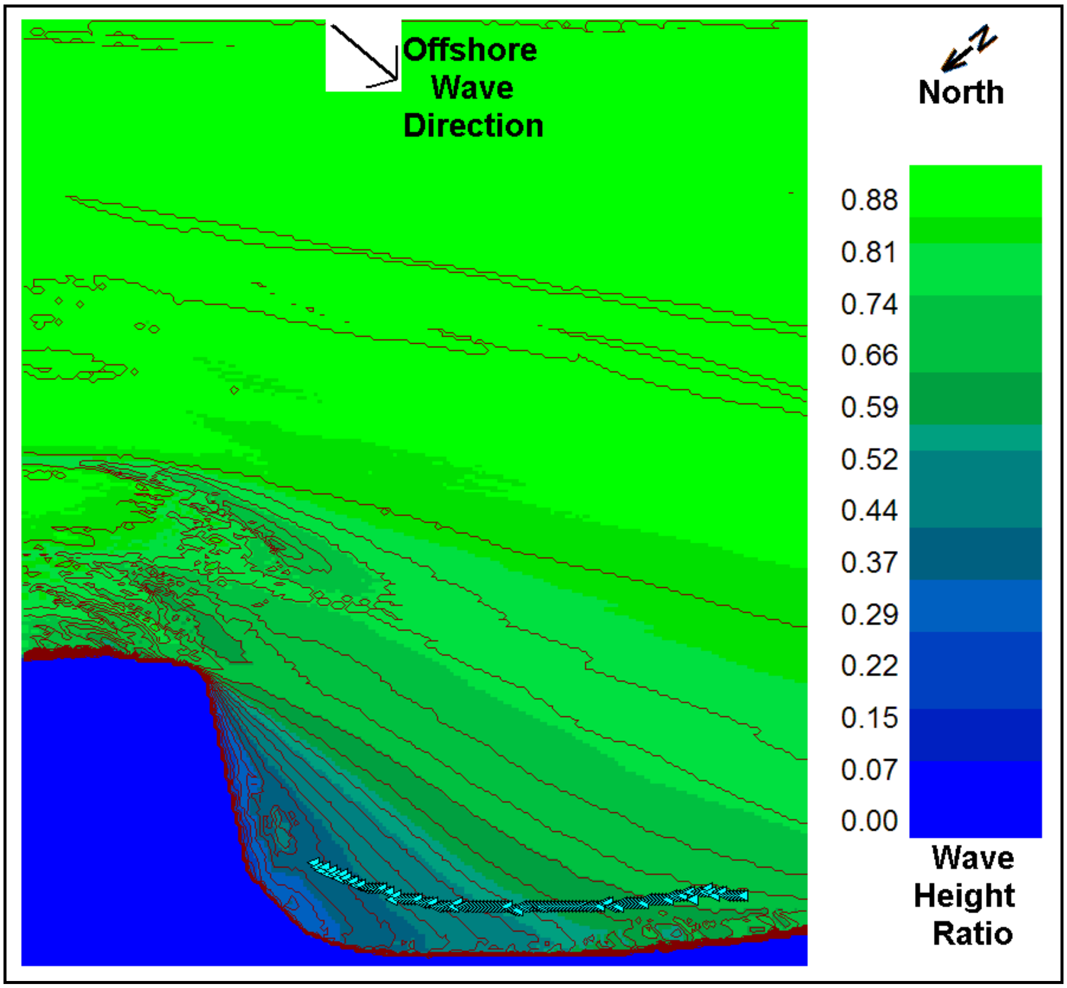

Figure 5-14. Example of wave heights throughout the STWAVE grid.

GENESIS Results -Wallops Island Sediment Budget

Longshore sediment transport rates vary from year to year primarily because of yearly variations in the input wave field. To determine the average transport rate along Wallops Island, the 20-year WIS wave data set was broken into 20 different four-year blocks (1980-1983, 1981-1984, etc.). GENESIS was run using each of these blocks and the model estimated net transport rates during the 4th year were averaged. This average net transport rate is shown in Figure 5-15. The sign convention assigns transport to the right (South) as positive and to the left (North) as negative. This figure indicates that for average transport conditions there is a divergent nodal point on the north end of Assawoman Island, with net southward transport to the south of that point and net northward transport to the north. The 95% confidence limits indicate that for most years the varying wave conditions shift the divergent point along the shoreline within about a 7000 ft window (a mile and a half).

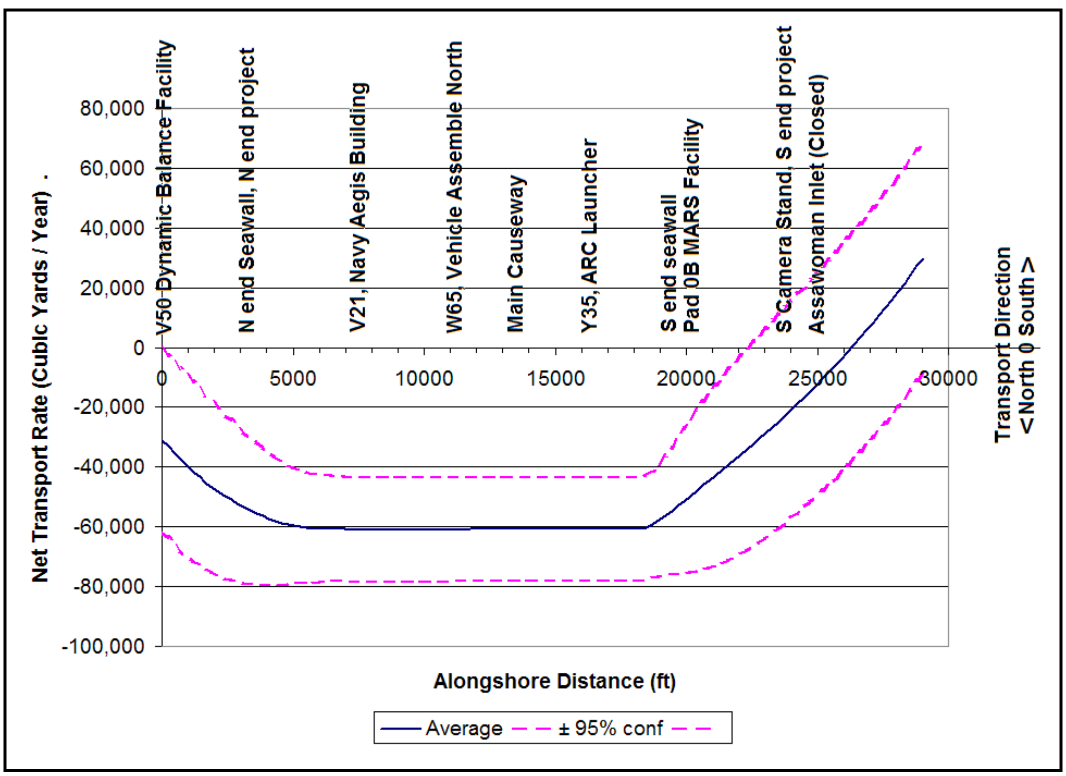

Figure 5-15. Wallops Island Sediment Budget

The GENESIS results presented in Figure 5-15 were used to produce the more typical schematic sediment budget representation shown in Figure

5-16. In this figure, the numbers 20, 40, and 60 represent thousands of cubic yards of transport per year, as per Figure 5-15.

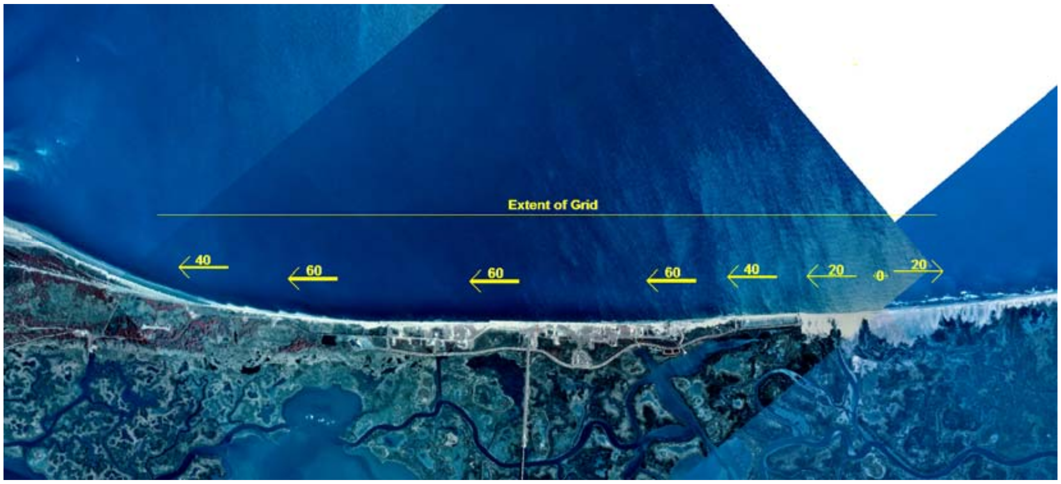

Figure 5-16. Wallops Island Sediment Budget. Numbers are the average net transport rate in thousands of cubic yards per year.

Figure 5-17, shows an example of distinct northward transport within the groin field along Wallops Island. It was taken in 1994 and shows several relatively un-deteriorated groins along the north end of Wallops Island. This is in an area of shoreline accretion.

These results show moderate agreement with the Moffat & Nichol 1986 (M&N 1986) sediment budget, which is discussed in Morang, Williams and Swean (2006). This earlier budget also shows the north end of Wallops Island as accreting and the south end as eroding. In addition, net transport rates are of comparable magnitude. The main difference is that the M&N 1986 budget shows a divergent nodal zone which is north of the causeway, and in addition, a convergent nodal zone near the north end of the seawall. The differences in the budgets can be attributed to the different methodologies used to develop them and to the different time periods on which they are based. Because of the continuing growth of Fishing Point (Figures 2-19 and 2-20) along with the southwestward migration of the offshore shoals (Wikel, 2008) it is to be expected that the divergent nodal zone along Wallops Island should be shifting to the south.

Figure 5-18 shows the average gross transport rate along Wallops Island. This figure shows gross rates of the order of 400,000 yd^3/yr south of the seawall, rates of the order of 100,000 yd^3/yr in front of the seawall, and rates on the order of 350,000 yd^3/yr north of the seawall.

Figure 5-17. Groins field on Wallops Island showing transport direction to the north. Photo taken 20 March 1994.

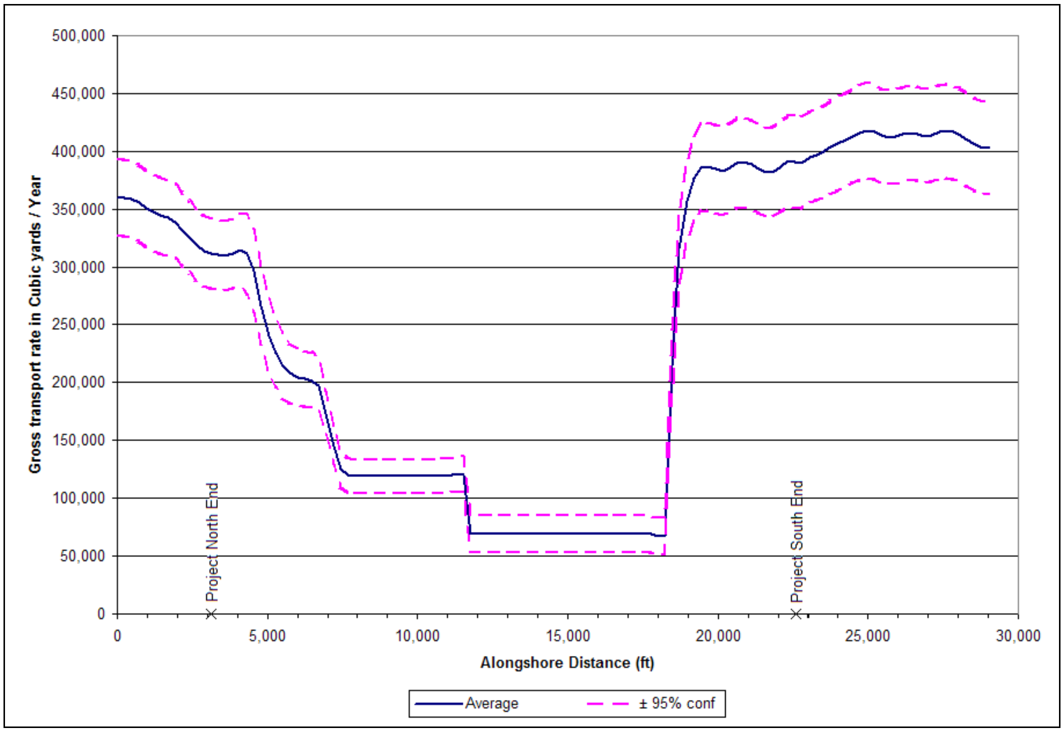

Figure 5-18. Average yearly gross transport rates along Wallops Island.

6 Beach Fill Design Alternatives

The appropriate amount of beach fill is the anticipated minimum amount (the minimum target fill) needed to provide defense from storm damage plus an additional sacrificial amount (the advanced fill) that is expected to be removed by longshore transport between renourishment events. This approach, described in the Coastal Engineering Manual (CEM, Part 5, Chapter 4; Gravens, et al., 2006), strives to ensure that the minimum amount of fill remaining at the project site just before renourishment is still adequate to provide storm damage protection. The volume needed for the minimum target fill is based upon the profile developed in Chapter 4 through SBEACH modeling. The amount of advanced fill is determined by GENESIS modeling of different project designs (alternatives). The derivation of both these volumes is discussed below.

Minimum Target Fill for Storm Damage Protection

The Minimum Target Fill volume was derived by summing several component volumes: the volume needed to bring the shoreline to an equilibrium condition (the Seawall Deficit volume), plus the volume needed to advance the shoreline seaward to achieve the B070 profile described in Chapter 4 (the Berm volume), plus the Dune volume for the B070 profile.

Characterization of the Seawall Deficit Volume

The Rock Seawall has halted the shoreline retreat along its length. However, as is typical, this has come at the cost of removing material below the waterline (steepening the profile) in front of the seawall. Profiles at both ends of the study area do not show this sub-aqueous sediment deficit. Figures 6-1 through 6-3 compare an equilibrium profile (shown in red) that is based upon the native beach grain size (D_{50} = 0.20 mm) to profiles at three locations. Figure 6-1 shows the profile at GENESIS cell 17, which is near the north end of the project site 3840 feet (1170 m) south of the GENESIS origin. The beach in front of the seawall at this location is accreting and is in a healthy condition. Figure 6-2 shows the profile at GENESIS Cell 50, near the center of seawall at a distance 11760 ft (3580 meters) south of the GENESIS origin. This location is 1200 ft (366 m) south of Building W-65. The profile here shows the greatest sediment deficit. Figure 6-3 shows the profile for GENESIS Cell 87, which is at the south end of the study area near the middle of the geotextile tube and 20640 ft (6290 meters) south of the GENESIS origin. The shoreline here is retreating but there is a sub-aerial beach and the position of the shoreline is not constrained by the geotextile tube. Figures 6-1 and 6-3 show that the native beach equilibrium profile is a reasonable approximation of the profiles north and south of the seawall and that these profiles have no substantial deficit of material. However, there is a substantial deficit of material on the Figure 6-2 profile, as, to a lesser extent, there is along most of the rock seawall.

Figure 6-4 shows these deficits in plan view for all the profile lines. Calculations for these deficits are based upon a D_{50} = 0.29 mm equilibrium profile, the median diameter of the borrow site material. In Figure 6-4, surplus (positive values for profile elevation minus 0.29mm equilibrium profile elevation) are shown in green and deficits (negative values) in red. The scale across the bottom of the figure shows the amount of the differences. The profile lines in this plan view run between the shoreline and the depth of closure. The black line in this figure shows the location of the rock seawall.

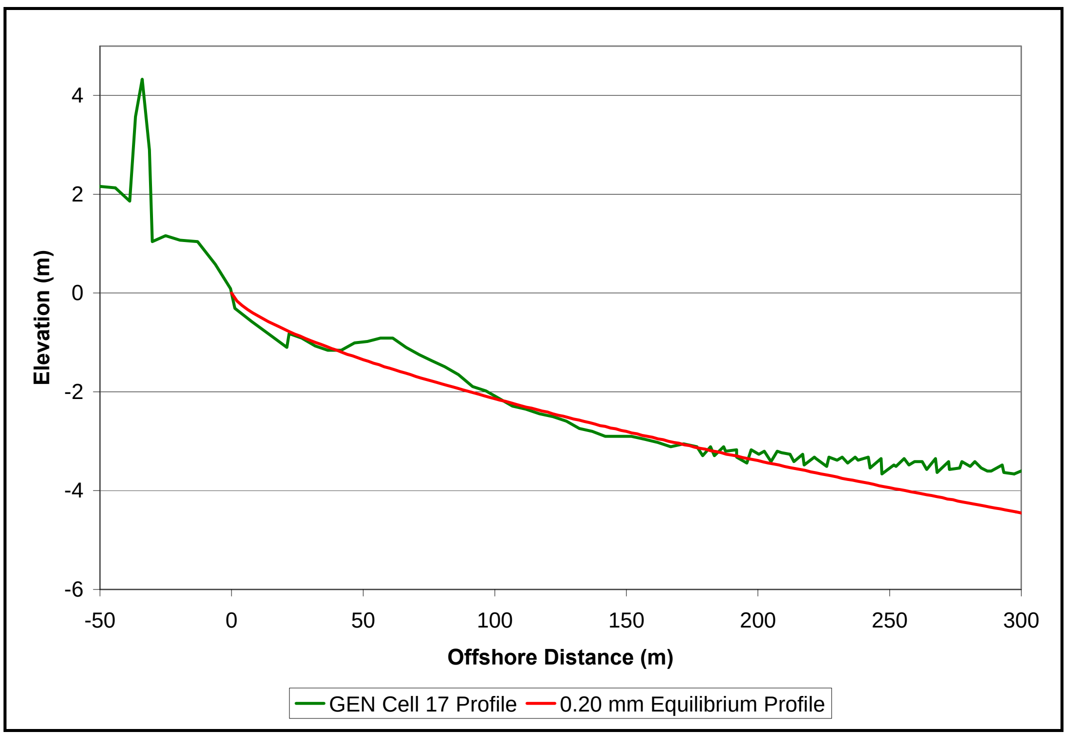

Figure 6-1. Comparison of healthy profile at north end of seawall with 0.20 mm Equilibrium profile.

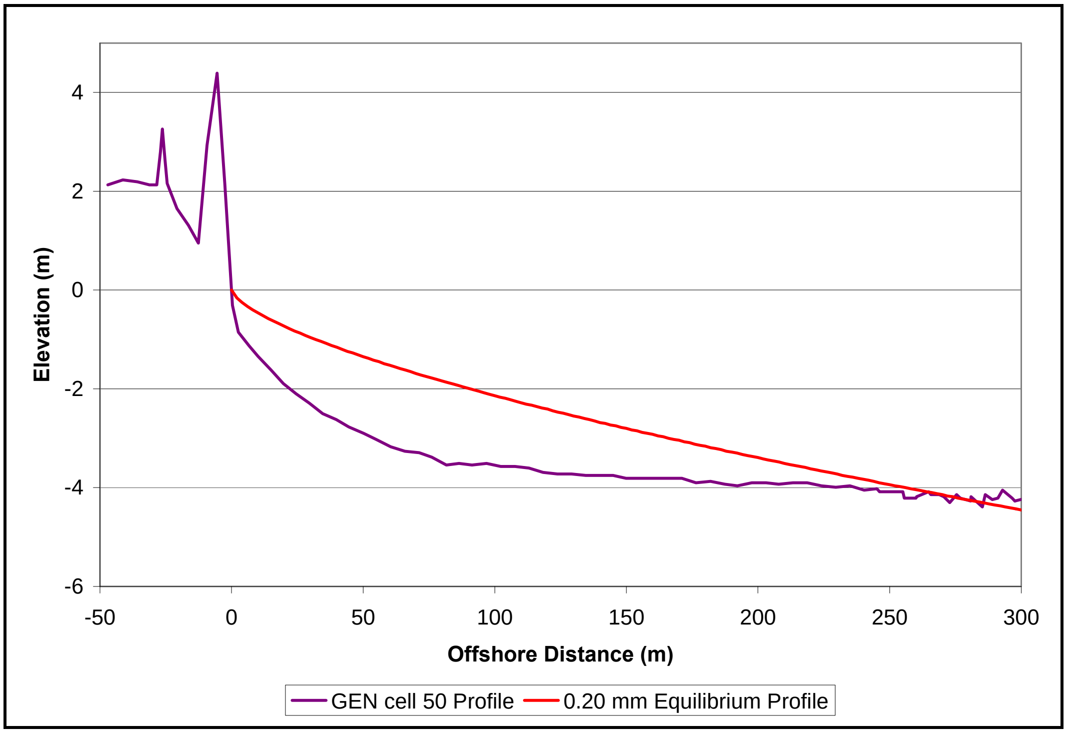

Figure 6-2. Comparison of eroded middle of seawall beach profile with the 0.20 mm Equilibrium profile.

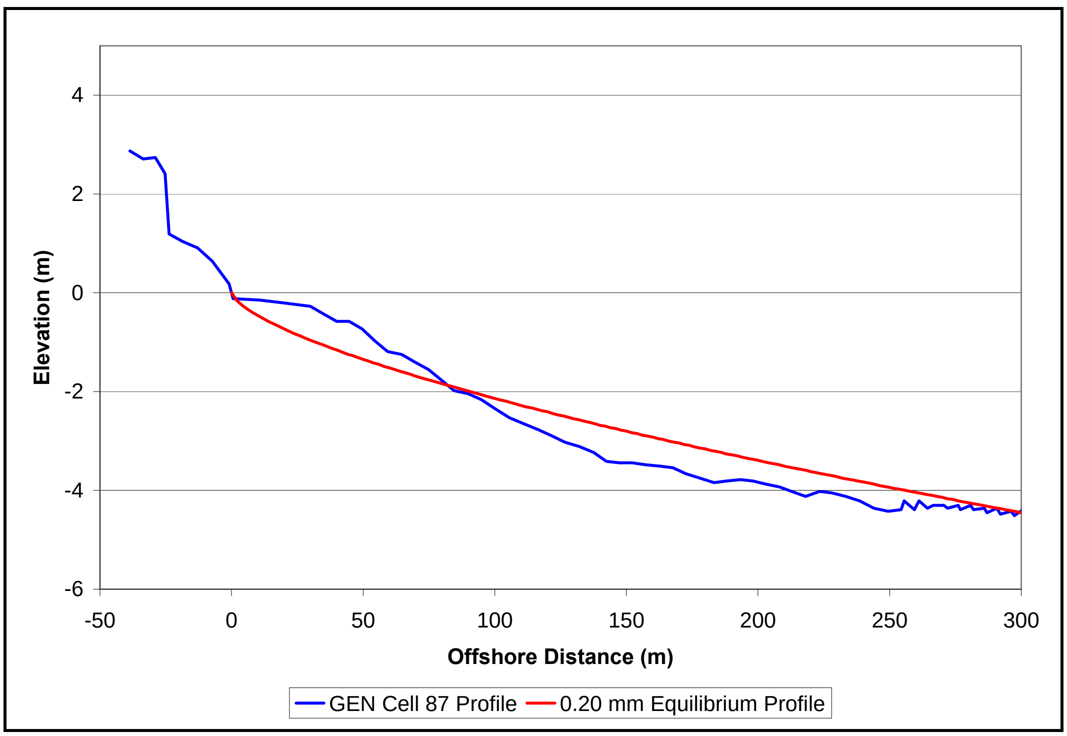

Figure 6-3. Comparison of healthy GENESIS Cell 87 profile with the 0.20 mm Equilibrium profile.

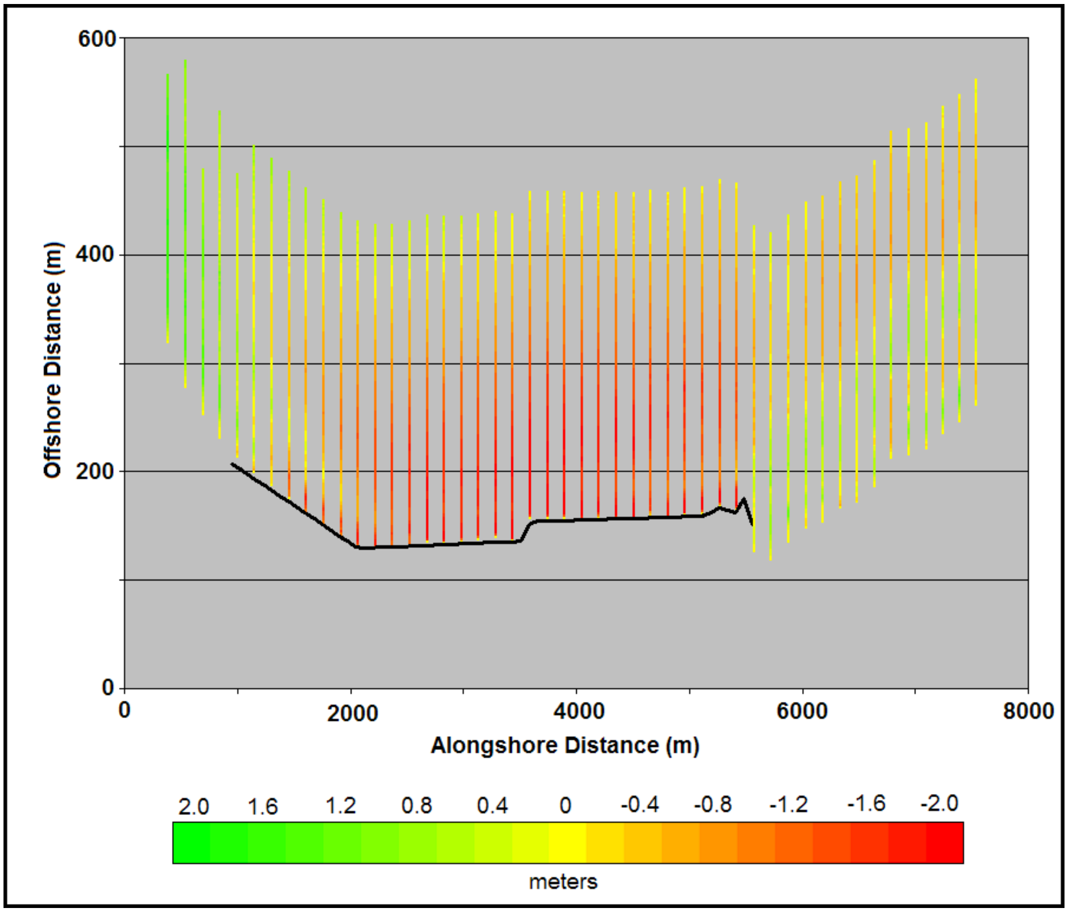

Figure 6-4. Locations of deficits in profile elevations. Note there is approximately a 10:1 distortion in the offshore to alongshore scales.

Before beach nourishment can advance the shoreline seaward, material must be provided to restore the profile to an equilibrium condition along the portions of the seawall where it is needed. In this report, this volume is termed the Seawall Deficit Volume. Volumes were calculated by interpolating the beach profile elevations into each GENESIS cell and comparing those profiles with a D_{50} = 0.29 mm equilibrium profile. Then the volumes needed in each GENESIS cell were summed along the length of the project. Based on the 2005 profiles, the Seawall Deficit Volume for this project is estimated at 684,000 yd^3 (523,000 m^3).

The Seawall Deficit estimate is based upon the beach fill material having a median grain size (D_{50}) of 0.29 mm. If, for any reason, the fill material that is placed on the beach has a finer grain size (for instance, by switching to an alternate borrow site), then additional material will need to be provided to compensate for the change in the underwater portion of the equilibrium profile. The difference in a 0.29 mm and a 0.20 mm based equilibrium profile is shown in Figure 6-5. The orange area between the two profiles represents the additional needed material. Table 6-1 lists the additional volume of material required if the fill material has a D_{50} less than 0.29 mm.

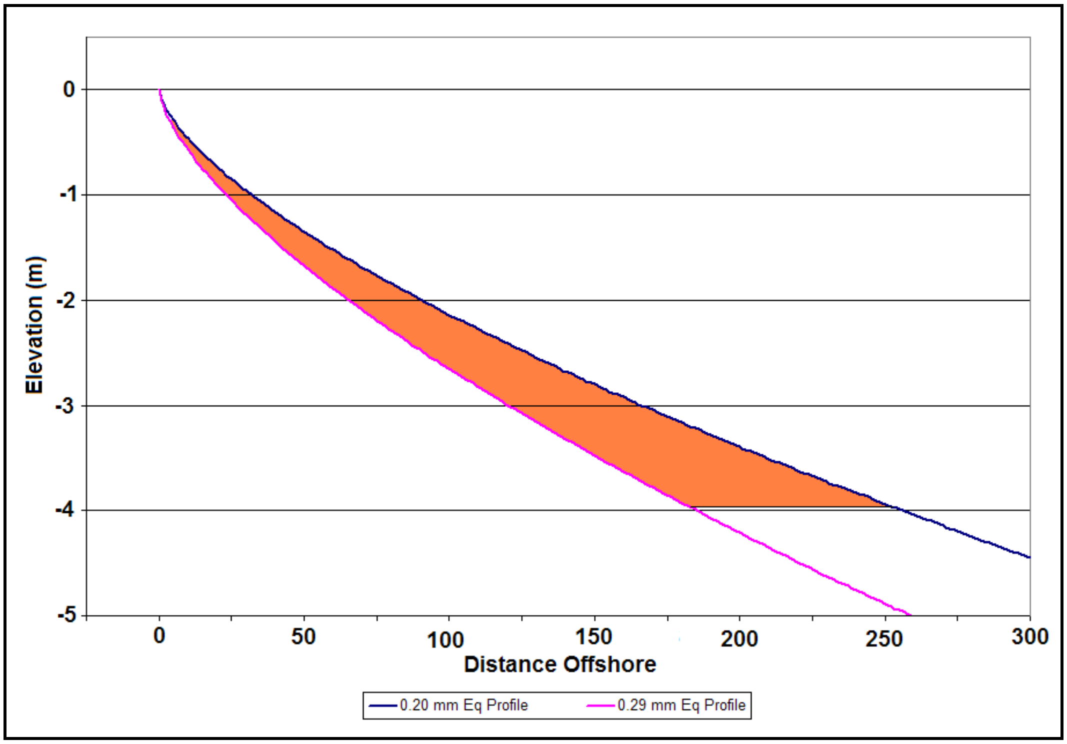

Figure 6-5. Equilibrium profiles for 0.20 mm and 0.29 mm grain sizes.

Table 6-1. Profile Adjustment Volumes based upon Fill Grain Size.

Median grain size (mm)	Profile Adjustment Volume (yds^3)
0.29	0
0.28	62,000
0.27	127,000
0.26	200,000
0.25	292,000
0.24	393,000
0.23	501,000
0.22	619,000
0.21	748,000
0.20	889,000

Characterization of Berm and Dune Volumes

Berm volumes were calculated for each GENESIS cell by multiplying the berm width (determined to be 70 ft (21 m) in Chapter 4) by the height between the berm elevation (+6 ft (1.83m)) and the depth of closure elevation (-13 ft (-3.96m)) by the cell width (240 ft (73.152 m)). These were summed to determine the total berm volume. Dune volumes were also calculated for each GENESIS cell and summed over the project length. Adjustments were made to cells at the south end of the project that did not have a rock seawall. The total berm and dune volumes needed for this project are 964,000 yd^3 and 255,000 yd^3, respectively (737,000 m^3 and 194,000 m^3).

Characterization of Overfill Volumes

The median grain diameter presently on the beach at Wallops Island is in the vicinity of D_{50n} = 0.20 mm = 2.32 ϕ, and the sediments are moderately well sorted with a typical standard deviation of $\sigma_{\phi n}$ = 0.5, where the subscript "n" is applied to the native material. The median grain diameter of the proposed offshore borrow material (subscript "b") is approximately D_{50b} = 0.29 mm = 1.79 ϕ. These sediments have standard deviations of $\sigma_{\phi b}$ = 0.5 to 0.9. As discussed in the CEM (Section V-4-1-e-3-i and Figure V-4-9 on pg V-4-26), this implies that the beach fill sediments will be within the stable region and the appropriate overfill multiplier is 1.0.

There is another issue to address in considering the Overfill Volume. This is the inclusion of a margin of safety in the design to help insure project success. There are two areas of greatest concern. The first is the grain size of the fill material. The project design analysis has been based upon the fill material having a D_{50} of 0.29 mm. This value was derived from sediments obtained from cores taken at the two most likely offshore borrow sites (Site A, and Site B; see Chapters 3 and 8). The average and the median of the D_{50}'s are in fact both coarser than 0.29 mm. However, these statistics are derived from a very limited dataset. Ten cores were obtained from Site A and six cores from Site B. Both sites cover two square miles. As shown in Table 6-1, the consequences of over-estimating the true fill grain size would lead to a significant underestimate of the appropriate under-water volume of fill material needed for the initial nourishment. However, the probability of the true grain size being less than 0.29 decreases rapidly with decreasing grain size.

If the true median grain size at the borrow site is as small as that represented by the smallest ¼ of the core sample D_{50}'s from both shoals, Figure 3-5 shows it would be near 0.27 mm, rather than the 0.29 mm value used for modeling purposes. Applying this value to Table 6-1, an Overfill Volume of 125,000 yds^3 was chosen. The preferred location, Shoal A (Chapter 8) has a larger median grain size than Shoal B. As discussed in Chapter 3, ¾ of the sediment samples from Shoal A had median grain sizes of 0.29 mm or larger.

While an overestimation of the median grain size of the fill material would have a significant impact on the volume of fill material needed on the underwater portion of the profile, there would be fewer impacts to the above water portion of the profile. These would be mostly limited to the portion of the profile between mean sea level and the berm crest (the foreshore slope), and this portion has been modeled in a conservative manner. This portion of the profile is exposed to wave action during the higher portions of the tide cycle and can be expected to reach an equilibrium slope based upon grain size in a manner similar to the underwater (below mean sea level) portion of the profile (steeper slopes for larger grain sizes). However, the Dean Equilibrium Profile Theory, which was applied for the underwater portion, is normally only applied up to an elevation of mean sea level. For this project, the foreshore slope was modeled as a straight line with a slope of tan (4.17°). This value was obtained as an average of foreshore slopes taken from existing profiles measured north and south of the seawall. The native beach material at Wallops Island is about 0.2 mm, and the foreshore slope is naturally adjusted for that grain size. The grain size of the fill material is expected to be substantially larger than this, and thus following nourishment the foreshore slope will likely be steeper than at present. A steeper foreshore slope would require less fill material between the berm crest and the depth of closure than is called for in the present design, and therefore the present design is considered conservative.

The other area of concern was the depth of closure value of 13 ft used in the analysis. Though the methodology used seemed defensible, given the lack of multiple profile data sets, the resulting value is low compared to other east coast sites. If the overfill volume chosen above is not needed to compensate for an overestimation of the fill grain size, it would provide sufficient additional material to adjust the depth of closure to over 15 ft.

Characterization of Sea Level Rise Volumes

The most recent USACE guidance on sea-level rise (SLR) (USACE, 2009a, pg 2, section 6b), which is an update of earlier guidance (USACE, 2000), requires a project assessment using Low, Intermediate, and High rise rates. The Low rate of SLR should be based upon the historic rate, the Intermediate rate upon Curve I of the National Research Council's (NRC) 1987 report *Responding to Changes in Sea Level: Engineering Implications*, and the High rate upon NRC (1987) Curve III.

The total rate of historical SLR (1.12 ft/100 years) at Wallops Island was obtained by taking the average of the rates from three nearby tide gage locations: Lewes, DE, Solomons Island, MD, and Portsmouth, VA. These stations have local trends from long term tide gage records (shown in Table 6-2) as evaluated by Zervas (2001). The locations are about equidistant from Wallops Island and are in widely different compass directions.

Table 6-2. NOAA Tide Stations used to obtain total SLR rate at Wallops Island, VA.

Station Name	Latitude	Longitude	First Year	Year Range	MSL Trend and Standard Error (mm/yr)		Distance from Wallops Island, VA (miles)	Direction from Wallops Island, VA (degrees)
Lewes, DE	38° 46.9' N	75° 07.2' W	1919	81	3.16	0.16	68	16°
Solomons Island, MD	38° 19.0' N	76° 27.1' W	1937	63	3.29	0.17	63	301°
Portsmouth, VA	36° 46.7' N	76° 18.1' W	1935	53	3.76	0.23	86	212°

Following NRC (1987), Knuuti (2002), Rosati and Kraus (2009), and USACE (2009a), the increase in sea level at a future date above the current level can be estimated using the equation:

$$Rise = (e + M)(t_2 - t_1) + b(t_2^2 - t_1^2) \qquad (6\text{-}1)$$

where:

$(e + M)$ is the total historical rise rate
= 0.0112 ft/yr for Wallops Island

t_2 is the future date minus year 1986,

t_1 is the project start date (2010) minus year 1986, and

b is a set of coefficients given in NRC (1987)

$b_{(\text{Historical})} = 0$

$b_{(\text{Curve I})} = 9.2 \times 10^{-5}$ ft/yr^2
$b_{(\text{Curve II})} = 21.7 \times 10^{-5}$ ft/yr^2
$b_{(\text{Curve III})} = 34.5 \times 10^{-5}$ ft/yr^2

Figure 6-6 shows the projected rate of SLR at Wallops Island for the 50-year project life as obtained from Eq. 6-1 for the Historical rate and for the three NRC (1987) curves. This figure shows that the NRC (1987) Curve III predicts a 2.25 ft (0.69 m) SLR at Wallops Island by the end of the project lifetime (2060). This 2060 SLR amount is four times the amount of SLR predicted by the historical (Low) amount (0.56 ft, 0.17 m) and 2.2 times the Curve I (Intermediate) amount (1.01 ft, 0.31 m).

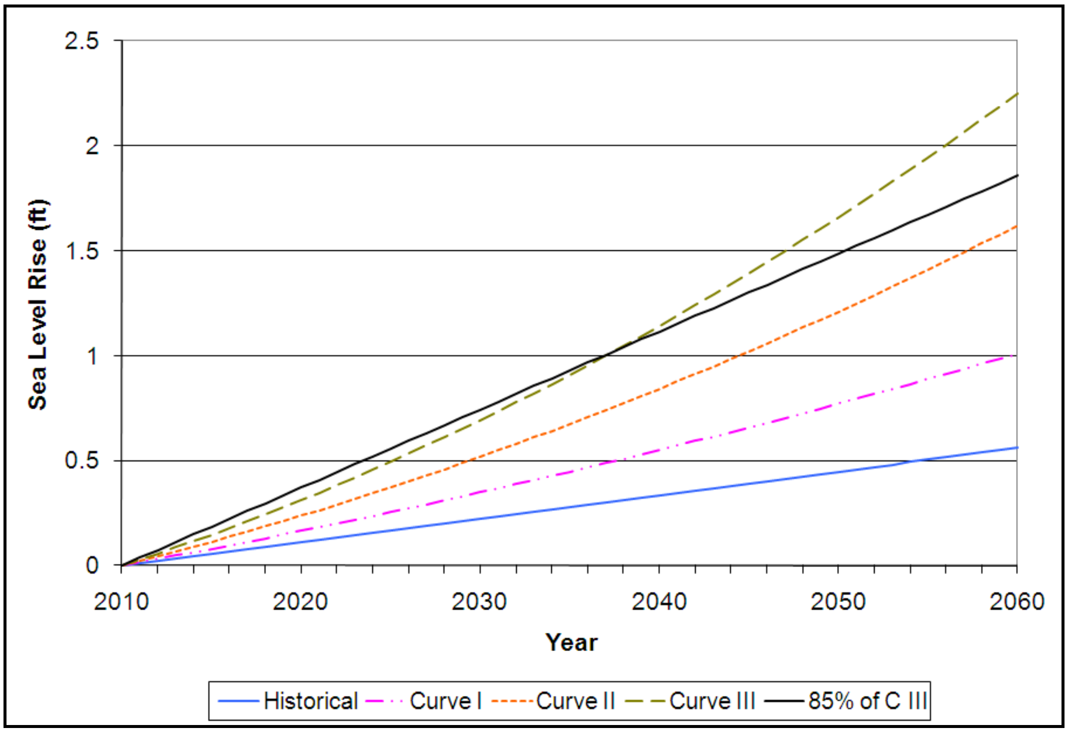

Figure 6-6. Projected Wallops Island, VA SLR, as based upon NRC (1987) curves.

For project planning purposes, it was decided to choose a target fill volume which was based upon 85% of the 2060 Curve III amount, but to add that volume in constant increments (for ease of planning). This equates to a 1.91 ft (0.58 m) of SLR in 2060 calculated as a constant rise rate of 0.037 ft (0.011 m) per year. This target value was chosen because it predicts a year 2060 rise that is about 80% of the difference in the historical and the Curve III amounts and about 70% of the difference in the Curve I and the Curve III amounts. This 85% line is also shown in Figure 6-6.

There is no USACE guidance that mandated the use of 85% (or any other percent) of the 2060 Curve III amount. It was chosen for planning purposes to be greater than that predicted by the Low and Intermediate estimates and a little less than the High estimate. This procedure was considered to conform to USACE guidelines and to be appropriately conserva-tive. However, the guidance is flexible enough that other procedures could have been equally well justified.

In the early years of the project, the amount of fill being added would exceed the amount necessary to match the Curve III amount with the cross over point being about halfway through the project lifetime (in the 28th year, 2038). Because this procedure uses a constant rise rate instead of a parabolic increasing rate (described by Eq. 6-1), this procedure places about 94% as much SLR sand on the beach as would be placed by following Curve III throughout the project lifetime.

The project plan to account for SLR is to add an appropriate additional amount of material at each planned 5-year renourishment interval. This SLR volume is the amount of material needed to elevate the entire profile (from the back of the dune seaward to the depth of closure) by (5 years * 0.037 ft/yr =) 0.186 ft (0.057 m). A schematic representation of this is shown by the blue area in Figure 6-8, below. For the Wallops Island project, the projected SLR volume needed at each 5-year renourishment interval based upon the 85% curve is 112,000 yd^3 (86,000 m^3). The total SLR volumes needed for the nine renourishment events based upon the 85% curve along with the Low, Intermediate, and High curves are given in Table 6-3.

Table 6-3. Wallops Island SLR Volumes.

SLR rate estimate	2060 SLR (ft) above 2010 level	Total volume of fill (yds^3) needed for all renourishments to account for SLR	Percent of the 85% volume planning estimate
Low - based upon historical rate	**0.56**	304,000	30%
Intermediate - based upon NRC (1987) Curve I	**1.01**	507,000	50%
Planning - based upon 85% of Curve III in yr 2060	**1.91**	1,008,000	100%
High - based upon NRC (1987) Curve III	**2.25**	1,067,000	106%

By compensating for SLR at each renourishment interval, the volume of material placed can be adjusted to match the amount of actual SLR, as obtained from the monitoring data, which could be greater or less than the predicted amount. It should be pointed out that the main usefulness of the SLR rate discussed here is to provide one of the component values needed to calculate the total volume of beach nourishment material that is expected to be needed over the project lifetime. It is not intended that this value actually be used at the time each renourishment occurs. Rather, it is intended that the volumes needed at renourishment will be primarily based upon an analysis of the data collected from the on-site project monitoring program.

Summary of Components Common to All Alternatives

Figures 6-7 and 6-8 show a conceptual representation of the components of the initial and renourishment B070 fill profiles, respectively. In these figures, Brown represents existing material (beach and upland sediments and rock seawall), Tan represents the Seawall Deficit Volume, Green represents the Berm Fill Volume, Yellow represents the Dune Volume, Pink represents the Advanced Fill Volume, and Light Blue represents the Sea Level Rise Volume. The amount of initial and renourishment advanced fill varies with the alternative chosen and is discussed below. The rest of the volumes are listed in Table 6-3. In this table, the row titled "Minimum Target Fill Volume for Storm Damage Reduction" is the sum of the "Seawall Deficit", "Berm", "Dune", and "Overfill" volumes.

Table 6-3. Volumes for B070 beach fill components.

Volume Component	yd^3	Ave yd^3/ft
Seawall Deficit	684,000	34.8
Berm	964,000	49.0
Dune	255,000	13.0
Overfill	125,000	6.4
Minimum Target Fill Volume for Storm Damage Reduction	2,028,000	103.2
Sea Level Rise	112,000	5.7

Note: This table does not provide either the total initial or the total renourishment fill volumes. For those volumes, see Table 7-1.

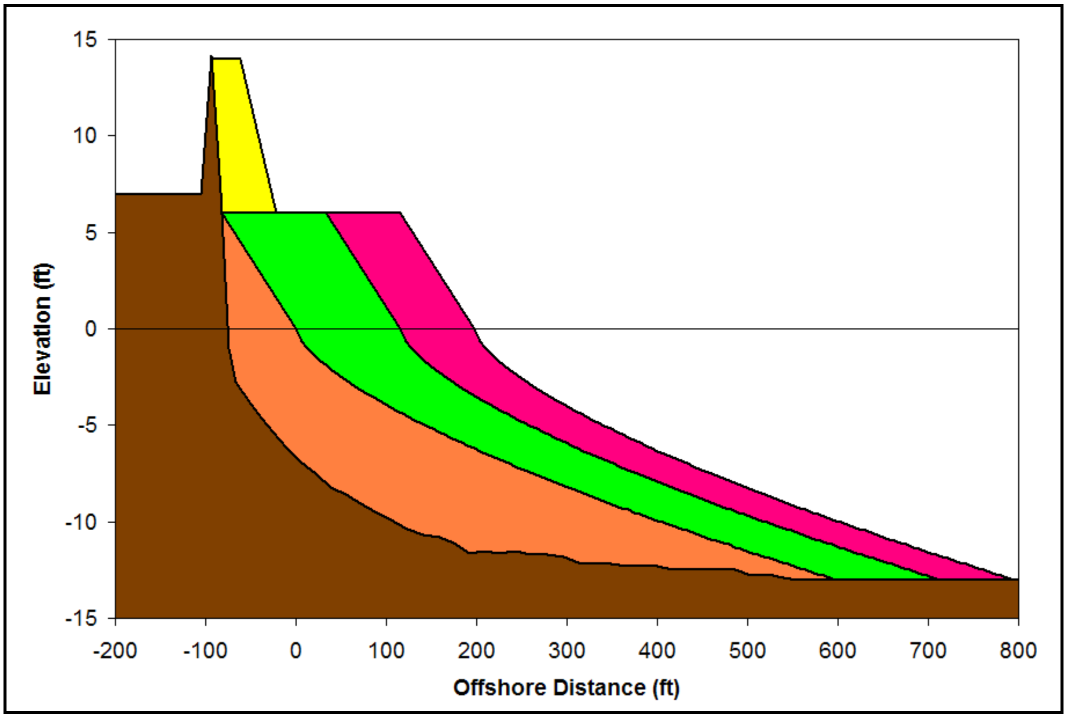

Figure 6-7. Conceptual Schematic of Initial Fill Placement.

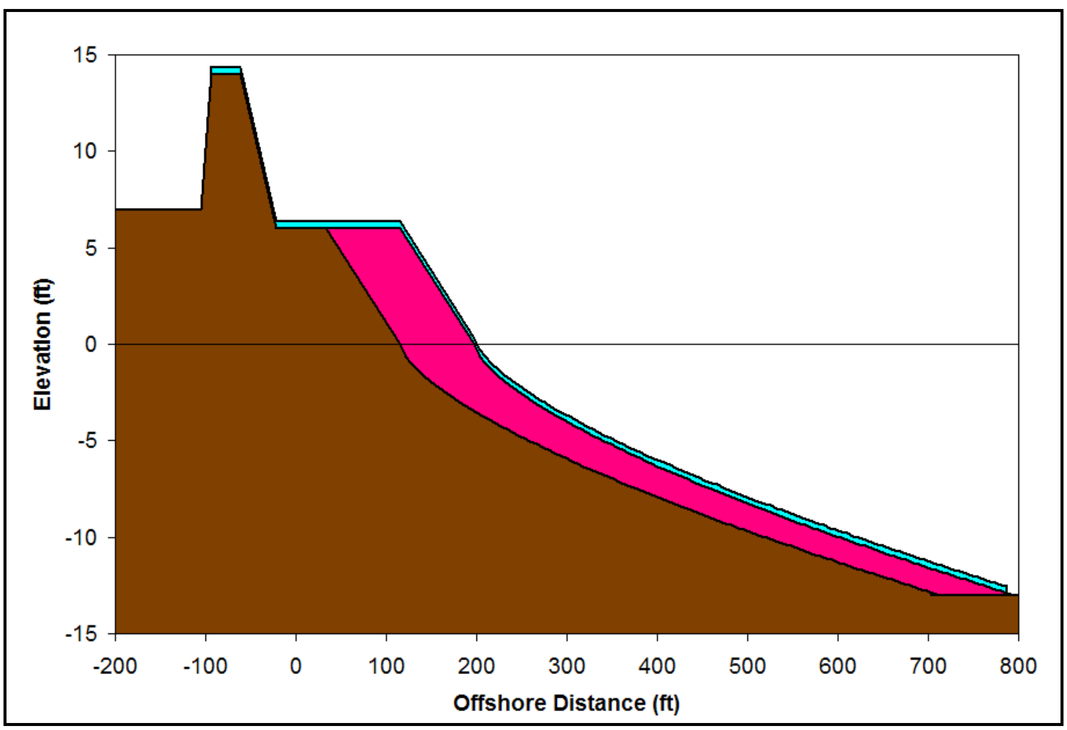

Figure 6-8. Conceptual Schematic of Renourishment Fill Placement.

Beach Fill Alternatives

In consultations among NASA, CENAO, and ERDC personnel, a large list of beach fill alternatives were initially screened. Most of these were removed from further consideration because either they did not provide adequate storm damage protection or they were less cost effective than similar designs. One example of each of three classes of alternative was retained for more complete analysis and optimization. These three alternative classes were:

1. A beach fill with no south end sand retaining structure.
2. A beach fill with a south terminal groin.
3. A beach fill with a south detached breakwater.

In addition to the features listed in Table 6-3, the three alternatives all have the common features listed in Table 6-4. Another important feature that all three alternatives have in common is that they all decrease the rate of erosion on the northern end of Assawoman Island.

Table 6-4. Common features for all alternatives.

Project Length	19,680 ft	6000 m
Project North End	North end of Rock Seawall	
Project South End	South Camera Stand	
Minimum Target Berm Width	70 ft	21.3 m
Minimum Target Width from Seawall to MSL	152 ft	46.3 m
Target Renourishment Interval	5 years	
Project Lifetime	50 years	
Projected Number of Renourishment Cycles in Project Lifetime	9	

Modeling of Advanced Fill Volumes

Following calibration and the modeling of existing conditions, the alternatives were modeled with GENESIS. Specifically, the model was used to address the question of how the shoreline of a particular alternative evolved over the time period between renourishment events. The fill volumes for each of the alternatives protrude different distances seaward of the present shoreline and the general tendency of most fill projects, including this one, is for the longshore sediment transport to move sediment along the coast away from the project site in both directions. The modeling consisted of iteratively including differing amounts of advanced fill to determine the optimal amount so that the volume left at the time of renourishment was sufficient to provide adequate protection from storm damage. Including a south terminal groin or a south detached breakwater changed the transport patterns, so the optimal designs of these features were obtained through additional iterations. The amount of renourishment advanced fill was determined by calculating the volume needed to return the beach to the initial advanced fill condition. This is a more conservative approach than running GENESIS for a second (and third, etc.) 5-year interval to iteratively determine the renourishment advanced fill volume.

For the modeling effort described above the wave block used to drive the model was generally the average year block described in the Sensitivity Testing section of Chapter 5. Once an acceptable solution was obtained using this wave set, the model was run 20 times using each of the twenty 4-year wave data blocks described in the Sediment Budget section of Chapter 5. This created 20 sets of output (for each model year) that could be averaged and for which 95% confidence intervals could be calculated. The modeling results for each alternative are presented below.

Alternative 1 - No sand retention structures

Alternative 1 has no sand retaining structures and thus requires the greatest initial and renourishment advanced fills. GENESIS modeling yielded an Advanced Initial Fill Volume of 1,939,000 yd^3 and an Advanced Renourishment Fill Volume of 694,000 yd^3 for this alternative.

Figure 6-9 shows the net longshore sediment transport rate during Year 5 (just prior to renourishment) along with 95% confidence limits for this alternative. In comparing this figure to Figure 5-15 (the pre-project condition) it is seen that the divergent nodal point is shifted approximately a mile to the north and that maximum transport rates substantially exceed present conditions.

Figure 6-10 shows how net transport rates vary from year to year. Though it is intended that renourishment should occur at the end of year 5, this analysis was carried out to year 14 without renourishment to help determine if adverse impacts occur to adjacent beaches if renourishment intervals are postponed or cancelled. This figure shows that substantial accretion occurs adjacent to both ends of the project through year 2. At the south end of the project, over time the transport rate asymptotically approaches a constant rate that is in excess of the current conditions

(Figure 5-15). Accretion occurs at the north end of the project though the rate decreases over time.

Figure 6-11 shows the gross longshore sediment transport rate during Year 5 (just prior to renourishment) along with 95% confidence limits for this alternative. In comparing this figure to Figure 5-18 (the pre-project condition) it is seen that Alternative 1 gross rates at both ends (away from the seawall) slightly exceed those of the present condition. Gross rates varied little from year to year.

Figure 6-12 shows the shoreline position at year 5 along with the 95% confidence intervals. This figure shows that the in many places the shoreline has retreated to near the minimum shoreline for storm damage protection, and thus, this is intended to be shortly before renourishment. Figure 6-13 shows shoreline positions for years 2 through 14. By year 12, all of the fill has been removed from the south end of the project; however, by year 14, there is still fill in front of the seawall.

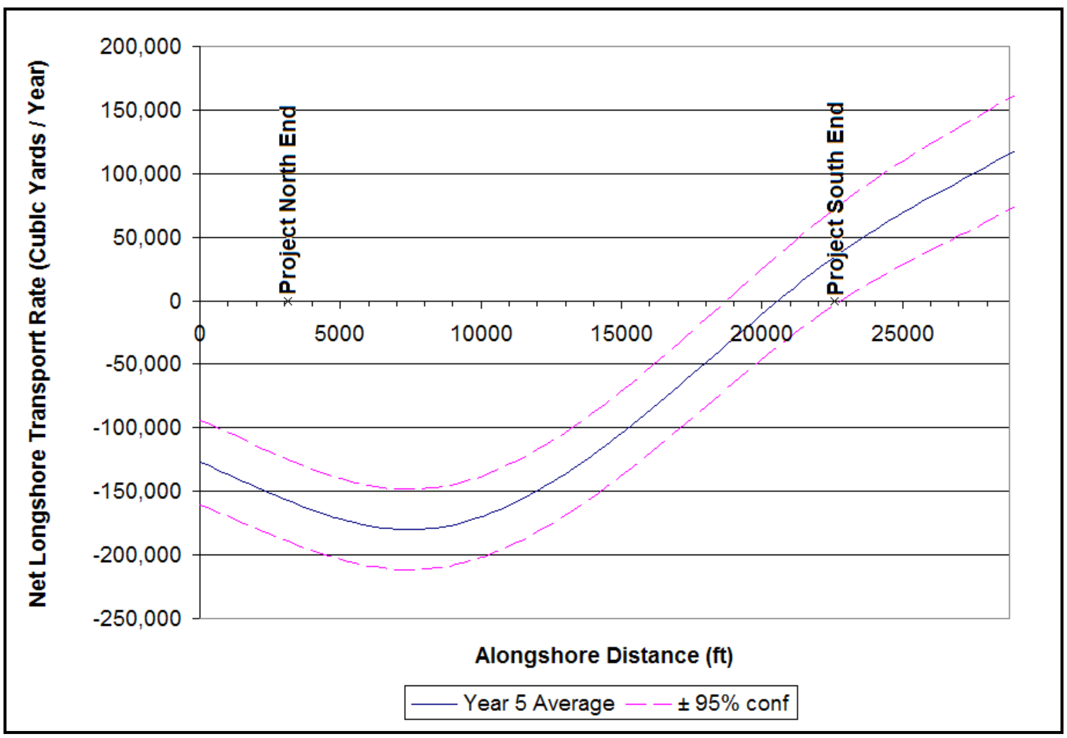

Figure 6-9. Net longshore transport rate for Year 5, Alternative 1.

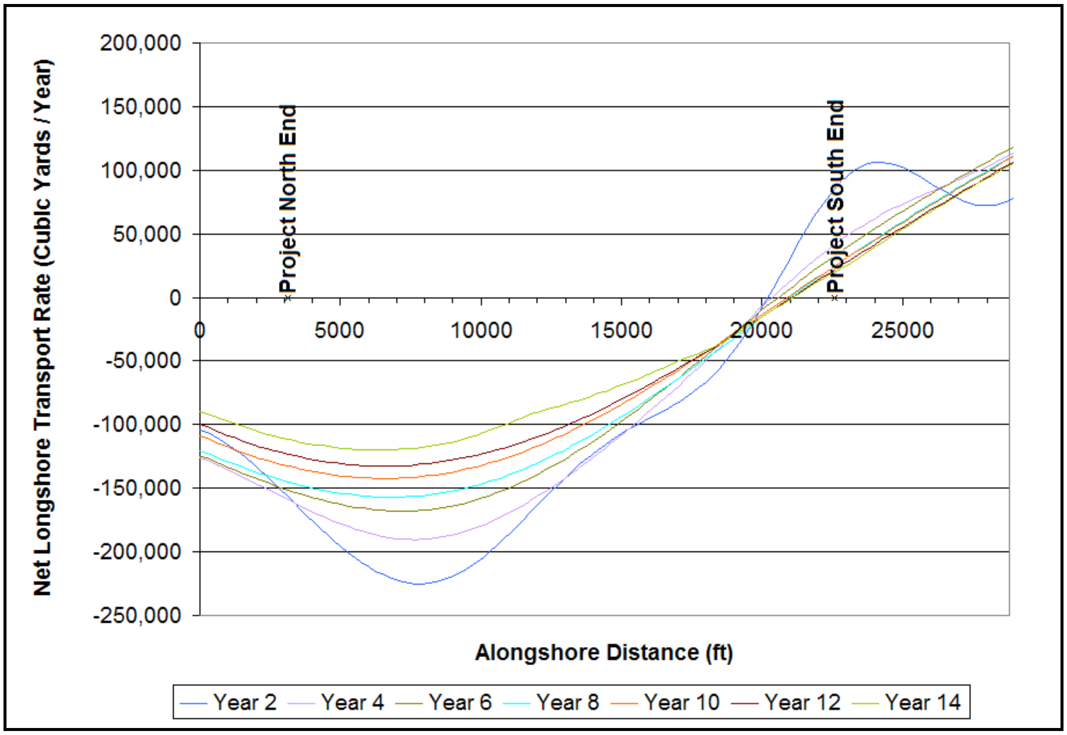

Figure 6-10. Net Transport rates over time for Alternative 1.

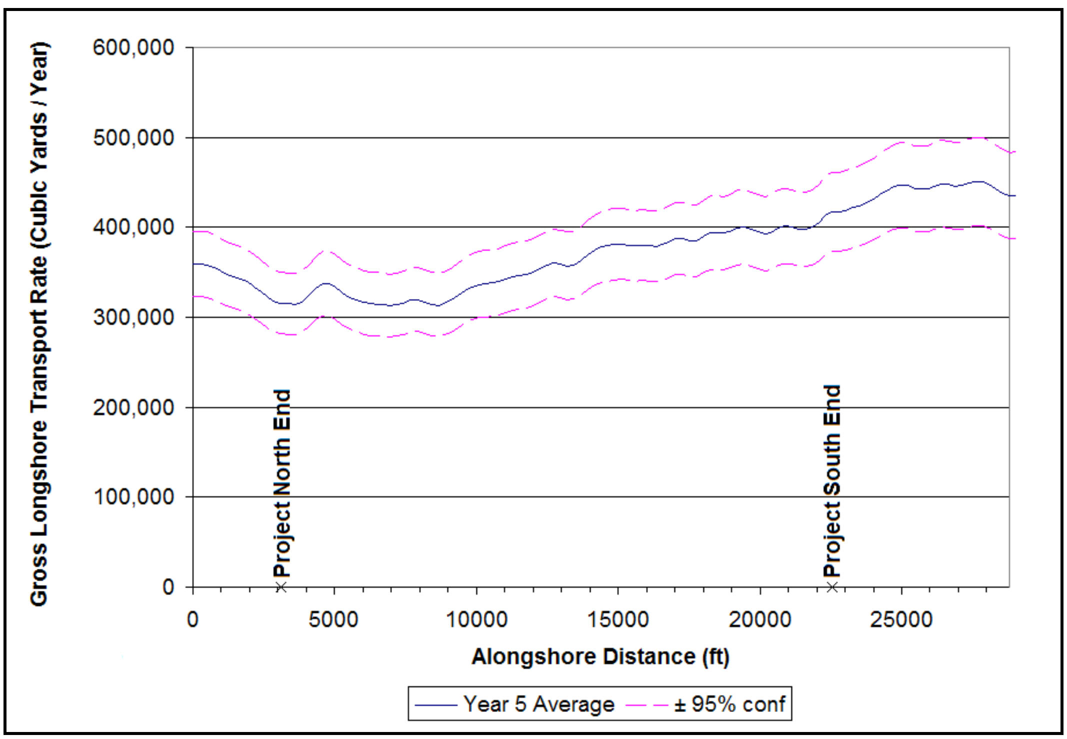

Figure 6-11. Gross Transport rate for Year 5, Alternative 1.

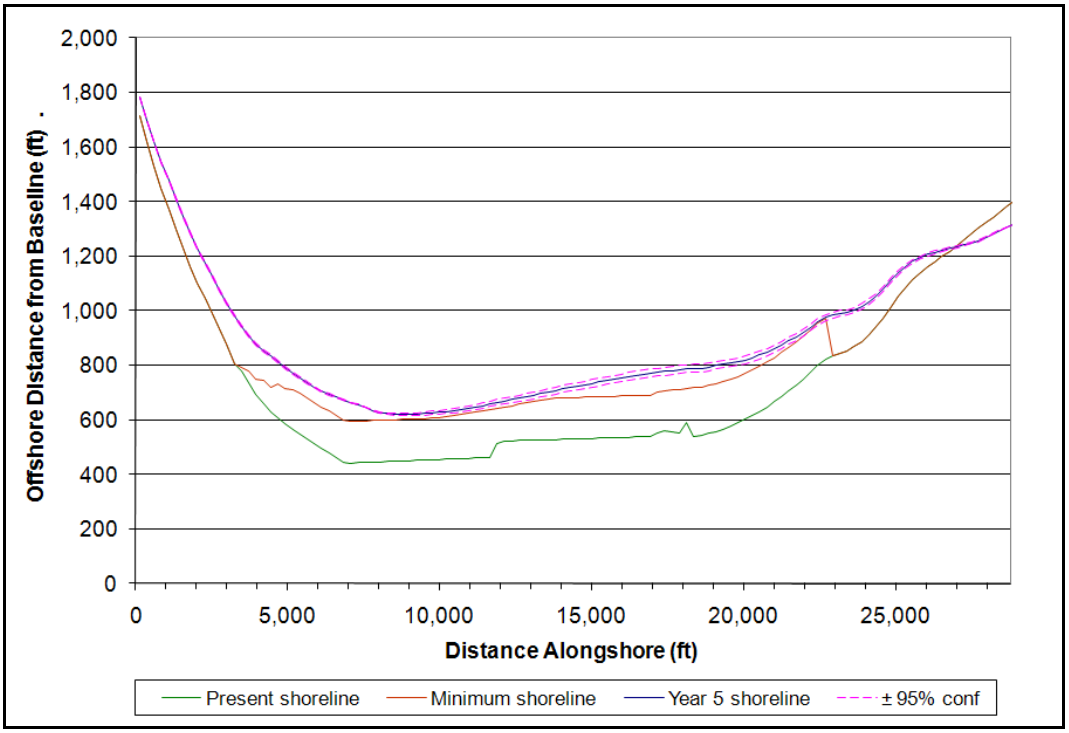

Figure 6-12. Shoreline position for year 5, Alternative 1.

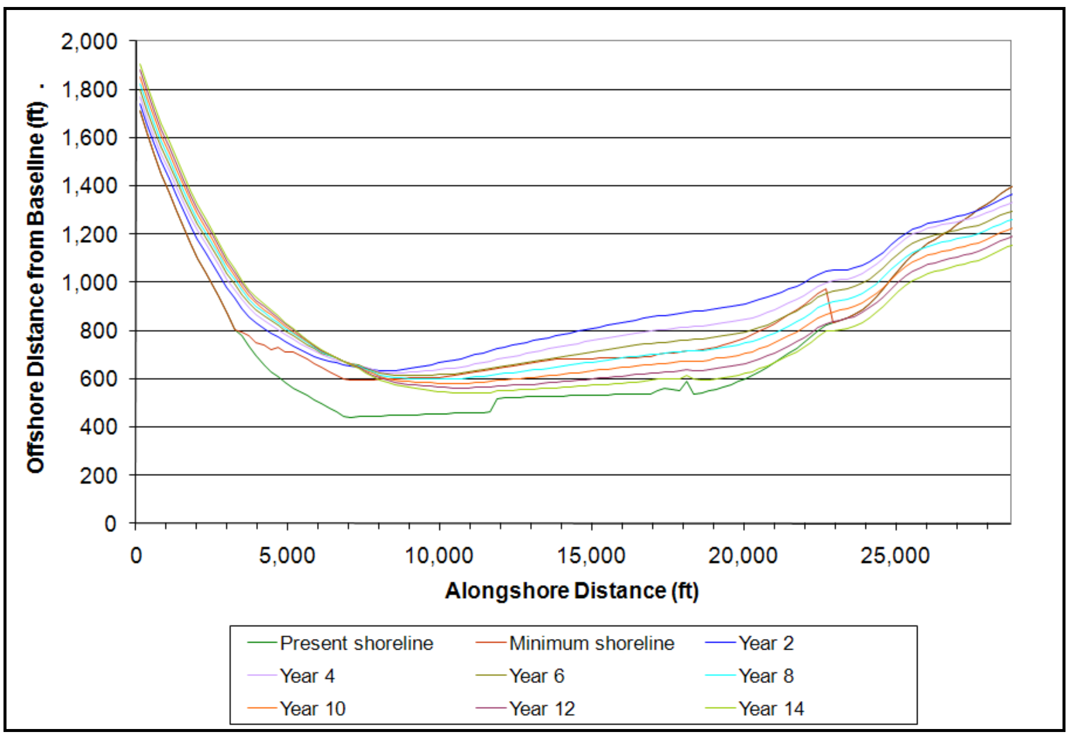

Figure 6-13. Shoreline positions over time for Alternative 1.

Alternative 2 - South terminal groin

Alternative 2 has a south terminal groin as a sand retaining structure. GENESIS modeling yielded an Advanced Initial Fill Volume of 810,000 yd^3 and an Advanced Renourishment Fill Volume of 619,000 yd^3 for this alternative.

The advice and guidance found in ASBPA 2008, Kraus, Hanson and Blomgren 1994, National Research Council 1995, and Basco, D.R. 2002 was followed in the design of the south terminal groin. The groin parameters are given in Table 6-5.

Table 6-5. South Terminal Groin Design

Descriptive Location	South Camera Stand	
Landward Coordinates	3764244 Easting	1169509 Northing
Groin Length seaward of Present Shoreline	431 ft	131 m
Groin Length seaward of Advanced Fill Shoreline	164 ft	50 m
Permeability	0.2	

Figures 6-14 through 6-19, show transport rates and shoreline positions for the south terminal groin alternative (Alternative 2). They are comparable to Figures 6-9 through 6-13 for the no structure alternative.

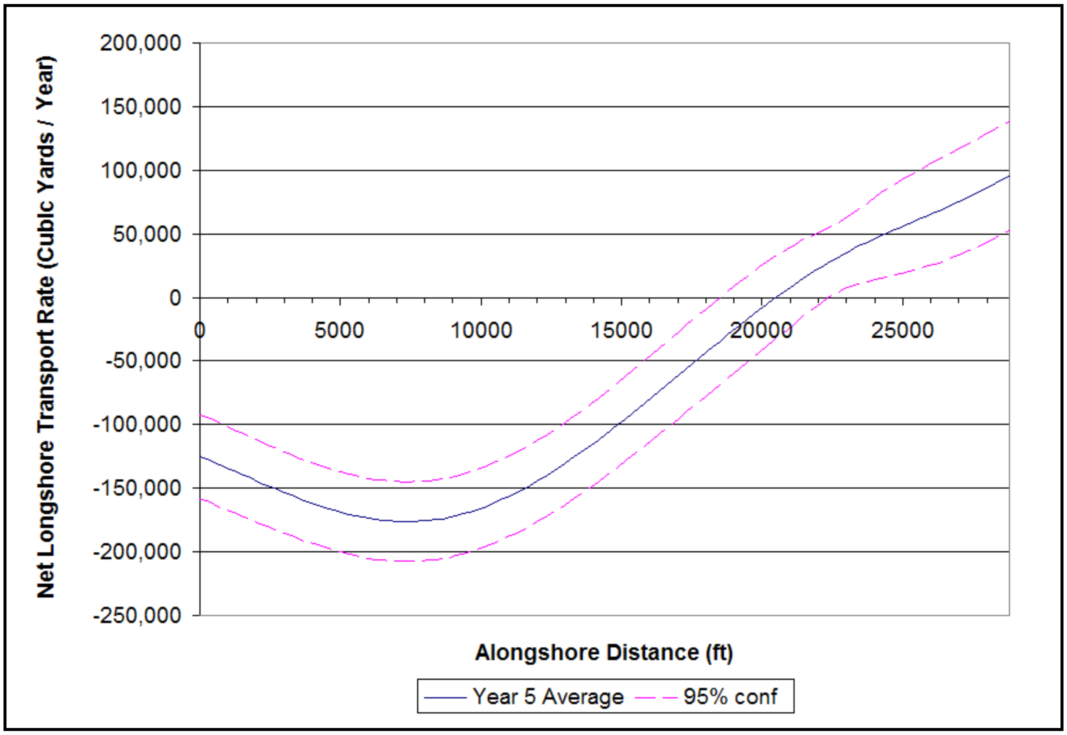

Figure 6-14. Net longshore transport rate for Year 5, Alternative 2.

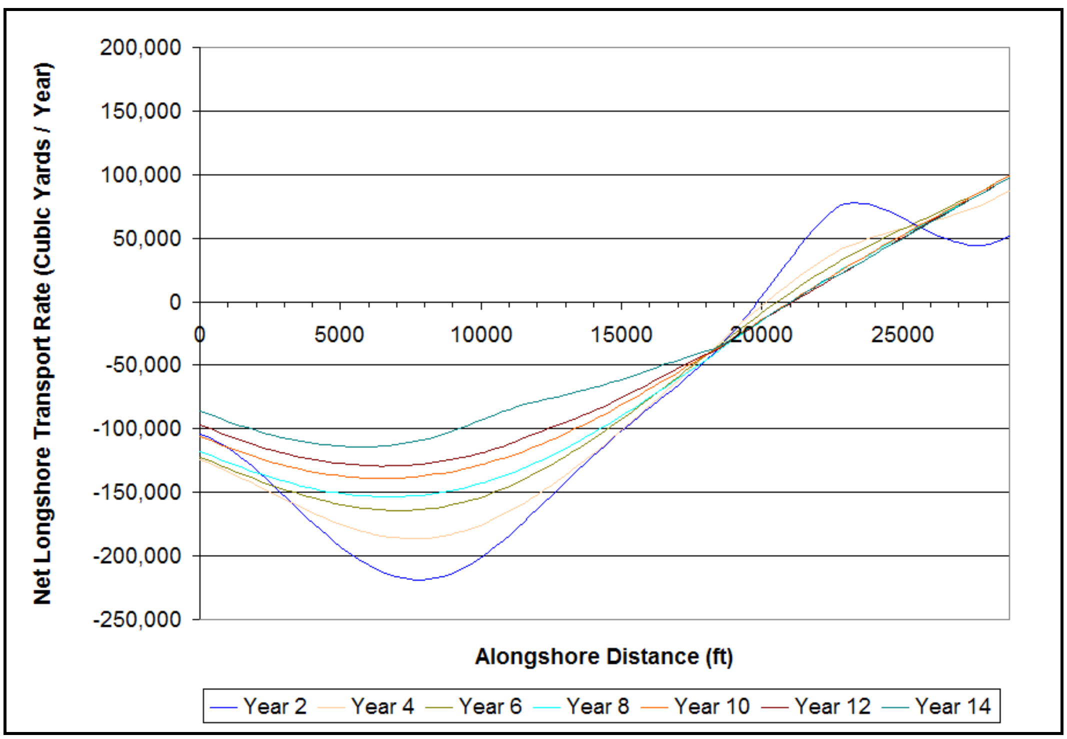

Figure 6-15. Net Transport rates over time for Alternative 2.

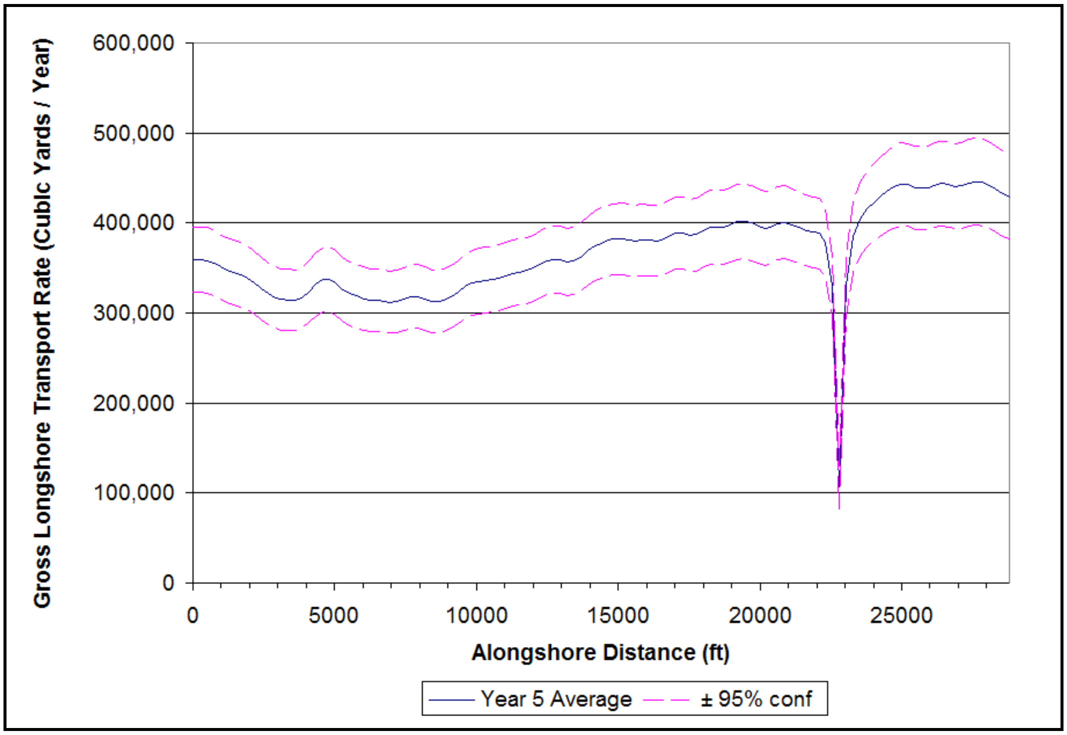

Figure 6-16. Gross Transport rate for Year 5, Alternative 2.

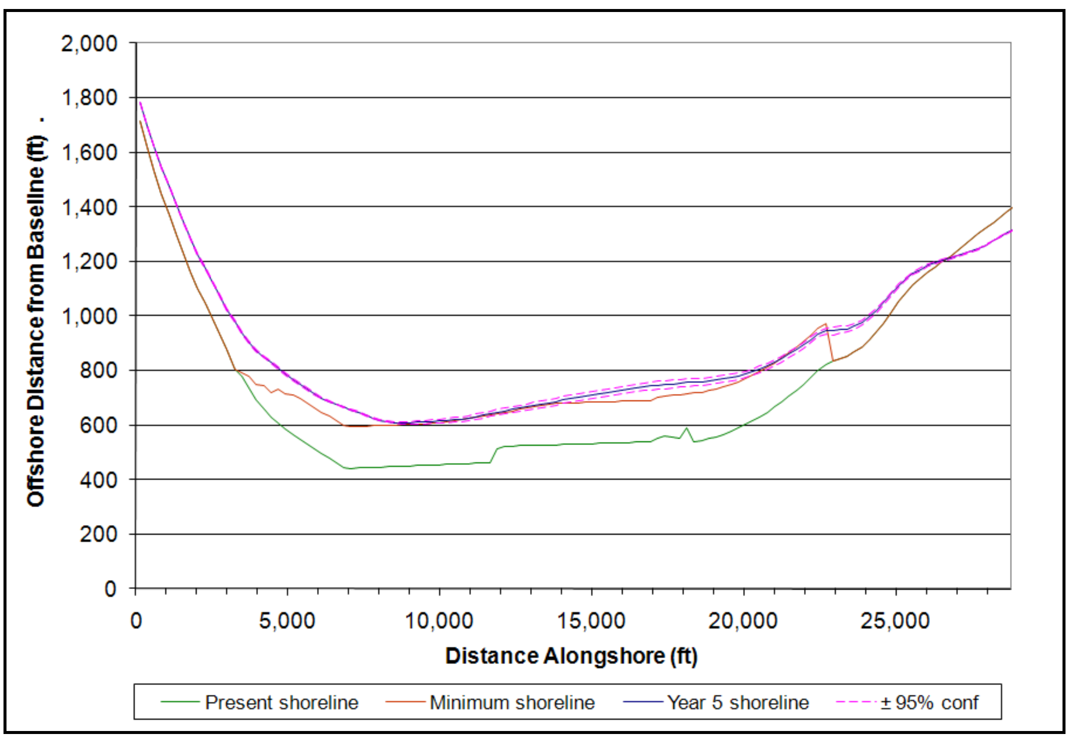

Figure 6-17. Shoreline position for year 5, Alternative 2.

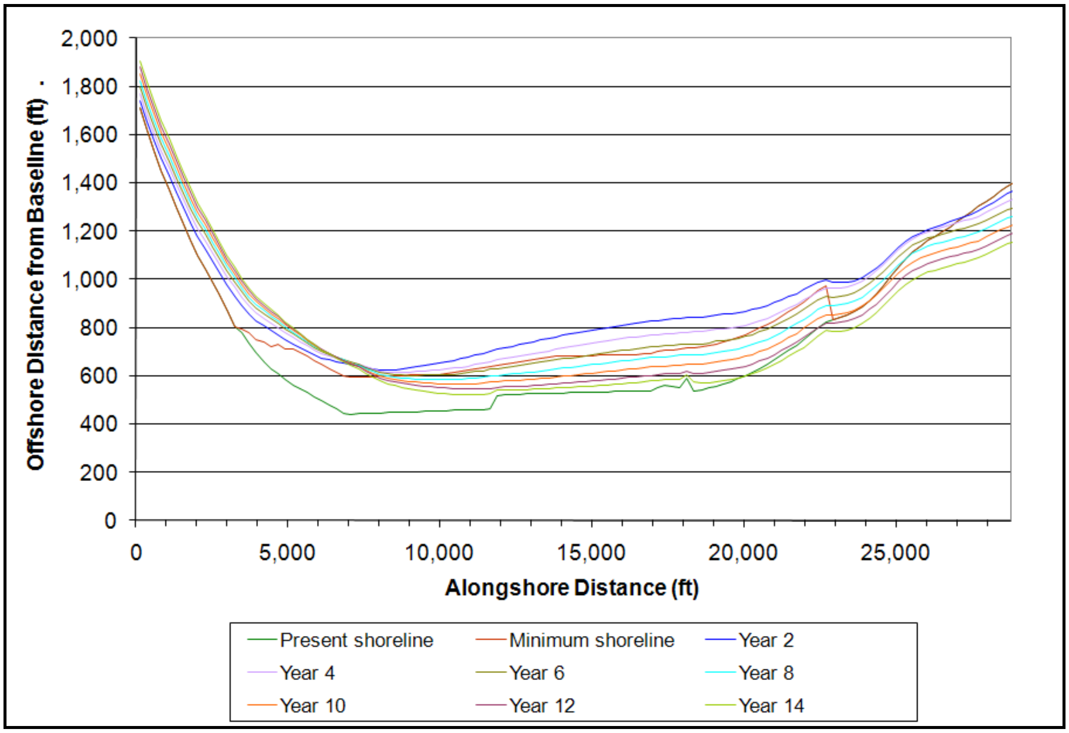

Figure 6-18. Shoreline positions over time for Alternative 2.

Alternative 3 - South detached breakwater

Alternative 3 has a south detached breakwater as a sand retaining structure. The design and modeling of a detached breakwater followed the advice in Chasten, et al. (1993), Basco (2002), Hanson and Kraus (1989), Gravens, Kraus, and Hansen (1991). GENESIS modeling yielded an Advanced Initial Fill Volume of 733,000 yd^3 and an Advanced Renourishment Fill Volume of 561,000 yd^3 for this alternative. The breakwater design parameters are given in Table 6-6.

Table 6-6. South Detached Breakwater Design		
Number of Segments	1	
Descriptive Location	Offshore of South Camera Stand	
North End Coordinates	3764531 Easting	1169310 Northing
South End Coordinates	3764477 Easting	1169237 Northing
Breakwater length	300 ft	91 m
Distance Offshore of Advanced Fill shoreline	750 ft	229 m
Distance Offshore of Present shoreline	1014 ft	309 m
Ratio of Breakwater Length to Offshore Distance	0.4	

Figure 6-19 through 6-23 show transport rates and shoreline positions for the detached breakwater alternative (Alternative 3). They are comparable to Figures 6-9 through 6-13 for the no structure alternative and Figures 6-14 through 6-18 for the groin alternative.

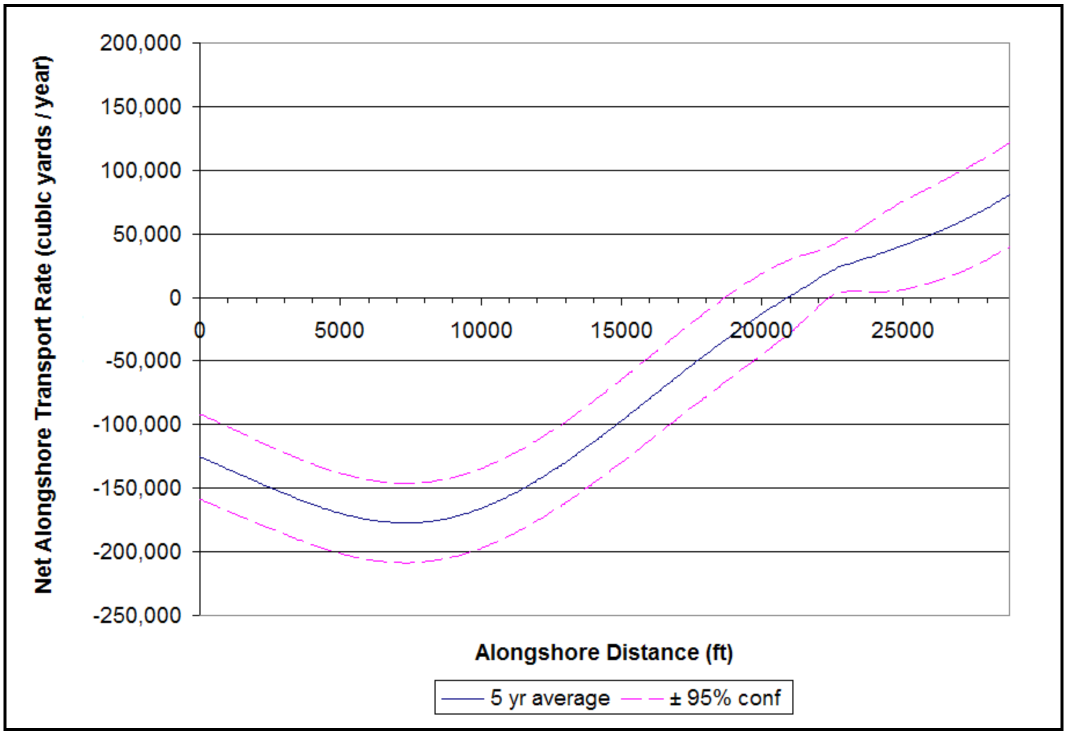

Figure 6-19. Net longshore transport rate for Year 5, Alternative 3.

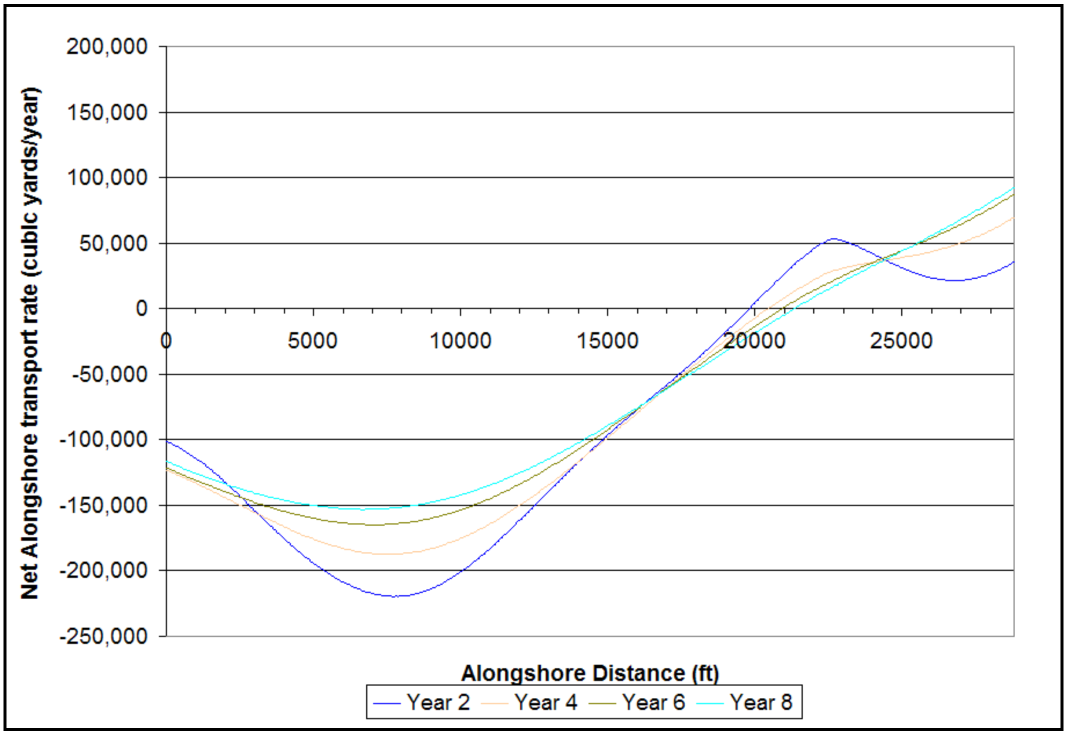

Figure 6-20. Net Transport rates over time for Alternative 3.

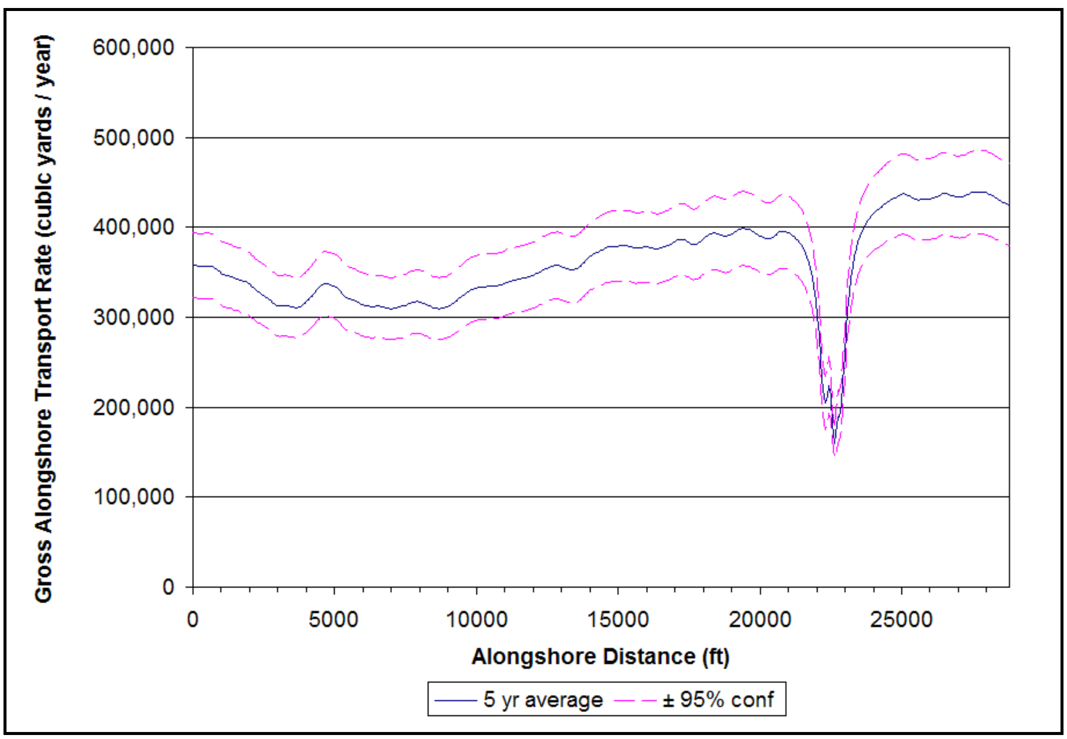

Figure 6-21. Gross Transport rate for Year 5, Alternative 3.

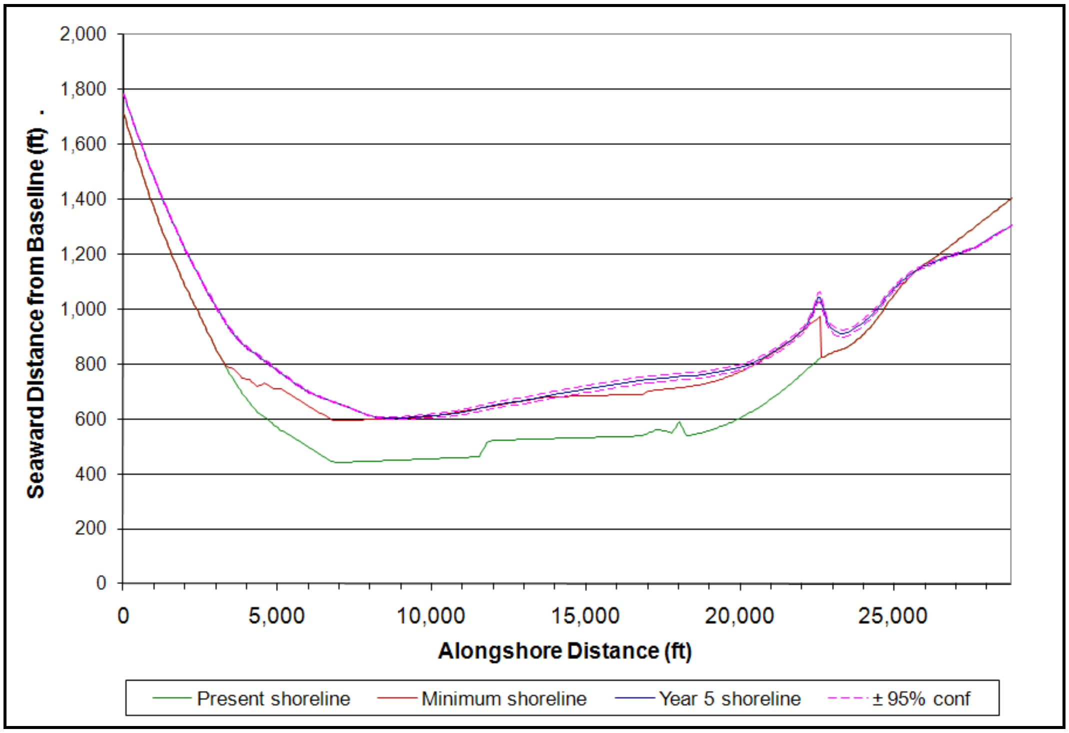

Figure 6-22. Shoreline position for year 5, Alternative 3.

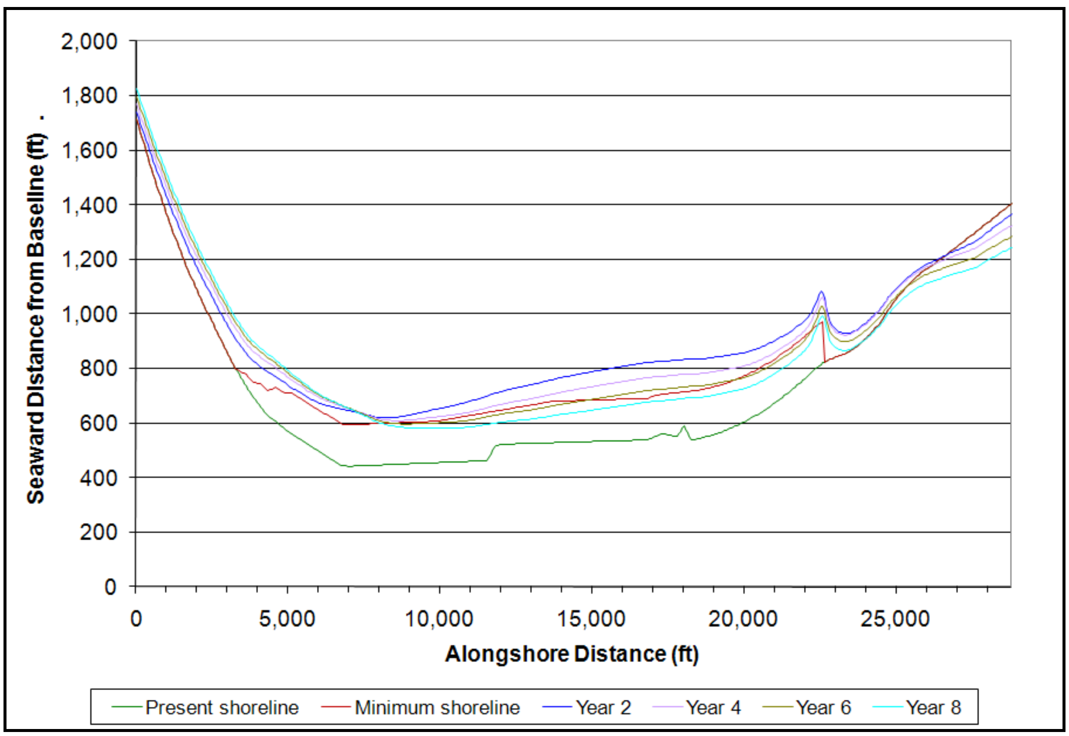

Figure 6-23. Shoreline positions over time for Alternative 3.

7 Wallops Island Storm Damage Reduction Project Design

During the development of this study, the complete storm damage reduction project has evolved to include the following components:

- Rehabilitation of the present rock seawall.
- A southern extension of the rock seawall.
- An initial beach fill along 19,700 feet (6,000 m) of shoreline.
- Depending upon the alternative chosen, the project may include a sand retention structure in the form of a south terminal groin or a detached breakwater or neither.
- A flood damage analysis of the Wallops Island infrastructure.
- A beach fill monitoring program.
- Scheduled beach renourishments at 5-year intervals.

Seawall Maintenance

This topic is covered in Chapter 3 of this report. This task is critically important to the existing rock seawall being able to survive and perform as expected during a target 100-year storm event, as discussed in Chapter 4. Following initial beach fill placement, the seawall is not expected to be exposed to wave attack except during infrequent, large storm events. However, following such events, it is expected that the seawall will be inspected and repaired as necessary.

Seawall Extension

There is significant infrastructure on Wallops Island that is south of the southern end of the rock seawall, primarily Building Z41 and Launch Pad 0B, the MARS facility. The only storm protection these facilities currently have is the geotextile tube and a low riprap wall. The present rock seawall will be extended up to 1400 meters (4600 ft) to the south. This will provide these structures with the same level of protection as the other facilities on the island. The details of the seawall extension design will be provided by USACE personnel at NAO.

Initial Beach Fill

The initial beach fill will provide a minimum beach width that is sufficient to provide storm damage protection along 19,700 feet of beach between the northern end of the rock seawall and the southern end of the present geotextile tube. This fill will be placed so that there will be a 6 ft high berm extending a minimum of 70 ft seaward of the rock seawall with an equilibrium profile that extends seaward to the depth of closure. The profile will also include a 14 ft high dune at the seawall. As discussed below, for budgetary reasons, this initial fill will be partially placed in project year two and completed the following year. Initial fill volumes for each of the three alternatives are given below in Table 7-1.

Sand Retention Structure

Depending upon the alternative chosen, the project may have a south terminal groin or a south detached breakwater. These are discussed in Chapter 6. The sand retention structure will be designed by USACE personnel at NAO.

Flood Vulnerability Analysis

As discussed in Chapter 4, the beach fill project and the rock seawall will provide significant protection to the infrastructure on Wallops Island from the direct impact of wave attack. However, flooding is still expected to pose a problem. NASA has ongoing measures in place to analyze and reduce the flood damage potential for each structure on Wallops Island. NASA intends to maintain this program for existing and future infrastructure.

Beach Monitoring Program

A beach monitoring program will be established to collect data on a regular schedule through the lifetime of the project. These data will be analyzed and relied upon to determine the amount and timing of beach fill renourishments. They will also be used to monitor any negative impacts of the project on Assawoman Island.

Scheduled Beach Renourishments

The storm damage reduction project has a design renourishment interval of 5 years. The design renourishment volume varies depending upon the alternative chosen and is based upon average longshore transport rates. However, it is intended that the timing and volume of each renourishment should be based upon the analysis results of the monitoring program rather than some predetermined volume and schedule. While it is intended that the initial fill material come from an offshore borrow site, renourishment fill material is expected to be derived from a combination of the offshore borrow site and material on the beach at the north end of Wallops Island that is being backpassed to the project site.

Implementation Schedule

WFF does not expect to receive sufficient funding to implement all of the initial components of the project in a single FY. Instead, the initial components have been staged to be accomplished over a three-year time span. The order in which construction will occur has been carefully considered. If the expected funding in Year-2 or Year-3 is postponed or cancelled, the already constructed portions of the project must be viable projects in themselves that do not have negative shoreline consequences either to Wallops Island or to its neighbors. This, and other issues, have dictated the following sequence for the initial project construction.

By phasing the construction in the manner described, only Year-3 activities will be dependent upon the beach fill alternative chosen. The alternative chosen has no other impacts prior to the time of the first renourishment.

Year-1 Activities

- Rehab and repair of the existing seawall.
- Construction of a 1500 ft southern seawall extension.
- Initiation of the monitoring program.

Year-2 Activities

- Partial initial beach fill (discussed below).
- Continuation of the monitoring program.

Year-3 Activities

- Completion of initial beach fill.

- Construction of the south terminal groin, the detached breakwater, or neither, depending upon the alternative chosen.
- Continuation of the monitoring program.

Discussion of 2-Year Initial Fill Placement

It is understood that requiring two dredging events to place the initial fill will incur additional costs. These include not only the cost of an additional dredge mobilization, but also the cost of the portion of the fill that is transported out of the project site between dredging events. These costs are accepted as being unavoidable due to budget constraints.

It is expected that, in Year-2, funding will be available to place approximately 1.2 million yd^3 of fill material. The volume needed to restore the underwater area in front of the seawall to its equilibrium condition is approximately 914,000 yd^3. The Year-2 fill material will be placed to accomplish this with the remainder of the material (286,000 yd^3) placed mainly in the center of the project site. By placing the majority of the Year-2 fill in the center of the project site, GENESIS modeling has indicated that the one-year end losses of that material are approximately 78,000 yd^3. These calculations were made for average wave conditions, a stormy year would be expected to have higher losses.

There are several consequences to the project in addition to the need to replace this 78,000 yd^3 Staged Placement Loss Volume. The first is that the project site will not obtain the full extent of the storm damage reduction protection until the third year of the project life. However, on the plus side, it is not anticipated that the first renourishment will be required until project year 8.

Initial and Renourishment Fill Volumes

Table 7-1 summarizes the initial and renourishment volumes required for each of the alternatives. As listed in this table, the Minimum Target Fill Volume is the sum of the Seawall Deficit, Berm and Dune volumes listed in Table 6-2. The Advanced Initial Fill Volume varies with alternative and is discussed in Chapter 6. The Staged Placement Loss Volume comes about as a result of not completing the initial fill in a single year, as discussed in the paragraph above. Advanced Renourishment Fill Volumes are discussed with each Alternative in Chapter 6. Sea Level Rise Volume is discussed in Chapter 6 and is listed in Table 6-2.

Table 7-1. Total Initial and Renourishment Volumes for Alternatives			
	Alt 1, No sand retention Structures (yd^3)	Alt 2, South Terminal Groin (yd^3)	Alt 3, South Detached Breakwater (yd^3)
Minimum Target Fill Volume	2,028,000	2,028,000	2,028,000
Advanced Initial Fill Volume	1,093,000	810,000	733,000
Staged Placement Loss Volume	78,000	78,000	78,000
Total Initial Fill Volume	3,199,000	2,916,000	2,839,000
Advanced Renourishment Fill Volume	694,000	610,000	591,000
Sea Level Rise Volume	112,000	112,000	112,000
Total Renourishment Volume	806,000	722,000	703,000
# Renourishment Events	9	9	9
Project Lifetime Volume	10,453,000	9,414,000	9,166,000

Recommended Alternative

The recommended alternative is Alternative 1, the no sand retention structure alternative. The other two alternatives do retain more sand within the project site and, based upon current estimates, have lower overall projected costs, but these benefits are marginal. Because the groin or breakwater would be located in the vicinity of a sediment transport nodal point, they are less effective sand retaining structures than they would otherwise be. The modeling results for the three alternatives (Figures 6-8 through 6-24) do not show substantial differences in project performance.

In the authors' professional judgment, the benefits of Alternatives 2 and 3 do not outweigh the potential risks involved. As has been shown numerous times, sand retention structures placed within the surf zone have the potential for unintended consequences. While best practices have been followed in their design for this project, their behavior cannot be known with certainty. Flaws in the project design, uncertainty in future funding sources, extreme in weather patterns, or any of other numerous unexpected events all have the potential for causing this project to not perform as expected.

It is recommended that the other two alternatives be considered as adaptive management strategies. After initial project construction and monitoring has occurred, it may be found necessary to modify the project design. These alternatives (2 and 3) should be kept as options in such an eventuality.

8 Impact to Assateague Shoreline of Mining Offshore Shoals for Beach Fill Material

This section of the report assesses the potential impacts that mining of offshore shoals will have on the adjacent beaches. As material is removed from these shoals, the water depth changes. Since wave refraction is a function of the water depth, removal of material can significantly affect the longshore sediment transport on adjacent beaches. (See, for example, Combe and Soileau, 1987.) The analysis presented here closely follows the Minerals Management Service guidelines presented in Kelley, Ramsey, and Byrnes, (2001), referred to as MMS-2001-098 (available on the web at: http://www.mms.gov/itd/pubs/2001/2001-098.pdf).

The procedure used here was to refract offshore waves over the existing bathymetry into near-breaking depths. Then, the same offshore waves were refracted over bathymetry that had been modified by an appropriate increase in the depth in the borrow area(s). Both sets of resulting near-breaking waves were used to drive a sediment transport model, and the two sets of sediment transport results were compared. The amount of difference in the sediment transport for the two conditions was related to natural variation in the wave climate to determine if it was significant.

Deepwater (20+ meter depth) wave information was obtained from WIS data, and the numerical model, STWAVE, was used to transform these waves over the bathymetry to near-breaking depths. As discussed below, this procedure was only a slight modification of that presented in Chapter 5 to investigate the longshore sediment transport at Wallops Island. However, for this application, the full longshore sediment transport modeling capabilities of GENESIS were not required, since the main emphasis was on the differences in the sediment transport rate, rather than the rate itself. This is in accordance with the procedure described in MMS-2001-098. However, the same basic longshore sediment transport relationship that is used in GENESIS (the CERC formula) was also applied here in a simpler context.

Borrow Sites

As introduced in Chapter 3, three offshore sites were proposed as potential locations for obtaining beach fill material. Designated BlackFish Bank, Site A, and Site B, these are located offshore of the south end of Assateague Island in the vicinity of Fishing Point, as shown in Figure 8-1. Their location coordinates are given in Table 8-1. Coring analysis indicated that each of the sites held enough borrow material to satisfy the beach fill requirements of the project over its lifetime as given in Table 7-1.

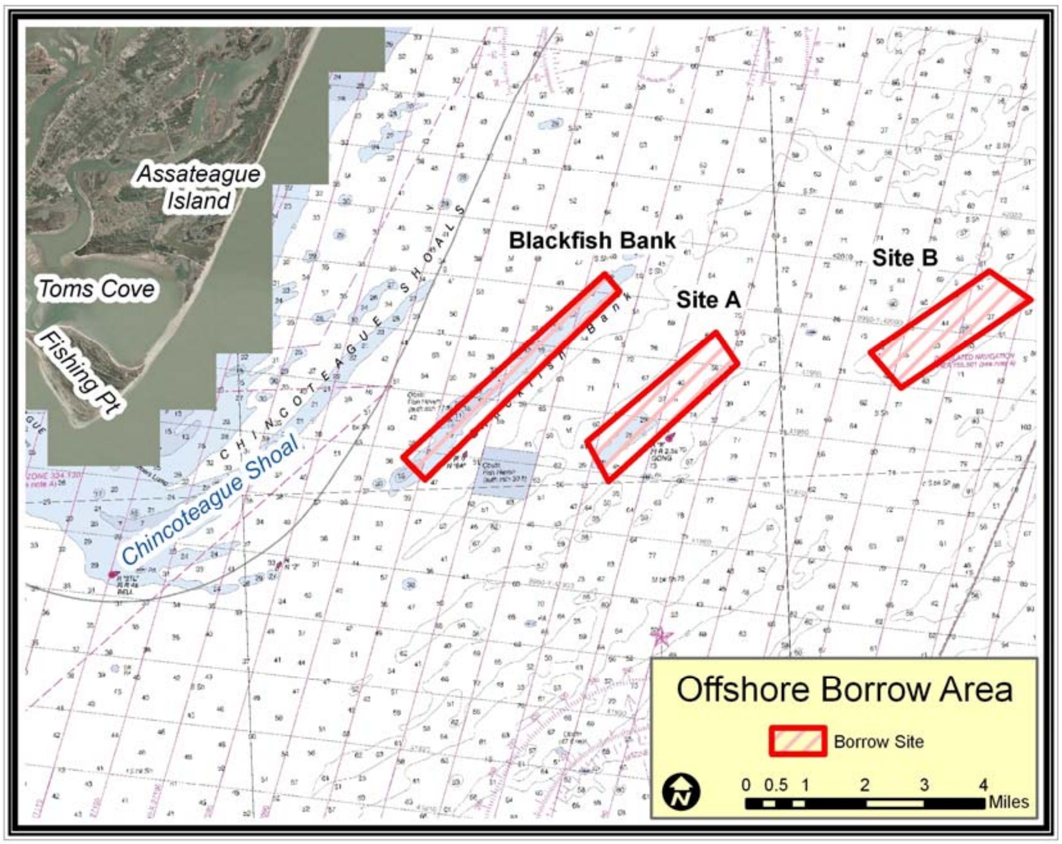

Figure 8-1. Offshore Borrow Site Locations.

The bathymetry offshore of much of the Delmarva Peninsula is extremely complex. McBride and Moslow (1991) indicate that the density of sand ridges in this area is greater than anywhere else in the country. Wikel (2008) discusses the dynamics of these shoals and their southwestward migration. The potential borrow sites are all located on separate sand ridges. Like other ridges in the area, these ridges trend from Northeast to Southwest, and the crests generally get deeper on further offshore ridges. Chincoteague Shoal is another sand ridge complex that is inshore of the three potential borrow sites. Because it is large and shallow, it greatly modifies the nearshore wave climate, and helps to reduce the shoreline impacts of mining activities that would occur on any of the shoals further offshore.

Table 8-1. Coordinates of the Potential Borrow Sites

BlackFish Bank		Site A		Site B	
Latitude (°N)	Longitude (°W)	Latitude (°N)	Longitude (°W)	Latitude (°N)	Longitude (°W)
37.8414167	75.2835667	37.8437167	75.2268833	37.8631167	75.1387333
37.8845667	75.2196000	37.8693500	75.1859500	37.8819167	75.1012167
37.8802000	75.2152333	37.8614000	75.1796667	37.8746000	75.0887833
37.8358167	75.2771000	37.8338833	75.2205833	37.8541667	75.1297167
Easting	Northing	Easting	Northing	Easting	Northing
3783053.94	1172186.16	3788031.43	1172612.75	3795708.67	1175037.19
3788514.55	1177166.28	3791532.18	1175581.71	3798932.63	1177240.66
3788915.34	1176695.22	3792115.68	1174719.29	3800055.10	1176468.51
3783644.04	1171584.39	3788623.51	1171541.16	3796536.98	1174072.73

The three borrow sites are differently shaped, but are all nearly the same size of 2.0 mi^2 (5.2 km^2). Blackfish Bank is the closest to shore, at a little over 5 miles (8.5 km), and the shallowest, with a minimum depth of -13 ft (-4 m). Site A, on an unnamed shoal is approximately 7.5 miles (12 km) from the nearest shoreline and rises to a depth of -25 ft (-7.6 m). Site B, on another unnamed shoal is the furthest offshore at a distance of over 11 miles (18 km) and the deepest, with a minimum depth of -29 ft (-8.8 m).

STWAVE Model Grids

Coarse and Fine Grids

MMS-2001-098 recommends that a fine grid be used for the beach in the immediate vicinity of the borrow area and a coarser grid be used to look at transport rates on more distant portions of the beach. Since the grid used to model the sediment transport on Wallops Island (Chapter 5) only covered a portion of the needed bathymetry, two new grids, designated the Fishing Point Coarse and Fishing Point Fine Grids, were established for this analysis. The locations of the grids are shown in Figure 8-2; the Coarse grid in green and the Fine grid in pink. In this figure, the Wallops Island grid (in blue, discussed in Chapter 5), the borrow sites (in lime, orange, and blue green), and two WIS stations (in black) are also shown for reference. The two Fishing Point grids shared the same offshore boundary. The also had the same orientation; the onshore direction is 300° (clockwise from North). This is slightly different than the Wallops Island Grid, whose onshore direction is 309°.

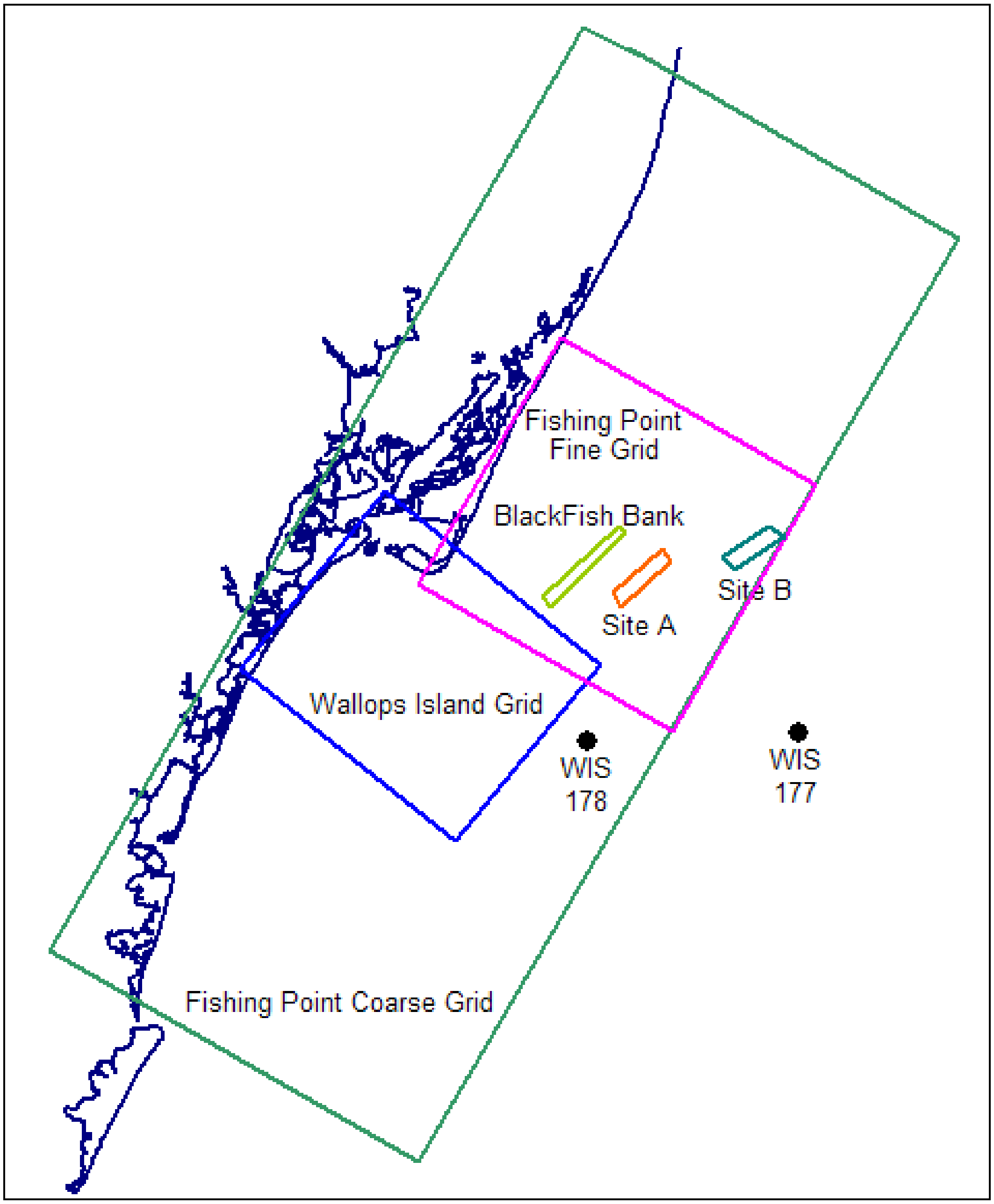

Figure 8-2. Location of STWAVE grids.

Bathymetry data were needed as input to the two STWAVE grids. These data were obtained from the same National Ocean Survey (NOS) source as described in Chapter 5.

Fishing Point Coarse Grid Description

The coarse grid covers 75 km (46.6 miles) of shoreline from Wachapreague Inlet in the south to a location near the Tingles Island Camping Area (part of Assateague Island State Park) which is 17.4 km (10.6 miles) north of the Maryland / Virginia state line. The grid stretches 30 km (18.6 miles) in the offshore direction. The cell size of the coarse grid is 200 m in both the cross-shore and along shore directions. The full grid parameters are listed in Appendix E, Table E-8. The bathymetry covered in this grid is shown in Figure 8-3. In this figure the near-shore save stations are shown in light blue. The color depth scale is given in meters. This grid was used to propagate waves from the nominal 20 meter depth at the right-hand side of the grid to the save stations near the shoreline along the left-hand side.

Fishing Point Fine Grid Description

The fine grid covers the south end of Assateague Island from the south tip at Fishing Point northward for 20 km (12.4 miles) to a point which is 3 km (2 miles) south of the Virginia / Maryland state line. The grid stretches 22.5 km (12.8 miles) in the offshore direction. The cell size of the fine grid is 40 m in both the cross-shore and along shore directions. Measuring in the alongshore direction from the south end of the coarse grid, the fine grid starts at 35,000 m (115,000 ft) and ends at 55,000 m (180,000 ft). The full grid parameters are listed in Appendix E, Table E-9. The bathymetry covered in this grid is shown in Figure 8-4.

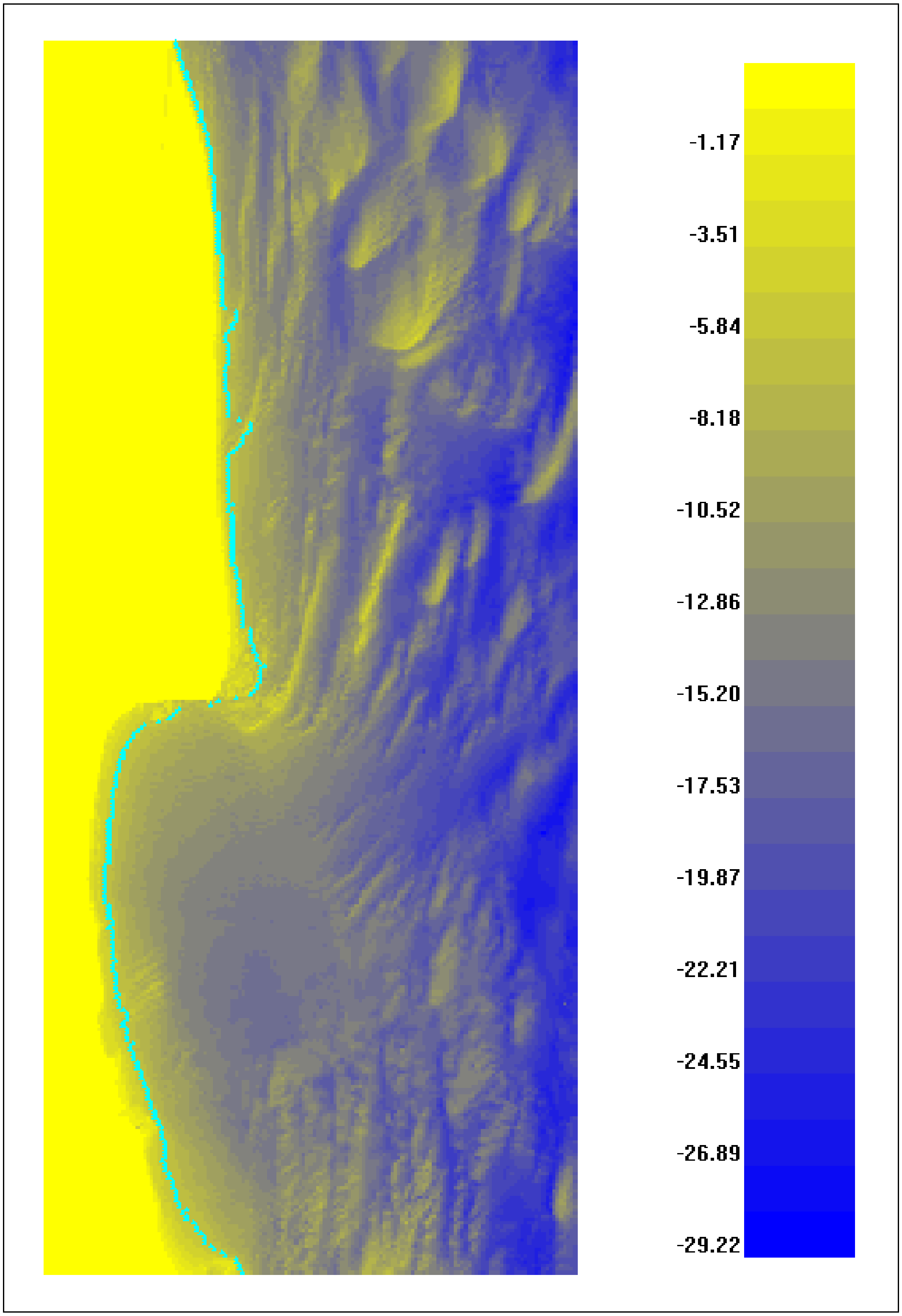

Figure 8-3. Fishing Point Coarse Grid bathymetry.

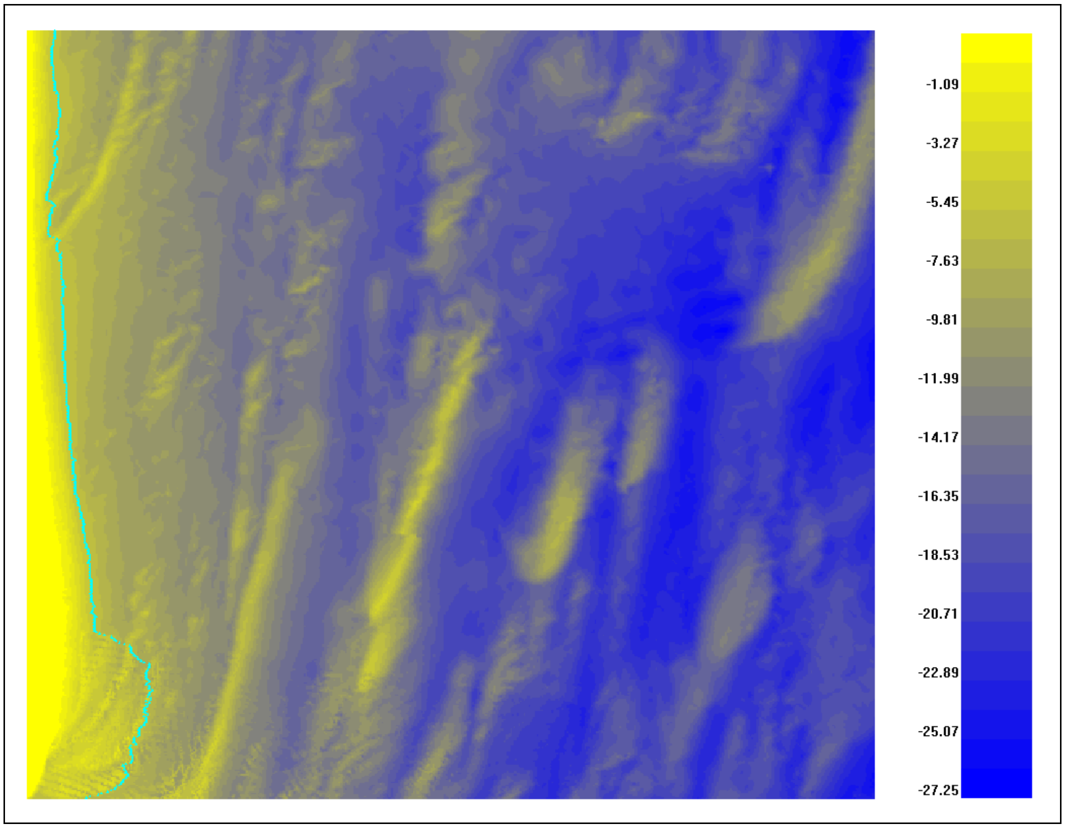

Figure 8-4. Fishing Point Fine Grid Bathymetry.

Cell Distribution within the Borrow Areas

A factor limiting the cell size of the coarse grid was the distribution and minimum number of grid points within the borrow sites. Table 8-2 shows that there were over 100 coarse grid cells within each of the borrow sites. While this is adequate to represent the bathymetry changes, the long slender shape of the BlackFish Bank borrow site was a concern. The distribution of these cells within the borrow sites is shown in Figure 8-5, and it is seen that BlackFish Bank is modeled by a minimum of only three grid cells in the cross-shore direction along several transects. This was considered a minimum number to properly resolve the refraction effects as waves transited the site. Sites A and B, being roughly the same size as BlackFish, but less elongated, had a more generous minimum number of 5 and 7 cells in the cross-shore direction, respectively. Thus, a 200 meter cell spacing was considered the maximum allowable for the coarse grid. This issue was not a concern for the fine grid because, with 40-meter cell spacing, it had a density of grid points that was 25 times as great as the coarse grid.

Table 8-2. Grid points within borrow areas						
Borrow Area	**BlackFish Bank**		**Site A**		**Site B**	
Grid Size	**Coarse**	**Fine**	**Coarse**	**Fine**	**Coarse**	**Fine**
Total points in borrow	134	3372	129	3239	132	3229
Cross-shore min pts	3	16	5	27	7	35
Cross-shore max pts	5	22	7	32	8	36
Along shore min pts	12	58	17	85	13	70
Along shore max pts	14	69	18	89	15	73

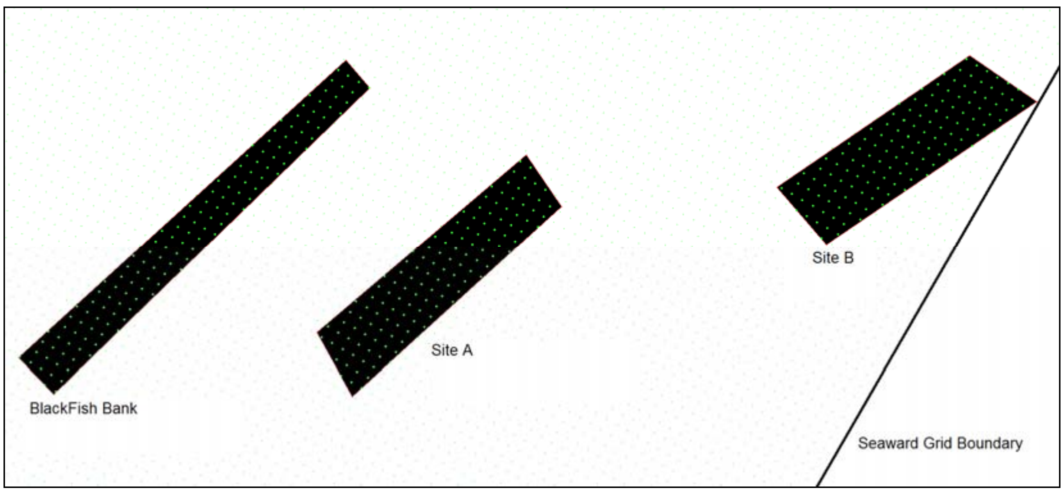

Figure 8-5. Portion of the STWAVE Coarse Grid showing cell locations within the borrow sites.

Dredging Modifications to the Borrow Sites

It is anticipated that a borrow site may be mined several times to supply material for the initial beach nourishment and each of the renourishments. Referring to Table 7-1, the maximum amount of fill material that would be required by the project over its lifetime would be of the order of 10 million cubic yards. The maximum change in wave refraction would occur once the entire volume was removed. Therefore, to determine the maximum impacts, wave refraction over the present bathymetry was modeled, as was wave refraction with 10 million cubic yards removed from each of the borrow sites.

How material would be dredged from the borrow areas is not known ahead of time. For this study, two material removal schemes were modeled. The first method was to remove the highest points within a borrow site down to an elevation that provided an adequate volume of material. This method, termed the Plane Method, would have the effect of turning rounded hills or ridges into one or more flat mesa tops while leaving lower slopes and adjacent valleys unchanged. The second method, termed the Contour Method, was to remove the same depth of material from all points within the borrow site. This would have the effect of lowering the contour everywhere within the borrow site by a constant amount.

It is not assumed that either of these schemes would be adopted by a dredging contractor. Rather, the first method was assumed to be the one that would have the greatest shoreline impacts, and the second would have more modest shoreline impacts. The actual dredging would likely produce shoreline impacts that fall somewhere between the results for these two scenarios.

The effects of these two methods on each of the borrow sites is shown graphically in Figures 8-6 through 8-8. These figures are histograms that rank all the elevations within the borrow site from highest to lowest for each of the three sites. The blue line represents the present distribution of elevations. The pink line shows the distribution of elevations if the site were Planed, and the lime green line, if the site were Contoured. Table 8-3 lists the highest elevation remaining within the borrow site if the site were Planed and the constant amount the profile would need to be lowered if the site were Contoured. These values were calculated based upon the removal of 10,000,000 yards^3 of material from each borrow site.

Table 8-3. Borrow Area Characteristics

Borrow Area	Blackfish	Site A	Site B
Current Minimum Depth (ft)	13.5	25.0	29.0
Current Maximum Depth (ft)	51.3	70.2	64.5
Plane Depth (ft)	31.5	45.6	46.3
Contour Depth Change (ft)	4.7	4.8	4.9

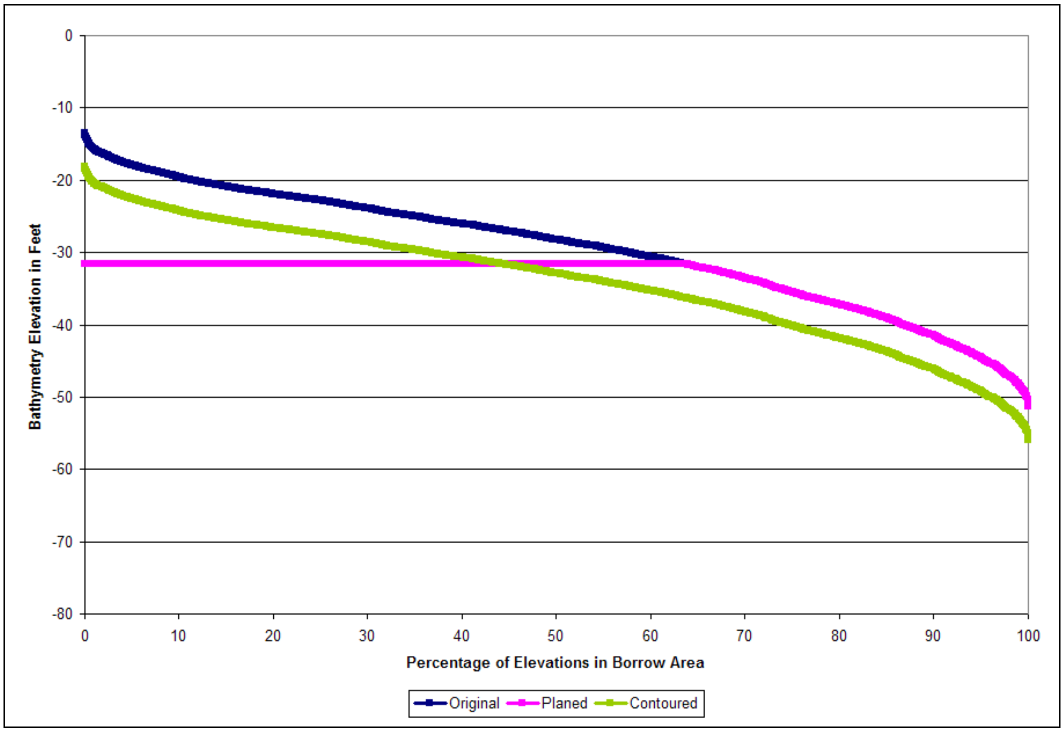

Figure 8-6. Histogram of BlackFish Bank depths for mining alternatives.

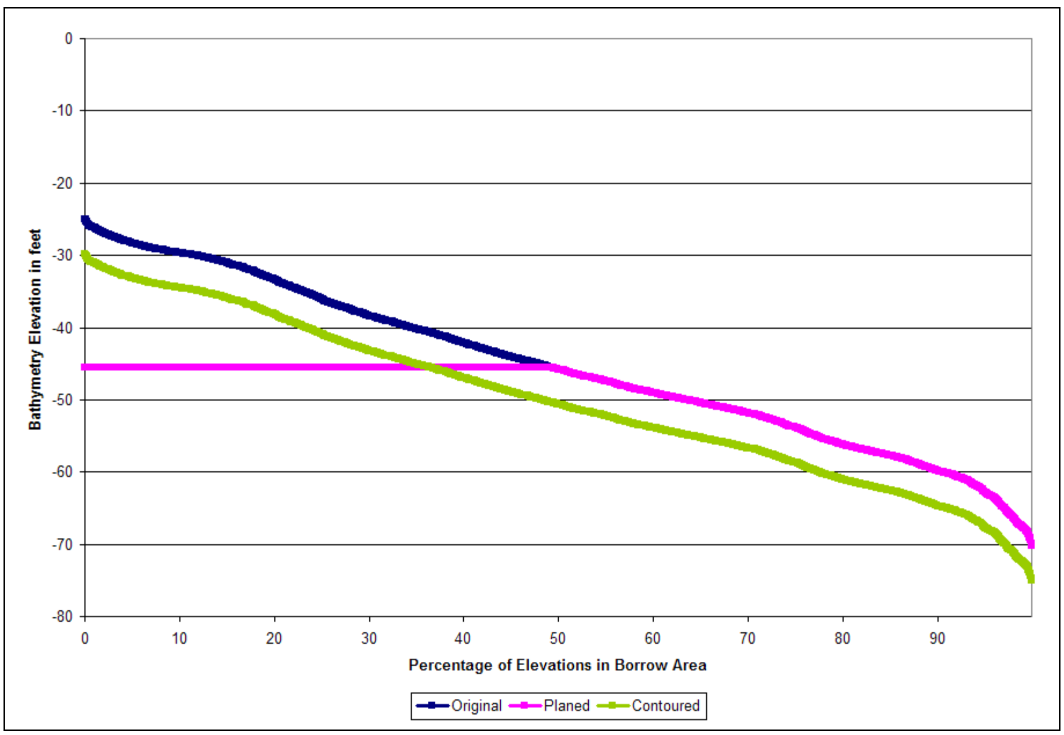

Figure 8-7. Histogram of Site A depths for mining alternatives.

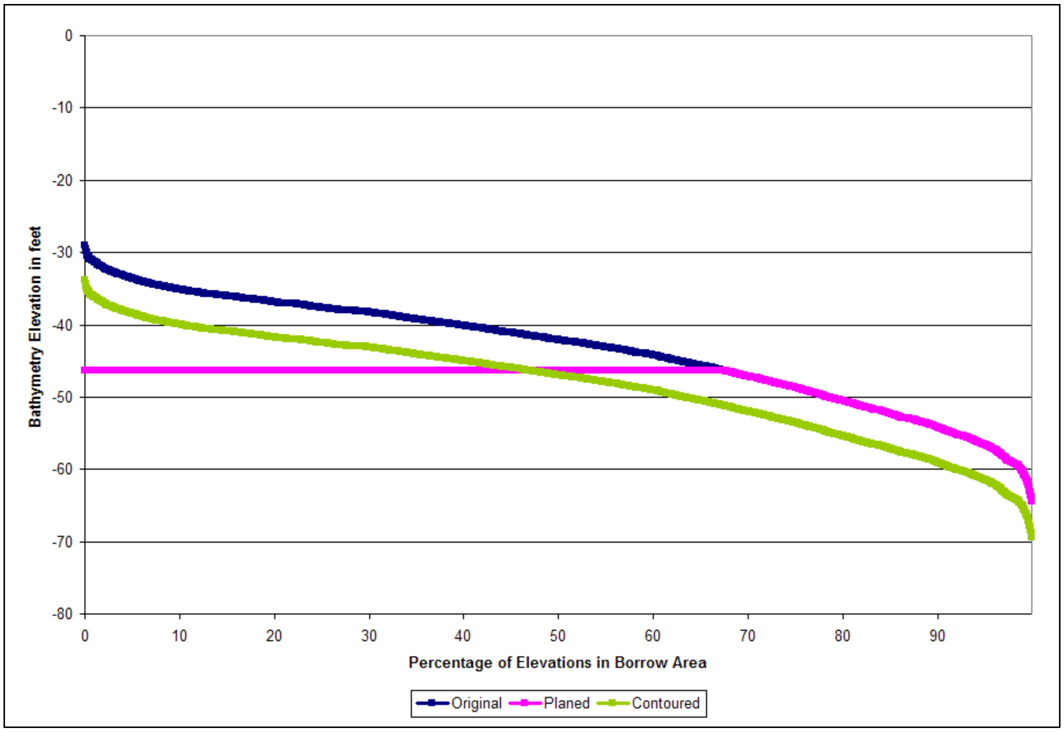

Figure 8-8. Histogram of Site B depths for mining alternatives.

STWAVE Grid Summary

Thus, 14 different bathymetry grids were developed for this analysis, as shown in Table 8-4. STWAVE was run using each of these grids.

Table 8-4. STWAVE Bathymetry Grids

	Coarse Grid	Fine Grid
As Is Bathymetry	X	X
Blackfish, Planed	X	X
Blackfish, Contoured	X	X
Site A, Planed	X	X
Site A, Contoured	X	X
Site B, Planed	X	X
Site B, Contoured	X	X

STWAVE Wave Climatology

For this analysis, wave data were obtained from a 20-year hourly hindcast (1980-1999) of wave heights, periods, and directions from WIS station 177, located at 37.75° N, 75.08° W, in 25 meters of water depth. This station is seaward of WIS station 178 used in the analysis presented in Chapter 5 and seaward of the seaward edge of the two Fishing Point grids, as shown in Figure 8-2.

These wave data were prepared for model use as described in Chapter 5, except as noted. As the grid orientation differed by 9° from the Wallops Island grid (to be better aligned with the shoreline orientation over the whole grid), the shore normal direction was 120°. The 20-year WIS wave climatology (175,320 hourly wave records) was characterized by binning the data into four peak spectral wave period bins, and twelve vector mean wave directions at the peak spectral frequency bins, as shown in Figure 8-9. Figure 8-9 shows the wave heights partitioned into nine bins for ease of comparison with Figure 5-3. However, for this analysis only one wave height bin, which contained all the heights, was used. The 47 period / angle bin combinations that were used are shown in Figure 8-10.

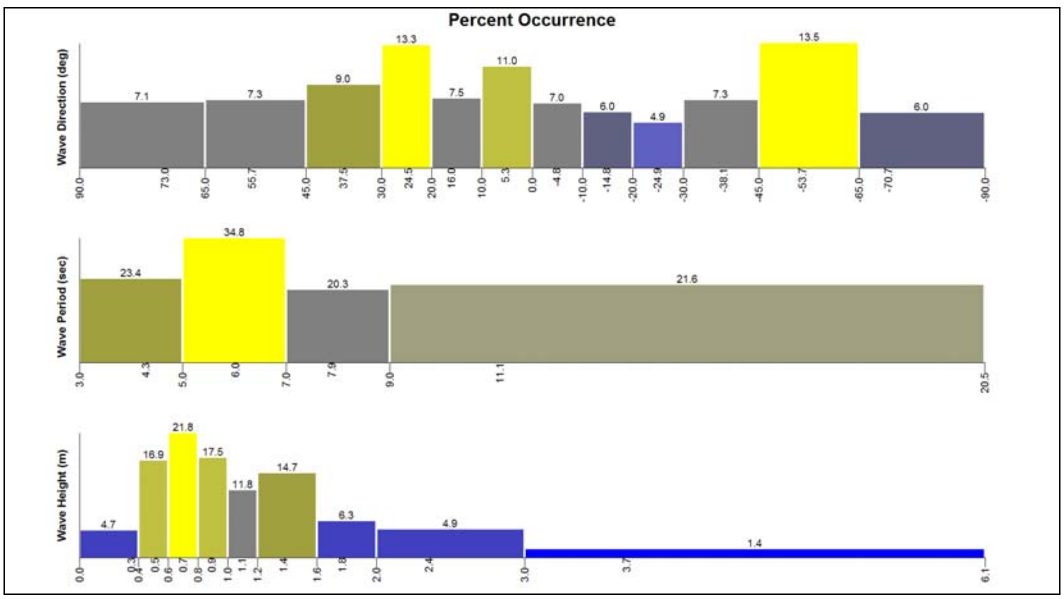

Figure 8-9. STWAVE Wave Height, Period, and Angle bins.

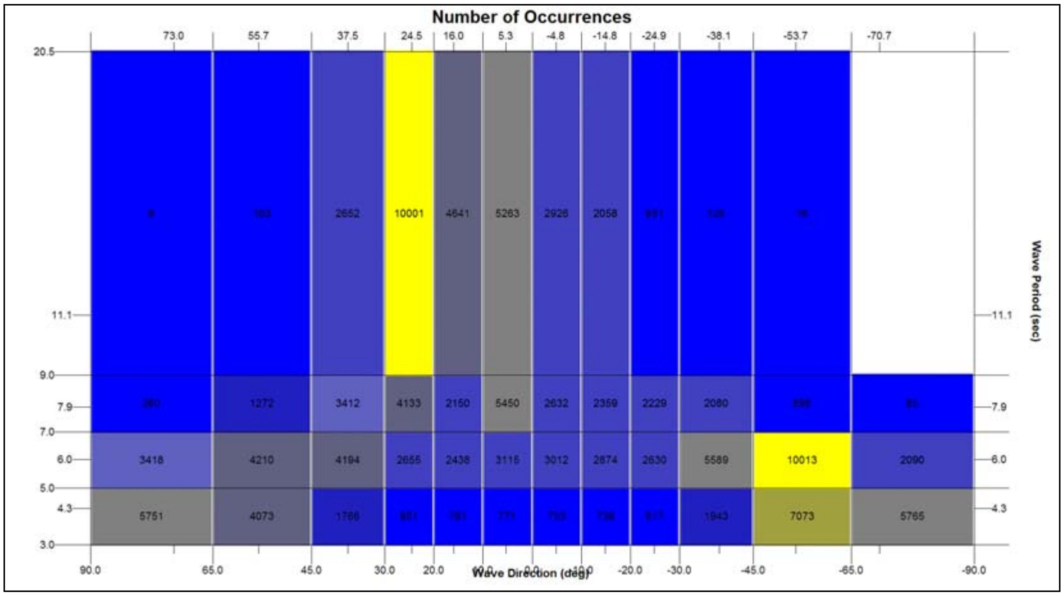

Figure 8-10. STWAVE block diagram of wave height vs. wave angle.

STWAVE was run using each of the 14 grids listed in Table 8-4 for the 47 bin combinations to transform the wave data from the offshore boundary of the grids to a near-breaking depth at the save stations. STWAVE model configuration parameters for these runs are listed in Table E-10 in Appendix E.

Sediment Transport Modeling

Following the STWAVE refraction analysis, sediment transport rates were calculated at each of the alongshore save station locations for each of the 14 grids for each hour in the wave record. Using the appropriate wave bin for each hour, the wave height, period and direction at the save station were obtained. These data were then transformed to breaking depth data using the methodology described in Gravens (1989). Then a longshore sediment transport rate was calculated using the CERC formula (Rosati, Walton, and Bodge, 2006). Repeating this procedure for the 20 years of the WIS data produced 20 yearly sediment transport rates for each shoreline location.

The significance of the offshore borrow site mining was determined using the methodology described in MMS-2001-098. The 20 yearly rates were averaged to obtain an overall average longshore sediment transport for each alongshore location. This was done for each of the 14 grids. For the transport rates calculated using the As Is bathymetry conditions, the yearly transport rates were combined into five 4-year groups and an average was calculated for each group. The five averages were then used to calculate a 4-year standard deviation (*4Yr St Dev*). If this standard deviation is less than the magnitude of the difference between the average As Is transport rate and the average rate calculated for a mined grid at even a single location (ratio >1 at any location), the MMS guidelines indicate that the shoreline impact is unacceptably large for that offshore shoal mining scenario.

Sediment Transport Rate Results

At each shoreline location, an impact factor was calculated using the formula:

$$Factor = \frac{Abs(A - B_i)}{(4Yr\ St\ Dev)} \tag{8-1}$$

where:

A = the 20-yr average transport rate calculated using the "As Is" conditions, and

B_i = the 20-yr average transport rate derived from one of the altered bathymetries.

Any factors that exceeded 1 would indicate an unacceptably large shoreline impact.

The transport rate analysis results are shown in Figures 8-11 through 8-13 for BlackFish Bank, Site A, and Site B, respectively. The left-hand panel of each figure shows the shoreline, the offshore bathymetry, and the borrow site. The fine grid results are displayed for the area between the pink lines; the coarse grid results are displayed outside of those lines. The center panel of each figure shows the factor number for each shoreline location that is the result of material being Planed from the borrow site. The right hand panel shows the same curve, but based upon the borrow material being removed by Contouring.

The BlackFish Bank Planed analysis yielded three locations where the Factor exceeded one. The Factor did not exceed one in any of the other analyses. (The coarse grid analysis included the region covered by the fine grid. These coarse grid data results are not shown, but in general values were less than for the fine grid results, and at no location on any coarse grid did the factor exceed one.

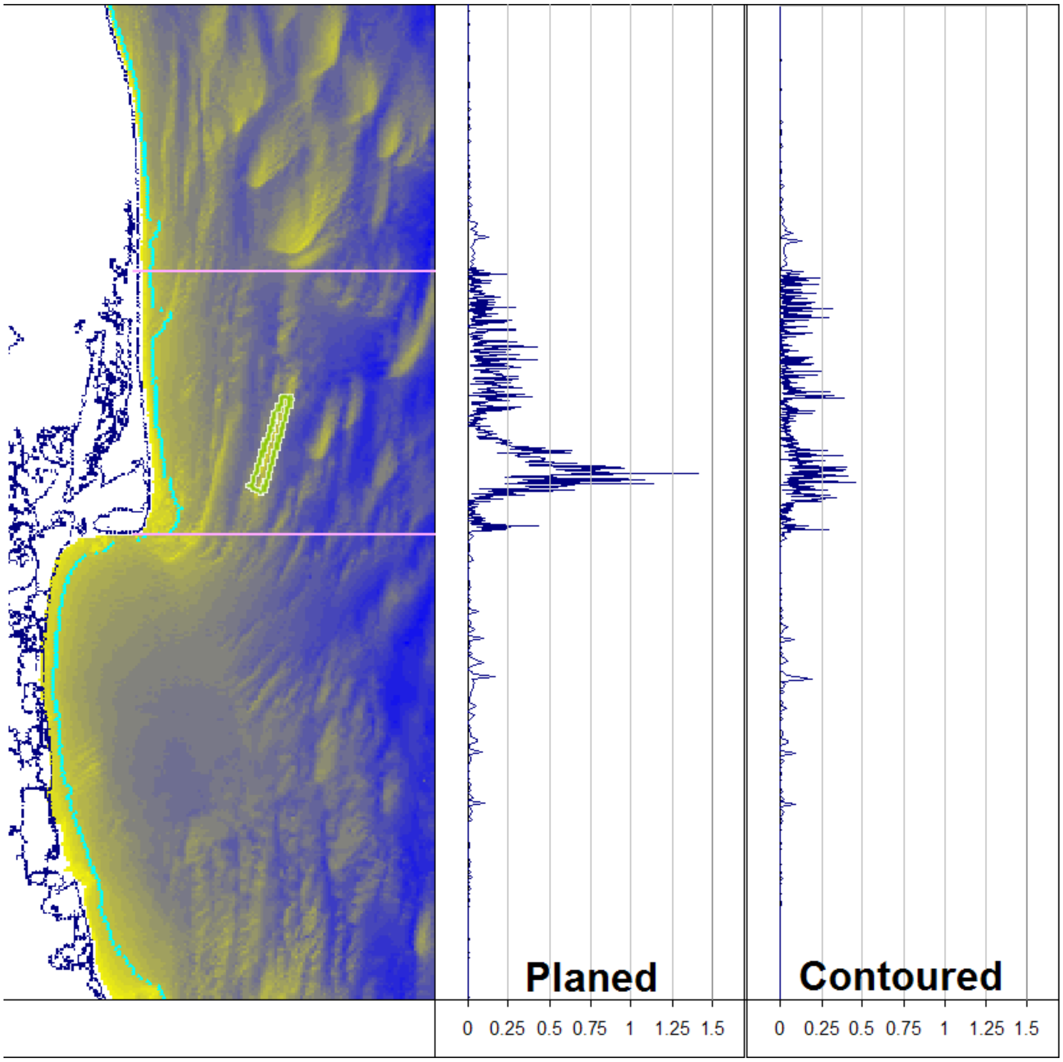

Figure 8-11. Impact Factor Results for BlackFish Bank Borrow Site.

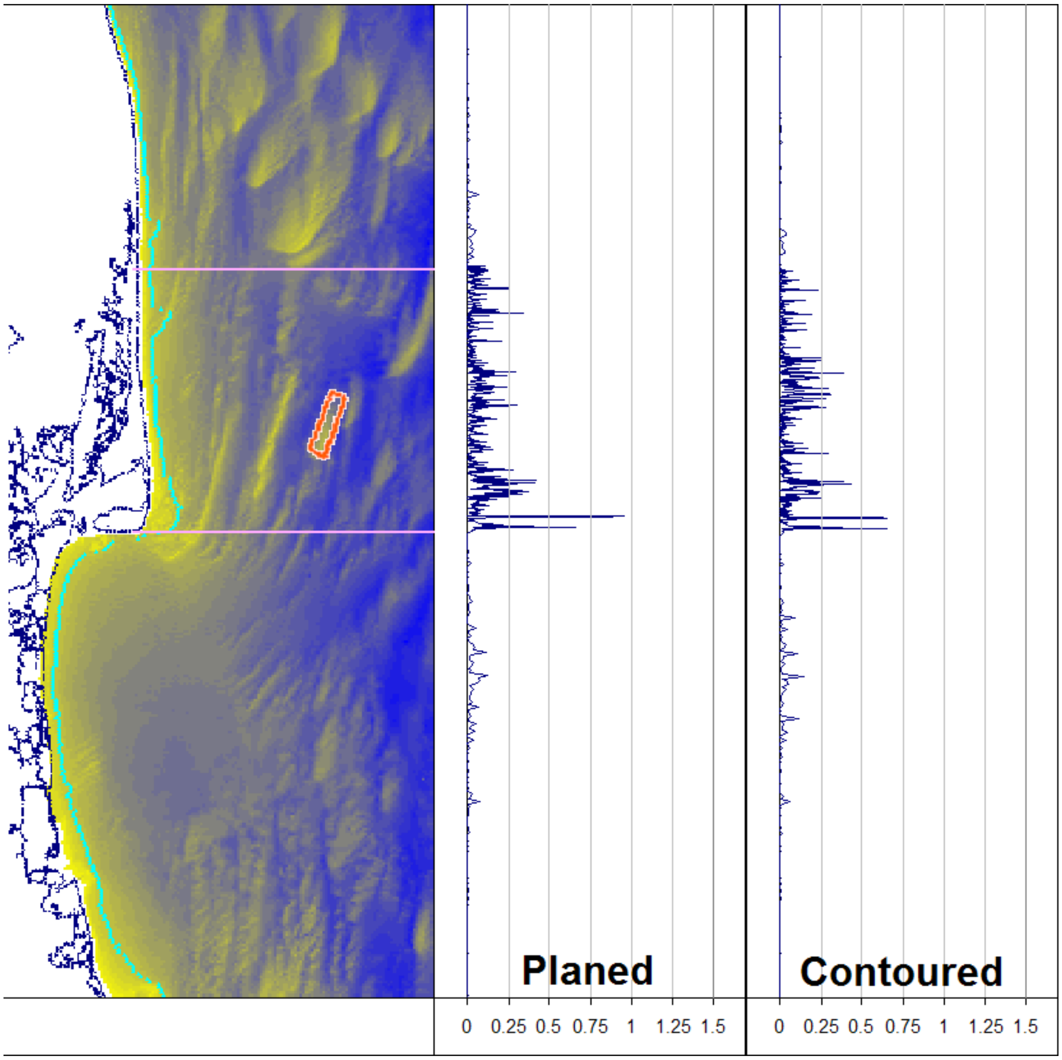

Figure 8-12. Impact Factor Results for Borrow Site A.

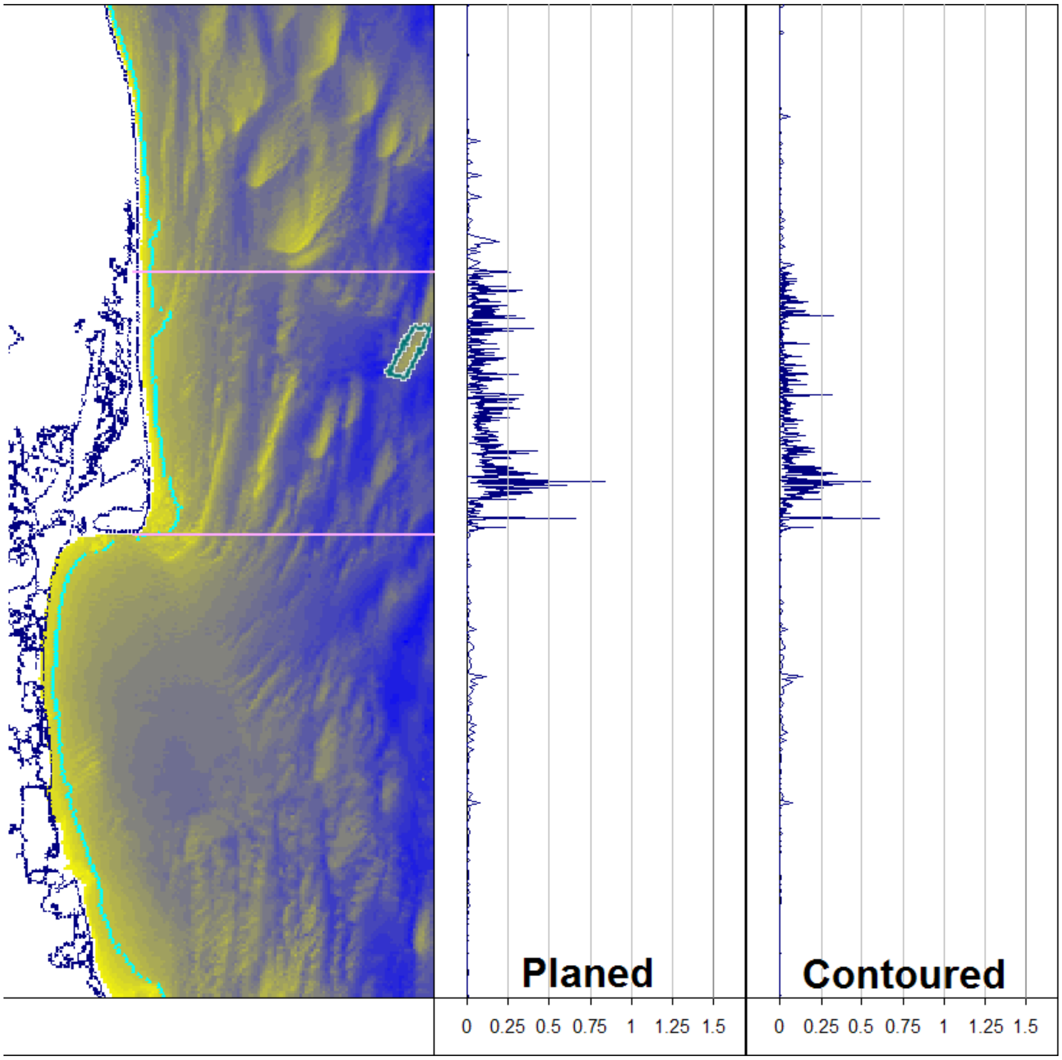

Figure 8-13. Impact Factor Results for Borrow Site B.

Discussion

Removing material from the borrow sites by Planing was included in the analysis not because this was expected to be the methodology used in actual dredging operations, but because it was assumed this would help readily identify less acceptable borrow site locations. By any of several measures, it is clear that the BlackFish borrow site would have a greater shoreline impact than either of the other two borrow sites. This is seen in Table 8-5, which shows the number of locations on the six graphs above where the Factor calculations (equation 8-1) exceed 1.0, 0.75, 0.5, and 0.25.

Table 8-5. Number of Eq 8.1 Exceedence Locations					
		1.0	**0.75**	**0.50**	**0.25**
BlackFish	**Plane**	3	12	36	111
	Contour	0	0	0	25
Site A	**Plane**	0	2	3	19
	Contour	0	0	3	15
Site B	**Plane**	0	1	3	43
	Contour	0	0	2	13

The fact that dredging BlackFish Bank would have a greater shoreline impact than dredging either of the other two shoals is hardly surprising. It is expected that borrow sites in the shallowest water and closest to shore will have the greatest shoreline impacts. Deeper shoals have less ability to refract waves, and greater distances to the shoreline allow the refraction effects to diffuse over a broader area, thus making a less significant impact at any one location. In addition, because Blackfish Bank and particularly Chincoteague Shoals are large shallow nearshore features (Figure 8-1), they exert a significant influence on the wave refraction by causing waves approaching from any direction to tend to align with the bottom contours. Thus, their existence helps to reduce the shoreline impacts that would be caused by mining shoals further offshore.

As discussed in MMS 2001-098, comparing the change in the transport rate caused by dredging to the natural wave variability (as represented by the 4-year Standard Deviation) is a superior method of determining dredge site acceptability when compared to other schemes that have been proposed. However, it is not perfect. Removing offshore borrow site material does not increase the variability in the longshore sediment transport rate so much as it introduces a constant bias in that rate. That is, the quantities in the numerator and denominator of Eq 8-1 are related, but are not the same statistical type. The numerator is the difference of two means, while the denominator is a standard deviation. It is not clear that a value for this factor of < 1 equates to a negligible long term shoreline impact.

The dynamic nature of this area was discussed in Chapter 2 along with the expected continuing occurrence of over-washes and inlet breaches in the Tom's Cove region of Assateague Island during the life of this project. One of the major goals of the National Park Service's management of Assateague National Seashore is to keep it in as natural a state as possible. Therefore, it is important to minimize any offshore mining effects on the shoreline sediment transport. This modeling effort has shown that the major shoreline impacts from mining any of the proposed borrow sites will be generally in the Tom's Cove area.

Therefore, it is strongly recommended that BlackFish Bank be removed from further consideration as a potential borrow site for this project. It is easily possible that additional modeling could show that a limited amount of material could be removed from that shoal without exceeding MMS guidelines. Indeed, this analysis has shown that the entire 10,000,000 yd^3 could be removed by the reasonable method of Contouring without exceeding MMS guidelines. However, that misses the point that this analysis has shown that this is a marginal site, and that other, more desirable, options are available.

The analysis has shown that Sites A and B are acceptable by MMS guidelines, and that they have fewer potential shoreline impacts than the BlackFish Bank site. In comparing Site A with Site B, this analysis has shown that the overall level of shoreline impact is roughly equivalent for the two sites (Table 8-5). However, comparing Figures 8-12 and 8-13, it is seen that site B produces somewhat larger impacts along the narrow Tom's Cove shoreline than Site A. This fact, in addition to other factors not considered in this chapter (Site A is closer to Wallops Island than Site B and thus has lower transportation costs, Site A sampled grain sizes are a little coarser than Site B (Figure 3-3, and Appendix A), no significant cultural artifacts were found at either site, similar biological organism densities were found at both sites), all support the selection of Site A as the recommended offshore borrow site.

9 On-shore Mining of the North End of Wallops Island for Beach Fill

A partial alternative to the offshore borrow sites exists on the north end of Wallops Island. The beach in this area is rapidly accreting, and the rate is expected to substantially increase as a result of the adjacent fill project. The potential borrow area is shown schematically by the red triangle in Figure 9-1.

Figure 9-1. General area of on-shore borrow site at the north end of Wallops Island.

The exact limits of the borrow area are intentionally undefined at this time as they will undoubtedly vary between mining events in response to: the volumes and patterns of accretion, the varying suitability of the sediment, Chincoteague Inlet dynamics, changes in vegetative cover, and biological factors, among others.

Sediment Budget

It is not possible to develop a comprehensive sediment budget for the north end of Wallops Island because of the lack of available data. It is clear that the area received sediment from further south on Wallops Island and from Fishing Point. The area also undoubtedly loses material to the interior shoals of Chincoteague Inlet.

GENESIS modeling has shown that, on average, approximately 40,000 yds^3/yr arrives in this area by longshore transport from further south along the Wallops Island shoreline (Chapter 5). Once the beach fill is placed, that volume is expected to increase to 100,000 to 150,000 yds^3/yr for any of the alternatives.

From the pattern of shoreline accretion, it is clear that substantial amounts of beach material cross Chincoteague Inlet from Fishing Point to the north end of Wallops Island. Large ebb shoals migrate westward across the inlet and weld onto the shoreline, causing the very large bulge in the shoreline. However, these are episodic events and their rate is not well documented. Additional material is dredged from the inlet channel and deposited in an offshore disposal site (Chapter 3, Table 3-3).

Since almost all inlets have been shown to be sediment sinks (e.g., Dean and Walton, 1975), it is assumed that Chincoteague Inlet sequesters sand from both adjacent beaches in its flood shoals, however, the rates are not known. What is clear is that the north end of Wallops Island is accreting. Therefore, more sand is being delivered to this area than is leaving.

Site Suitability

Obtaining fill material from this area is an attractive alternative for several reasons:

- There are a very limited number of structures on the island north of the seawall and none of these would be negatively impacted by mining the beach area. NASA has no plans for new construction in the area.

- The recycling of project fill material is an encouraged USACE policy, where practical, because it will reduce the volume of new fill material needed (and thus the overall disturbance to the environment) over the lifetime of the project.

- Limited analysis (discussed in Chapter 3) has shown that the native material has a D_{50} in the range of 0.25 mm and is suitable as fill.

- Obtaining fill from the site would be cost effective when compared with the costs from offshore sources. This process would most likely be accomplished with large earth moving equipment (pan/scraper) or off road dump trucks in the subaerial (dry) portion of the beach. NOTE: this is just an approximate area not the exact borrow area.

If the initial fill placement is made from offshore sources, the material being transported north to this site will have an expected median grain size of 0.29mm. This will mix with the native material producing a sediment with a D_{50} finer than 0.29mm. The beach fill volume calculations were based upon the fill material having a D_{50} of 0.29mm. The use of finer material will require a one-time additional volume to adjust the beach profile. Assuming the resulting mixture has a D_{50} of 0.25 mm, the one-time profile adjustment volume would be 292,000 yds^3. For other D_{50} sizes, see Table 6-1.

Plan

It is anticipated that the initial fill material will be derived from an offshore borrow site (Chapter 8). The monitoring program will provide detailed information on grain sizes and available volumes on the north end of Wallops Island during renourishment events. Therefore, individual event decisions can be made for whether none, some, or all of the required renourishment volume should be obtained from this adjacent onshore site. For planning purposes, it is reasonable to assume that 50% of the overall needed renourishment volume will be derived from the onshore site.

10 Shoreline Impacts from Seawall Extension

As discussed in Chapter 7, an extension of the southern end of the rock seawall is planned for Year 1 of the project, and the first beach fill placement is planned for Year 2. This section of the report assesses the potential impacts to the shoreline that may occur during the time interval between the construction of the seawall extension and the initial beach fill. The shoreline along the south end of Wallops Island is eroding. The fact that sand would be sequestered behind a seawall extension that would otherwise have eroded will lead to the potential to exacerbate the erosion on the adjacent shoreline.

The extent of this exacerbated erosion during the initial implementation of this project is the focus of this chapter. This is a temporary condition. Once the initial beach fill is in place, the model results presented in Chapter 6 indicate that the shoreline south of the project (south end of Wallops Island and north end of Assawoman Island) will stop eroding and start accreting.

GENESIS Modeling Conditions

The shoreline response was examined by running the GENESIS model described in Chapter 5. For this application, the 2005 shoreline (the most recent complete shoreline available) was used in the model as the initial shoreline. As this modeling effort was intended to represent the time before any sediment placement, no beach fills were included in the model runs. As the preferred alternative has no sand retention structure at the south end of the project, no groin or detached breakwater were included in the modeling.

NASA's current plan is to construct a 1500 ft southern extension onto the end of the current rock seawall. This would provide the MARS launch facility with seawall protection. However, NASA is exploring funding possibilities to extend the seawall further to the south up to 4600 ft, the location of the south camera stand and the southern end of the beach restoration project. To represent various potential designs, seawall extensions of 1500, 3000, and 4600 ft were modeled as shown in Figure

10-1, and shoreline responses for these cases were compared to the zero extension ("as is") condition. Because of model grid spacing and other considerations, the actual seawall extension distances modeled were closer to 1680, 3120, and 4560 ft, respectively, but these distances are referred to by their nominal 1500, 3000, and 4600 ft lengths.

Figure 10-1. Potential seawall extensions modeled in this study.

The results presented below are based upon average shoreline values. These model results were obtained by driving the model with 20 different 4-year wave blocks, and averaging the results, as described in Chapter 5. The 95% confidence intervals were also calculated from the 20 shoreline realizations.

The cross-shore location of the seawall relative to the shoreline has a dominant effect on the extent of the adjacent shoreline impacts. If the seawall is placed far enough landward of the shoreline, erosion will not reach the seawall and the seawall will cause no adjacent shoreline impacts. Initial modeling was done to determine appropriate cross-shore seawall locations. The most significant impacts occur when the seawall is placed along the initial model shoreline. It was determined that only minimal impacts would occur if the seawall were located 10 yards (9.1 m) landward of the shoreline. Therefore, these two cross-shore seawall placements (at shoreline and 10 yards inland) were fully modeled and their results are presented below.

NASA is committed to the project schedule outlined in Chapter 7 with the seawall construction occurring in Year 1 and the initial beach fill in Year 2. However, since federal funding cannot be assured for the out-years of multi-year projects, the modeling also looked at the effect of delays in implementation of the beach fill after a seawall extension was constructed. While any delay is unlikely, if one were to occur, it would most likely mean that there was a 2-year time period between seawall extension construction and beach fill placement. Longer delays, which seem a remote possibility, were lumped into a generic 10-year period between seawall construction and beach fill placement. Therefore, the modeling looked at

1-year, 2-year, and 10-year shoreline impacts. Except as noted above, the GENESIS modeling parameters are provided in Appendix Tables E5 and E7.

Modeling Results

Shoreline Change

Figure 10-2 shows model predictions of shoreline positions for the portion of the GENESIS grid that is south of the existing seawall, a distance of about 2 miles (see Figure 5-5). Each shoreline is an average of the results of 20 model runs that were driven with the 20 different four-year wave blocks discussed in Chapter 5. This figure is for a 1500 ft extension built at the shoreline. Similar plots for 3000 ft and 4600 ft extensions at the shoreline are shown in Figures 10-3 and 10-4. At this resolution, little difference can be seen in the shoreline position for seawalls built at the shoreline and 10 yds inland.

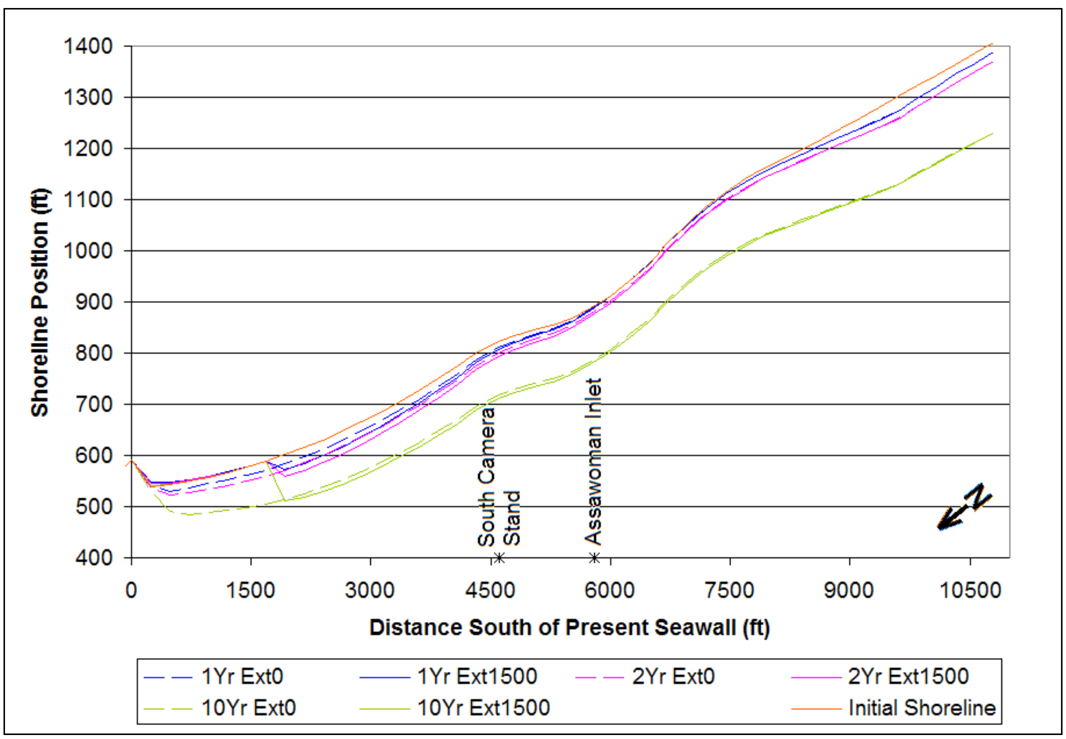

Figure 10-2. Modeled shoreline positions south of the existing seawall at 1, 2, and 10 years comparing the no extension condition to a 1500 ft seawall extension at the shoreline.

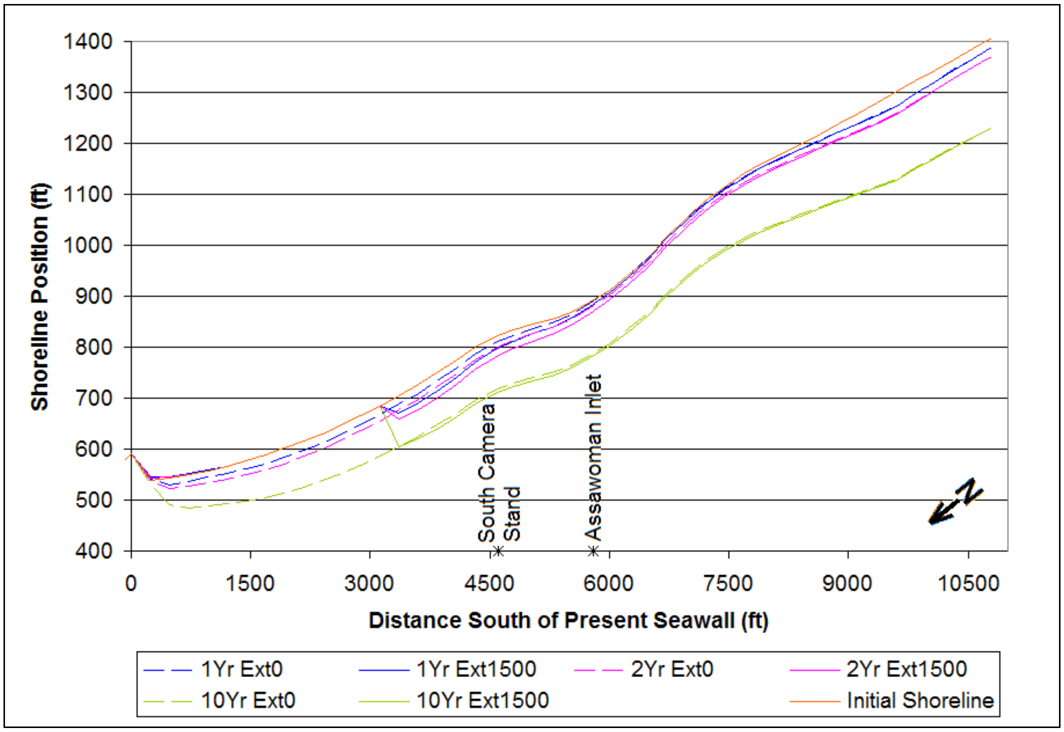

Figure 10-3. Modeled shoreline positions south of the existing seawall at 1, 2, and 10 years comparing the no extension condition to a 3000 ft seawall extension at the shoreline.

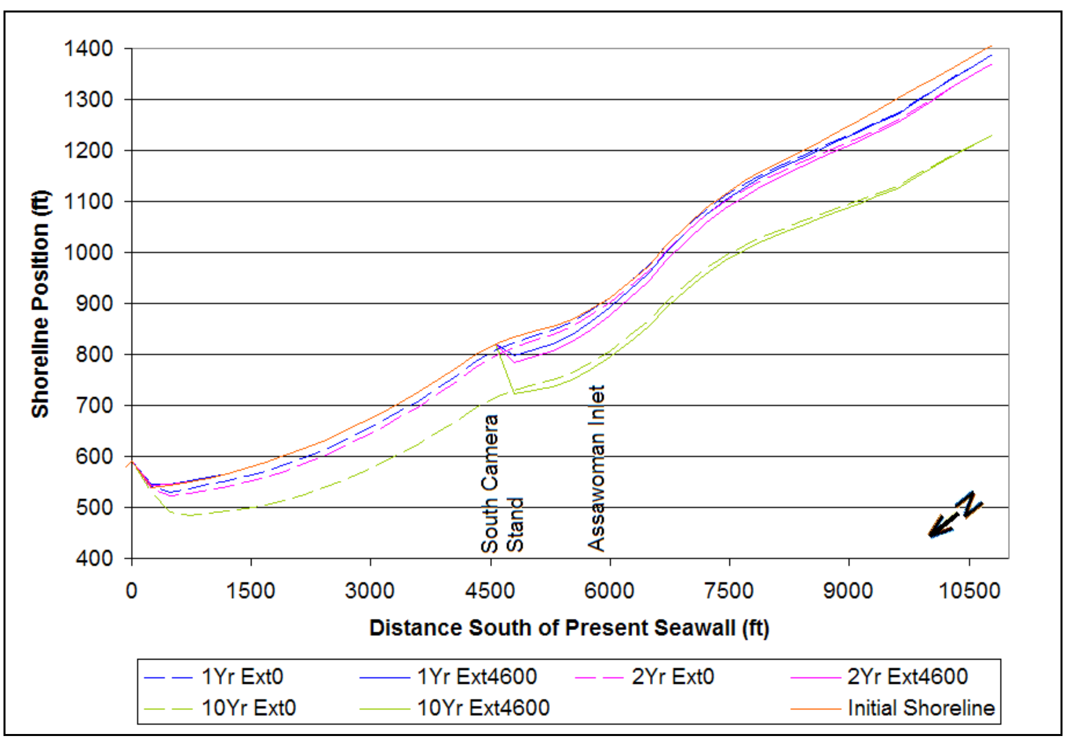

Figure 10-4. Modeled shoreline positions south of the existing seawall at 1, 2, and 10 years comparing the no extension condition to a 4600 ft seawall extension at the shoreline.

To minimize clutter, the 95% confidence interval shorelines are not included in these figures. It should also be noted that there is about a 5 to 1 vertical to horizontal distortion in these figures.

1-Year, 1500 ft Extension

Figure 10-5 covers the same shoreline location south of the existing seawall as Figures 10-2 through 10-4. This figure show the predicted difference in the shoreline position after 1 year for a 1500 ft seawall built at the shoreline. In this figure, the Average (blue) line shows the difference in the two blue lines (dashed and solid) in Figure 10-2. In this figure it can be seen that the greatest increase in the erosion (13.2 ft (4.0 m)) occurs immediately south of the end of the 1500 ft seawall and that the difference asymptotically decreases to zero to the south. Within the first 1500 ft, the seawall has stopped the erosion, so this difference shows up as a positive quantity. However, this positive value should not be interpreted as accretion; it is a decrease in erosion when compared to the no seawall extension condition. This pattern - a decrease in erosion at the seawall extension and a maximum increase in erosion just south of the end of the extension with an asymptotic decrease to zero further to the south - occurs in each of the conditions which were modeled.

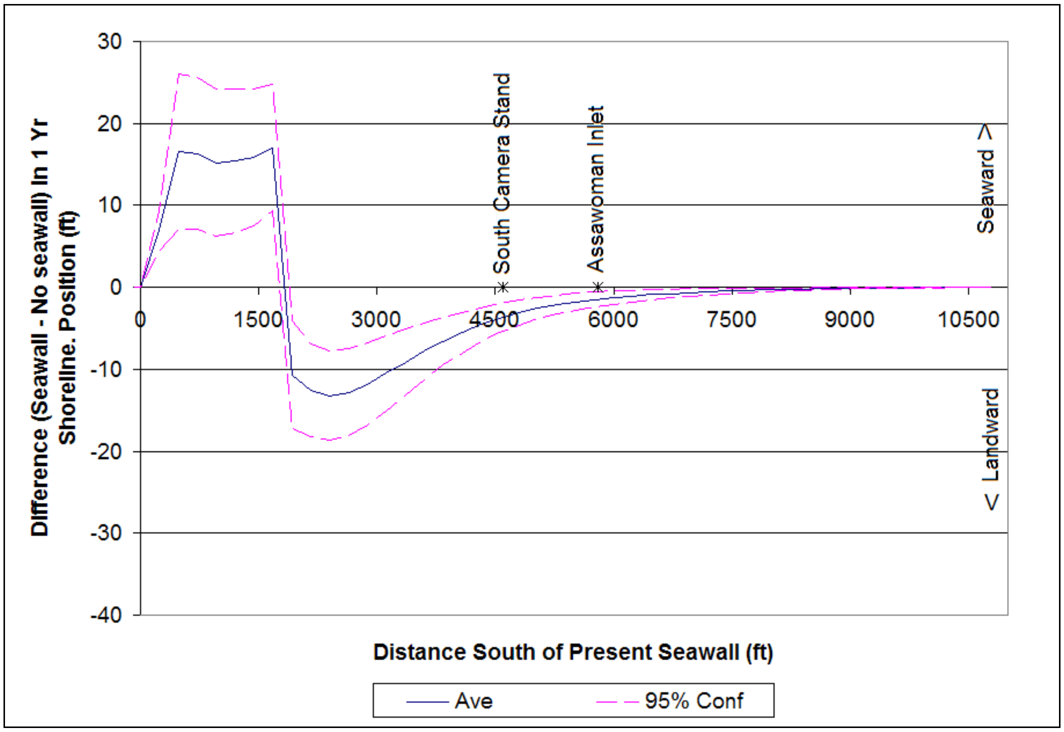

Figure 10 5. One year shoreline difference between 1500 ft seawall extension at the shoreline and no seawall extension.

Figure 10-6 shows the same results as Figure 10-5 except that the seawall is placed 10 yards landward of the shoreline. Placed at this location, the seawall causes substantially less negative impacts to the south of the extension (max about 2.4 ft (0.7 m)).

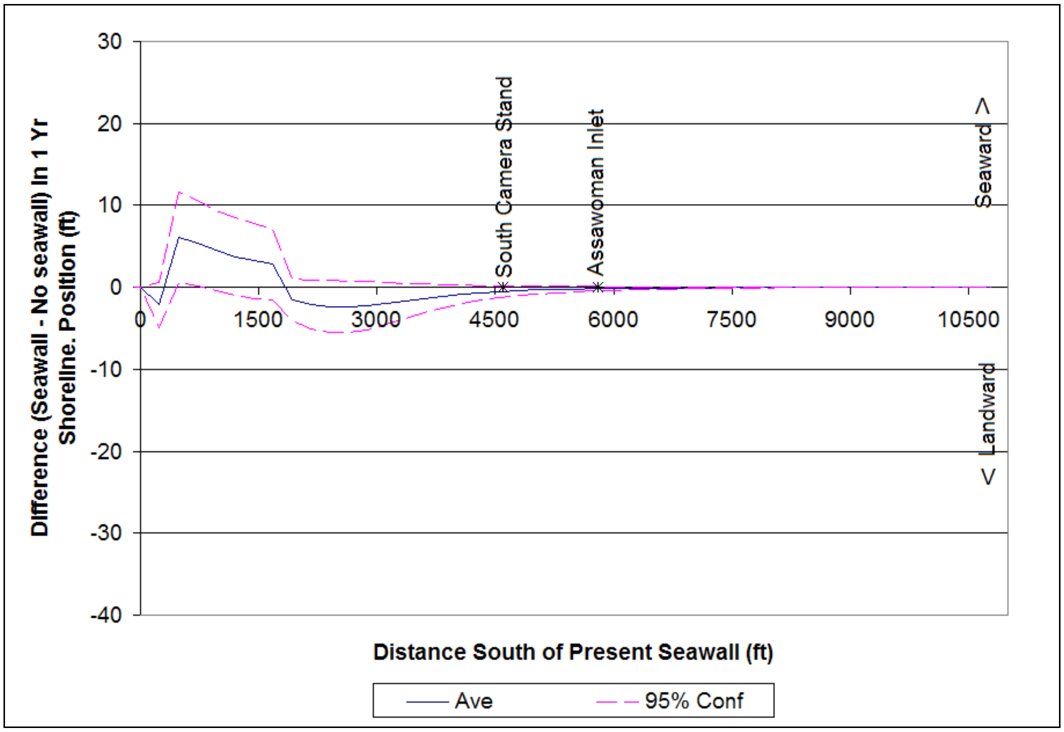

Figure 10 6. One year shoreline difference between 1500 ft seawall extension 10 yards landward and no seawall extension.

1-Year, 3000 ft Extension

Figures 10-7 and 10-8 show the same conditions as Figures 10-5 and 10-6, respectively, except that these are for a 3000 ft seawall extension. In Figure 10-7, the Average (blue) line shows the difference in the two blue lines in Figure 10-3. Again, there is much less impact from the seawall that is 10 yds inland from the shoreline. The maximum increase in erosion is 20.1 ft (6.1 m) in Figure 10-7, but only 3.7 ft (1.1 m) in Figure 10-8.

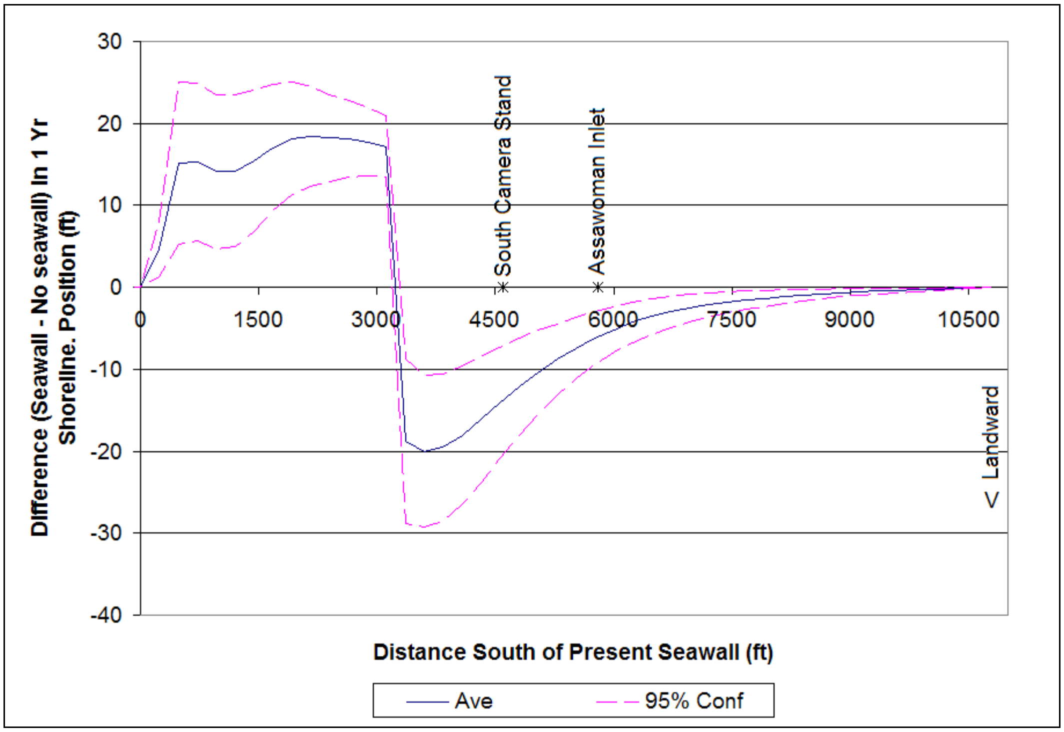

Figure 10-7. One year shoreline difference between 3000 ft seawall extension at the shoreline and no seawall extension.

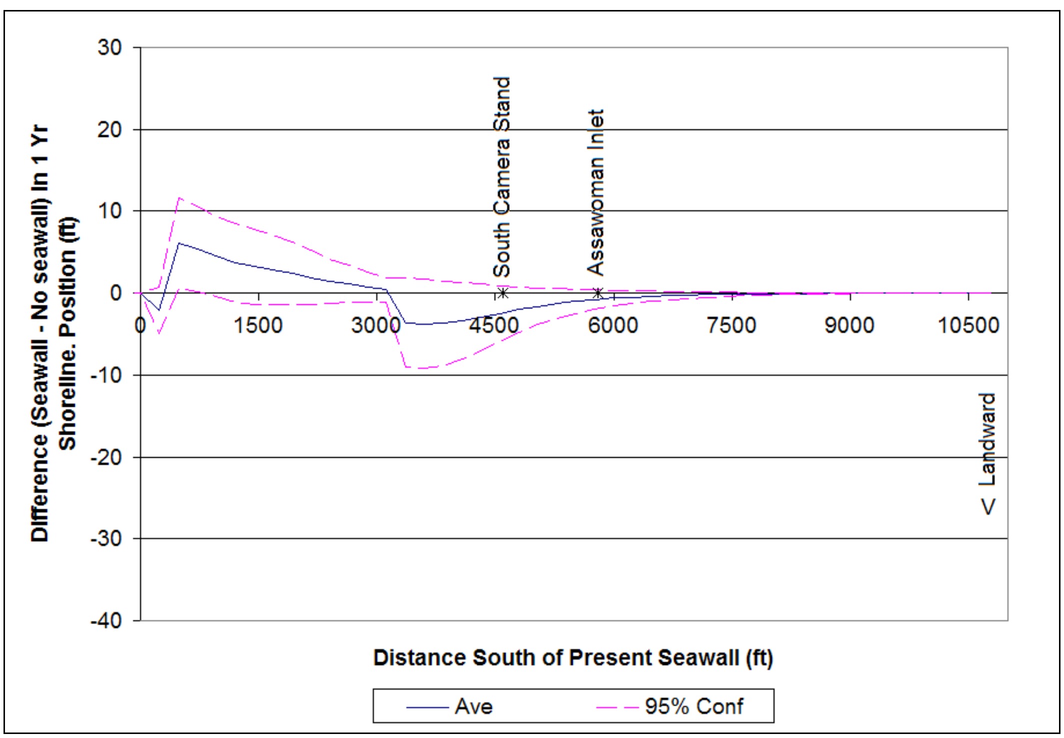

Figure 10-8. One year shoreline difference between 3000 ft seawall extension 10 yds landward and no seawall extension.

1-Year, 4600 ft Extension

Figures 10-9 and 10-10 show the same conditions as above, except that these are for a 4600 ft seawall extension. The seawall at the shoreline, Figure 10-9, shows a maximum erosion increase of 27.5 ft (8.4 m) while the 10 yd landward seawall has a more modest maximum erosion increase of 4.3 ft (1.3 m)

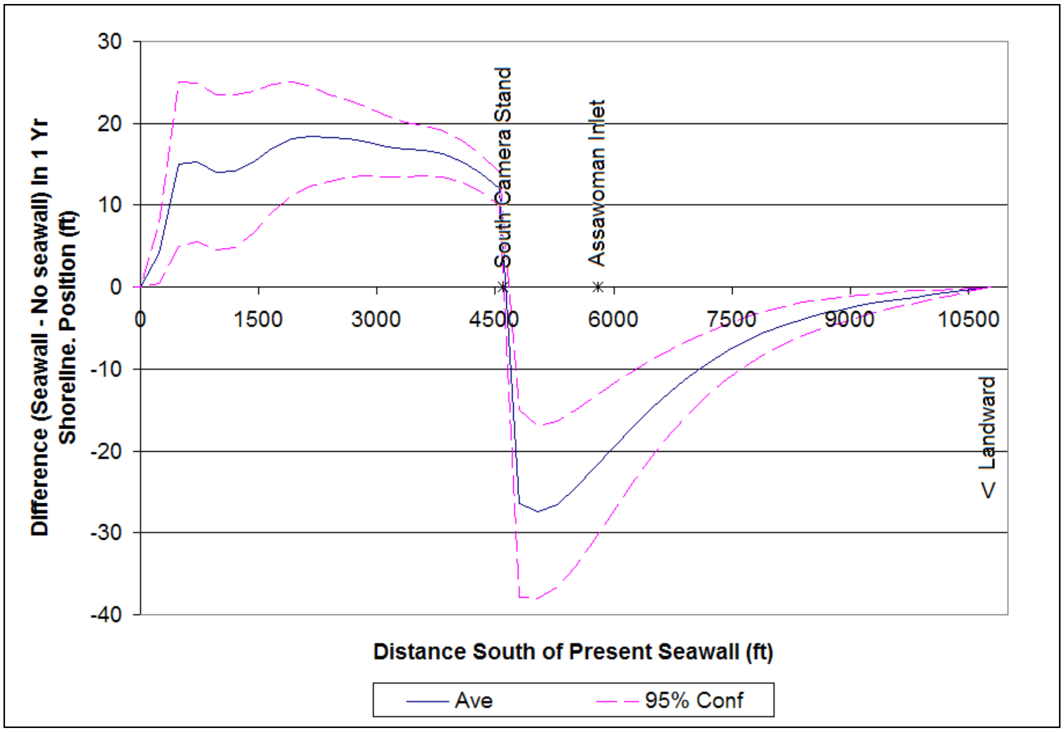

Figure 10-9. One year shoreline difference between 4600 ft seawall extension at the shoreline and no seawall extension.

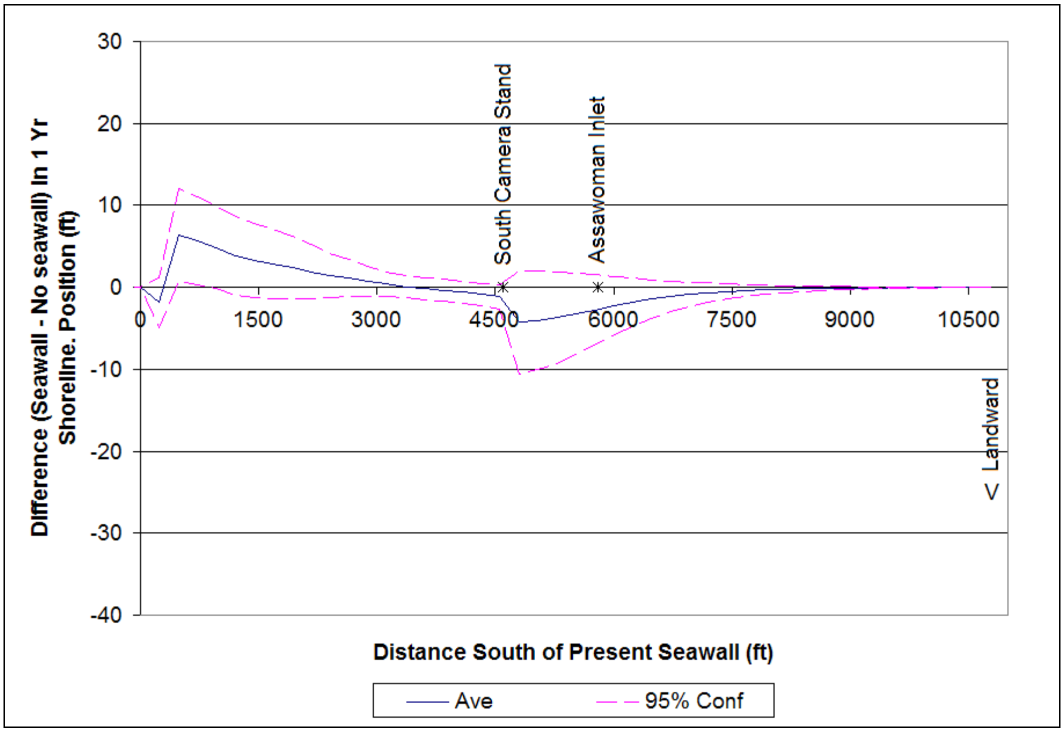

Figure 10-10. One year shoreline difference between 4600 ft seawall extension 10 yds landward and no seawall extension.

2-Year and 10-Year Shoreline Changes

The modeling results for the 2 year and 10 year ft shoreline differences show the same patterns as the 1 Year differences above. Impacts were largest immediately south of structure and the seawall placed 10 yards landward of the shoreline had significantly milder impacts than the seawall placed at the shoreline. The maximum erosion differences were not substantially larger than for the 1 year results. However, the impacts did extend further south as the longer time periods allowed the effects to diffuse down the coast. The 2 Year and 10 Year shoreline difference figures corresponding to Figures 10-5 through 10-10 are included in Appendix F.

It should be noted that the model requires that the shoreline change rate be specified at each end of the model. That has the effect of forcing the shoreline differences to zero at the 10,800 distance in these figures. For many of the figures shown above, the shoreline differences pinch out to zero well to the north of this point, and those are valid model predictions. However, some of the figures, particularly those for the 4600 ft seawall extension and those for the longer time periods show the differences being forced to zero at the 10,800 ft distance. These should be considered model artifacts and not representative of the true distance that impacts could extend onto Assawoman Island.

Discussion

Table 10-1 shows the 1-year average deficit volumes. The column labeled "South of Extension" is equivalent to the areas in Figures 10-5 to 10-10 between the blue lines and the zero line that are between the end of the extensions and 10,800 ft. The areas are converted to volumes by multiplying by the vertical distance between the top of the berm and the depth of closure. The column labeled "South of Assawoman Inlet" is equivalent to the more restrictive area between the blue line and zero that is between the point labeled Assawoman Inlet and the 10,800 ft distance. The first column represents the total negative impacts while the second represents the negative impacts to Assawoman Island. These volumes can be compared to the total 1-year volume change within the 10,800 ft distance (equivalent to the "no action alternative") of 96,000 yds^3. This number is equivalent to the area between the orange line and the dashed blue line in Figures 10-2 through 10-4. Because of the caveat discussed in the preceding paragraph, these numbers should not be used for planning purposes. Rather they are meant for internal comparisons to show the relative magnitudes of the impacts for the different scenarios.

Table 10-1. 1-Year Seawall Extension Deficit Volumes (yd^3)

		South of Extension	South of Assawoman Inlet
1500 ft Extension	Seawall at Shoreline	22,000	1,000
	Seawall 10 yds Inland	4,000	0
3000 ft Extension	Seawall at Shoreline	32,000	5,000
	Seawall 10 yds Inland	5,000	0
4600 ft Extension	Seawall at Shoreline	45,000	22,000
	Seawall 10 yds Inland	16,000	6,000

Table 10-2 shows the relative magnitude of the shoreline impacts in a different way. It shows the average shoreline change rate at Assawoman Inlet. These values were calculated by dividing the 10-year shoreline changes at Assawoman Inlet by 10. The "Ave" column under "Total

Shoreline Change Rate" is equivalent to the distance between the orange line and the various green lines in Figures 10-2 through 10-4 at Assawoman Inlet divided by 10. The columns under "Shoreline Change Rate Attributed to Construction" are equivalent to the distance between the zero line and the various colored lines in Figures F-7 through F12 at Assawoman Inlet divided by 10.

Table 10-2. Average Shoreline Change Rate (ft/yr) at Assawoman Inlet.

	Total Shoreline Change Rate			Shoreline Change Rate Attributed to Construction		
	Min	Ave	Max	Min	Ave	Max
No Seawall Extension	-9.3	-10.3	-11.3			
1500 ft Extension at Shoreline	-9.8	-10.9	-12.0	-0.4	-0.6	-0.7
1500 ft Extension 10 yds Landward	-9.4	-10.5	-11.7	0.0	-0.2	-0.4
3000 ft Extension at Shoreline	-9.4	-10.9	-12.4	0.1	-0.5	-1.2
3000 ft Extension 10 yds Landward	-9.1	-10.5	-12.0	0.4	-0.2	-0.8
4600 ft Extension at Shoreline	-9.7	-11.7	-13.7	-0.1	-1.4	-2.7
4600 ft Extension 10 yds Landward	-9.4	-11.4	-13.5	0.2	-1.1	-2.4

The most important result of this analysis is that construction of a seawall extension will have only modest negative impacts of the adjacent shoreline, particularly if the seawall is set back at least 10 yards from the shoreline. As seen in Table 10-2, the average shoreline change rate at Assawoman Inlet attributed to the construction will be less than the variability in the change rate caused by yearly changes in the wave climate. That is, stormy years are expected to cause greater shoreline change than the seawall extension will in years of normal waves.

Not surprisingly, the smallest impacts are caused by the shortest seawall extension and the shortest time interval between extension construction and beach fill placement. It is expected that any negative impacts can be redressed at the time of placement and that following beach fill placement, this area will accrete rather than erode.

11 Conclusions and Recommendations

The most important conclusion from the analysis described in this document is that it is feasible to design a project that provides a significant level of storm damage reduction to the facilities on Wallops Island, while at the same time does not negatively impact Assawoman Island to the south.

The storm damage reduction project is designed as a three tiered defense, including a beachfill, the rock seawall, and flood protecton. The beachfill is expected to provide the majority of the defense against smaller, more frequent storms. The rock seawall is intended to provide damage reduction against the largest storms expected over the lifetime of the project. While the seawall is expected to reduce wave heights in its lee, flooding can still be an issue. To provide a high level of protection, NASA personnel need to continue to address flooding concerns for each structure on the island.

Modeling of the beach's response to storms (SBEACH modeling in Chapter 4) has indicated that the beach fill should provide a minimum 70 ft wide berm with a 14 ft high dune. This defense should run from the end of the seawall at the north to the south camera stand, a distance of 19,000 ft.

The rock seawall is in need of maintenance, as discussed in Chapter 3. It is recommended that repairs be made at low elevation locations to raise the seawall to +12 or optimally +14 ft and at steep seaward-facing slopes to create a 1:2 slope. Repairs should be made by keying armor stones into the existing matrix or by rebuilding the wall where necessary. These repairs are similar to those recommended in Moffat and Nichol (1998) and Morang, Williams, and Swean (2006). Any future storm damage will need to be addressed as appropriate.

Due to the porosity of the seawall, the continued development of scour holes behind the seawall is expected until the beachfill is in place. It appears that placing rubble in the scour holes has been effective at halting the scour.

The seawall should be extended south as far as the South Camera Stand, if possible.

The components of the initial fill (Chapter 6) should include a seawall deficit volume, a berm volume, a dune volume, an overfill volume and an advanced nourishment volume. The components of the renourishment fill should include the advanced fill volume and a sea-level rise volume.

From a large initial list, three final alternatives are presented in this report that have gone through an extensive optimization process. These all have similar performance characteristics, and any of the three are expected to satisfy the project requirements. As discussed in Chapter 7, concerns about unintended consequences has led to the selection of Alternative 1, the no sand retention structure alternative as the recommended alternative.

The offshore borrow sites are analyzed in Chapter 8. It is recommended that the Blackfish Bank site be removed from further consideration as a source of project fill material because of the potential to negatively impact the Assateague Island shoreline in the vicinity of Tom's Cove. MMS guidelines indicate that the other two sites are equally acceptable alternatives. However, because of the location of the shoreline impacts, distance to the project, borrow site grain size, and other considerations, Site A is the recommended alternative, though Site B is still acceptable if needed. Anything that can be done to reduce the amount of total fill taken from these sites will lessen their shoreline impacts.

Chapter 9 discusses the potential of the north end of Wallops Island as an alternative borrow site. It is recommended that the initial fill be obtained from an offshore site, but that as much of the renourishment fill as practical be obtained from the onshore site.

As discussed in Chapter 10, the seawall extension should be constructed a minimum of 10 yards landward of the shoreline.

A monitoring program should be initiated as soon as practical. Analysis of the data collected will be the primary tool to monitor the behavior of the project and identify any problems. These data will also be used to determine when renourishment should take place and the amount of material needed. They will also be used to determine the amount of material available from the north end of Wallops Island.

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Appendix A: Vibracore Sediment Data

Table A1. Grain Size Data from Borrow Site A

Core #	Position	Depth (ft)	Mean (mm)	Median (mm)	ϕ St Dev
WIVC-29	Upper	0-3.7	0.382	0.342	0.69
	Mid	3.7-7.2	0.382	0.344	0.63
	Lower	7.2-11.3	0.46	0.406	0.82
	Composite	0-11.3	0.39	0.339	0.77
WIVC-30	Upper	0-4.1	0.599	0.49	0.93
	Mid	4.1-9.5	0.493	0.457	0.76
	Lower	9.5-15.6	0.423	0.403	0.67
	Composite	0-20.2	0.503	0.454	0.85
WIVC-54	Upper	0-5	0.695	0.616	1.225
	Mid				
	Lower	5-11.4	0.785	0.616	1.25
	Composite	0-11.4	0.901	0.683	1.55
WIVC-55	Upper	0-5.6	0.366	0.342	0.5
	Mid	5.6-9	0.451	0.366	0.675
	Lower	9-13.4	0.347	0.342	0.425
	Composite	0-13.4	0.392	0.342	0.55
WIVC-56	Upper	0-6.1	0.354	0.33	0.48
	Mid				
	Lower	6.1-10	0.254	0.259	0.425
	Composite	0-10	0.308	0.287	0.5
WIVC-57	Upper	0-4	0.243	0.241	0.44
	Mid	4-8	0.246	0.241	0.425
	Lower	8-12.5	0.231	0.233	0.365
	Composite	0-12.5	0.243	0.241	0.44
WIVC-58	Upper	0-4	0.302	0.297	0.425
	Mid	4-8	0.282	0.287	0.275
	Lower	8-13	0.273	0.277	0.325
	Composite	0-13	0.279	0.287	0.36
WIVC-61	Upper	0-5	0.218	0.218	0.45
	Mid				
	Lower	5-9.5	0.221	0.233	0.475
	Composite	0-9.5	0.218	0.218	0.45
WIVC-65	Upper	0-2	0.399	0.349	0.575
	Mid	2-5	0.342	0.33	0.4
	Lower	5-8	0.354	0.33	0.45
	Composite	0-8	0.372	0.342	0.475
WIVC-66	Upper	0-1.8	0.47	0.349	0.89
	Mid	1.8-5	0.241	0.241	0.5
	Lower	5-9.2	0.27	0.259	0.59
	Composite	0-9.2	0.386	0.287	1.075

Table A2. Grain Size Data from Borrow Site B

Core #	Position	Depth (ft)	Mean (mm)	Median (mm)	ϕ St Dev
WIVC-67	Upper	0-5	0.324	0.33	0.325
	Mid	5-10	0.475	0.406	0.775
	Lower	10-15.5	0.416	0.366	0.715
	Composite	0-15.5	0.394	0.354	0.645
WIVC-68	Upper	0-5	0.366	0.342	0.5
	Mid	5-9.3	0.428	0.392	0.625
	Lower	9.3-13	0.308	0.301	0.45
	Composite	0-13	0.379	0.5	0.55
WIVC-69	Upper	0-5	0.423	0.379	0.74
	Mid	5-10	0.268	0.259	0.6
	Lower	10-14.1	0.297	0.287	0.7
	Composite	0-14.1	0.342	0.319	0.85
WIVC-70	Upper	0-5	0.268	0.277	0.45
	Mid				
	Lower	5-9.2	0.287	0.241	0.65
	Composite	0-9.2	0.273	0.268	0.525
WIVC-71	Upper	0-1.3	0.313	0.241	1.075
	Mid	1.3-5	0.171	0.165	0.5
	Lower	5-9.8	0.132	0.139	0.375
	Composite	0-9.8	0.171	0.165	0.5
WIVC-72	Upper	0-2.6	0.354	0.297	0.9
	Mid	2.6-5	0.25	0.25	0.45
	Lower	5-9.9	0.224	0.218	0.36
	Composite	0-9.9	0.256	0.25	0.485

Table A3. Offshore Borrow Site Core Locations				
Borrow Site A				
Core #	**Collection Date**	**Latitude N**	**Longitude W**	**Water Depth (ft)**
WIVC-29	5/26/2007	37º 50.8256'	75º 12.6719'	33.8
WIVC-30	5/26/2007	37º 50.4283'	75º 13.2921'	30.9
WIVC-54	12/19/2007	37º 50.6815'	75º 13.1323'	39.1
WIVC-55	12/19/2007	37º 50.5173'	75º 12.8844'	31.5
WIVC-56	12/19/2007	37º 51.1555'	75º 12.3637'	37.9
WIVC-57	12/19/2007	37º 51.0571'	75º 12.0077'	45.9
WIVC-58	12/19/2007	37º 50.8522'	75º 12.3458'	38.7
WIVC-61	12/9/2007	37º 51.6176'	75º 10.5438'	53.4
WIVC-65	12/19/2007	37º 51.5180'	75º 11.9769'	46.7
WIVC-66	12/19/2007	37º 51.4734'	75º 11.6215'	48.5
Borrow Site B				
Core #	**Collection Date**	**Latitude N**	**Longitude W**	**Water Depth (ft)**
WIVC-67	12/18/2007	37º 51.7890'	75º 08.0322'	48.9
WIVC-68	12/18/2007	37º 51.4230'	75º 07.6073'	41.3
WIVC-69	12/18/2007	37º 52.3717'	75º 07.0961'	54.6
WIVC-70	12/18/2007	37º 52.0486'	75º 06.2773'	41.8
WIVC-71	12/18/2007	37º 52.7470'	75º 06.1573'	63.4
WIVC-72	12/18/2007	37º 52.4896'	75º 05.4791'	55.9

Figure A-1. Example Core, WIVC-65, top 5 feet.

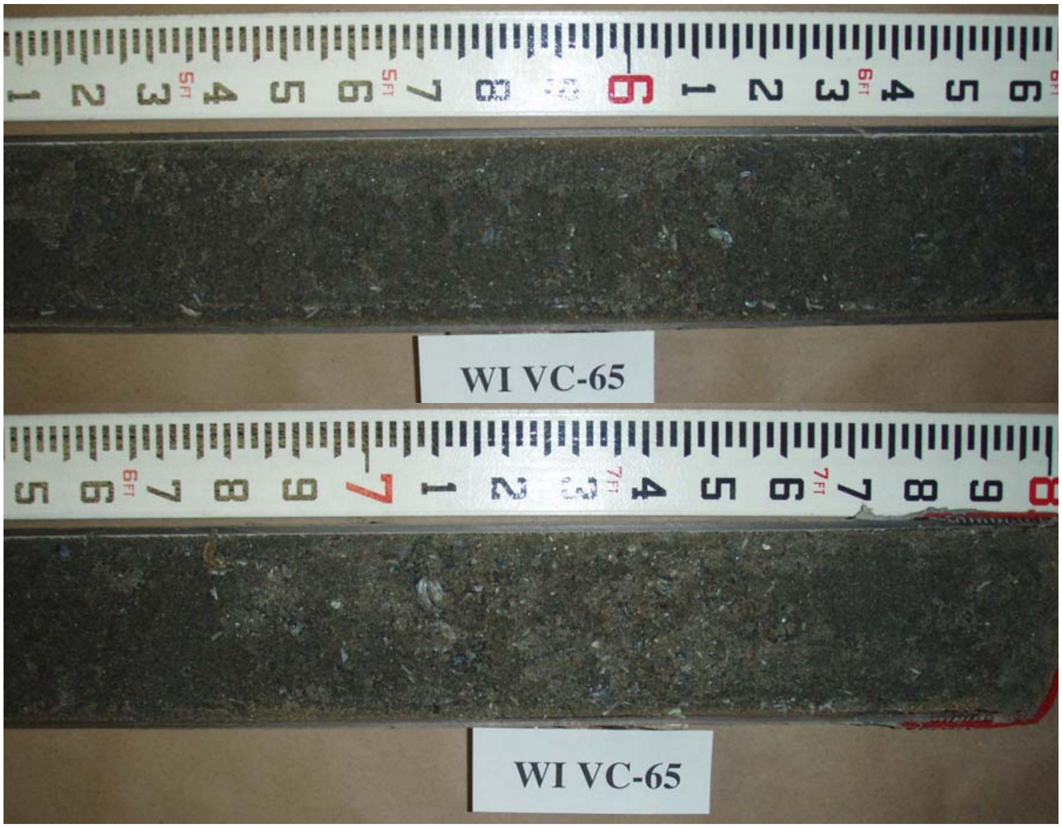


Figure A-2. Example Core, WIVC-65, depth: 5 8 feet.

Appendix B: Wallops Island Site Visit Report of 07 September 1999

This appendix provides the USACE site visit report of 07 September 1999 to Wallops Island, VA.

ENG DEVELOPMENT DIV ID: NOV 04'03 12:12 No.003 P.02

Wallops Island, VA Site Visit
September 07, 1999

Attendees

Verizon

Mr. Sam McGee
CENAO

Mr. Mark Hudgins
CENAO

Ms. Joan Pope
CEERD

Mr. William R. Curtis
CEERD

Mr. William (Bill) D. Phillips
Head, Facilities Management Branch
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Bldg. N-161 Room 126
Wallops Island, VA 23337
Voice: (757) 824-1209
Fax: (757) 824-1831
William.D.Phillips.1@gsfc.nasa.gov

Mr. Thomas Arcenoaux
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Bldg. N-161
Wallops Island, VA 23337

Mr. Peter N. Turlington
Civil Engineer, facilities Engineering/Planning Group
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Bldg. N-161 Room 124
Wallops Island, VA 23337
Voice: (757) 824-1748
Fax: (757) 824-1831
Peter.N.Turlington.1@gsfc.nasa.gov

Mr. William B. Bott
Environmental Group Leader, Code 205.W Wallops Environmental Office
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility

Bldg. N-161 Room 127
Wallops Island, VA 23337
Voice: (757) 824-1103
Fax: (757) 824-1876
William.B.Bott.1@gsfc.nasa.gov

Mr. David Morris
Private Environmental Contractor
Goddard Space Flight Center
Wallops Flight Facility

Meeting Notes

- Complex coastal project due to proximity if inlet to location of site on barrier island. Therefore CHL involvement.
- Not a recreational beach. Need not consider aesthetics, but only functionality.
- No erosion at north end of island.
- Important facilities above 100-year water level.
- 10-ft structure elevation would prevent nuisance flooding if impermeable structure.

- WRDA'99: Wallops authorized as Corps project. Authorization only, not funds received yet.
- Unusual funding avenue, may need political involvement to execute funding.
- Authorized as emergency project and for plans and specifications and construction, rather than as a study.
- WRDA written as beach restoration with language for recovery of funds from other federal agencies. Language leaves avenue for open inter-governmental exchange of funds.
- $8 million FY00, $8 million FY01, $4 million FY02 appropriated.
- May not be able to spend $8 million in FY00 due to environmental permitting issues and site investigations (borrow site identification, etc). May be able to get permitting from State in a year if project is non-controversial. Large constituency/proponency for project, and NASA may be able to round up political pressure to expedite permitting.

- Seawall constructed by NASA in-house labor to save on cost.
- Seawall 3-mi long and 12-ft MSL high. Crest elevation currently being raised to 15 ft MSL at cost of $5 million for additional stone (NASA funding).
- Seawall to be extended at southern end to protect Virginia Commercial Space Flight Center in FY00 at cost of $3 million.
- Launch range operations expansions documentation will allow for extension of seawall without NEPA document.
- 60% of stone specified as 2-3 ton granite. Stone shipped via rail from Lawrenceville, VA.
- $35/ton delivered plus $10/ton placed.
- Stone to arrive in November and will be placed over 1.5 years.

- Seawall too permeable and has experienced loss of material on landward side.

- Voids, no toe protection, no core, narrow crest, steep slopes (nearly vertical at some locations).
- May consider pre-cast units and setting up batch plant.

- Hog Creek dredged every three years. Fine-grained material placed at southern end of facility and vegetated.
- May be able to re-dredge existing Navy birthing sites in backside of island to create infrastructure for construction of shore protect project. Highly encouraged by Turlington.
- May be able to spend some Corps FY00 dollars for armor stone placement at end of FY00 is permitting moves quickly.
- Beach nourishment will go out for bid in FY01.
- Can only dredge between 150-250 mcy from Chin. Inlet annually without modifying hydrodynamics of inlet.
- Inlet material may be too fine. Therefore may need to identify borrow areas.
- Perhaps there are MMS surveys of sand resources in the area. VIMS will also be a good resource for sand.
- GIS model of site available. Need to specify what format is preferred to Turlington. Need to get model quickly, as GIS person is leaving facility.
- Topo based on GPS survey. Have own GPS base station.
- Possibility of some historical wave data. No historical tide data for inlet and sound.
- Demo project will span 3500 ft of shoreline centered on nodal point.
- How can structure be retrofitted without removing stone?

CEERD-HC-S (1110-2-1403b)

19 October 1999

MEMORANDUM FOR Commander, U.S. Army Engineer District, Norfolk ATTN: CENAO-EN-C (Mr. Samuel E. McGee) and CENAO-EN-H (Mr. Mark Hudgins), 803 Front Street Norfolk, VA 23510-1096

SUBJECT: Transmittal of Trip Report for Site Visit to Goddard Space Flight Center, Wallops Island, Virginia

1. Please find enclosed two copies of the trip report requested by your office. If you have any questions pertaining to the material contained herein, my technical point of contacts are Ms. Joan Pope (601/634-3034) or Mr. William R. Curtis (601/634-3040).

Encls

JAMES R. HOUSTON, PhD
Director
Coastal and Hydraulics Laboratory

Copy Furnished w/enclosures:

Mr. Thomas Arceneaux
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Building N-161
Wallops Island, VA 23337

SUBJECT: Site visit and general recommendations for shore protection options at Goddard Space Flight Center, Wallops Island, Virginia.

1. U.S. Army Engineer District, Norfolk (CENAO) requested that the US Army Engineer Research and Development Center's Coastal and Hydraulics laboratory (CHL) provide technical assistance in evaluating the shore protection features and developing strategies for improving the shore protection system at the Goddard Space Flight Center (GSFC) on Wallops Island, Virginia. Existing works, including a rubblemound seawall, degraded timber groins, and various relict structures do not provide adequate protection during coastal storm events nor from long-term erosion trends. Critical Federal (i.e., NASA and Navy) and non-Federal (Virginia Commercial Space Flight Center (VCSFC)) facilities are at risk.

2. Personnel from CHL, CENAO and GSFC visited the site and held a project review meeting on September 7, 1999. At the time of the site visit, as-built structure drawings, design wave and water level information, survey data, and project history data were not yet available to CHL personnel. Wallops Island is a low relief, approximately 6-mile long barrier island along the Delmarva (i.e., Delaware-Maryland-Virginia Peninsula). It is located immediately southwest of Chincoteague Inlet and Assateague Island. Assateague Island protects the northern one-third of Wallops Island from open-coast waves. This portion of the island is wide, backed by dunes, has a broad flat beach, and is dominated by the tide processes associated with Chincoteague Inlet, while the southern one mile section of the island is unstructured, narrow, and prone to overwash. The central 3-4 miles is faced by a rubblemound seawall and assorted relict structures. During the site visit, the seaward face of the seawall was partially submerged and being impacted by breaking waves. Thus it was only possible to closely examine the subaerial structure from the landward side. Even from this limited perspective and with the assistance of the GSFC and CENAO representatives familiar with this project, it is possible to make an initial field summary of the project status and provide some general recommendations for improving structure functionality. These field observations and recommendations are provided in this Trip Report. The discussion of field observations references several figures, which are included as an enclosure to this report.

3. General field observations pertaining to the current shore protection condition are:

a. The rubblemound seawall is a linear structure that demarcates a structured shoreline fronting GSFC launch facilities and infrastructure. At the southern end, the seawall extends landward behind the natural shoreline to provide protection to the Virginia Commercial Space Flight Center (VCSFC). (Figure 1).

b. The seawall is constructed of 60% 2 to 3 ton granite stones. These large stones function effectively as armor units (Figure 2).

c. The seawall has a narrow crest width of 1 or two stone widths.

d. Crest elevation ranges from less than 12 ft to 15 ft NGVD. Maximum crest elevation is limited by the necessity for observation of spacecraft launches from various camera platforms located landward of the seawall. According to GSFC, personnel the crest elevation for the entire seawall will be raised to 15 ft NGVD over the next 1.5 years.

e. Seaward and landward cross sectional slopes are 1:1.5 to 1:2. In areas where it is assumed at that loss of stone or subsidence has occurred on the seaward face of the structure, the seaward slope is nearly vertical.

f. It is assumed that the structure has no toe protection or bedding layer, although this could not be confirmed during the site visit.

g. The seawall has no graded core material to reduce structure permeability and wave transmission. However, the large stone was placed over a pre-existing sheet pile and timber pile wall (Figures 3 and 4). The crest elevation of the pile wall was not available during the site visit. The pile wall is not continuous. It is assumed where the pile wall is non-existent, that either the wall failed or was removed prior to seawall construction, or the timber pile wall rotted and failed following construction. Where the pile wall did not exist, or where the water elevation was higher than the pile wall elevation, swash was observed to rapidly permeate the seawall with the extent of runup located landward of the structure.

h. On the landward side of the seawall, a narrow-crested dune was constructed to provide protection from coastal flooding. The crest elevation of the dune was not available during the site visit. However, it was observed that the dune crest was equivalent to or exceeded the seawall crest elevation. Significant dune erosion occurred at discrete locations behind the seawall during Hurricane Dennis, which occurred recently before the site visit. Figures 5 and 6 show examples of dune erosion. It is speculated that the eroded dune material was lost to the nearshore area through the highly permeable seawall, as overtopped and transmitted waves drained seaward through the structure.

i. Near the southern end of the seawall a cement ramp extends from the dune crest to the top of the pile wall (Figure 4). Armor stone does not protect the ramp. Foundation material (sand) has eroded from beneath the cement (Figure 7). Consequently the ramp is in a state of disrepair. It is speculated that the ramp facilitates wave overtopping of the dune during storm events.

j. GSFC infrastructure landward of the seawall is at an elevation of at least 10-ft NGVD. According to GSFC personnel, a design elevation of 10 ft NGVD is sufficient to avoid damage caused by nuisance flooding that may occur during normal extratropical storms.

k. Relic timber groins are located intermittently along the length of the seawall and beyond the southern extent of the seawall (Figures 3, 4, and 8). Groin structures extending from the seawall do not extend far enough into the surf zone to impede alongshore sediment transport and are ineffective in accreting beach material.

4. Based on these observations, the seawall and dune provide limited functional shore and flood protection during large coastal storms and are likely to require significant maintenance as their foundation and shoreward base material are under continuous long-term erosion. To summarize:

a. The seawall is highly permeable and allows wave transmission and loss of sediment from landward of the seawall to the nearshore during interior drainage of wave runup and overtopping.

b. Pile walls located below and immediately landward of the permeable seawall cause wave reflection that may enhance scour of foundation material and subsidence of stone. Additionally, timber pile walls will eventually degrade which will increase wave transmission to areas landward of the seawall, erosion of foundation material and subsequent subsidence of stone.

c. If the seawall has no bedding layer and toe protection, continued loss of foundation material and subsidence of stone at the base of the structure is likely.

d. Existing groin structures are ineffective at accreting sediment to provide a protective beach.

e. Site evidence including the shoreward propagation of non-breaking waves suggests that the bottom seaward of the seawall is fairly flat, deep and sand deficient.

5. Shore protection alternatives that may be applied at GSFC are briefly discussed in this report. Alternatives are identified as immediate activities designed to improve the integrity and performance of the seawall and as longer-term shore protection strategies. The "do nothing" option would expose the facility launch pads and infrastructure to potential risk from damaging waves, flooding, and erosion. All alternatives should be evaluated from environmental, engineering, economic, and societal perspectives and require study beyond this cursory discussion prior to implementation. It is important to note that the seaward shoreline of Wallops Island is part of a complex littoral system. The complexity of this system arises from the presence of nearby established and intermittent coastal inlets. Keeping this complex system in mind, alternatives considered for coastal protection at Wallops Islands should be evaluated within the regional context. A regional understanding of coastal processes is necessary to ensure a functional long-term shore protection project with minimal negative impact on adjacent shorelines.

6. To provide sound engineering recommendations for a long-term shoreline management plan at Wallops Island, both short-term and long-term trends in hydrodynamic conditions, sediment transport, geomorphology evolution, and land use must be examined. A list of elements to be investigated before specific shoreline protection alternatives can be designed includes:

a. Identification of key Federal and non-Federal facilities and prioritization for protection

b. History of coastal damage to Federal and non-Federal facilities

i. When and what damage occurred

ii. Cause of damage (waves, flooding, wind)

c. Historic shore protection activities at Wallops Island

i. Pre-construction and as-built designs

ii. Date of construction and /or removal

iii. Performance evaluation

iv. Regulatory history

d. Previous technical documentation of coastal processes (regional and local)

e. Sediment transport (regional and local)

i. Recent and historic aerial shoreline surveys (regional and local)

ii. Historic shoreline change maps (regional and local)

iii. Recent and historic wading surveys (local)

iv. Recent and historic nearshore bathymetry (regional and local)

v. Predicted shoreline change based on geologic assessment and numerical modeling

f. Waves, currents and water levels (regional and local)

i. Measured

ii. Numerically modeled

g. Design storm event and other design criteria

h. Chincoteague Inlet maintenance history and plans for continued maintenance

i. Frequency of dredging (maintenance and emergency operations)

ii. Volume per dredge cycle

iii. Present method of dredging and disposal

iv. Cost per dredge cycle

v. Regulatory history

vi. Sediment analysis (physical and chemical)

i. Environmental considerations

j. Local land use (both ocean-side and bay side of island)

7. Immediate and long-term actions may be taken to improve the degree of protection provided by the existing rubblemound seawall. These alternatives are outlined below and the advantages and disadvantages of each alternative are summarized in Table 1. Potential alternatives for immediate action include:

a. Develop and implement emergency response plan. The plan should focus on the repair and construction of a continuous dune landward of the seawall. The dune should have a crest elevation sufficient to provide flood protection from a selected design storm. The dune should be wide enough to sacrifice material during the design storm, yet maintain crest elevation.

b. Remove existing seawall and construct new seawall. New seawall design should be based upon a sound and stable cross-section including a bedding layer, toe protection and core. Seawall design should be based on a selected design storm event.

c. Identify seriously deficient sections of existing protection and retrofit existing seawall. Retrofit design may vary along the length of the seawall depending on the present condition of the structure and the nature/value of the protected facilities. General retrofit recommendations include:

i. Place fill between the dune and seawall with large gravel and cobble material. During periods of elevated water levels and storms, waves will permeate the structure and move the fill material into the voids of the seawall creating a self-sealing mechanism. As the fill is lost from behind the seawall, it should be replaced until loss of fill material abated.

ii. Construct a splash apron on the landward side of the seawall to reduce fluid velocities during wave overtopping.

iii. Remove cement ramp. The cement may be broken up *in situ* to gravel or cobble sized pieces and used as fill material between the dune and seawall.

iv. Design and construct the seaward slope of the seawall based on an engineering evaluation of the local wave climate and existing stone size.

v. If seawall toe protection does not exist, construct a bedding layer of stone material and a structure toe to minimize scour of foundation material at the base of the structure.

vi. If a bedding layer of stone material does not exist below the seawall, place fill material at the seaward base of the structure. Wave action will work the fill material through the structure voids and fill scour holes. Fill should continue to be placed at the base of the structure until voids are filled to a desired elevation.

vii. The crest elevation of the dune should be raised and maintained to an elevation sufficient to provide flood protection from a design water level and wave event.

viii. Prior to retrofitting, it is recommended that CENAO and CHL personnel conduct a detailed engineering inspection of the seawall structure (including pile walls, groins and dune). It is also recommended that CENAO personnel collect cross sectional surveys of the seawall including a wading survey to identify existence of toe protection and the presence of scour at the base of the seawall.

d. Initiate activities to collect data and conduct analysis required to develop a longer-term shoreline management plan.

e. Design, implement and monitor proposed beach nourishment pilot project.

8. A longer-term shore protection strategy may include the proper design, construction and maintenance of a protective beach nourishment project potentially in combination with beach erosion control structures to reduce erosion rates. Beach nourishment is the placement of large quantities of sand into the littoral zone. The objective of the nourishment is to build the shoreline

seaward so that the beach may provide protection to landward areas from wave attack and coastal flooding. Elements of this strategy include:

a. Evaluation of sediment source areas and construction methods.

b. Development of cross-sectional design for an integrated beach, seawall, dune system. The integrated design may include limited retrofit of existing seawall.

c. Beach nourishment performance modeling that includes consideration of beach fill alone and beach fill with sediment retaining structures (i.e., detached breakwaters, submerged sills, groins, etc).

d. Development of beach nourishment maintenance and monitoring plan.

Table 1. Summary of Shore Protection Alternatives

Alternative	Advantage	Disadvantage
Emergency dune repair and construction	• Low construction and maintenance cost • Limited degree of flood protection • Immediate construction without regulatory considerations	• Temporary structure without adequate wave protection • Continued maintenance
Removal and reconstruction of existing seawall	• Highly functional shore protection • Low/no maintenance	• High material and labor costs • Deepening of beach profile immediately seaward of structure allowing larger waves to impact shoreline • Regulatory considerations
Retrofit of existing seawall and dune	• Functional shore protection, though to a lesser degree than reconstruction • Low construction and maintenance costs • Immediate construction without regulatory considerations	• Continued maintenance • Deepening of beach profile immediately seaward of structure allowing larger waves to impact shoreline • Difficult to obtain design crest elevation of impermeable core
Construction of beach nourishment pilot project	• Will provide localized shore protection • Environmentally favorable • Low construction costs • Opportunity for evaluation of design and construction techniques to be applied to larger beach nourishment project	• Limited area of protection due to placement of small volume of sediment • Rapid loss of sediment from project area due to placement of material in a sediment starved system, potential lack of beach grade material, and lack of sediment retaining structures • Limited protection (temporal and spatial)
Construction of beach nourishment shore protection project	• Highly functional shore protection if maintained • Environmentally favorable • Potential beneficial use of dredged material	• Potentially high construction costs if distance from borrow site to project is great • Regulatory considerations • Continued maintenance
Construction of beach nourishment shore protection project with erosion control structures	• Highly functional shore protection • Reduction in maintenance over non-structural alternative • Environmentally favorable • Potential beneficial use of dredged material	• Potentially high construction costs • Regulatory considerations • Continued maintenance

9. A roundtable discussion at GSFC of existing shore protection structures was conducted on September 7, 1999. Present were:

Mr. Thomas Arceneaux (GSFC)
Mr. William B. Bott (GSFC)
Mr. William R. Curtis (CHL)
Mr. Mark Hudgins (CENAO)
Mr. Sam McGee (CENAO)
Mr. David Morris (GSFC)
Mr. William D. Phillips (GSFC)
Ms. Joan Pope (CHL)
Mr. Peter N. Turlington (GSFC)

Each of the individuals present at the roundtable discussion (with the exception of Messrs. Arceneaux, Bott and Phillips) participated in the site visit to the seawall on the same day.

10. Questions regarding this trip Report may be addressed to Ms Joan Pope (601/634-3034) or Mr. William R. Curtis (601/634-3040).

Ms. Joan Pope
Acting Chief/ Coastal Sediments and Engineering Division

Mr. William R. Curtis
Research Oceanographer

Appendix C: Seawall Condition Survey of 29 October 2008 - Calculations

Example calculations are based on equations in the Coastal Engineering Manual (CEM) available online at http://chl.erdc.usace.army.mil/cem

Structure Stability

Equations: CEM VI-5-67 (Hudson Equation)

$$\frac{H}{\Delta \, Dn_{50}} = \left(K_D \cot \alpha \right)^{1/3}$$

where

H = incident wave height
K_D = stability coefficient
α = structure slope with the horizontal
Dn_{50} = nominal cubic dimension of the median stone size

$$\Delta = \frac{\gamma_r}{\gamma_w} - 1$$

where

Δ = relative density of stone
γ_r = unit weight of rock
γ_w = unit weight of water

Definition: $W_{50} = Dn_{50}^3 \, \gamma_r$

where

W_{50} = weight of median stone

Assumptions: the unit weight of stone (γ_r) is 165 pcf, unit weight of water (γ_w) is 64 pcf, the stability coefficient (K_D) for breaking waves is 2.0 (CEM Table VI-5-22), and structure slope is 1:2 ($\cot\alpha = 2.0$).

From the above equations, a 2.5-ton stone (W_{50}) has a nominal cubic dimension (Dn_{50}) of 3.1 ft. For a 1:2 slope, this stone will be stable against a wave height (H) of 7.8 ft.

Wave Runup

Equations: Coastal Engineering Manual (CEM) VI-5-2

$$\xi_{op} = \frac{\tan\alpha}{\sqrt{s_{op}}}$$

where

ξ_{op} = surf similarity parameter based on deepwater wavelength and wave period of
peak energy density
α = structure slope with the horizontal

$$s_{op} = \frac{2\pi H_s}{gT_p^2}$$

where

s_{op} = wave steepness based on deepwater wavelength and wave period of peak
energy density
H_s = significant wave height
g = acceleration of gravity
T_p = wave period of peak energy density

CEM VI-5-6

$$\frac{Ru_{2\%}}{H_s} = 1.5\,\xi_{op} \quad \text{for } 0.5 \prec \xi_{op} \prec 2.0$$

$$3.0 \quad \text{for } 2.0 \prec \xi_{op}\, 3-4$$

where

$Ru_{2\%}$ = vertical elevation of runup exceeded by 2% of the waves

From the above equations, an 8 ft wave height (H_s) with 8 sec peak period (T_p) will have a wave steepness (s_{op}) of 0.0244. With a structure slope of 1:2 (tanα = ½ = 0.5), the surf similarity parameter (ξ_{op}) is 3.2. The $Ru_{2\%}$ is therefore three times the wave height, or 24 ft for an 8 ft wave height. This is for runup on a smooth slope.

From CEM Table VI-5-3, the runup reduction factor for 2 or more layers of rock is 0.55 – 0.60. Using 0.55, the calculated runup for an 8 ft, 8 sec wave is therefore (0.55 * 24 ft) 13.2 ft above the swl.

Appendix D: Datums

Horizontal Datums

The horizontal datum used for coordinate data input into the models was NAD83, State Plane Virginia South, 4502, meters. Where necessary, coordinates in other datums were converted to this datum using the conversion program Corpscon, ver 6.0.1, available at: <http://www.tec.army.mil/>.

Several figures presented in this report are based upon the GENESIS grid set up on Wallops Island. These figures generally show along shore distances along the X axis and offshore distances along the Y axis (and frequently the offshore scales are distorted relatively to the along shore scales). the origin of this coordinate system is at: 3768396.5200 Easting, 1174969.9500 Northing in the Virginia State Plane system listed above. This origin is located in the front yard of building V50, the NASA Dynamic Balance Facility, Center Bldg. The grid is rotated 129^{o} clockwise from North, which is the equivalent of a counter-clockwise rotation of 231^{o} from East. This allows the GENESIS x-axis (horizontal) to run in a SSW direction generally parallel to the beach.

Vertical Datums

The vertical datum used in this study was MSL (mean sea level), meters. The difference in MLLW (mean lower low water) elevations and MSL elevations is 0.58 m (1.9 ft). This is the NOAA value for half the tide range (between MLLW and MHHW) on the open coast at Wallops Island as shown in Table D-1. The data in this table were obtained from the website: <http://tidesandcurrents.noaa.gov/tides07/tab2ec2b.html#44>. These relationships were derived from a temporary tide station deployed on the open coast offshore of Wallops Island during 1983.

Since NOAA does not provide a full suite of tidal relationships for this location, when necessary Chincoteague Harbor of Refuge relationships, supplied by NAO were used. These are shown in Figure D-1. For example, MLW (mean low water) elevations were first converted to MLLW by adding (subtracting a negative) 0.04 m (1.4 ft), the value given in Figure D-1. Most GEODAS depths were referenced to Mean Low Water.

LIDAR elevations were generally given in NAVD88. NAVD88 is 0.05 ft above MSL (1.95-1.90 ref to MLLW). Note, this is equivalent to 1.5 cm of elevation. This small difference is less than the accuracy of some measurement systems, and thus, for practical purposes, at Wallops Island NAVD88 and MSL elevations can be used interchangeably.

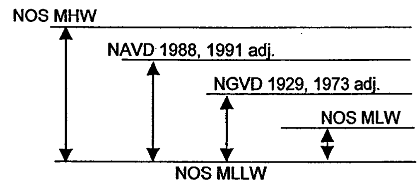
Table D-1: Elevation data for the open coast at Wallops Island, VA

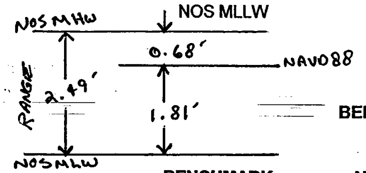
Outer Coast Station	Latitude	Longi-tude	Mean Range (ft)	Spring Range (ft)	Mean Tide Level (ft) (relative to MLLW)
Wallops Island	37° 50.5'	75° 28.7'	3.6	4.4	1.9

Chincoteague Harbor of Refuge

Elevations of datums referred to NOS MLLW, 1960-1978 tidal epoch, in feet

NOS MHW	2.63
NAVD 1988	1.95
NGVD 1929	1.14
NOS MLW	0.14
NOS MLLW	0.00





BENCHMARK ELEVATIONS IN FEET

BENCHMARK	NOS MLLW	NOS MLW	NOS MHW	NGVD 1929, 1973 adj	NAVD 1988, 1991 adj
NOS "NO 2, 1962"	5.32	5.18	2.69	4.17	3.36
NOS "NO 3, 1962"	4.74	4.60	2.11	3.61	2.80
NOS "863 0316 A 1977"	4.99	4.85	2.36	3.85	3.04
NOS "863 0316 B 1977"	6.45	6.31	3.82	5.31	4.50
NOS "863 0316 C 1977"	5.90	5.76	3.27	4.76	3.95
CE "HARBOR RESET, 1984"	6.47	6.33	3.84	5.33	4.52
CE "BASIN-1, 1984"	6.75	6.61	4.12	5.61	4.80

NOTE: NOS MLLW, 1960-1978 tidal epoch, elevations for CE "HARBOR RESET, 1984" and CE "BASIN-1, 1984" were established by USACE Norfolk District. The established elevations being utilized since 14 December 1998. (No backup exists for how the elevations were established.) NGS Published elevations (NGVD and NAVD) utilized for NOS "NO 2, 1962" and NOS "NO 3, 1962".

STATEMENT OF TECHNICAL REVIEW

Notice is hereby given that an independent technical review, has been conducted for the datum diagram /vertical control monuments for Chincoteague Harbor of Refuge as defined in the Norfolk District, Operating Branch, 'Standard Operating Procedure (SOP) for Quality Control and Quality Assurance Associated with Survey Datum Diagram/Vertical Control Monuments Determinations', dated 2, June 2003. The following signatories attest to this fact.

Survey Manager (E. Legaspi) Date: 02 July 2003

Independent Technical Review (D. Linn) Date: 02 July 2003

Independent Technical Review Date: ______

Chief, Navigation and Survey Section (T. Woodward) Date: 02 July 2003

Created by E. Legaspi
02 July 2003

Figure D-1: Harbor of Refuge Tidal Datums obtained from NAO.

Appendix E: Model Configuration Parameters

The SBEACH / EST and the STWAVE / GENESIS modeling systems that are available within CEDAS (version 4.03) were used in this study. The CEDAS package is available to USACE employees at:

<http://chl.erdc.usace.army.mil/cedas>,

or to the general public at:

<http://www.veritechinc.com>.

SBEACH Configuration Parameters

The description of the SBEACH modeling effort is given in Chapter 4. The SBEACH model configuration parameters that were used are listed in Table E-1.

Table E-1. SBEACH Configuration Parameters

Reach Configuration		
Grid Data		
	Grid Type	Variable
	Position of Landward boundary	-50
Beach		
	Landward surf zone depth limit:	0.30
	Effective grain size (mm)	0.29
	Maximum slope	30
Sediment Transport Parameters		
	Transport rate coefficient	1.5E-06
	Overwash transport parameter	0.005
	Coefficient for slope-dependent term	0.002
	Transport rate decay coefficient multiplier	0.5
	Water temperature	16
Storm Configuration		
Storm Information		
	Time step (min)	1
	Wave type	Irregular
	Input wave water depth	6

	Wave Height Randomization	Yes
	Seed Value	8186
	% variability	5
Wave Height and Period		
	Input	Variable
	Time step (min)	60
Wave Angle		
	Input	Constant
	Wave Angle	0
Water Elevation		
	Input	Variable
	Time step (min)	60
Wind Speed		
	Input	Constant
	Wind Speed	0
	Wind Angle	0

EST Configuration Parameters

The description of the EST modeling effort is given in Chapter 4. EST configuration parameters are listed in Table E-2.

Table E-2. EST Configuration Parameters

Case Properties	**Value**
Units	English
Vertical Datum	0
Tropical Event Input	**Value**
Number of Input Parameters	9
Event Frequency	0.277
Number of Response Parameters	8
Life Cycles	500
Duration of Life-Cycles in years	100
Probability Assignment	Read from file
Random number seed	123456
Extra-tropical Event Input	**Value**
Number of Input Parameters	9

Event Frequency	0.78
Number of Response Parameters	8
Life Cycles	500
Duration of Life-Cycles in years	100
Probability Assignment	Read from file
Random number seed	123456

Wallops Island STWAVE Grid Parameters

The description of the STWAVE modeling effort for the Wallops Island domain is given in Chapter 5. The parameters used to set up the Wallops Island STWAVE bathymetry grid within CEDAS (Version 4.03) are listed in Table E-3.

Table E-3: Wallops Island STWAVE Grid Parameters		
Project Name	Wallops Island Storm Damage Reduction Project	
Domain Name	Wallops Island	
Domain Number	1 of 3	
Domain Descriptive Shoreline Boundaries	Mid Tom's Cove to Mid Assawoman Island	
USGS Reference Charts	12210, 12211	
Data Horizontal Coordinate System	Virginia State Plane South, 4502, NAD 83, meters	
Data Vertical Coordinate System	MSL, meters	
Set up date	20-Jul-07	
STWAVE Origin Coordinates	1167524.1515 N	3787122.9661 E
Approximate Offshore Boundary Depth	20 m	
X_Azimuth (Onshore Direction)	309^{o}, clockwise from N	N51W
Grid cell size cross-shore Δ_x	73.152 m	240 ft
Grid cell size along-shore Δ_y	73.152 m	240 ft
Number of Grid Cells	265 cross-shore	221 along-shore
Grid Distance Cross-shore, R_x	19312.128 m	63360 ft
Grid Distance Along-shore, R_y	16093.440 m	52800 ft
Near-shore Save Station Target Depth	6 m	

Wallops Island STWAVE Wave Parameters

The description of the STWAVE modeling effort for the Wallops Island Domain is given in Chapter 5. The Wallops Island STWAVE wave parameters used in the modeling effort are listed in Table E-4.

Table E-4: Wallops Island STWAVE Wave Parameters		
Project Name	Wallops Island Storm Damage Reduction Project	
Domain Name	Wallops Island	
Domain Number	1 of 3	
Set up date	20-Jul-07	
Wave Config Number	1 of 1	
WIS Station Number	178, Atlantic	
WIS Station Location	37.75° N	75.25° W
WIS Station Depth	20 m	
Shore_Ref 1 Wave Angle	129°, clockwise from N	
Wave Bin Boundaries		
Height	**Period**	**Angle**
mean	mean	mean
0	3	90
0.4	4	65
0.6	5	45
0.8	6	30
1	7	20
1.2	9	10
1.6	11	0
2	13	-10
3	20.5	-20
6		-30
		-45
		-65
		-90

GENESIS Configuration and Calibration Parameters

The GENESIS module within CEDAS (version 4.03) was used in this study. The GENESIS grid was set up using the configuration parameters listed in Table E-5.

Table E-5: GENESIS Configuration Parameters		
GENESIS Origin Coordinates	3768396.5200 Easting	1174969.9500 Northing
Offset from STWAVE X-Axis	6071.616 m	19920 ft
X_Azimuth Alongshore Orientation	219°, clockwise from N	S39W
Grid cell size along-shore	73.152 m	240 ft
Number of Grid Cells	121	
Grid Distance Along-shore	8851.392 m	29040 ft
Model Time step	1 hour	
Ratio GEN to STW cells	1:1	

It was necessary to modify the GENESIS grid when detached breakwaters were being modeled, because of the finer shoreline resolution needed in the lee of the breakwaters. Modified parameters are shown in Table E-6. For these runs, the other parameters remained as shown in Table E-5.

Table E-6: GENESIS Configuration Parameters for Detached Breakwater Runs

Grid cell size along-shore	18.288 m	60 ft
Number of Cells	484	
Model Time Step	0.15 hour	
Ratio GEN to STW cells	4:1	

The GENESIS calibration parameters used in this study are listed in table E-7.

Table E-7. GENESIS calibration parameters.

Parameter	**Value**
K_1	0.39
K_2	0.195
Median Grain Size	0.2 mm
Berm Height	2 m
Depth of Closure	4 m
Initial calibration shoreline	1996 LIDAR shoreline
Final calibration shoreline	2005 LIDAR shoreline
Initial verification shoreline	2005 LIDAR shoreline
Final verification shoreline	2007 Profile shoreline
Model wave climate	Average years
Calibration duration	9 years
Verification duration	2 years
Left lateral boundary condition	Moving @ +0.011 m/day
Right lateral boundary condition	Moving @ -0.015 m/day
Regional Contour Trend	As shown in Figure 5-9
Hard Structures	Seawall and Geotextile Tube
Soft Structures	No beachfill or Bypassing

When the alternatives were being modeled, beach fills were added, sand retention structures were added as appropriate, and the median grain size was changed from 0.2 to 0.29 mm.

Fishing Point STWAVE Coarse Grid Parameters

The description of the STWAVE modeling effort for the Fishing Point Coarse Grid domain is given in Chapter 8. The parameters used to set up the Fishing Point Coarse Grid STWAVE bathymetry grid within CEDAS (Version 4.03) are listed in Table E-8.

Table E-8: Fishing Point STWAVE Coarse Grid Parameters		
Project Name	Wallops Island Storm Damage Reduction Project	
Domain Name	Fishing Point Coarse	
Domain Number	2 of 3	
Domain Descriptive Shoreline Boundaries	Wachapreague Inlet to Tingles Island camping area	
USGS Reference Charts	12210, 12211	
Data Horizontal Coordinate System	Virginia State Plane South, 4502, NAD 83, meters	
Data Vertical Coordinate System	MSL, meters	
Set up date	15/5/2009	
STWAVE Origin Coordinates	1197436.0162 N	3812183.8413 E
Approximate Offshore Boundary Depth	20 m	
X_Azimuth (Onshore Direction)	300^o, clockwise from N	N60W
Grid cell size cross-shore Δ_x	200 m	656.168 ft
Grid cell size along-shore Δ_y	200 m	656.168 ft
Number of Grid Cells	151 cross-shore	376 along-shore
Grid Distance Cross-shore, R_x	30000 m	98425.197 ft
Grid Distance Along-shore, R_y	75000 m	246062.992 ft
Near-shore Save Station Target Depth	6 m	19.685 ft

Fishing Point STWAVE Fine Grid Parameters

The description of the STWAVE modeling effort for the Fishing Point Fine Grid domain is given in Chapter 8. The parameters used to set up the Fishing Point Fine Grid STWAVE bathymetry grid within CEDAS (Version 4.03) are listed in Table E-9.

Table E-9: Fishing Point STWAVE Fine Grid Parameters	
Project Name	Wallops Island Storm Damage Reduction Project
Domain Name	Wallops Island
Domain Number	3 of 3

Domain Descriptive Shoreline Boundaries	Fishing Point northward to 2 miles south of VA/MD State Line	
USGS Reference Charts	12211	
Data Horizontal Coordinate System	Virginia State Plane South, 4502, NAD 83, meters	
Data Vertical Coordinate System	MSL, meters	
Set up date	15/5/2009	
STWAVE Origin Coordinates	1180115.5081 N	3802183.8413 E
Approximate Offshore Boundary Depth	20 m	
X_Azimuth (Onshore Direction)	300°, clockwise from N	N60W
Grid cell size cross-shore Δ_x	40 m	131.234 ft
Grid cell size along-shore Δ_y	40 m	131.234 ft
Number of Grid Cells	514 cross-shore	501 along-shore
Grid Distance Cross-shore, R_x	20520 m	67322.835 ft
Grid Distance Along-shore, R_y	20000 m	65616.800 ft
Near-shore Save Station Target Depth	6 m	19.685 ft

Fishing Point STWAVE Wave Parameters

The description of the STWAVE modeling effort for Fishing is given in Chapter 8. The STWAVE wave parameters used in the modeling effort for both the coarse grid and the fine grid are listed in Table E-10.

Table E-10: Fishing Point STWAVE Wave Parameters

Project Name	Wallops Island Storm Damage Reduction Project	
Domain Names	Fishing Point Coarse and Fine Grids	
Domain Numbers	2 of 3 and 3 of 3	
Set up date	15/05/2009	
Wave Config Number	1 of 1	
WIS Station Number	177, Atlantic	
WIS Station Location	37.75° N	75.083° W
WIS Station Depth	25 m	
Shore_Ref 1 Wave Angle	120°, clockwise from N	
Wave Bin Boundaries		
Height	**Period**	**Angle**
mean	mean	mean
0	3	90
10	5	65
	7	45
	9	30
	20.5	20
		10
		0
		-10
		-20

		-30
		-45
		-65
		-90

Appendix F: Seawall Extension Shoreline Difference Figures

These figures are discussed in Chapter 10.

2 Year Shoreline Differences

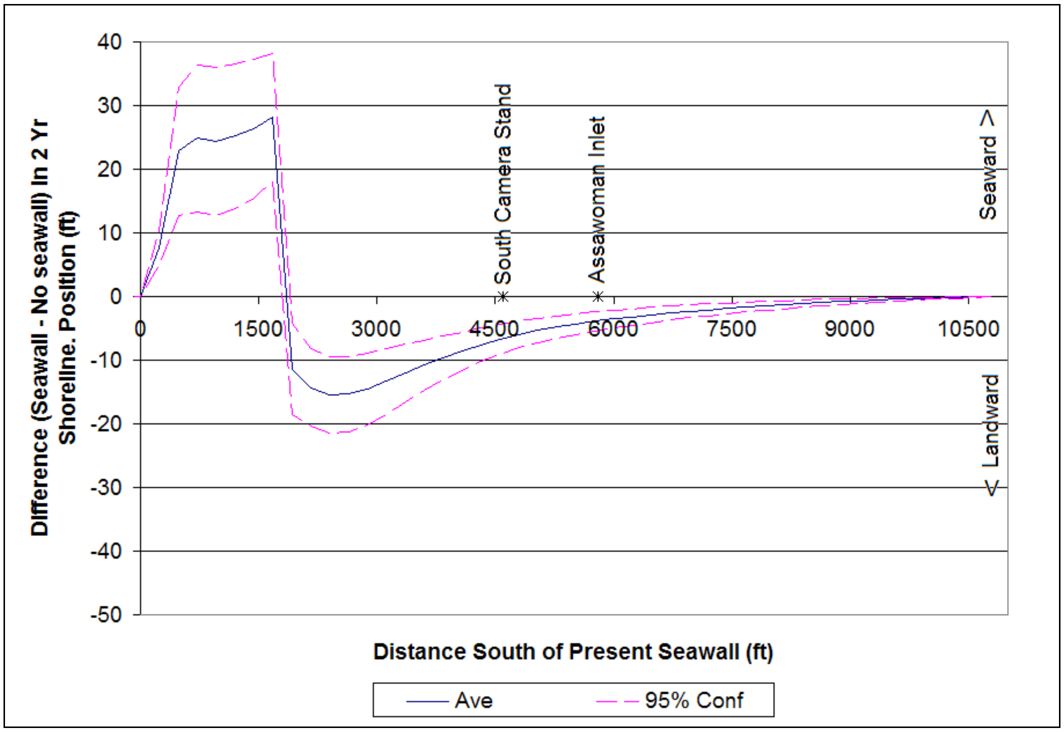


Figure F-1. Two year shoreline difference between 1500 ft seawall extension at the shoreline and no seawall extension.

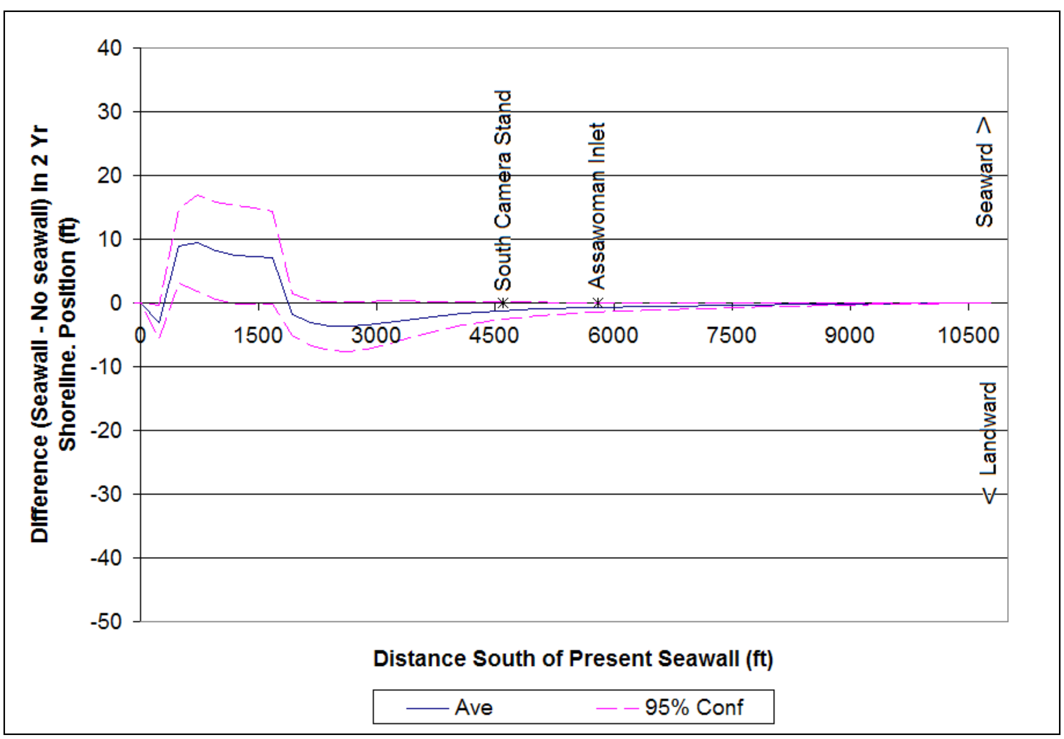


Figure F-2. Two year shoreline difference between 1500 ft seawall extension 10 yds landward and no seawall extension.

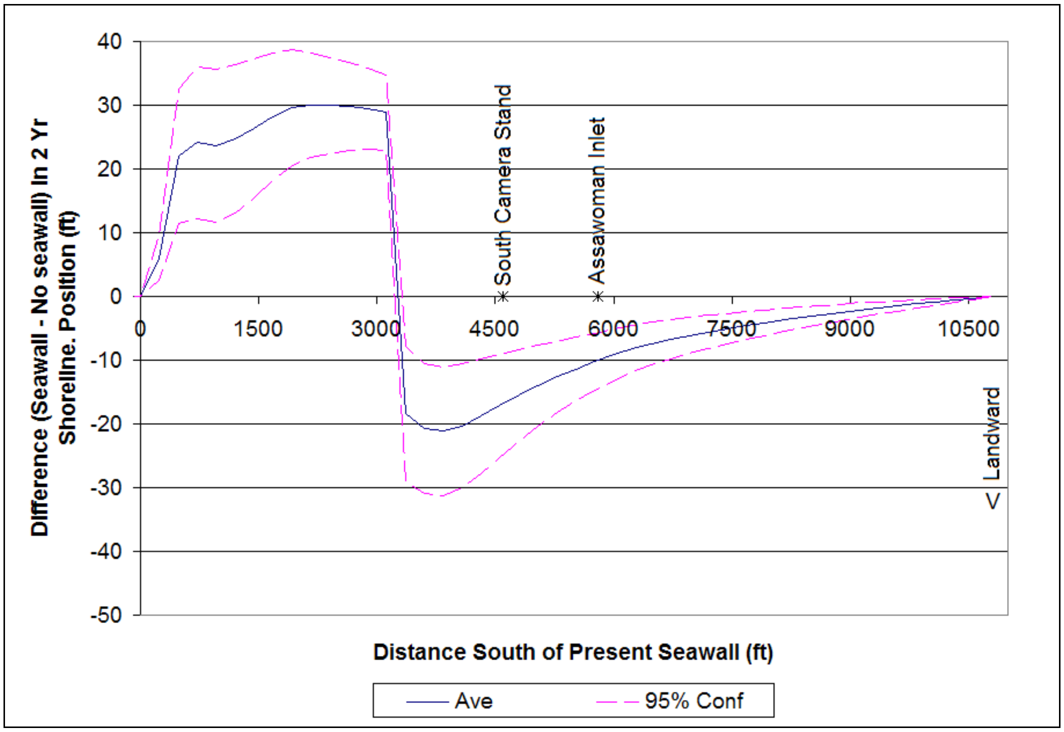


Figure F-3. Two year shoreline difference between 3000 ft seawall extension at the shoreline and no seawall extension.

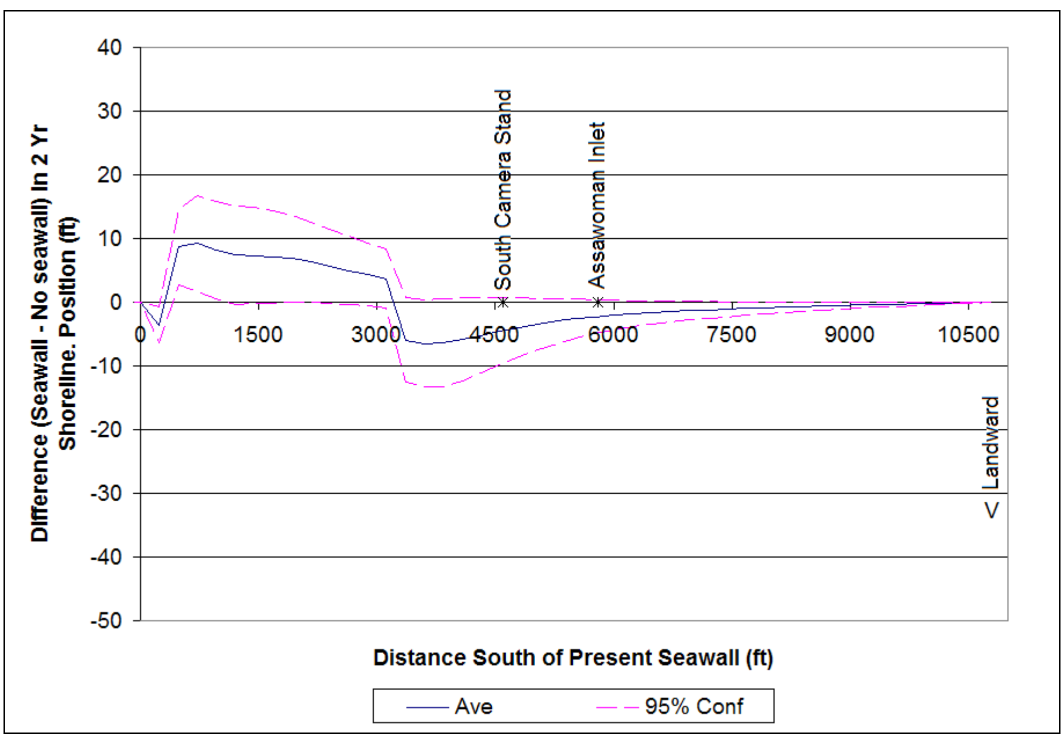


Figure F-4. Two year shoreline difference between 3000 ft seawall extension 10 yds landward and no seawall extension.

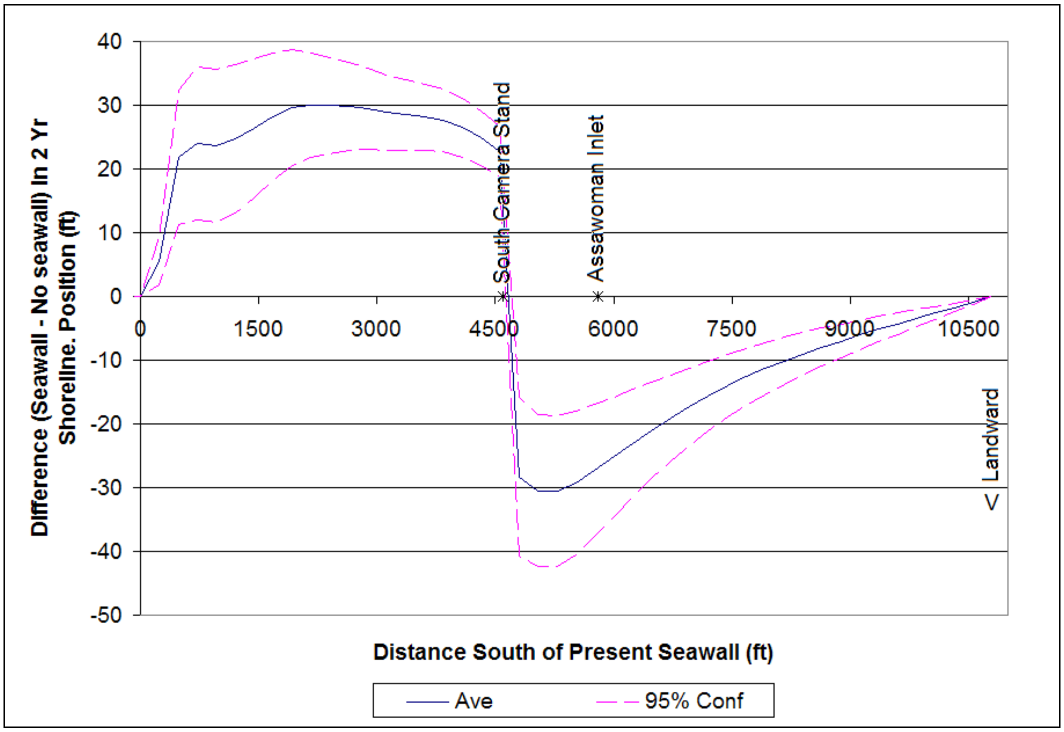


Figure F-5. Two year shoreline difference between 4600 ft seawall extension at the shoreline and no seawall extension.

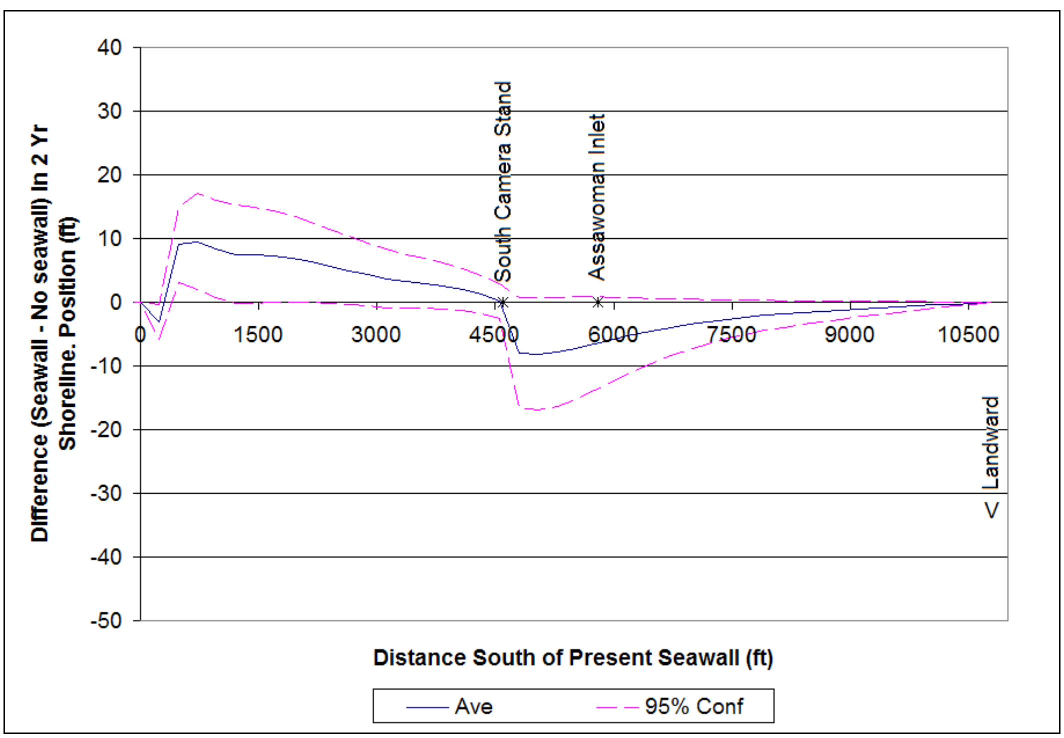


Figure F-6. Two year shoreline difference between 4600 ft seawall extension 10 yds landward and no seawall extension.

10 Year Shoreline Differences

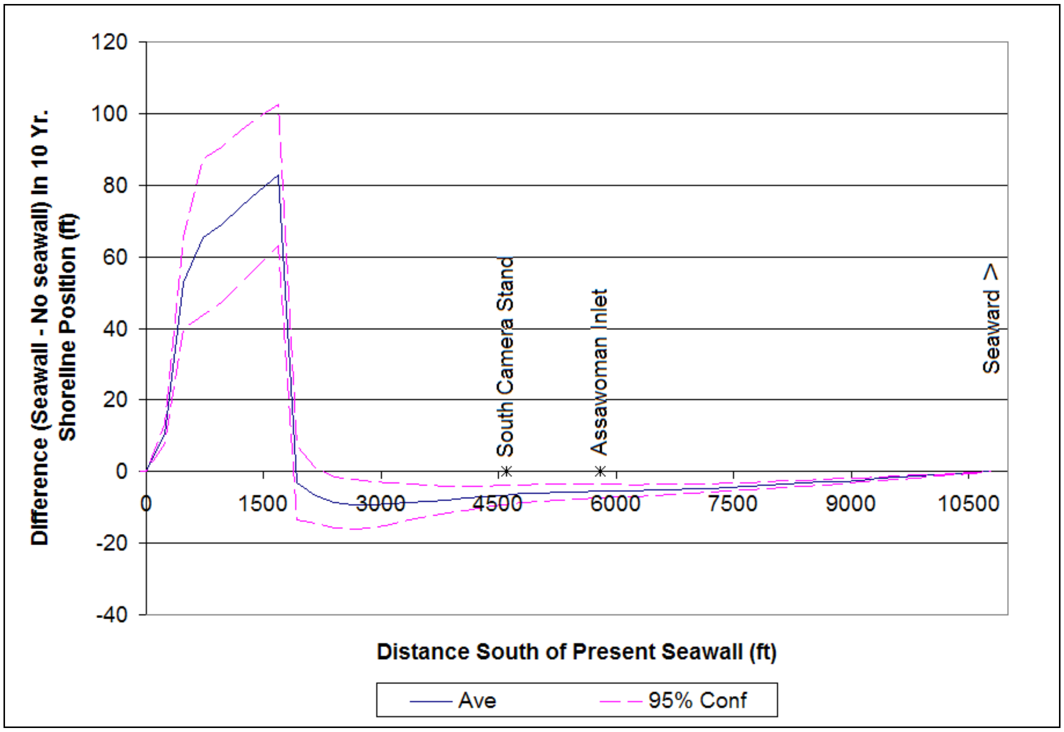


Figure F-7. Ten year shoreline difference between 1500 ft seawall extension at the shoreline and no seawall extension.

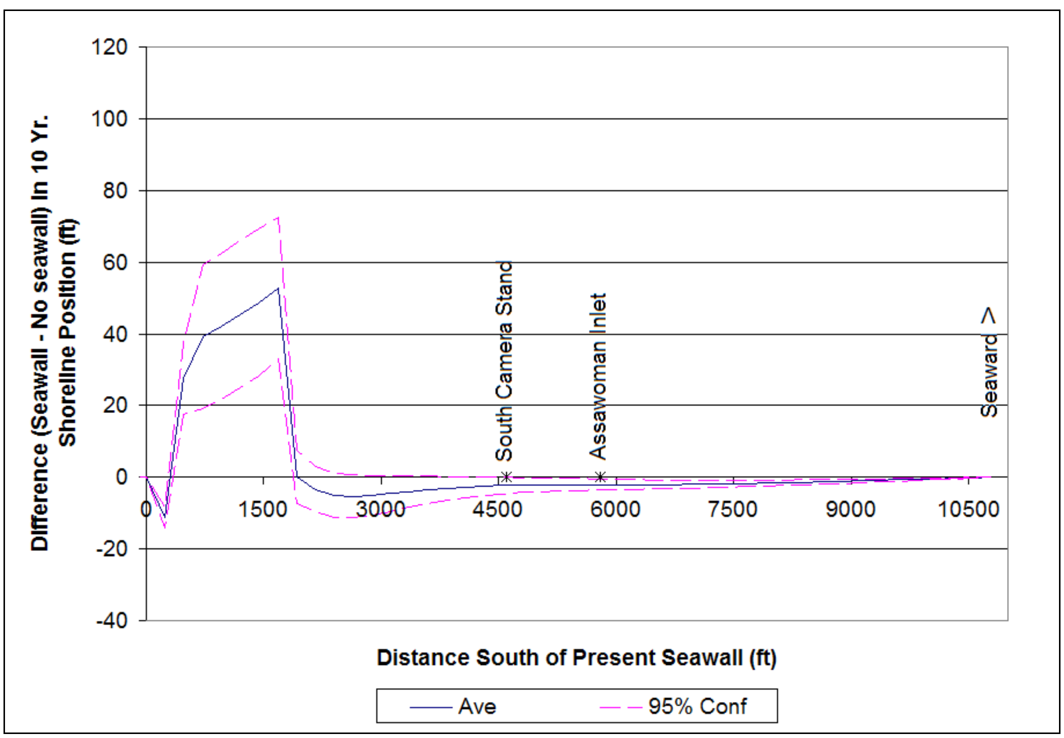


Figure F-8. Ten year shoreline difference between 1500 ft seawall extension 10 yds landward and no seawall extension.

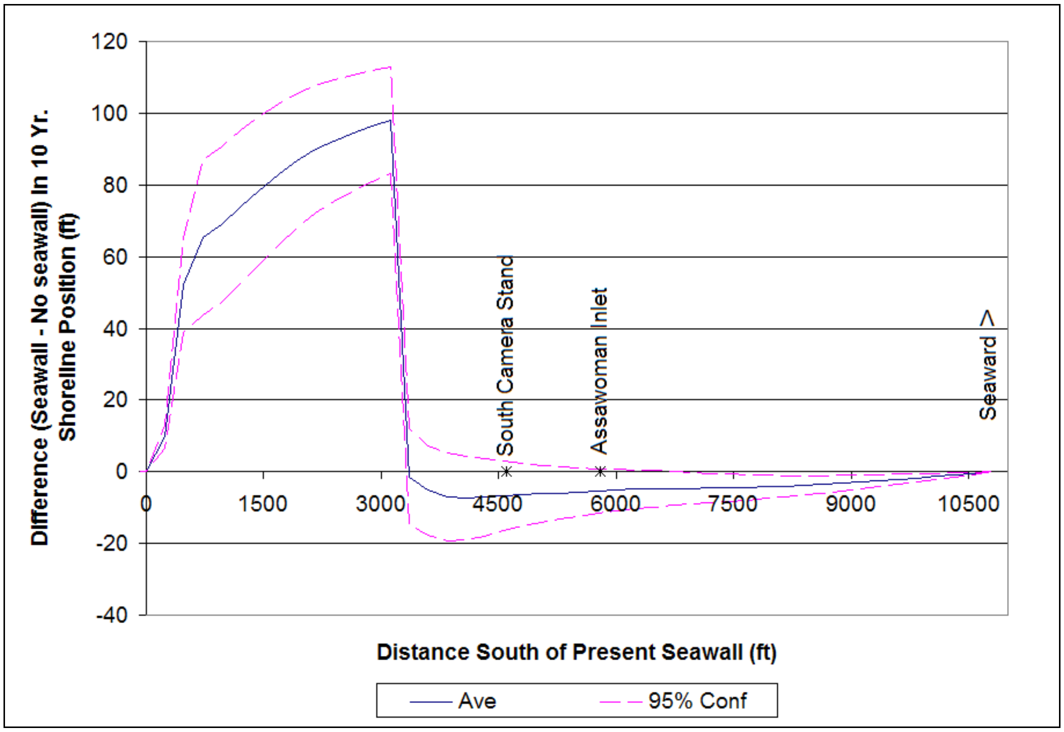


Figure F-9. Ten year shoreline difference between 3000 ft seawall extension at the shoreline and no seawall extension.

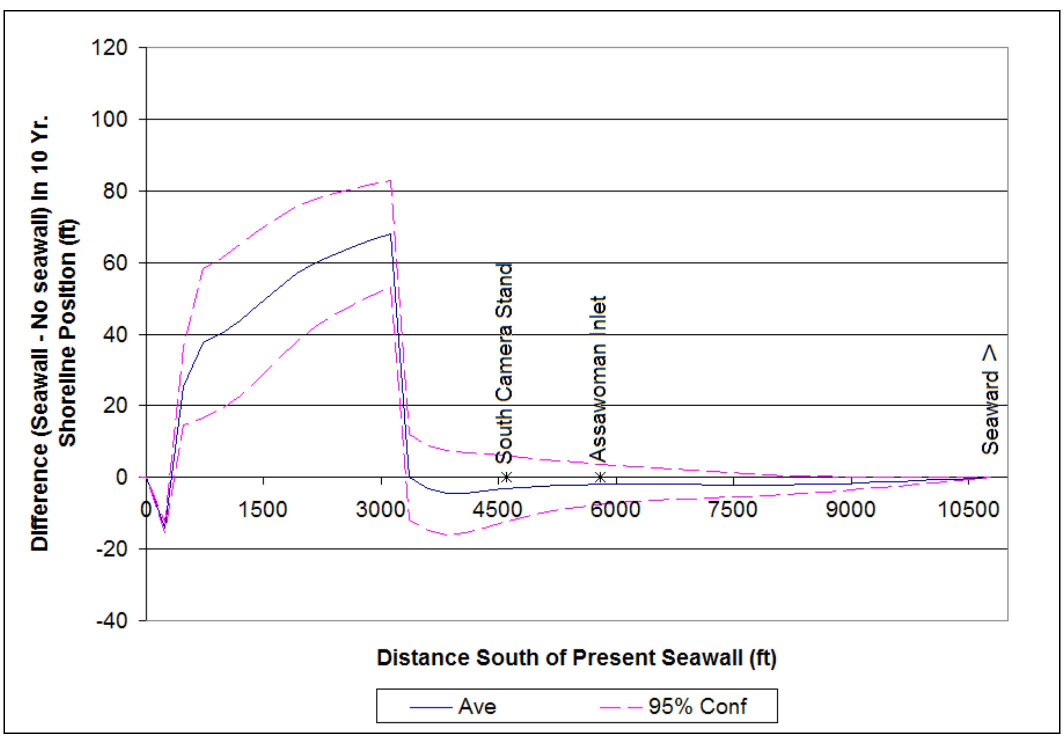


Figure F-10. Ten year shoreline difference between 3000 ft seawall extension 10 yds landward and no seawall extension.

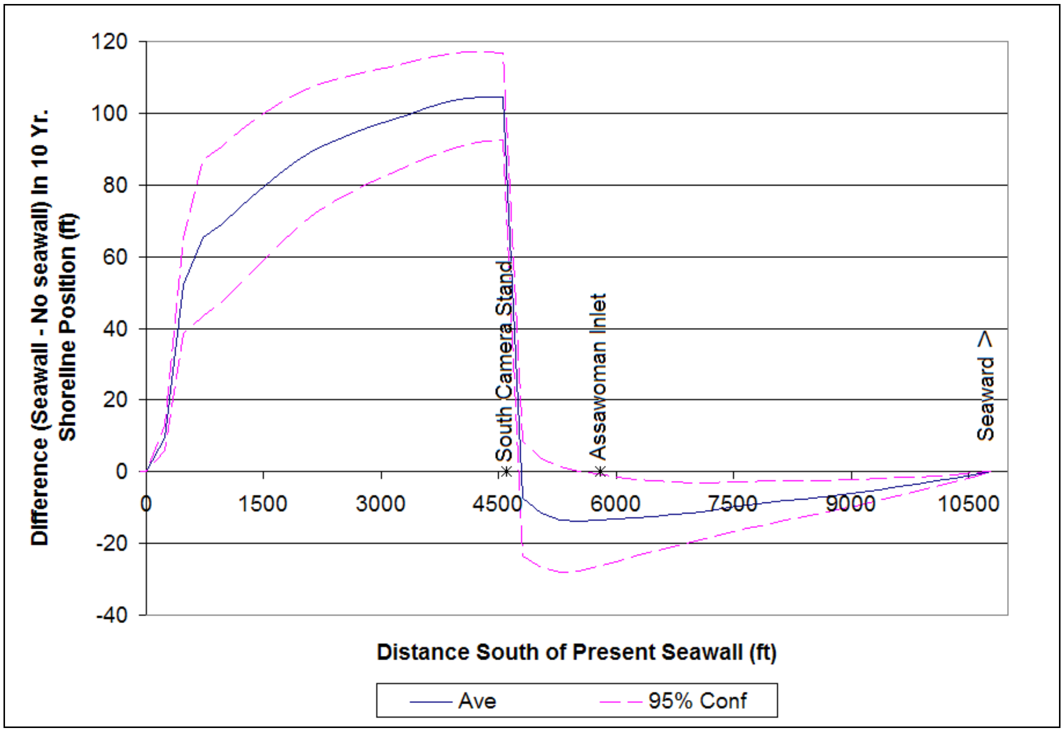


Figure F-11. Ten year shoreline difference between 4600 ft seawall extension at the shoreline and no seawall extension.

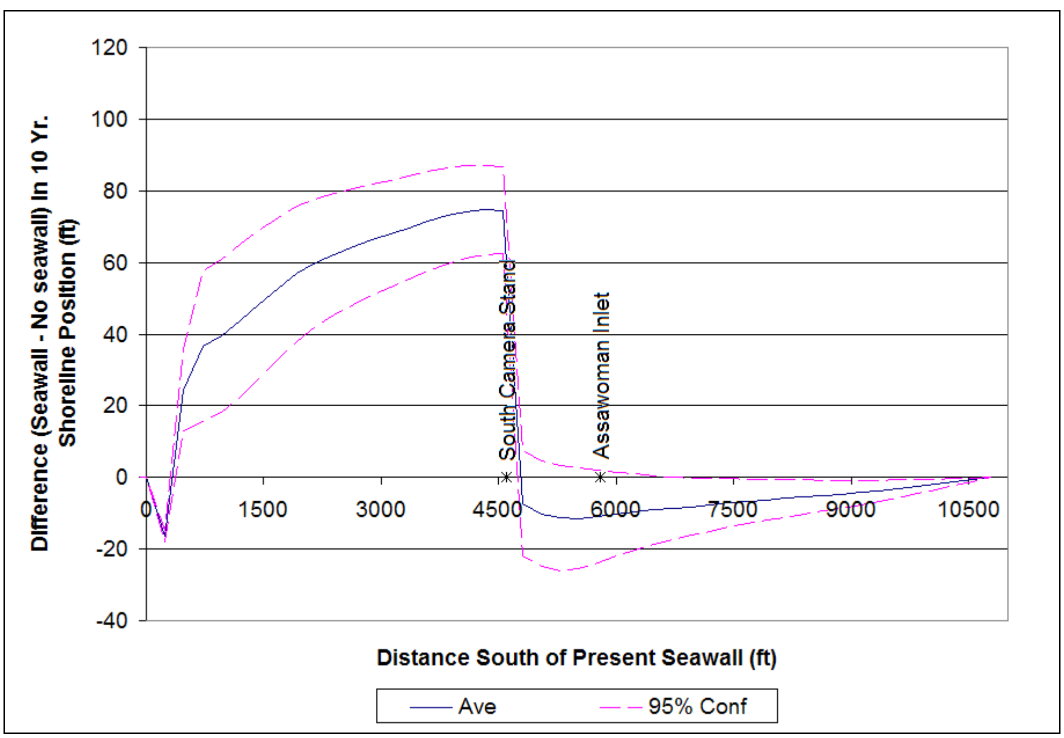


Figure F-12. Ten year shoreline difference between 4600 ft seawall extension 10 yds landward and no seawall extension.

Appendix B
SRIPP Benthic Video Survey Technical Memorandum

FINAL TECHNICAL MEMORANDUM

BENTHIC HABITAT SURVEY OF TWO OFFSHORE BORROW SITES

WALLOPS FLIGHT FACILITY SHORELINE RESTORATION AND INFRASTRUCTURE PROTECTION PROGRAM

Prepared for

National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

November 2009

Prepared by

URS Group, Inc.
200 Orchard Ridge Drive, Suite 101
Gaithersburg, MD 20878
15301785

This Technical Memorandum summarizes the results of a video survey of benthic habitats conducted at the two potential offshore borrow sites for the SRIPP. The survey was conducted in July 2009.

1.0 PROJECT STUDY AREA

The video survey was conducted on two offshore sand shoals (Unnamed Shoal A and B) that are being evaluated as potential borrow sources for beachfill sand for NASA's SRIPP (Attachment 1 - Figure 1). These sand ridges trend from northeast to southwest and the shoal crests and generally get deeper further offshore.

1.1 Unnamed Shoal A

Unnamed Shoal A is located approximately 11 kilometers (7 miles) east of Assateague Island. The southern end of Unnamed Shoal A is approximately 15 kilometers (10 miles) from the Wallops Island shoreline, and the north end of this shoal is approximately 21 kilometers (13 miles) from the shoreline. Unnamed Shoal A has a depth of approximately 7.5 to 12 meters (25 feet to 40 feet). Between Unnamed Shoals A and B, water depth ranges from to 23 to 12 meters (75 to 40 feet).

1.2 Unnamed Shoal B

Unnamed Shoal B is located approximately 16 kilometers (10 miles) east of Assateague Island. The southern end of Unnamed Shoal B is approximately 21 kilometers (13 miles) from the Wallops Island shoreline, and the north end of this shoal is approximately 26 kilometers (16 miles) from the shoreline. Unnamed Shoal B ranges in depth from approximately 9 to 15 meters (30 to 50 feet).

2.0 METHODS

2.1 Review of Existing Data

To understand the potential benthic habitat and communities that may exist in the project area, URS reviewed existing data collected in the general vicinity of the borrow sites. There are no existing benthic studies of Unnamed Shoal A and B. Relevant existing data consists of studies conducted on primarily shoals offshore of Ocean City, MD and to a lesser degree Sandbridge Shoal, VA.

In addition, sediment sampling was conducted by Alpine Ocean Seismic Survey in July 2007 and January 2008 on the shoals considered for borrow sites (Alpine 2007, 2008). Vibracores were collected throughout the shoal area with grain size analyses conducted on discrete strata of the cores indicating that the sediment in both shoals is generally fine to medium sand.

2.2 Video Survey

The video survey was conducted within and adjacent to approximate 5.2 square kilometer (2.0 square miles) blocks of each shoal. These blocks were delineated by the USACE Norfolk District and each one contains an adequate volume of suitable sand for the entire 50-year life cycle of the beachfill.

A digital drop camera with light assembly was deployed at approximately 40 stations on each shoal to collect video of the benthic habitats present. The camera was a VSPN™

3003 High Resolution video camera. Video images were fed to an onboard display in realtime and images recorded on a DVD. Distance off the bottom was maintained by hand feeding the camera's umbilical line. Select still shots were collected from the video during post-processing using Snagit software from TechSmith Corporation.

The video stations were comprised of eight (8) transects across each shoal roughly perpendicular to the shoreline with each transect including five (5) stations throughout the two potential borrow areas: one station on the shoreward trough, one station on the shore-facing slope, one station on the shoal crest, one station on the seaward-facing slope, and one station on the seaward trough. Figures 2 and 3 depict the locations of the video stations on Unnamed Shoal A and B, respectively.

Video was collected for approximately 5 minutes at each station. The video included a date and time stamp along with a display of the geographic coordinates in Virginia State Plane North (NAD-83). A Hemisphere Crescent R130 DGPS with inertial navigation corrections (for up to 45 minutes after loss of signal) was used for the survey. The Hemisphere system transmits information in NMEA 0183 code to a computer navigation system using the *Hypack 2009a* survey software. The *Hypack* software incorporates the NMEA 0183 data string and displays vessel position on a computer screen relative to pre-programmed track lines and each instrument sensor. It also performs instantaneous data translations between various geodetic projections, which combine all incoming data with accurate positions for seamless data integration and post acquisition processing. The Hemisphere Crescent 130 DGPS is considered to be accurate to within 8 inches Root Mean Square (RMS) values under optimal conditions.

The survey vessel was allowed to drift during deployment of the camera. Starting and ending coordinates were collected and recorded for each station.

The images were analyzed for benthic habitat type and biological structures such as tubes or burrows. Organisms captured on the video were identified to lowest practical taxon. The videos were post-processed and reviewed by a benthic ecologist. The video processing followed methods presented and described by Cutter and Diaz (2000). Data sheets were developed to summarize the data collected from each video. The data collected at each station included:

1) Shoal Name
2) Starting Coordinates (Easting, Northing)
3) Ending Coordinates (Easting, Northing)
4) Length of Video
5) Average Water Depth
6) Bottom Type
    a. 1 = sand
    b. 2 = fine sand/silt
7) Bedform size
    a. 1 = none, no bedforms – bottom relatively flat and uniform
    b. 2 = large bedforms, wavelengths approximately 30 cm or greater
    c. 3 = small bedforms, wavelengths less than approximately 30 cm
8) Bedform shape
    a. 1 = none

   b. 2 = smooth crested with top of bedform rounded
   c. 3 = sharp crested with top of bedform peaked

9) Shell Cover
   a. < 10% of surface area
   b. > 10% of surface area
10) Biogenic structures such as tubes and burrow openings
11) Fauna observed
12) Comments – visibility conditions, sea state, etc.

3.0 RESULTS

3.1 Summary of Existing information

Benthic Communities

Relevant recent studies have been conducted of the offshore benthic communities in this region (Maryland and Virginia) of the Mid-Atlantic Bight. Cutter et al. (2000), Diaz et al. (2004) and Slacum et al. (2006) reported on the benthic communities of the sand shoals and reference areas offshore of northern Maryland (approximately 35 to 50 kilometers [20 to 35 miles] north of the proposed SRIPP borrow sites). The sampling sites were located approximately 16 to 25 kilometers (10 to 15 miles) offshore in water depths between 10 and 20 meters (6 and 12 feet). In addition, VIMS (Diaz et al 2006) examined Sandbridge Shoal located approximately 5 kilometers (3 miles) offshore of Virginia Beach to the south of the SRIPP study area.

Cutter and Diaz (2000) collected benthic grab samples, video, and sediment profile imaging data of sand shoals offshore northern Maryland and southern Delaware in 1998 and 1999. Cutter and Diaz (2000) and Diaz et al. (2004) reported that in the sediment grab samples they collected offshore of northern Maryland and southern Delaware, they found that the infaunal communities were dominated by annelid worms, followed by mollusks and crustaceans. Mollusks accounted for over 85 percent of the biomass.

Cutter and Diaz (2000) also reported on the epifauna of the area. They found that three crabs (hermit crabs [*Pagurus* spp.], portly spider crab [*Libinia emarginata*], and Atlantic rock crab [*Cancer irroratus*]) were most abundant. Large gastropods such as the whelk (*Busycon canaliculatum*) and moon snail (*Polinices* spp.) were also collected. Other large benthos collected were the infaunal bivalves such as the surf clam (*Spisula solidissima*) and common razor clam (*Ensis directus*). Astartes (*Astarte* spp.), bivalves known to lie on the sediment surface, were collected along with starfish (*Asterias* spp.) and common sand dollar (*Echinarachnius parma*). Overall, crabs were most abundant in the habitats with biogenic structure, such as tubes created by the polychaetes *Asabellides* and *Diopatra*, and appeared to be using these habitats as nursery areas since the most of the individuals were small (<5 centimeters [<2 inches]). Other species were broadly distributed across all habitats such as nudibranchs, *Pagurus* spp., sand shrimp (*Crangon septemspinosa*), and *Asterias* spp. The two species that appeared to prefer the sandy and more dynamic habitats were moon snail and sand dollar.

Slacum et al. (2006) collected large epifauna during their trawling efforts on shoals offshore Maryland (Table 1). These organisms are expected to occur on the offshore shoals in the project area.

Table 1: Organisms Collected by Slacum et. al. (2006) in Trawls Collected from Shoals Offshore of Maryland (seasonal sampling from fall 2002 to summer 2004).

Scientific Name	Common Name
Asteroidea	Starfishes
Busycon carica	Knobbed whelk
Busycotypus canaliculatus	Channeled whelk
Callinectes sapidus	Blue crab
Cancer irroratus	Atlantic rock crab
Crangon septemspinosa	Sand shrimp
Echinoidea	Heart urchins
Gastropoda	Gastropods
Libinia emarginata	Portly spider crab
Limulus polyphemus	Horseshoe crab
Nudibranchia	Nudibranchs
Octopus vulgaris	Common octopus
Ovalipes ocellatus	Lady crab
Ovalipes stephensoni	Coarsehand lady crab
Paguridae	Right-handed hermit
Polinices	Moon snails

Slacum et al. (2006) reported that the abundance of epifaunal groups between two habitats, i.e., the shoal and uniform bottom, showed no differences; suggesting that shoals are not preferred by epifaunal species when compared to their reference site habitat.

Diaz et al (2006) reported on the benthic habitat and fauna of Sandbridge Shoal located 4.5 – 6.6 km (2.8 – 4.1 mi) offshore in approximately 10 – 13 m (32 – 43 ft) of water. They reported that the sediment surface was dominated by physical processes and the habitats were relatively uniform. The most common fish were sea robins (*Prionotus* spp.). The most common epifauna were hermit crabs (*Pagurus* spp.) and sand shrimp (*Crangon septemspinosa*). They also collected grabs samples and characterized the infaunal community. It was dominated by polychaetes, amphipods, bivalves, and lancelets.

Sediments

Table 1 below lists the grain sizes and vibracore samples collected by Alpine on Unnamed Shoal A and Unnamed Shoal B. Vibracore strata to approximately 6 feet are provided. In general, the sediment at both shoals ranged from fine to medium sand.

Table 1: Grain size found in samples taken within the boundaries of the proposed borrow site options.

Shoal	Core Sample Number	Sample Depth in meters (feet)	Mean Grain Size (φ)	Mean Grain Size (mm)
A	07-WIVC-30	0-1.2 (0-4.1)	0.74	0.60
A	07-WIVC-30	1.2-2.9 (4.1-9.5)	1.03	0.49
A	WIVC-54	0-1.5 (0-5)	0.525	0.69
A	WIVC-54	1.5-3.5 (5-11.4)	0.35	0.78
A	WIVC-55	0-1.7 (0-5.6)	1.45	0.37
A	WIVC-55	1.7-2.7 (5.6-9)	1.15	0.45
A	07-WIVC-29	0-1.1 (0-3.7)	1.40	0.38
A	07-WIVC-29	1.1-2.2 (3.7-7.2)	1.40	0.38
A	WIVC-58	0-1.2 (0-4)	1.725	0.30
A	WIVC-58	1.2-2.4 (4-8)	1.825	0.28
A	WIVC-56	0-1.9 (0-6.1)	1.5	0.35
A	WIVC-56	1.9-3 (6.1-10)	1.975	0.25
A	WIVC-57	0-1.2 (0-4)	2.04	0.24
A	WIVC-57	1.2-2.4 (4-8)	2.025	0.24
A	WIVC-65	0-0.6 (0-2)	1.325	0.40
A	WIVC-65	0.6-1.5 (2-5)	1.55	0.34
A	WIVC-66	0-0.5 (0-1.8)	1.09	0.47
A	WIVC-66	0.5-2.6 (1.8-5)	2.05	0.24
B	WIVC-67	0-1.5 (0-5)	1.625	0.32
B	WIVC-67	1.5-3 (5-10)	1.075	0.47
B	WIVC-68	0-1.5 (0-5)	1.45	0.37
B	WIVC-68	1.5-2.8 (5-9.3)	1.225	0.43
B	WIVC-69	0-1.5 (0-5)	1.24	0.43
B	WIVC-69	1.5-3 (5-10)	1.9	0.27
B	WIVC-70	0-1.5 (0-5)	1.9	0.27
B	WIVC-70	1.5-2.8 (5-9.2)	1.8	0.29

Shoal	Core Sample Number	Sample Depth in meters (feet)	Mean Grain Size (φ)	Mean Grain Size (mm)
B	WIVC-71	0-0.4 (0-1.3)	1.675	0.31
B	WIVC-71	0.4-1.5 (1.3-5)	2.55	0.17
B	WIVC-72	0-0.8 (0-2.6)	1.5	0.35
B	WIVC-72	0.8-1.5 (2.6-5)	2	0.25

Source: Alpine Ocean Seismic Survey (2007, 2008)

3.2 Survey Results

The video survey was conducted from July 7 – 9, 2009. In general, visibility was better at Unnamed Shoal B than Unnamed Shoal A. Data sheets summarizing the analysis of the video are provided in Attachment 2. Representative photographs are provided on the following pages.

In general, results of the video survey indicated that sediment on the shoal crests and topographically higher portions of the shoals were dominated by physical features such as ripple marks. These higher areas were typically uniform sand and had a lower surface cover of shell than deeper portions of the study area. The deeper portions of each of the shoals were dominated by shell fragments and hash, as well as biological features such as tubes and mounds created by benthic organisms with little or no evidence of ripple marks.

The benthic habitats and epifaunal communities were similar on the two shoals. The benthic habitat was comprised of unvegetated soft sediment dominated by fine to medium sand. No hard bottom habitats were observed. Dominant epifaunal benthos included; hermit crabs (*Pagurus* spp.) (Photo B-16), sand dollars (*Echinarachinus parma*) (Photo B-9, B-10), crabs [*Libinia emarginata* (Photo A-7), *Cancer* spp. (Photo B-15)], moon snail (*Polinices* spp.) (Photo B-7) and whelk (*Busycon* spp.). Hermit crabs were observed at most of the stations. Moon snail sand collars or egg cases (Photo B-7) were observed at many of the stations. In addition, there was a patch of ascidians (sea squirts) located at Station 24 in approximately 58 ft of water. Fish were rarely seen at any of the stations; those that were observed were primarily (*Prionotus* spp.) (Photo B-20).

Representative Photographs from Unnamed Shoal A (Note that the Photo contains the date and time of collection in upper left and Virginia State Plane North NAD-83 coordinates in upper right)

Photo A-1 : Station #2 from Unnamed Shoal A at a depth of 55 ft with high shell content and lack of surface bedforms.

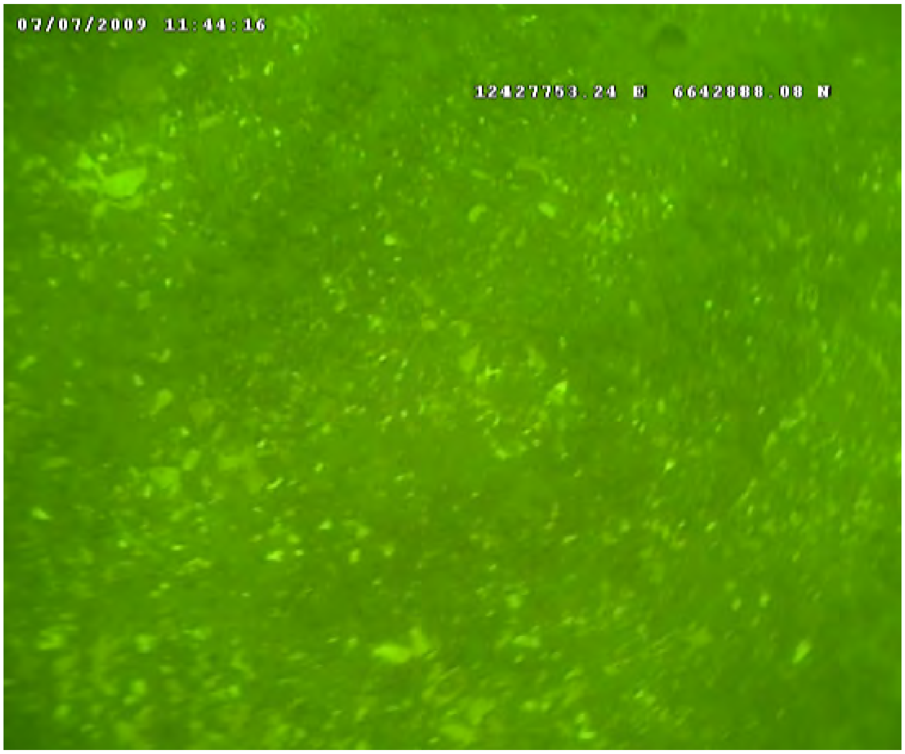


Photo A-2 : Station #6 from Unnamed Shoal A at a depth of 44 ft with well-defined ripple marks and low shell content.

Photo A-3 : Station #6 from Unnamed Shoal A at a depth of 44 ft with well-defined ripple marks and low shell content.

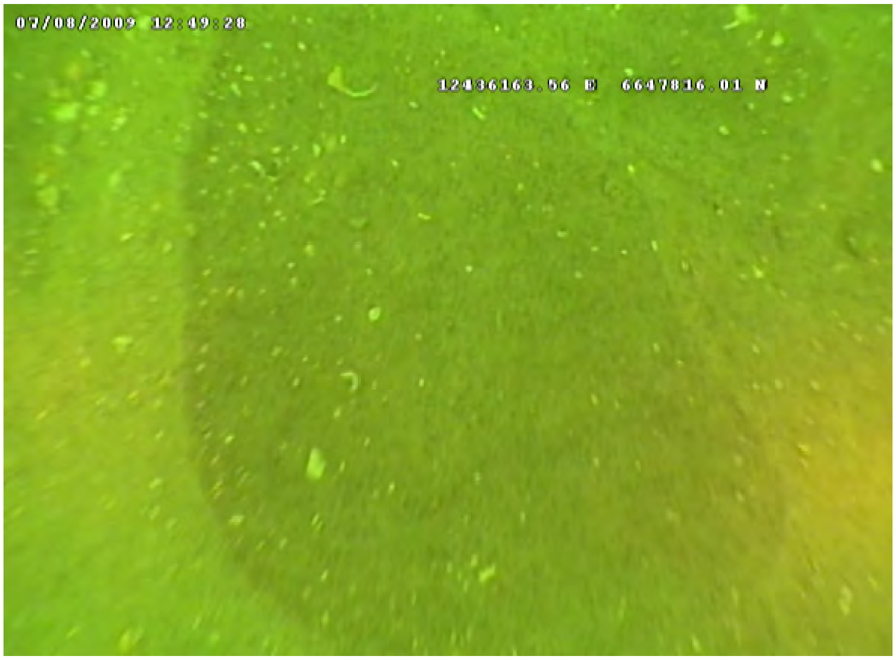


Photo A-4: Station #14 from Unnamed Shoal A at a depth of 53 ft with a lack of surface bedforms.

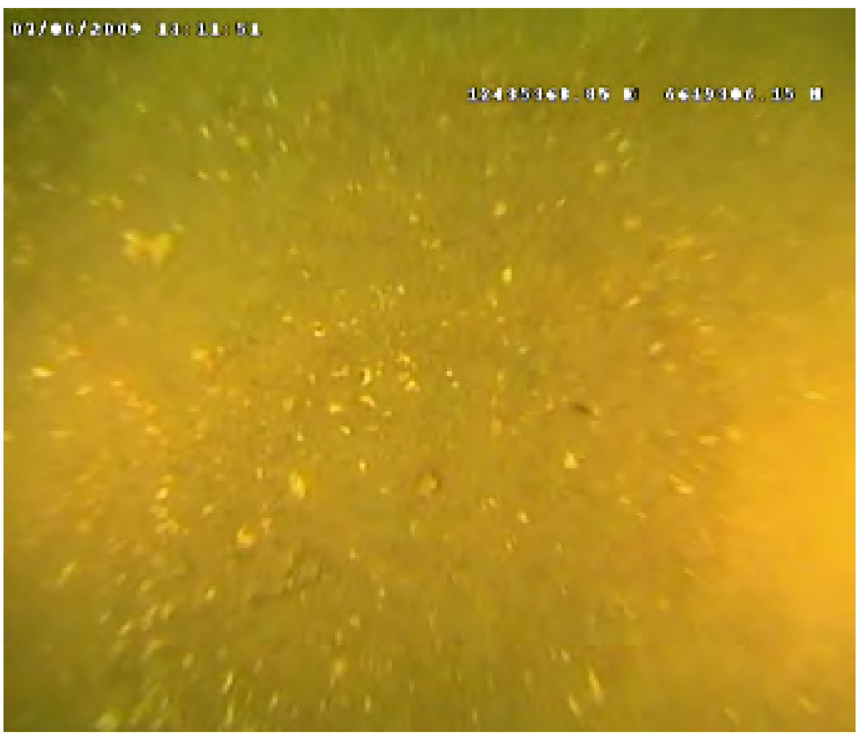


Photo A-5: Station #15 from Unnamed Shoal A at a depth of 53 ft with a lack of surface bedforms.

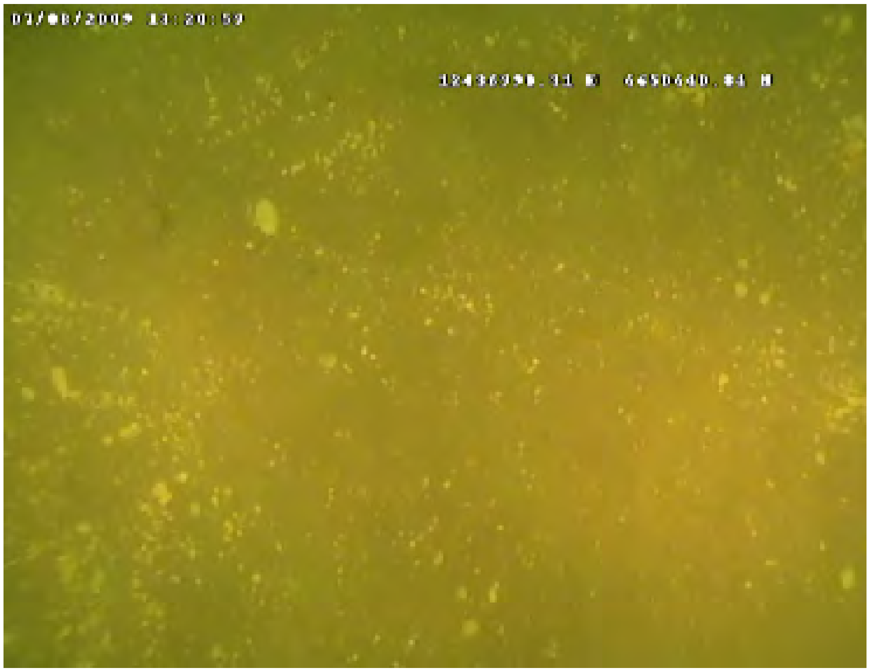


Photo A-6: Station #17 from Unnamed Shoal A at a depth of 64 ft with a high shell content and lack of surface bedforms.

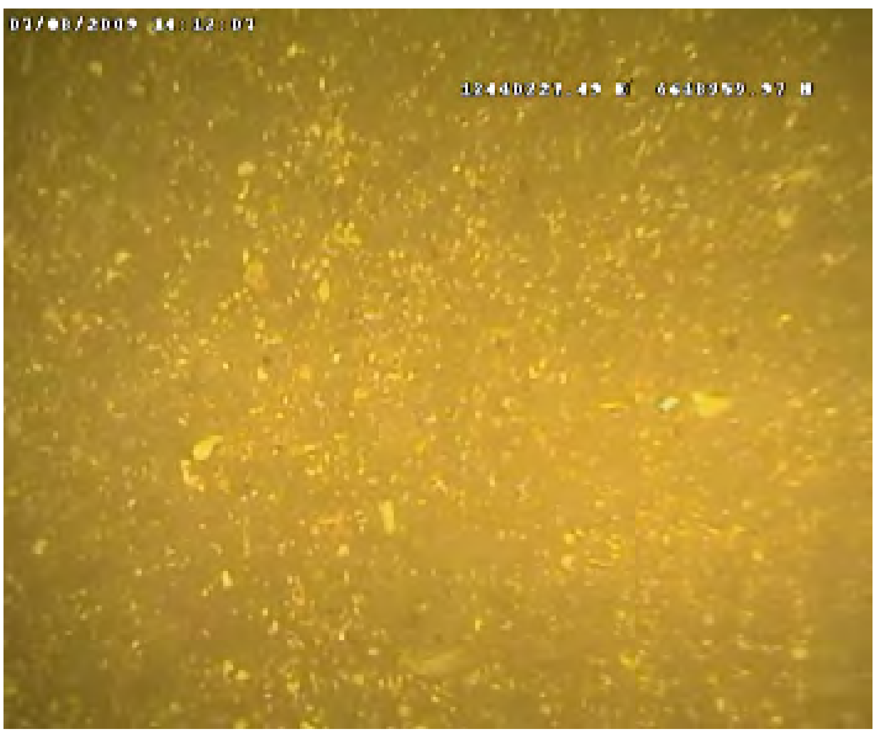


Photo A-7: Station #23 from Unnamed Shoal A at a depth of 60 ft. Portly spider crab (*Libinia emarginata*) in lower right quadrant.

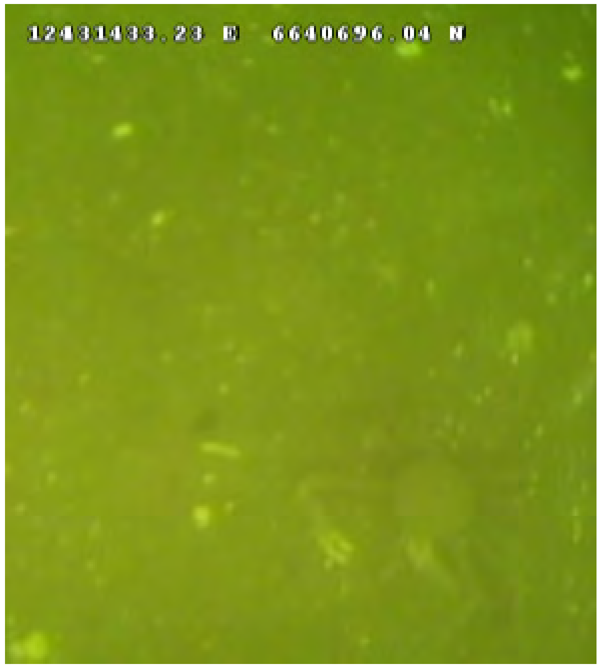


Photo A-8: Station #31 from Unnamed Shoal A at a depth of 50 ft with a lack of surface bedforms and low shell content.

Photo A-9: Station #36 from Unnamed Shoal A at a depth of 42 ft with ripple marks and low shell content.

Photo A-10: Station #38 from Unnamed Shoal A at a depth of 33 ft depicting well-defined ripple marks and a sand dollar (*Echinarachinus parma*) in upper right quadrant.

Photo A-11: Station #39 from Unnamed Shoal A at a depth of 31 ft. Shell concentrated in troughs of ripple marks.

Representative Photographs from Unnamed Shoal B

Photo B-1: Station #1 Unnamed Shoal B at a depth of 42 ft.
Tube/burrow opening to right of center.

Photo B-2: Station #2 Unnamed Shoal B at a depth of 42 ft with well-defined ripple marks and low shell content characteristic of stations on shoal crest.

Photo B-3: Station #6 Unnamed Shoal B at a depth of 45 ft depicting surface bedforms.

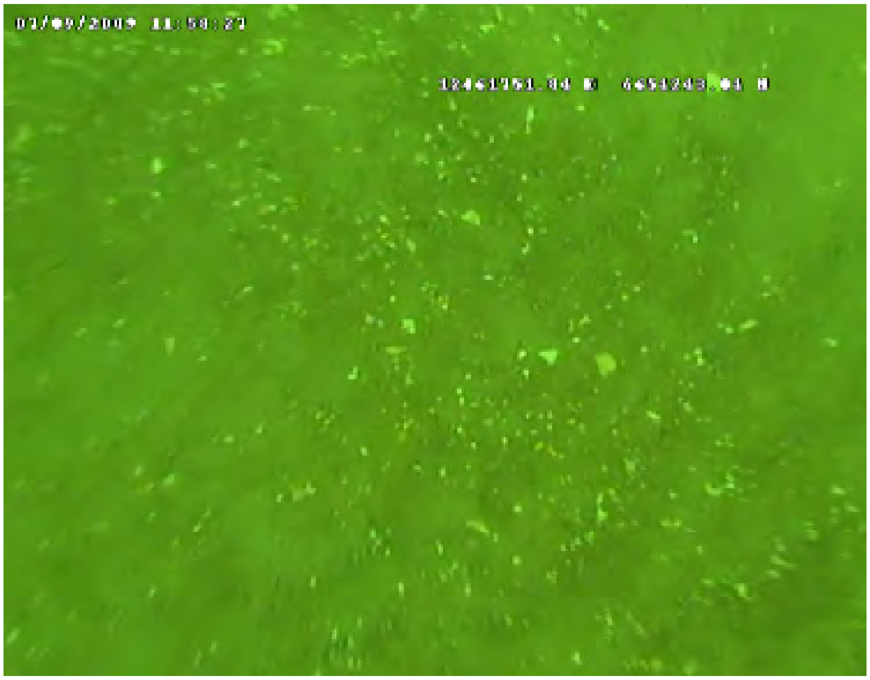


Photo B-4: Station #9 Unnamed Shoal B at a depth of 55 ft. Starfish (*Astropecten* spp.) in upper left quadrant.

Photo B-5: Station #9 Unnamed Shoal B at a depth of 55 ft with no surface bedforms and high shell content.

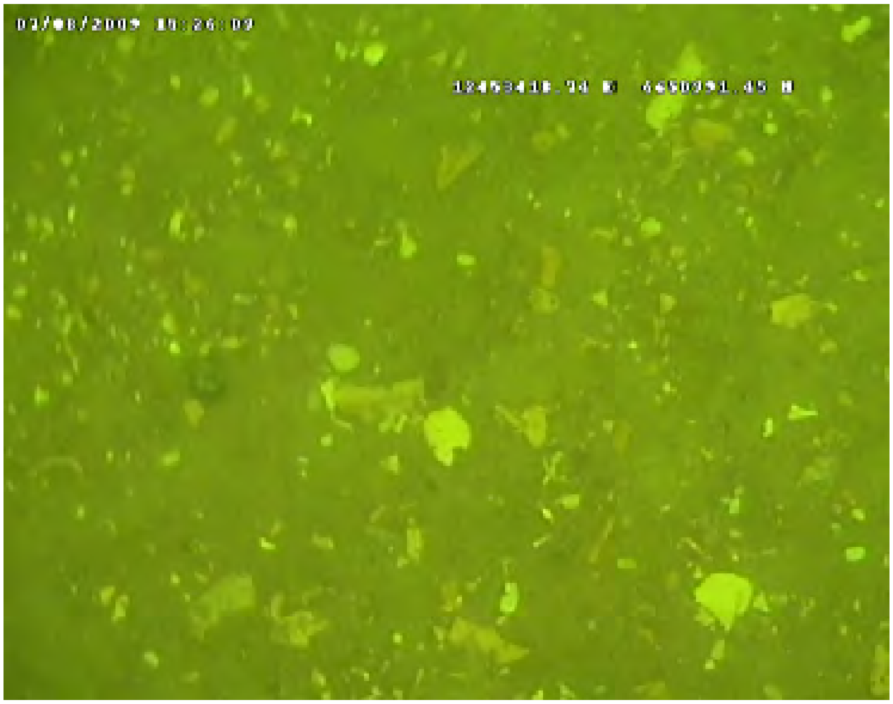


Photo B-6: Station #10 Unnamed Shoal B at a depth of 55 ft. Portly spider crab (*Libinia emarginata*) in lower right quadrant.

Photo B-7: Station #10 Unnamed Shoal B at a depth of 55 ft. Moon snail (*Polinices* spp.) sand collars in upper right quadrant and moon snail in upper left quadrant.

Photo B-8: Station #12 Unnamed Shoal B at a depth of 58 ft with lack of surface bedforms and high shell content.

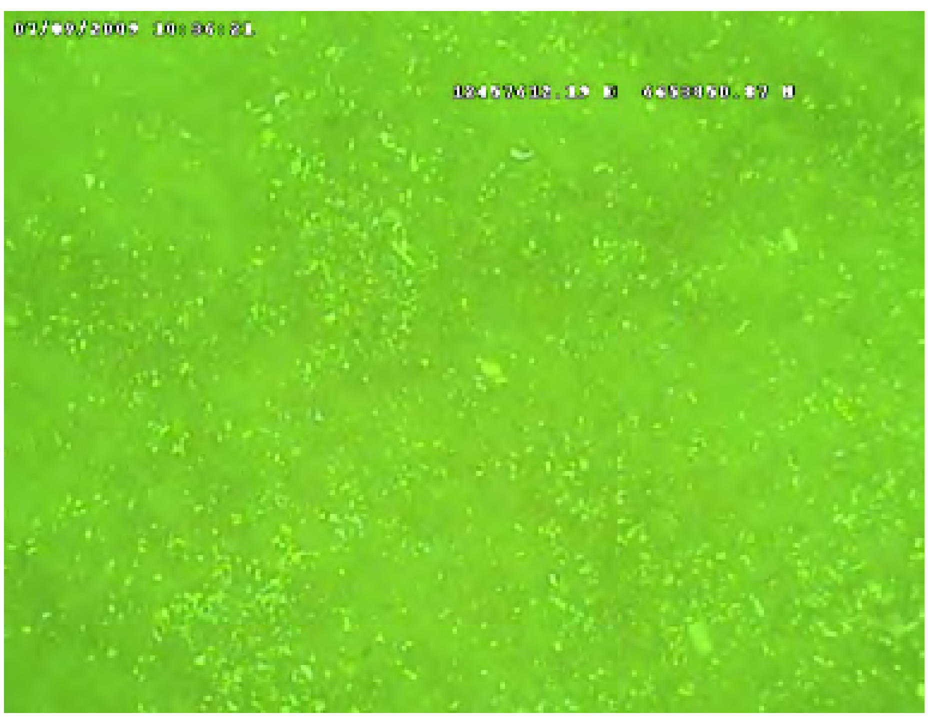


Photo B-9: Station #14 Unnamed Shoal B at a depth of 48 ft. Sand dollars (*Echinarachinus parma*) at upper right and lower left quadrants.

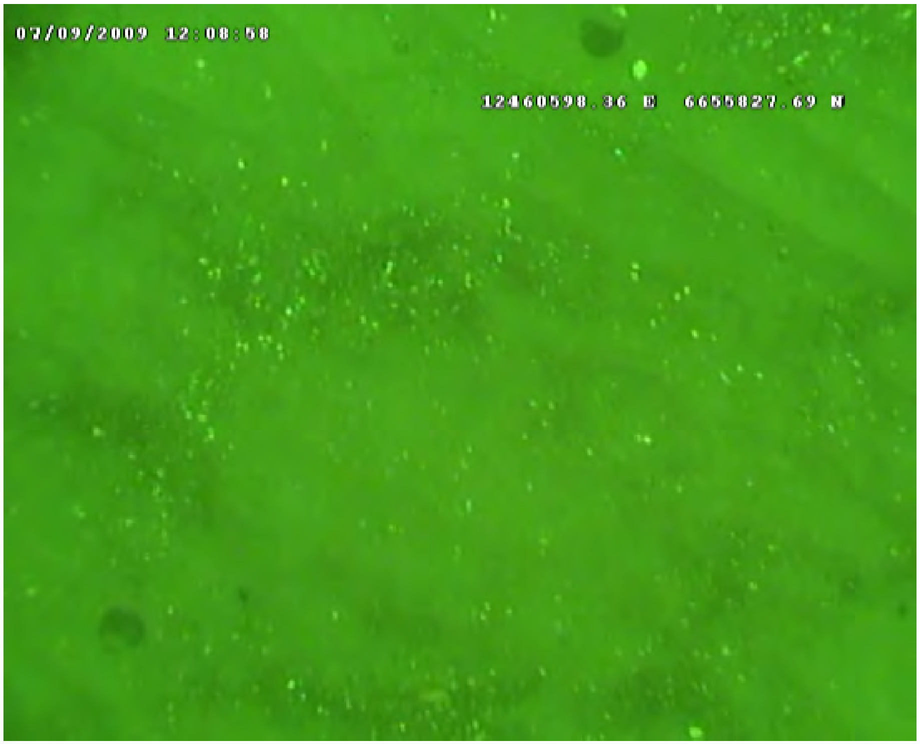


Photo B-10: Sand dollars (*Echinarachinus parma*) from Station #14 Unnamed Shoal B at a depth of 48 ft.

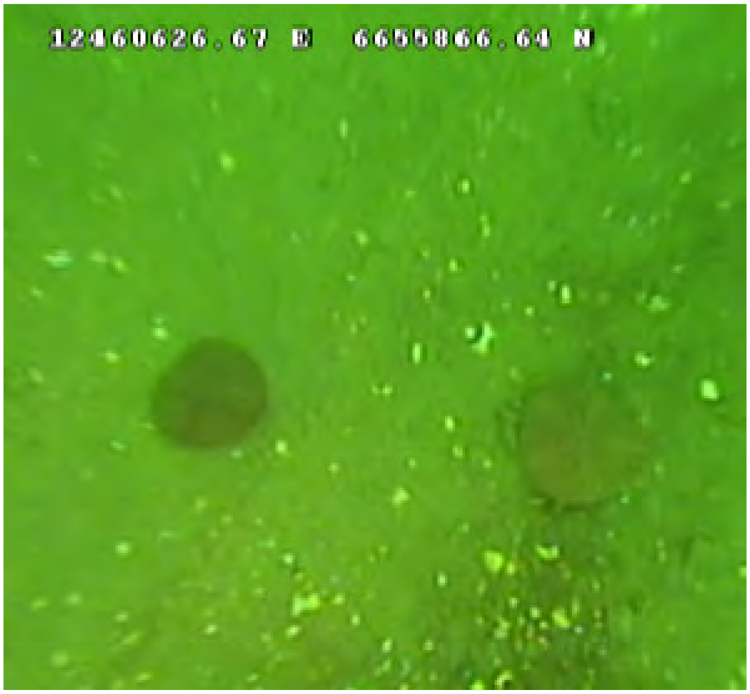


Photo B-11: Station #20 from Unnamed Shoal B at a depth of approximately 45 ft depicting well-defined ripple marks and low shell content.

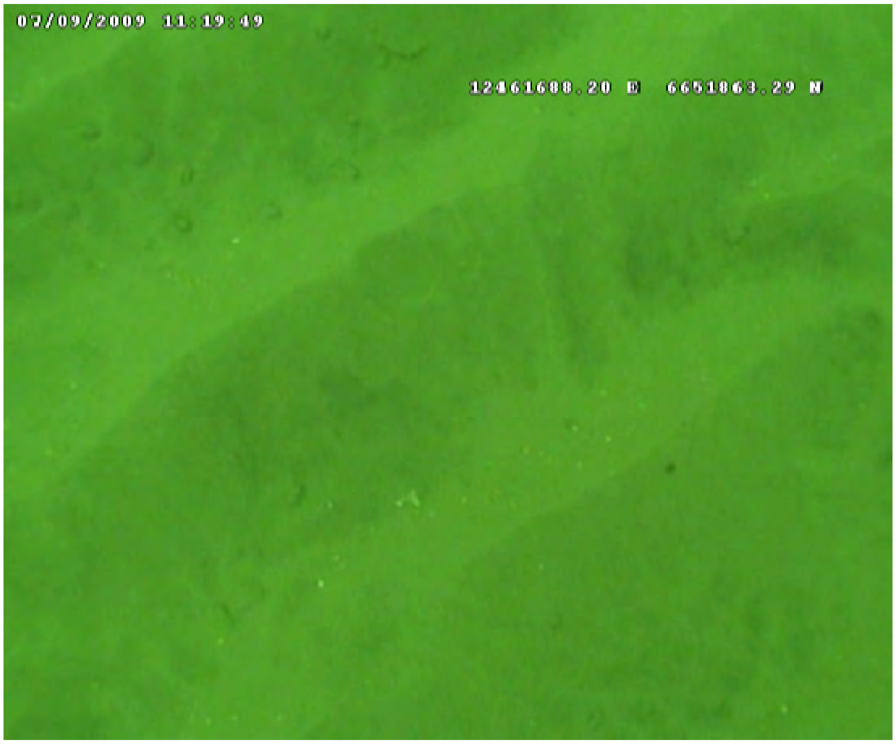


Photo B-12: Station #20 from Unnamed Shoal B at a depth of approximately 45 ft with well-defined ripple marks and low shell content.

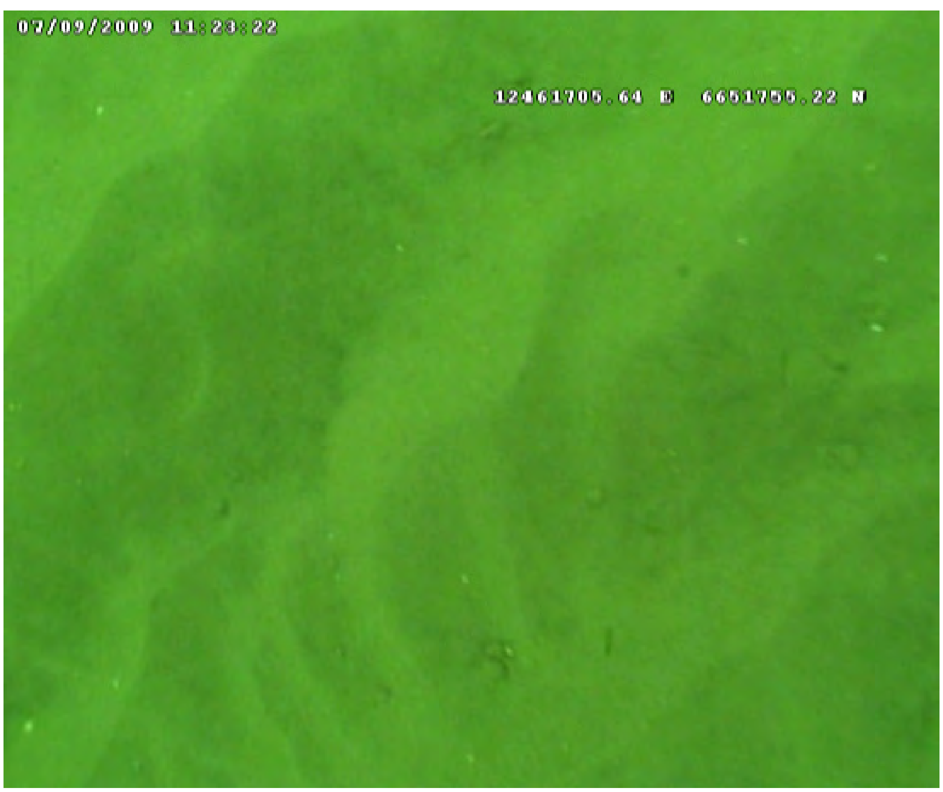


Photo B-13: Station #22 from Unnamed Shoal B at a depth of approximately 43 ft with well-defined ripple marks and low shell content.

Photo B-14: Station #22 from Unnamed Shoal B at a depth of approximately 43 ft with well-defined ripple marks and low shell content.

Photo B-15: Station #25 from Unnamed Shoal B at a depth of approximately 74 ft. Crab (*Cancer irroratus*) located in upper left quadrant with high shell content.

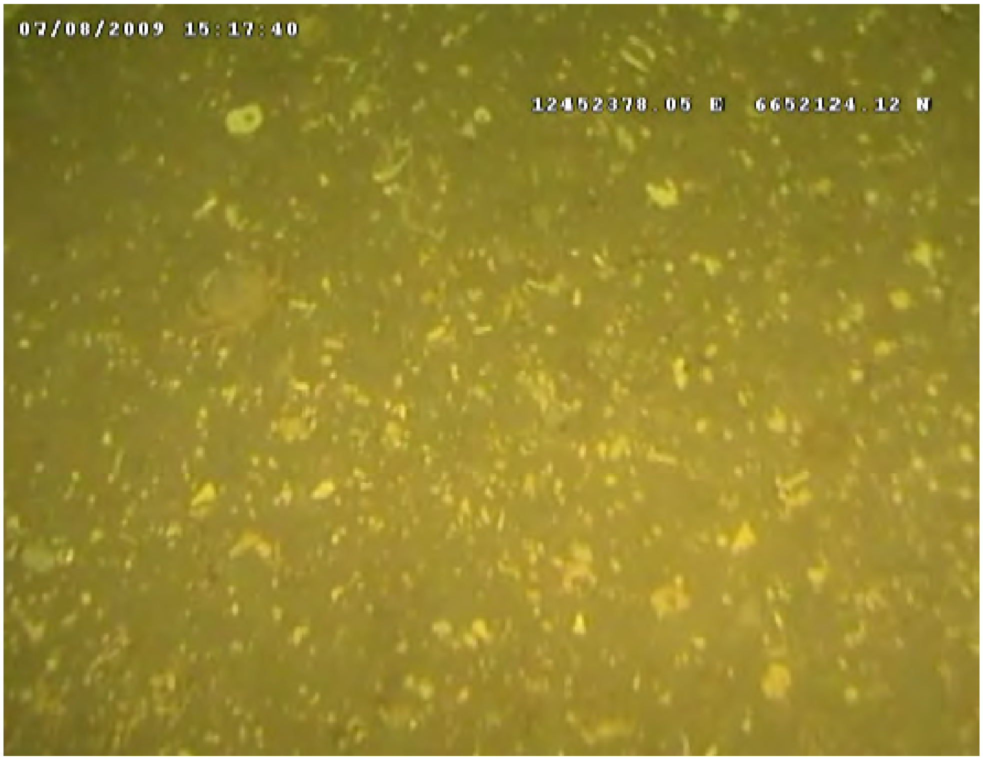


Photo B-16: Station #29 from Unnamed Shoal B at a depth of approximately 66 ft. Hermit crab (*Pagurus* spp.) located in lower right quadrant.

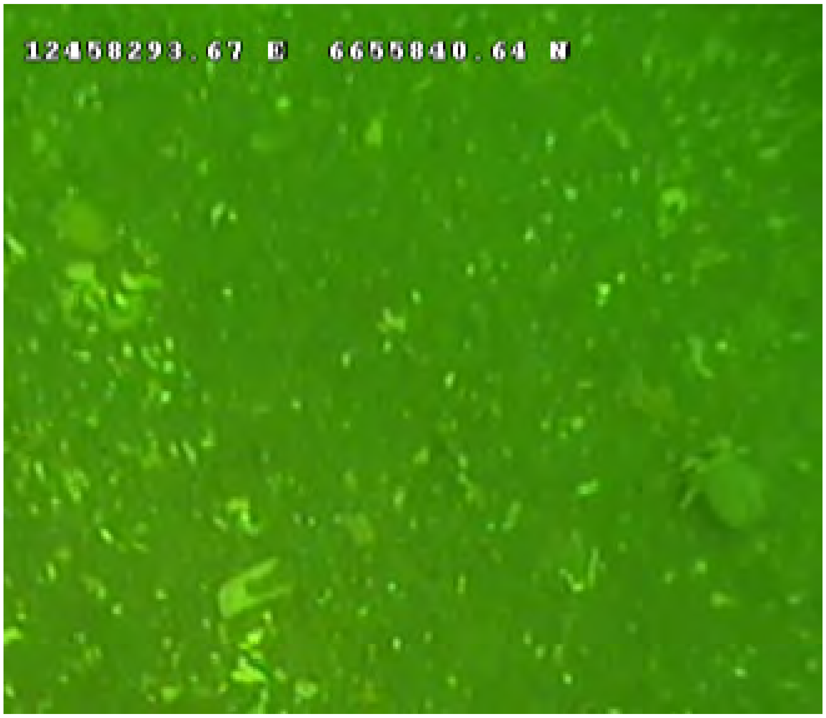


Photo B-17: Station #31 from Unnamed Shoal B at a depth of approximately 60 ft with lack of well-defined bedforms.

Photo B-18: Station #35 from Unnamed Shoal B at a depth of approximately 63 ft with defined bedforms and organic material concentrated in troughs.

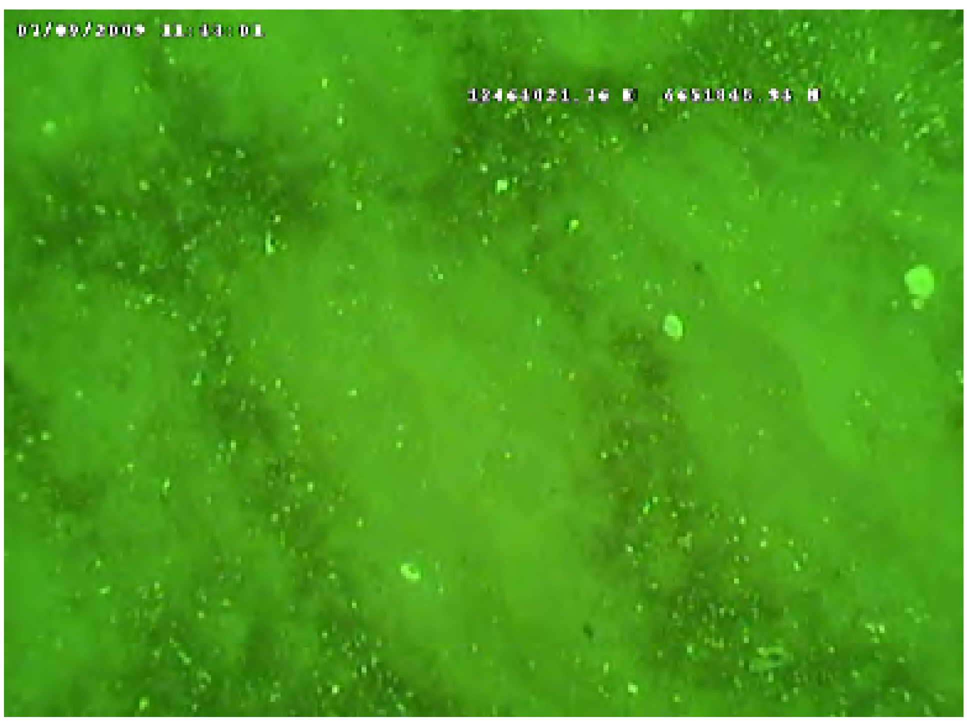


Photo B-19 : Station #39 from Unnamed Shoal B at a depth of approximately 56 ft with defined bedforms and low shell content.

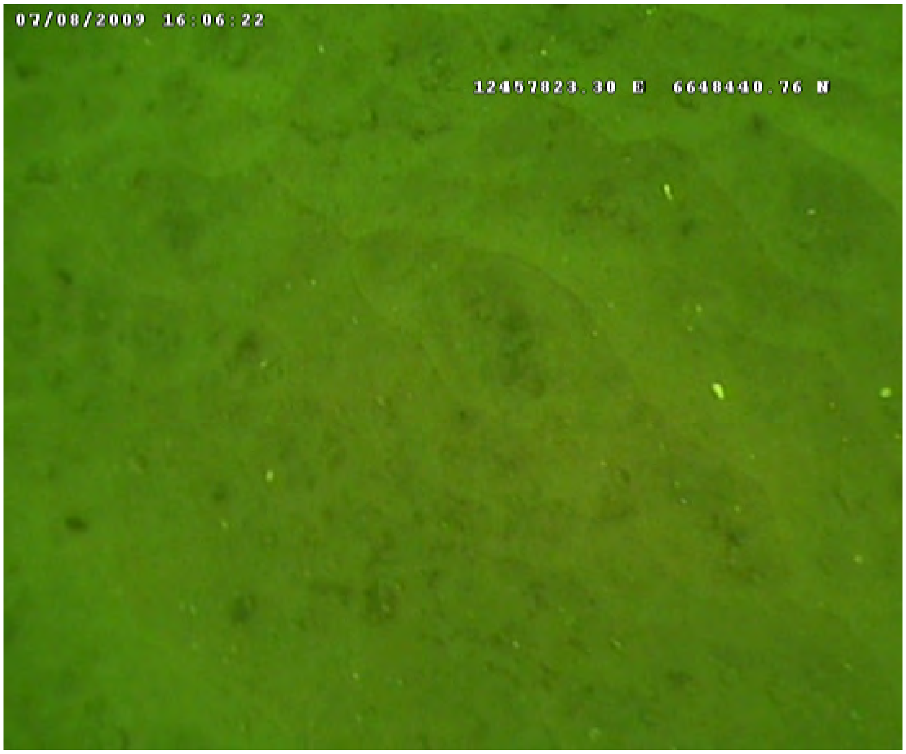


Photo B-20: Sea robin (*Prionotus* spp.) in lower right quadrant from Station #39 Unnamed Shoal B at a depth of 56 ft.

4.0 CONCLUSIONS

The results of the video survey indicate that the two shoals are comprised of unconsolidated sand. These results were confirmed with results of the cultural resource remote sensing survey of the two shoals. Sub bottom profiler data analysis for both Unnamed Shoal A and B indicated that these sand features have relatively poor bedding, which indicates that the sands are homogenous in nature. This sediment homogeneity has likely resulted from long-term preferential grain size sorting by current, wave action, and large storm events.

The benthic habitats and epifaunal communities were similar on the two shoals. Dominant epifaunal benthos included sand dollars, hermit crabs, crabs such as the portly spider crab and Atlantic rock crab, moon shell, and whelk. Fish were rarely seen at any of the stations; those that were observed were primarily (*Prionotus* spp.)

In general for both shoals, the shallowest video stations located on the crests of the shoals contained evidence of well-defined bedforms or ripple marks with wavelengths less than 30 cm (12 in) (e.g., Photos A-3, A-9, A-10, A-11 and Photos B-2, B-9, B-11, B-12, B-13, and B-14). In addition, the shallow stations had low surface shell content. The presence of these bedforms is typically associated with physically-dominated (i.e., waves and currents) habitats, where the presence of worm tubes and burrows would be indicative of a more biologically accommodated habitat (Rhoads and Germano 1986). The lack of apparent biogenic features does not necessarily indicate a paucity of biological resources (Cutter and Diaz 1998). The majority of the benthos on the shoal crests are adapted to the energetic conditions, live within the sediment, and were not visible to the camera. They do not construct tubes or feeding mounds; thereby, resulting in the “clean” appearance of the sand (Cutter and Diaz 1998).

5.0 REFERENCES

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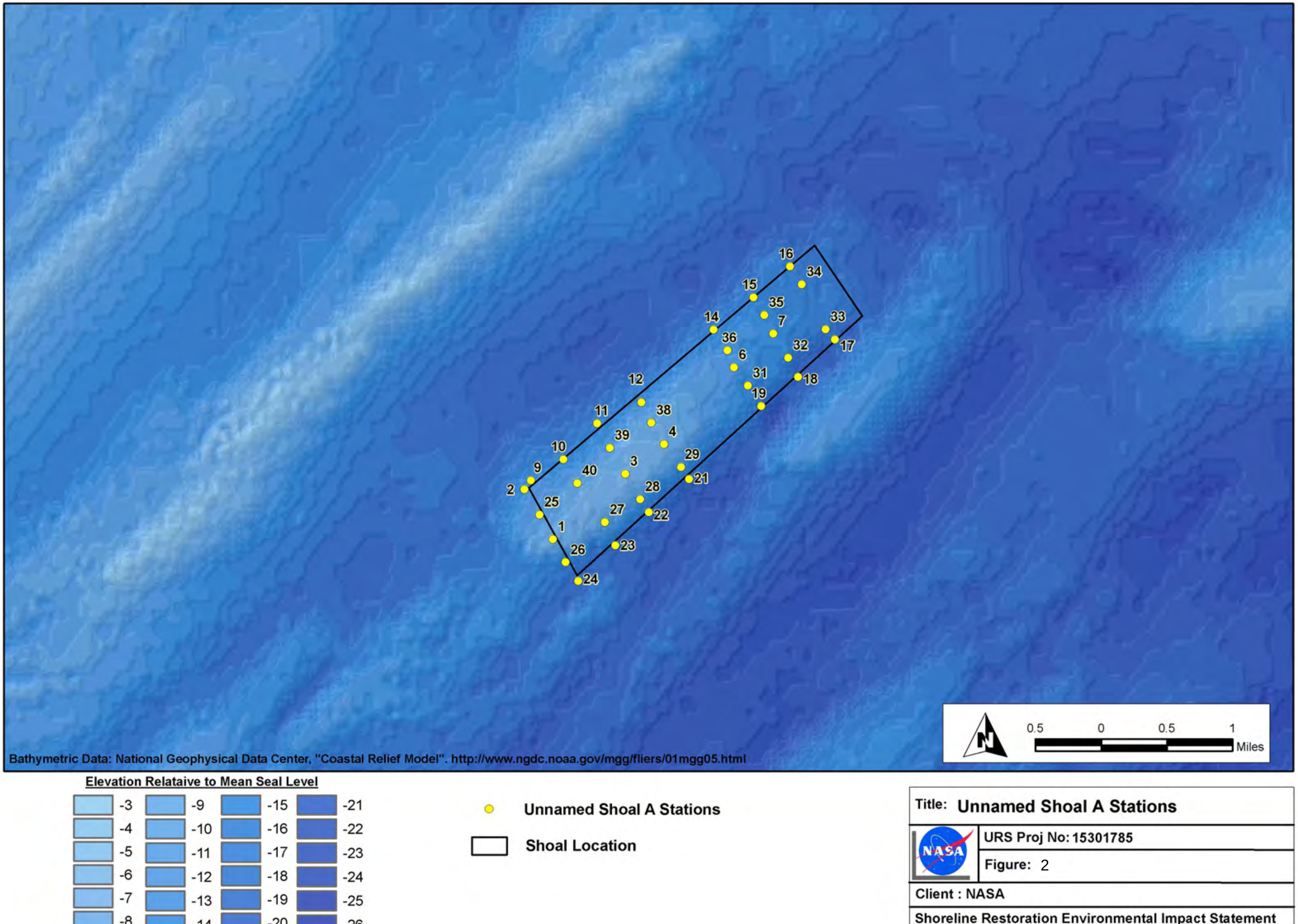
Slacum, H.W. Jr., W.H. Burton, J.H. Vølstad, J. Dew, E. Weber, R. Llansó, and D. Wong. 2006. Comparisons Between Marine Communities Residing on Sand Shoals and Uniform-bottom Substrate in the Mid-Atlantic Bight. Final Report to the U.S. Department of the Interior, Minerals Management Service, International Activities and Marine Minerals Division, Herndon, VA. OCS Report MMS 2005-042, 149 pp. + app.

ATTACHMENT 1

FIGURES


Wallops Main Base
Wallops Island
Wallops Mainland
Black Fish Bank Shoal
Unnamed Shoal A
Unnamed Shoal B
1 0 1 2 Miles
Bathymetric Data: National Geophysical Data Center, "Coastal Relief Model". http://www.ngdc.noaa.gov/mgg/fliers/01mgg05.html
Elevation Relataive to Mean Seal Level
0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10 -11 -12 -13 -14 -15 -16 -17 -18 -19 -20 -21 -22 -23 -24 -25 -26 -27 -28 -29 -30 -31 -32
Shoal Location
WFF Boundary
Title: Offshore Bathymetry
URS Proj No: 15301785
Figure: 1
Client : NASA
Shoreline Restoration Environmental Impact Statement



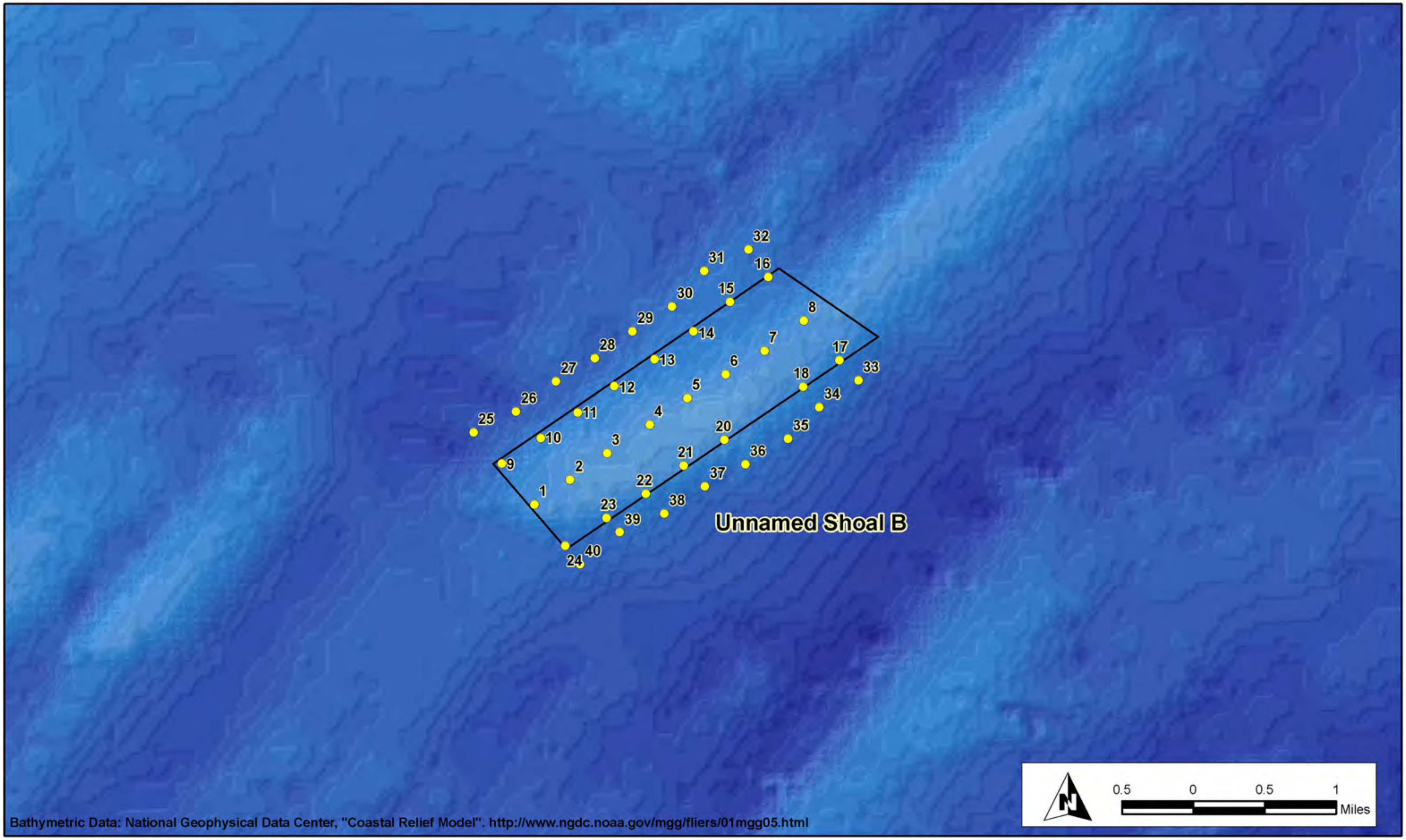
Title: **Unnamed Shoal A Stations**

URS Proj No: 15301785

Figure: 2

Client : NASA

Shoreline Restoration Environmental Impact Statement



Elevation Relataive to Mean Seal Level

-9	-15	-21	-27
-10	-16	-22	-28
-11	-17	-23	-29
-12	-18	-24	-30
-13	-19	-25	-31
-14	-20	-26	-32

Unnamed Shoal B Stations

Shoal Location

Title: **Unnamed Shoal B Stations**	
	URS Proj No: 15301785
	Figure: 3
Client : NASA	
Shoreline Restoration Environmental Impact Statement	

ATTACHMENT 2

DATA SHEETS

NASA SRIPP EIS
Benthic Video Survey
Project # - 15301785

Unnamed Shoal A

Shoal #	Station #	Starting coordinates	Ending coordinates	Video Length	Depth (ft)	Bottom Type	Bedform Size and Shape	Shell Cover	Biogenic Structures	Fauna Observed	Comments (sea conditions, visibility, etc.)
A	1	12428912.24 E, 6640926.18 N	12428911.29 E, 6640923.13 N	4:56	28	1	2,3	1			7/7/09 - visbility poor
A	2	12427765.17 E, 6642925.32 N	12427856.87 E, 6643139.26 N	3:49	55	1	1,1	2		crab (Cancer spp?) at 0:02,	7/7/09 - visibility good
A	3	12431820.61 E, 6643554.58 N	12431874.42 E, 6644025.12 N	4:58	25	1	2/3,3	1		Echinarachinus parma	7/7/09 - visibility poor
A	4	12433373.77 E, 6644751.13 N	12433381.86 E, 6644722.18 N	5:11	30	1	3,2	1			7/7/09 - visibility poor
A	5	NOT COLLECTED LOW VISIBILITY									
A	6	12436181.21 E, 6647845.81 N	12436152.68 E, 6647778.55 N	6:33	44	1	3,3	1		Pagurus spp.	7/8/09 - visibility poor
A	7	12437769.93 E, 6649201.59 N	12437783.06 E, 6649140.07 N	4:56	53	1	1,1	2			7/8/09 - visibility poor
A	8	NOT COLLECTED LOW VISIBILITY									
A	9	12428034.16 E, 6643288.51 N	12428047.27 E, 6643321.72 N	0.29	55	2	1,1	2			7/7/09 - visibility good
A	10	12429333.69 E, 6644135.29 N	12429444.39 E, 6644486.58 N	4:32	60	1	1,1	2		Spisula shell	7/7/09 - visibility poor/good
A	11	12430686.81 E, 6645585.45 N	12430639.92 E, 6645967.35 N	3:49	54	1	1,1	2			7/7/09 - visibility v. poor
A	12	12432468.35 E, 6646432.14 N	12432433.46 E, 6646939.08 N	5:05	51	1	3,2	2		Spisula shell, crab (Cancer spp?)	7/7/09 - visibility v. poor, shell hash concentrated in troughs
A	13	NOT COLLECTED LOW VISIBILITY									
A	14	12435362.78 E, 6649357.31 N	12435353.80 E, 6649282.98 N	7:38	53	1	3,2	1		Spisula shell	7/8/09 - visibility poor
A	15	12436972.83 E, 6650649.31 N	12437007.84 E, 6650609.53 N	7:36	53	1	1,1	2		crab (Cancer spp? white chelipeds - 13:26:08)	7/8/09 - visibility poor
A	16	12438431.38 E, 6651895.95 N	12438432.06 E, 6651904.12 N	7:35	68	1,2	1,1	2		Spisula shell, Ensis shell	7/8/09 - visibility poor
A	17	12440236.84 E, 6648959.79 N	12440150.32 E, 6648937.86 N	6:44	64	2	1,1	2		fish (14:13:22), whelk (14:16:08), Spisula shell	7/8/09 - visibility poor
A	18	12438761.28 E, 6647461.56 N	12438717.16 E, 6647457.92 N	7:06	64	2	1,1	2	mud tubes	Spisula shell, Ensis shell, Pagurus spp, algae filaments ?	7/8/09 - visibility poor
A	19	12437275.94 E, 6646284.31 N	12437153.01 E, 6646158.13 N	6:29	63	1,2	1/3, 1/2	2		Pagurus spp., Polinices spp., crab w/ white chelipeds (12:27:57)	7/8/09 - visibility good
A	20	NOT COLLECTED LOW VISIBILITY									
A	21	12434390.08 E, 6643349.56 N	12434297.11 E, 6643951.86 N	5:06	60	1.2	1/3, 1/2	2	mud tubes	crab (red) spp ?, Pagurus spp,	7/7/09 - visibility poor, bouncing along bottom
A	22	12432764.81 E, 6642009.33 N	12432815.13 E, 6642457.94 N	5:03	60	1	1/2, 1/2	1		starfish (13:37:16), Echinarachinus parma, Pagurus spp.	7/7/09 - visibility poor
A	23	12431428.80 E, 6640677.82 N	12431545.28 E, 6641268.30 N	6:53	60	1	1/3, 1/2	1	burrow	crab white chelipeds Libinia emarginata (13:22:35), Echinarachinus parma, crab	7/7/09 - visibility poor/good, camera moving quickly
A	24	12429938.93 E, 6639252.66 N	12430131.06 E, 6639618.35 N	5:30	58	1,2	1,1	1		Ascidian (red) patch (12:27:15), Pagurus spp., Spisula shell, Ensis shell, crab spp ?	7/7/09 - visibility poor/dark, camera moving quickly
A	25	12428372.96 E, 6641911.43 N	12428562.37 E, 6642244.81 N	4:55	54	1	1/3, 1/2	2		Pagurus spp., Spisula shell	7/7/09 - vsibility poor
A	26	12429426.10 E, 6640002.76 N	12429567.71 E, 6640268.00 N	4:08	45	1	1/3, 1/3	1		Spisula shell	7/7/09 - visibility poor/good
A	27	12431003.98 E, 6641612.42 N	12431074.50 E, 6642071.83 N	4:55	43	1	3,2	1	black coloring in spots	Echinarachinus parma, Polinices spp.	7/7/09 - visibility poor
A	28	12432424.52 E, 6642531.76 N	12432448.72 E, 6642991.17 N	5:08	38	1	3, 2/3	1	black coloring in spots	Polinices sand collar, no fauna observed	7/7/09 - visibility poor/good, not much shell present
A	29	12434064.88 E, 6643837.64 N	12433972.10 E, 6644410.81 N	5:02	35	1	3, 2/3	1	black coloring in spots	starfish observed in several spots (ex. 14:56:32, 14:58:28), Polinices sand collar	7/7/09 - visibility poor/good

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Unnamed Shoal A

Shoal #	Station #	Starting coordinates	Ending coordinates	Video Length	Depth (ft)	Bottom Type	Bedform Size and Shape	Shell Cover	Biogenic Structures	Fauna Observed	Comments (sea conditions, visibility, etc.)
A	30	NOT COLLECTED LOW VISIBILITY									
A	31	12436751.31 E, 6647108.45 N	12436694.42 E, 6647018.60 N	6:18	50	1	1,1	1		Pagurus spp.	7/8/2009 - visibility poor
A	32	12438363.88 E, 6648226.51 N	12438356.41 E, 6648177.22 N	5:24	60	1	1,1	1		Pagurus spp., Echinarachinus parma, Polinices sand collar	7/8/09 - visibility v. poor
A	33	12439867.04 E, 6649374.47 N	12439841.78 E, 6649418.65 N	7:18	60	1	1,1	1		Pagurus spp., Spisula shell	7/8/09 - visibility v. poor
A	34	12438910.18 E, 6651176.29 N	12438922.36 E, 6651150.82 N	6:57	58	1	1,1	2		Pagurus spp., Spisula shell, Ensis shell	7/8/09 - visibility v. poor
A	35	12437397.64 E, 6649943.08 N	12437018.82 E, 6649611.21 N	7:03	50	1	1,1	1		Pagurus spp., Echinarachinus parma	7/8/09 - visibility v. poor, last half of video camera moving very quickly
A	36	12435928.10 E, 6648526.07 N	12435937.30 E, 6648464.97 N	7:36	42	1	3,3	1		Pagurus spp., Echinarachinus parma	7/8/09 - visibility poor/good
A	37	NOT COLLECTED LOW VISIBILITY									
A	38	12432866.12 E, 6645616.23 N	12432817.77 E, 6646154.23 N	5:05	33	1	3,3	1		Echinarachinus parma	7/7/09 - visibility good
A	39	12431204.83 E, 6644596.15 N	12431251.70 E, 6645098.58 N	5:03	31	1	3,2	1		Pagurus spp., Polinices sand collar	7/7/09 - visibility v. poor, shell concentrated in ripple troughs
A	40	12429894.04 E, 6643181.30 N	12430004.60 E, 6643579.79 N	4:36	36	1	1,1	1	tubes		7/7/09 - visibility good, camera moving quickly

Note:

Video Length = minutes:seconds

Bottom type - (1) sand; (2) mud/silt

Bedform size - (1) none, no bedforms, flat relatively uniform bottom; (2) large bedforms, wavelength approx. 30 cm or greater; (3) small bedforms, wavelength less than approx. 30 cm

Bedform shape - (1) none, (2) smooth crested with top of bedform rounded; (3) sharp crested with top of bedform peaked

Shell cover - (1) <10% or (2) >10% of the bottom covered by shell and shell fragments

Biogenic structure - none, tubes, burrow openings

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Unnamed Shoal B

Shoal #	Station #	Starting coordinates	Ending coordinates	Video Length	Depth (ft)	Bottom Type	Bedform Size and Shape	Shell Cover	Biogenic Structures	Fauna Observed	Comments (sea conditions, visibility, etc.)
B	1	12454655.72 E, 6649458.59 N	12454656.74 E, 6649457.60 N	5:34	42	1	2/3,3	1	burrow (approx 1:00),	Pagurus spp., (2:22), Polinices sand collars	7/8/09 - video not recording correctly first approx 50 sec, visibility v. good
B	2	12455979.52 E, 6650375.24 N	12455907.54 E, 6650511.21 N	5:06	42	1	3,3	1		Echinarachinus parma (low density), Pagurus spp., Polinices sand collars, Spisula shell, Ensis shell	7/8/09 - visibility v. good
B	3	12457350.89 E, 6651354.57 N	12457339.05 E, 6651328.98 N	5:11	44	1	3,3	1	burrow openings (09:38:22, 09:42:06)	Pagurus spp.	7/9/09 - visibility v. good - "cross-rippling" of sand (09:38:12)
B	4	12458929.23 E, 6652417.15 N	12458885.54 E, 6652569.62 N	5:48	44	1	3,3	1		Echinarachinus parma (low density), Pagurus spp.,	7/9/09 - visibility good
B	5	12460328.49 E, 6653402.49 N	12460352.25 E, 6653260.74 N	5:03	44	1	3,2/3	1		Pagurus spp.	7/9/09 - visibility good
B	6	12461736.04 E, 6654280.46 N	12461764.61 E, 6654165.27 N	5:05	45	1	3,2	1		Pagurus spp., Polinices sand collars, Spisula shell	7/9/09 - visibility good
B	7	12463177.31 E, 6655159.22 N	12463447.31 E, 6655134.82 N	5:06	43	1	1/3, 1/2	1		Pagurus spp., Spisula shell	7/9/09 - visibility poor/good
B	8	12464630.83 E, 6656273.85 N	12464691.71 E, 6656116.10 N	5:15	41	1	3,3	1		crab exiting sediment (13:37:30), Polinices sand collar, Spisula shell, Ensis shell	7/9/09 - visibility poor/good
B	9	12453447.41 E, 6650964.83 N	12453399.31 E, 6651018.65 N	5:33	55	2	1,1	1		starfish Astropecten spp? (15:25:25), Pagurus spp., Polinices sand collar, Spisula shell, Ensis shell	7/8/09 - visibility poor
B	10	12454891.79 E, 6651912.73 N	12454771.57 E, 6652063.81 N	5:05	55	1	3/1,2/1	1	feeding pits, tubes, burrows	crab Libinia emarginata (white chelipeds) (16:32:31), Pagurus spp., Polinices sand collar, Polinices spp (16:33:14), crabs Libinia, Cancer spp (16:34:23), Spisula shell, Ensis shell	7/8/09 - visibility good
B	11	12456258.22 E, 6652866.68 N	12456204.76 E, 6652943.67 N	5:12	55	1	1,1	1	curled tube (09:27:10)	Pagurus spp., Polinices sand collars, Spisula shell, Ensis shell	7/9/09 - visibility good
B	12	12457611.09 E, 6653847.69 N	12457632.10 E, 6653975.65 N	5:06	58	1	1,1	1		Pagurus spp., Spisula shell	7/9/09 - visibility poor/good
B	13	12459105.28 E, 6654846.55 N	12459102.91 E, 6654844.27 N	5:07	54	1	3,3	1		Pagurus spp., ctenophores,	7/9/09 - visibility v. good
B	14	12460551.34 E, 6655873.06 N	12460630.78 E, 6655835.14 N	5:17	48	1	3,3	1		Echinarachinus parma (patchy high density), Pagurus spp., Polinices sand collars, Spisula shell, Ensis shell	7/9/09 - visibility v. good
B	15	12461899.30 E, 6656967.95 N	12461919.25 E, 6656929.67 N	5:05	56	1	3,3	1		Echinarachinus parma, Pagurus spp., Polinices sand collars, Ensis shell	7/9/09 - visibility good
B	16	12463321.67 E, 6657892.14 N	12463320.16 E, 6657872.95 N	5:04	65	1	3/1,2/1	1		crab - Cancer spp? (13:48:14), Pagurus spp., Echinarachinus parma, Spisula	7/9/09 - visibility good
B	17	12465959.95 E, 6654815.13 N	12465952.38 E, 6654756.45 N	5:17	56	1	3,2	1		Polinices sand collar, crabs Cancer spp. (13:29:28), Pagurus spp.	7/9/09 - visibility poor/good
B	18	12464612.03 E, 6653834.03 N	12464622.72 E, 6653725.02 N	5:10	48	1	3,2	1	sparse tubes	crab Cancer spp. (12:56:13), Pagurus spp.	7/9/09 - poor
B	19	12463033,50 E, 6652921.65 N	12463052.63 E, 6652836,26 N	5:03	40	1	3,2	1	tubes	Pagurus spp.	7/9/09 - visibility poor, v similar to #18
B	20	12461687.55 E, 6651863.08 N	12461723.48 E, 6651686.81 N	5:03	45	1	3/2,3	1	scattered tubes	Echinarachinus parma, Pagurus spp., Polinices sand collars, Spisula shell, Polinices spp.	7/9/09 - visibility good, cross rippling
B	21	12460188.94 E, 6650906.74 N	12460153.74 E, 6650896.20 N	5:18	41	1	3,3	1		Pagurus spp., Polinices sand collar, Spisula shell	7/9/09 - visibility poor/good, cross rippling
B	22	12458781.46 E, 6649858.66 N	12458751.53 E, 6649842.06 N	5:25	43	1	3,3	1		Pagurus spp., Polinices sand collar, gastropod (?) in trail (09:49:52)	7/9/2009 - visibility good
B	23	12457337.38 E, 6648957.19 N	12457264.15 E, 6649082.95 N	5:04	50	1	3,3	1		Pagurus spp., crab ? (16:17:15), Polinices sand collars, sea robin	7/8/09 - visibility good, cross rippling
B	24	12455806.30 E, 6647921.81 N	12455661.63 E, 6648078.05 N	5:32	63	1	3,3/2	1		Pagurus spp., crab ? (15:47:01), Polinices sand collars, Spisula shell, Ensis shell	7/8/09 - visibility good

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Unnamed Shoal B

Shoal #	Station #	Starting coordinates	Ending coordinates	Video Length	Depth (ft)	Bottom Type	Bedform Size and Shape	Shell Cover	Biogenic Structures	Fauna Observed	Comments (sea conditions, visibility, etc.)
B	25	12452407.08 E, 6652123.96 N	12452349.19 E, 6652091.10 N	5:52	74	1	1,1	2		crab cancer spp. (15:17:41), Pagurus spp., Spsiula shell, Ensis shell	7/8/09 - visibility poor/good, dark
B	26	12453978.91 E, 6652900.79 N	12453886.19 E, 6653033.38 N	5:45	73	1/2	1,1	1		Pagurus spp., crab Cancer spp., Polinices sand collar, Ensis shell, Spisula shell	7/8/09 - visibility poor/good
B	27	12455454.76 E, 6654020.51 N	12455409.31 E, 6654032.50 N	5:48	72	1	1,1	1/2		horseshoe crab carapace, crabs Cancer spp. ? (09:19:31), Spisula shell, Ensis shell	7/9/09 - visibility good
B	28	12456891.41 E, 6654878.36 N	12456859.50 E, 6654920.46 N	5:16	67	1	1,1	1		crab ?? Spp. (10:43:16), Pagurus spp., Spisula shell, Ensis shell	7/9/09 - visibility good
B	29	12458288.05 E, 6655872.13 N	12458276.12 E, 6655833.93 N	5:07	66	1	1,1	2		starfish Astropecten spp? (10:53:48), Pagurus spp., Polinices sand collar, ophiuroid ? (10:54:21), Spisula shell, Ensis shell	7/9/09 - visibility good
B	30	12459752.01 E, 6656799.42 N	12459673.94 E, 6656732.60 N	5:19	60	1	1,1	2		Pagurus spp., Polinices sand collar, Spisula shell	7/9/09 - visibility good
B	31	12460939.18 E, 6658111.10 N	12460936.87 E, 6658064.60 N	5:37	60	1	3/1,2/1	1		Pagurus spp., Polinices sand collars, whelk Busycon spp. (12:28:12), Echniarachinus parma, Spisula shell, Ensis shell	7/9/09 - visibility v. good
B	32	12462579.47 E, 6658907.85 N	12462529.40 E, 6658737.04 N	5:08	61	1	1,1	1		Pagurus spp., Polinices sand collar, Spisula shell, Ensis shell	7/9/09 - visibility good
B	33	12466661.84 E, 6654067.28 N	12466587.57 E, 6654134.22 N	5:11	66	1	3,2	1		Pagurus spp., Polinices sand collar	7/9/09 - visibility good
B	34	12465212.08 E, 6653073.16 N	12465193.50 E, 6653026.45 N	5:05	63	1	3,3	1		Pagurus spp.	7/9/09 - visibility good
B	35	12464060.44 E, 6651901.12 N	12464023.44 E, 6651834.66 N	5:09	63	1	3,3	1		Pagurus spp., Polinices sand collar, Spisula shell	7/9/09 - visibility good, not continuous ripples
B	36	12462471.53 E, 6650957.65 N	12462443.44 E, 6650896.96 N	5:05	64	1	3,3	1		Pagurus spp., crab ??spp. (14:32:14), Spisula shell	7/9/09 - visibility - v. good
B	37	12460979.07 E, 6650139.04 N	12460942.35 E, 6650152.76 N	5:18	64	1	3,3	1		Pagurus spp., crab Cancer spp., Spisula shell	7/9/09 - visibility good
B	38	12459473.68 E, 6649118.43 N	12459463.89 E, 6649160.24 N	5:41	64	1	3,3,	1		Pagurus spp., Spisula shell, Ensis shell	7/9/09 - visibility good
B	39	12457824.00 E, 6648440.68 N	12457714.11 E, 6648630.16 N	5:06	56	1	3/1,3/2/1	1		Pagurus spp., sea robin (16:08:31), crab Cancer spp.(16:11:12), Spisula shell	7/8/09 - visibility good
B	40	12456357.79 E, 6647242.04 N	12456220.05 E, 6647415.24 N	5:08	65	1	3/1,2/1	1		crab Libinia emarginata, Pagurus spp., Spisula shell, Ensis shell, algal strands ?	7/8/09 - visibility good, dark

Note:

Video Length = minutes:seconds

Bottom type - (1) sand; (2) mud/silt

Bedform size - (1) none, no bedforms, flat relatively uniform bottom; (2) large bedforms, wavelength approx. 30 cm or greater; (3) small bedforms, wavelength less than approx. 30 cm

Bedform shape - (1) none (2)smooth crested with top of bedform rounded; (3) sharp crested with top of bedform peaked

Shell cover - (1) <10% or (2) >10% of the bottom covered by shell and shell fragments

Biogenic structure - none, tubes, burrow openings

National Aeronautics and
Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Reply to Attn of: 250.W

February 12, 2010

Ms. Julie Crocker
Protected Resources Division
National Marine Fisheries Service
One Blackburn Drive
Gloucester, Massachusetts 01930

Dear Ms. Crocker:

In accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, and Section 7(c) of the Endangered Species Act of 1973 (ESA), the National Aeronautics and Space Administration (NASA) has prepared a Draft Programmatic Environmental Impact Statement (DPEIS) and Biological Assessment (BA) for the proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP) at its Goddard Space Flight Center's Wallops Flight Facility (WFF) on Wallops Island, Virginia.

As the project sponsor, NASA is serving as the lead agency for NEPA and ESA consultation with the National Marine Fisheries Service and U.S. Fish and Wildlife Service. The U.S. Department of the Interior, Minerals Management Service (MMS) and the U.S. Army Corps of Engineers (USACE) would undertake actions connected to the SRIPP and are participating in NASA's NEPA process and ESA consultation. The effects of their actions are considered in all project-related environmental documentation, including the enclosed DPEIS and BA (Appendix I of the DPEIS). As such, please include all three action agencies in future correspondence regarding the SRIPP.

In cooperation with MMS and USACE, NASA has determined that the proposed SRIPP "may affect but is not likely to adversely affect" seabeach amaranth, red knot, humpback whale, fin whale, right whale, leatherback sea turtle, and the Atlantic green sea turtle; and "may affect and is likely to adversely affect" the piping plover, Kemp's ridley sea turtle, and the loggerhead sea turtle. As adverse effects on listed species within your agency's jurisdiction may occur, please consider this correspondence as NASA's request to begin formal consultation pursuant to the ESA. NASA respectfully requests that your agency's Opinion be provided within 135 days of receiving this correspondence.

If you have any questions or require any additional information please contact me at (757) 824-2319, or Ms. Shari Silbert at (757) 824-2327.

Sincerely,

Joshua A. Bundick
WFF NEPA Program Manager

Enclosure

cc:
MMS/Mr. D. Herkhof
NMFS/Ms. D. Palmer
USACE/Mr. R. Cole
USFWS/Mr. T. Dean

National Aeronautics and
Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Reply to Attn of: 250.W

February 12, 2010

Ms. Cindy Schulz
Virginia Field Office
U.S. Fish and Wildlife Service
6669 Short Lane
Gloucester, Virginia 23061

Dear Ms. Schulz:

In accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, and Section 7(c) of the Endangered Species Act of 1973 (ESA), the National Aeronautics and Space Administration (NASA) has prepared a Draft Programmatic Environmental Impact Statement (DPEIS) and Biological Assessment (BA) for the proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP) at its Goddard Space Flight Center's Wallops Flight Facility (WFF) on Wallops Island, Virginia.

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If you have any questions or require any additional information please contact me at (757) 824-2319, or Ms. Shari Silbert at (757) 824-2327.

Sincerely,

Joshua A. Bundick
WFF NEPA Program Manager

Enclosure

cc:
MMS/Mr. D. Herkhof
NMFS/Ms. J. Crocker
USACE NAO/Mr. R. Cole
USFWS/Mr. T. Dean

BIOLOGICAL ASSESSMENT

WALLOPS FLIGHT FACILITY SHORELINE RESTORATION AND INFRASTRUCTURE PROTECTION PROGRAM

Prepared for

National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

In cooperation with

U.S. Department of the Interior, Minerals Management Service and
U.S. Army Corps of Engineers

February 2010

Prepared by

URS Group, Inc.
200 Orchard Ridge Drive, Suite 101
Gaithersburg, MD 20878
15301785

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Tables

Figures

ACS	American Cetacean Society
BA	Biological Assessment
BO	Biological Opinion
ºC	degrees Celsius
CFR	Code of Federal Regulations
dB	decibel
DTRU	Dry Tortugas Recovery Unit
EIS	Environmental Impact Statement
ESA	Endangered Species Act
GSFC	Goddard Space Flight Center
GCRU	Greater Caribbean Recovery Unit
Hz	hertz
kHz	kilohertz
MALSF	Marine Aggregate Levy Sustainability Fund
MARS	Mid-Atlantic Regional Spaceport
MMS	Minerals Management Service
msl	mean sea level
NASA	National Aeronautics and Space Administration
NGMRU	Northern Gulf of Mexico Recovery Unit
NMFS	National Marine Fisheries Service
NPS	National Park Service
OCS	Outer Continental Shelf
PFRU	Peninsular Florida Recovery Unit
SAV	Submerged Aquatic Vegetation
SRIPP	Shoreline Restoration and Infrastructure Protection Program
TED	Turtle Exclusion Device
UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial Vehicle
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WFF	Wallops Flight Facility

SECTION ONE: INTRODUCTION

1.1 PURPOSE OF THIS DOCUMENT

Section 7(c) of the Endangered Species Act (ESA) of 1973 requires that a Biological Assessment (BA) be prepared for all Federal actions that may affect federally listed endangered or threatened species. The Federal action considered in this BA is the funding, authorization, and implementation of the Shoreline Restoration and Infrastructure Protection Program (SRIPP) at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center's (GSFC) Wallops Flight Facility (WFF) on Wallops Island, Virginia.

The U.S. Army Corps of Engineers (USACE), Norfolk District, and the U.S. Department of the Interior, Minerals Management Service (MMS) are assisting NASA in preparing this BA. The USACE will design the SRIPP and serve in a construction management capacity during project implementation. The USACE also has permitting authority for the project under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. MMS has jurisdiction over mineral resources on the Federal Outer Continental Shelf (OCS). Public Law 103-426, enacted October 31, 1994, gave MMS the authority to convey, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration projects, or for use in construction projects funded in whole or part or authorized by the Federal government. MMS would issue a negotiated agreement with NASA to authorize the dredging of sand from the OCS for the SRIPP.

In cooperation with MMS and the USACE, NASA has prepared this BA to consider the potential impacts to listed species under the jurisdiction of the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) that may occur within the proposed Action Area. Generally, the USFWS manages land and freshwater species, while NMFS manages marine and anadromous fish species. Anadromous species are fish, such as the shortnose sturgeon, that live their adult lives in the ocean but move into freshwater streams to reproduce or spawn. The USFWS and NMFS have joint jurisdiction of sea turtle species.

The Action Area is comprised of onshore and offshore components. The onshore Action Area (land) is located in Accomack County, Virginia. Federally listed species that may occur within the vicinity of the onshore and offshore Action Area are listed below in Table 1.

Table 1: Protected Species That May Occur in the Action Area

Common Name	Scientific Name	Likelihood of Occurrence Within Onshore Action Area[2]	Likelihood of Occurrence Within Offshore Action Area[2]	Expected Seasonal Presence	Federal Status	Jurisdiction
Seabeach amaranth	*Amaranthus pumilus*	possible	n/a	All	Threatened	USFWS
Northeastern beach tiger beetle	*Cicindela dorsalis dorsalis*	highly unlikely	n/a	n/a	Threatened	USFWS
Delmarva Peninsula fox squirrel	*Sciurus niger cinereus*	highly unlikely	n/a	n/a	Endangered	USFWS
Red knot[1]	*Calidris canutus rufa*	known to occur	n/a	Spring/Fall Migration	Candidate [1]	USFWS
Piping plover	*Charadrius melodus*	known to occur	n/a	All	Threatened	USFWS
Shortnose sturgeon	*Acipenser brevirostrum*	n/a	highly unlikely	n/a	Endangered	NMFS
Humpback whale	*Megaptera novaeangliae*	n/a	possible	All	Endangered	NMFS
Fin whale	*Balaeanoptera physalus*	n/a	possible	Spring/Summer	Endangered	NMFS
Right whale	*Eubalaena glacialis*	n/a	possible	Fall/Winter	Endangered	NMFS
Sei whale	*Balaenoptera borealis*	n/a	highly unlikely	n/a	Endangered	NMFS
Leatherback sea turtle	*Dermochelys coriacea*	possible	possible	Summer	Endangered	NMFS/ USFWS
Hawksbill sea turtle	*Eretmochelys imbricate*	highly unlikely	highly unlikely	n/a	Endangered	NMFS/ USFWS
Kemp's ridley sea turtle	*Lepidochelys kempi*	possible	possible	Spring/Summer	Endangered	NMFS/ USFWS
Loggerhead sea turtle	*Caretta caretta*	likely	likely	Spring/Summer	Threatened	NMFS/ USFWS
Atlantic green sea turtle	*Chelonia mydas*	possible	possible	Summer	Threatened	NMFS/ USFWS

[1]Although candidate species are not protected under the ESA, NASA was requested by the USFWS to include the Red Knot.
[2]n/a = not applicable; Highly unlikely = habitat not available and species is not documented in the Action Area; Possible = habitat available but species is rarely, if ever, documented in the Action Area; Likely =habitat available and species is occasionally documented in the Action Area; Known to occur = habitat available and species regularly documented in the Action Area.
Sources: USFWS, 2000; USFWS, 2009; NASA, 2007; NASA, 2009

As shown in Table 1, several species are highly unlikely to occur in the Action Area. The northeastern beach tiger beetle has a historic range from New Jersey to Cape Cod and along much of the eastern and western shorelines of the Chesapeake Bay from southern Maryland to Virginia. Although the northeastern beach tiger beetle was present historically on the Atlantic coast beaches, especially in the northeast, it is extirpated from nearly this entire region. It has not been documented within the Action Area, but is found on Chesapeake Bay beaches (Fenster et al., 2006; Dean, 2009).

The Delmarva Peninsula fox squirrel lives in mature forests of mixed hardwoods and pines with a closed canopy and open understory on the Delmarva Peninsula and does not inhabit the beaches which comprise the onshore Action Area. The shortnose sturgeon does not often occur within the offshore Action Area or within the waters of adjacent wildlife refuges. Because it is unlikely or highly unlikely that these species occur in the Action Area, they will be excluded from further discussion in this BA.

During previous consultation with the NMFS in 2007 regarding the SRIPP, NMFS issued a Biological Opinion (BO) that excluded sperm whales, sei whales, blue whales, and hawksbill sea turtles from further consideration due to the very low probability that any of these species would be present within the Action Area and/or affected by the Proposed Action. Because no protected populations of these species exist within the Action Area, and because it is unlikely or highly unlikely that these species occur in the Action Area, they will be excluded from further discussion in this BA.

1.2 ENDANGERED SPECIES ACT

This BA is a component of the formal consultation process provided under Section 7 of the ESA. More detailed procedures for this formal consultation process are defined in 50 CFR 402.14(c). Early consultation is conducted when the action agency is planning a project or program that may affect protected species; however, not every project detail may be known. During previous consultations for the SRIPP, the specific borrow area(s) off the coast of Wallops Island had not been identified. However, NASA completed early consultation for potential dredging within a broad area of State waters east of Wallops Island for the SRIPP by submitting a BA in May 2007. NASA received a BO from NMFS on September 25, 2007.

In a letter to USFWS dated March 1, 2007, NASA transmitted a BA addressing potential impacts of the SRIPP on the Piping Plover. In a letter dated April 24, 2007, USFWS stated that the Proposed Project would not adversely affect threatened or endangered species under their jurisdiction.

With the preparation of this BA, NASA, in conjunction with MMS and USACE, is continuing the Section 7 consultation process by submitting additional project information to NMFS and USFWS. Once NMFS and USFWS issue a BO, NASA will finalize the consultation process by obtaining any required incidental take permits from NMFS and USFWS.

Binding clauses may be built into a BO resulting from this BA requiring NASA to consult again for future dredging activities; however, this document, the March 2007 BA and the September 2007 BO lay the groundwork for the consultation process and allow all three agencies to efficiently finalize future consultations for this project. It is anticipated that the dredging would continue at varying degrees of intensity for the next 50 years, with renourishment cycles approximately every 5 years.

In addition to Section 7 consultation, NASA is preparing a Programmatic Environmental Impact Statement (PEIS) to assess the impacts from the SRIPP on the human environment.

1.3 LOCATION AND NEED FOR PROPOSED ACTION

WFF facilities and those of its tenants are located on the Eastern Shore of Virginia facing the Atlantic Ocean. WFF is comprised of three distinct land masses: the Main Base, the Mainland, and Wallops Island. SRIPP activities would be limited to Wallops Island. Wallops Island is a barrier island bounded by Chincoteague Inlet to the north and Assawoman Inlet (now closed) to the south (Figure 1). WFF has been occupied by NASA since the 1940s. During this time WFF has experienced erosion along the coast. The ocean has encroached substantially toward launch pads, infrastructure, and test and training facilities belonging to NASA, the U.S. Navy, and the Mid-Atlantic Regional Spaceport (MARS). These assets are valued at over $1 billion and are increasingly at risk from storm waves. The potential risks to infrastructure from wave impacts are two-fold: first is the interruption of NASA, U.S. Navy, and MARS missions supported from Wallops Island facilities due to temporary loss of facility functions; and second is the potential for complete loss of these unique facilities. If no protective measures are taken, then the assets on Wallops Island will be increasingly at risk from even moderate storm events.

The purpose of the proposed project is to reduce the potential for storm damage to facilities by restoring the beach with sand dredged from offshore in order to move the zone of wave breaking well away from the infrastructure. The project would not protect against flooding or other impacts during major hurricanes and nor'easters.

Shoreline retreat on Wallops Island has averaged about 3.7 meters (12 feet) per year since 1857. The first attempt to reduce erosion occurred in 1961 with the construction of a wooden seawall. As erosion continued and the seawall deteriorated, stone rubble-mound rocks were used as a replacement for the wooden seawall. The current stone seawall, completed in 1999, temporarily fixed the shoreline in place. However, because the seawall is porous, it has allowed sediment to flow out of the area, without allowing replenishment. The integrity of the seawall is at risk due to the lack of protective beach sand, which results in waves breaking directly on the rocks. The seawall extends approximately 4,600 m (15,100 ft) along the shoreline. Currently, beach only exists seaward of the northern portion of the seawall. There is no beach along approximately 4,250 m (14,000 ft) of the seawall. The current shoreline is at an elevation of 2.1 meters (6.9 feet) above mean sea level (msl).

The proposed project would involve the use of one or two borrow sites located in Federal waters to provide fill for the initial and future nourishment of the beach. Initially, sand would be obtained from one of two offshore shoals: Unnamed Shoal A. Future renourishment material would be dredged from Unnamed Shoal A, Unnamed Shoal B, or the northern portion of Wallops Island which is experiencing accretion. The southwest end of Unnamed Shoal A is located approximately 11 kilometers (7 miles) east of Assateague Island and approximately 18 kilometers (11 miles) from the north tip of Wallops Island. The southwest end of Unnamed Shoal B is located approximately 19 kilometers (12 miles) east of Assateague Island and approximately 26 kilometers (16 miles) from the north tip of Wallops Island (Figure 1).

1.4 ACTION AREA

The Action Area is defined in 50 Code of Federal Regulations (CFR) 402.02 as “All areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.” The Action Area for this BA includes the following:

- The northern portion of Wallops Island
- The portion of Wallops Island shoreline that will be affected by the extended seawall and the beach fill
- The area affected by the nearshore pump-out or booster station
- Offshore borrow sites
- The waters between and immediately adjacent to the above areas, where project vessels will transit and dredged material will be transported
- 1,219 meters (4,000 feet) in all directions from the area to be dredged to account for the sediment plume generated during dredging activities.

Figure 2 shows the Action Area for the SRIPP.

1.4.1 Wallops Island

WFF is located in the northeastern portion of Accomack County, Virginia, on the Delmarva Peninsula, and is comprised of the Main Base, Wallops Mainland, and Wallops Island. Wallops Island is a barrier island approximately 11 kilometers (7 miles) long and 800 meters (2,650 feet) wide. It is bordered by Chincoteague Inlet to the north, Assawoman Inlet to the south, the Atlantic Ocean to the east, and marshland to the west. The mainland area to the west is comprised mainly of rural farmland. South of Wallops Island are Assawoman Inlet (now closed) and Assawoman Island, a 576-hectare (1,424-acre) island managed as part of the Chincoteague National Wildlife Refuge by the USFWS. A string of undeveloped barrier islands extends further south, down the coast to the mouth of Chesapeake Bay. Southern Wallops Island includes the permitted open burn area, the launch complexes, and the Unmanned Aerial Systems (UAS) runway and associated structures. Northern Wallops Island includes rocket storage facilities and the Navy’s AEGIS and Ship Self Defense System Facilities.

As noted above, the existing seawall on Wallops Island is approximately 4,600 meters (15,100 feet) in length. Without an existing beach currently in front of it, the seawall is the primary shoreline protection feature for Wallops Island and consists of large stone and riprap piled to a height of approximately 4.6 meters (15 feet) (Figure 3). Sand in front of the seawall has eroded and five sections of the seawall are currently in need of repair.

Development is relatively sparse along the Atlantic Ocean coastline on the Eastern Shore of Virginia because most of the barrier islands in this region are protected by either Federal agencies (USFWS, National Park Service [NPS]) or conservation organizations (e.g., The Nature Conservancy). Chincoteague Inlet and Chincoteague Island are located to the north of Wallops Island. The currently closed Assawoman Inlet defines the southern end of Wallops Island.

1.4.2 Atlantic Ocean Offshore Areas

Nearshore state jurisdictional waters extend 5.5 kilometers (3 nautical miles) offshore of the Wallops Island coast. Water depth in state waters ranges up to approximately 12 meters (40 feet). This zone is located on the inner portion of the outer continental shelf and extends to about 130 to 160 kilometers (80 to 100 miles) off the mid-Atlantic Coast.

Borrow area depths range from approximately 6 to 21 meters (20 to 70 feet). In May and June of 2007, core samples were collected by the USACE to evaluate the sediment grain size in areas offshore of Wallops Island and identify suitable sand types. These samples showed that the nearshore ocean substrate consists of deposits of fine sand and shell. Sediment texture varies from gravel patches and a fine sand mixture inshore, to medium sand offshore. The sediments in the Action Area are typical of the nearshore and inner continental shelf in this region, consisting of fine quartz sand with a patchy veneer of shells.

Numerous invertebrate species are present in the unconsolidated substrate and open waters of the nearshore zone. Common species include annelid worms, bivalves, crabs, sand dollars, gastropods, comb jellies, and jellyfish. Many of these organisms are an important food source for fish, birds, and sea turtles.

The project area contains a broad diversity of fish species. The MAB contains over 300 species of fish, most of which are seasonal migrants with only a few species considered endemic to the area (Sherman et al., 1996). The diversity results from the MAB being an area of transition from cold water in the north and warmer waters to the south. Boreal (northern) species are present in the winter and warm-temperate/sub-tropical species are present in the summer (Musick et al., 1986). Many of the species migrate from nearshore to areas offshore or southward seasonally, as dictated by temperature cycles, feeding opportunities, and spawning cycles (MMS, 1999). Generally, fish abundance is low in the winter with a progressive influx in the spring and peak abundances in the fall. In addition, diversity is highest in September and lowest in late winter (February/March) (MMS, 1999).

SECTION TWO: PROPOSED ACTION

The objective of the SRIPP is to reduce physical damage to Wallops Island infrastructure incurred during normal coastal storms and nor'easters by moving the zone of breaking waves away from vulnerable infrastructure.

The Proposed Action would involve an initial construction phase with follow-on renourishment cycles. The initial phase would include two distinct elements:

1. Extending Wallops Island's existing rock seawall a maximum of 1,400 meters (4,600 feet) south of its southernmost point; and
2. Placing sand dredged from Unnamed Shoal A, located offshore in Federal waters, on the Wallops Island shoreline in front of the seawall.

2.1 SEAWALL EXTENSION

The rock seawall extension would be implemented first and would consist of the placement of 1,400 meters (4,600 feet) of 4.5 to 6.4 metric tons (5 to 7 tons) of rocks parallel to the shoreline. The seawall extension would be placed in line with and adjacent to the end of the existing seawall and would be installed in a straight line parallel to the shoreline. It would be placed in the beach (some rock slightly below the beach surface, the majority of rock sitting on top of the beach surface), and would be approximately 5 meters (14 feet) above the normal high tide water level, depending on the extent of existing shoreline retreat at the time of construction.

2.2 BORROW SITES

In 2007 and 2008, the USACE conducted sediment sampling to identify potential offshore borrow sites with compatible grain size and adequate volume for use as beach fill. Three offshore shoals in Federal waters, referred to as Unnamed Shoals A and B, and Blackfish Bank Shoal were identified as potential borrow sites. The evaluation of the sediment grain size and bathymetry, conducted by the USACE, indicate that Shoals A and B would provide adequate sand volumes and appropriately sized sediment (grain size greater than 0.20 mm for nourishment of the beach throughout the SRIPP's 50-year design life. Blackfish Bank Shoal, initially identified as a potential sand source, has since been eliminated as a potential borrow site for the SRIPP due to: (1) concerns expressed during the scoping process over potential impacts to commercial and recreational fishing; and (2) potential adverse impacts to Assateague Island due to increased wave energy resulting from lowering of the shoal.

North Wallops Island

The north Wallops Island borrow site is a beach area where sand has accreted as a result of regional longshore sediment transport. Due to concerns regarding potential species habitat, the total potential area estimated for sand removal is approximately 60 hectares (150 acres).

Offshore Shoals

The southwest end of Unnamed Shoal A is located approximately 11 kilometers (7 miles) east of Assateague Island and approximately 18 kilometers (11 miles) northeast of the north tip of

Wallops Island. The total predicted volume of Unnamed Shoal A is approximately 31 million cubic meters (40 million cubic yards). This shoal covers an area of approximately 700 hectares (1,800 acres).

The southwest end of Unnamed Shoal B is located approximately 19 kilometers (12 miles) east of Assateague Island and approximately 26 kilometers (16 miles) northeast of the north tip of Wallops Island. The total predicted volume of Unnamed Shoal B is approximately 57 million cubic meters (70 million cubic yards). This shoal covers an area of approximately 1,600 hectares (3,900 acres).

2.3 INITIAL BEACH NOURISHMENT

Under the Proposed Action, 2.4 million cubic meters (3.2 million cubic yards) of sand would be placed seaward of the seawall along 6.0 kilometers (3.7 miles) of shoreline during the initial nourishment. The beach fill would extend 21 meters (70 feet) from the present shoreline in a 1.8-meter-high (6-foot-high) berm, and then would slope underwater for an additional 52 meters (170 feet) seaward; the total distance of the fill profile from the current shoreline would be 73 meters (240 feet). During storm events, the new beach would provide a surface to dissipate wave energy and provide additional sediment in the nearshore system.

Sand for both the initial beach nourishment and all renourishment cycles would be dredged from within an approximately 520-hectare (1,280-acre) area of offshore Unnamed Shoal A.

2.4 RENOURISHMENT EVENTS

Under the Proposed Action, subsequent beach re-nourishment cycles would vary throughout the expected 50-year life of the SRIPP as determined by the proposed monitoring program. The exact locations and magnitude of renourishment cycles may fluctuate due to the frequency and severity of storm activity and subsequent shoreline erosion. Each renourishment cycle would require approximately 616,000 cubic meters (806,000 cubic yards) of sand be placed on the beach approximately every 5 years. The length of a beach fill is a key parameter in determining how long the fill will last. A “full” beach fill loses much less of a percentage of its volume in a given time interval than a shorter, or “reduced” fill (USACE, 2006). At Wallops Island, a rectangle-shaped fill’s half-life (the time it would take for the fill to lose 50 percent of its volume) is estimated to be 8.7 years for the full 6.0 kilometers (3.7 miles) of fill. The topography and bathymetry of the beach would be monitored on a regular basis to determine sand movement patterns and to plan when renourishment is needed.

Renourishment fill volumes could be borrowed from Unnamed Shoal A, Unnamed Shoal B, or a combination of one of these two shoals and the north Wallops Island borrow site. It is anticipated that approximately half of the fill volume for each renourishment cycle could be provided by the north Wallops Island borrow site.

2.5 SAND REMOVAL METHODS

2.5.1 North Wallops Island

Excavation depth for sand removal in the north Wallops Island proposed borrow site area would be limited to approximately 1 meter (3.5 feet) below the ground surface due to tidal fluctuations and the high permeability of the soil (USACE, 2009b). Based on target depth of sediment removal, the area to be excavated would vary. For example, excavating to a depth of 1 meter (3.5 feet) would require a 28.3-hectare (70-acre) area to provide a renourishment volume of 308,000 cubic meters (403,000 cubic yards).

Sand from north Wallops Island would be removed from land using a pan excavator. Because this excavator runs on several rubber tires with a low tire pressure, it can work in areas of the beach where typical equipment may be bogged down in unstable sand. The pan excavators would stockpile the sand, which would be loaded onto dump trucks that would transport the fill material up and down the beach. Bulldozers would then be used to spread the fill material once it is placed on the beach. All heavy equipment would access the beach from existing roads and established access points. No new temporary or permanent roads would be constructed to access the beach or to transport the fill material to renourishment areas.

2.5.2 Offshore Dredging Operations

Offshore dredging would be accomplished using a trailer suction hopper dredge (equipped with a turtle deflector), which is a ship capable of dredging material, storing it onboard, transporting it to the placement area, and pumping it on-shore. The hopper dredge fills its hoppers by employing large pumps to create suction in pipes that are lowered into the water to remove sediment from the shoal bottom (the process very closely resembles that of a typical vacuum cleaner). The hopper dredges likely to be used typically remove material from the bottom of the sea floor in layers up to 0.3 meter (1 foot) in depth (Williams, personal comm.).

Once the dredge hopper is filled, the dredge would transport the material to a pump-out buoy or station which would be anchored just offshore of the placement area. The distance from Unnamed Shoal A to a theoretical average location for a pump-out buoy placed at a water depth of 9 meters (30 feet), which is reached approximately 1,830 meters (6,000 feet) offshore, is 26 kilometers (16 miles). The corresponding transit distance from Unnamed Shoal B and the theoretical pump-out buoy is 34 kilometers (21 miles).

The dredge would then mix the sand with water to form a slurry, and pump the slurry from its discharge manifold through a submerged or floating pipeline. Discharge at the beach would occur at a fixed point in tandem with contouring of the deposited sand by bulldozers. Based on previous offshore dredging operations along the east coast, it is assumed that dredgers with a hopper capacity of approximately 3,000 cubic meters (4,000 cubic yards) would be used; however, because this volume is a slurry and not all sand, it is assumed that the actual volume of sand that each dredge would transport during each trip would be approximately 2,300 cubic meters (3,000 cubic yards).

Because of overflow from the hopper dredge at the offshore borrow site(s) during dredging, and losses during pump-out and placement, a larger volume of material would need to be dredged to meet the targeted fill volume. Based on information from other shoreline restoration projects, sediment losses during dredging and placement operations may be up to 25 percent. Dredge volumes for the offshore borrow sites are shown below in Table 2.

Table 2: Maximum Sand Removal Volumes

Nourishment Event	Possible Sources of Fill[1]	Volume of Sand Removed cubic meters (cubic yards)
Initial Nourishment	Shoal A	3,057,500 (3,998,750)
Single Renourishment Event	Shoal A or Shoal B	770,000 (1,007,500)
	North Wallops Island	308,000 (403,000)
Project Lifetime	Shoal A	9,990,000 (13,066,250)
	Shoal B	6,933,000 (9,067,500)
	North Wallops Island	2,773,000 (3,627,000)

[1]The north Wallops Island Borrow Site could provide up to about half of the renourishment fill per cycle.

Source: USACE, 2009

2.6 SAND PLACEMENT

Once the dredge hopper is filled, the dredge would transport the material to a pump-out buoy or station that would be anchored just offshore of the placement area. The distance from Unnamed Shoal A to a theoretical average location for a pump-out buoy placed at a water depth of 9 meters (30 feet), which is reached approximately 1,830 meters (6,000 feet) offshore, is 26 kilometers (16 miles). The corresponding transit distance from Unnamed Shoal B and the theoretical pump-out buoy is 34 kilometers (21 miles).

Once the dredge arrives at the pump-out buoy, it would connect to the discharge pipeline on the buoy. The dredge would then mix the dredged sand with water to form a slurry, and pump the slurry from its discharge manifold through a submerged or floating pipeline. Discharge at the beach would occur at a fixed point in tandem with contouring of the deposited sand by bulldozers.

All heavy equipment would access the beach from existing roads and established access points. No new temporary or permanent roads would be constructed to access the beach or to transport the fill material to renourishment areas.

SECTION THREE: AFFECTED SPECIES

3.1 SPECIES POTENTIALLY AFFECTED BY PROPOSED ACTION

The primary concern of this BA is whether impacts associated with the Proposed Action will "jeopardize" the continued existence of protected species that may exist in the Action Area. The Endangered Species Act (50 CFR 402.02) defines "jeopardize" as "engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of that species."

Table 3 below includes federally listed species identified as potentially affected by the Proposed Action by NMFS, USFWS, or other agencies during previous and ongoing discussions and consultations regarding the SRIPP. These include those species whose probability of occurring in the Action Area is likely and possible. No critical habitat for any species, as defined by the ESA, has been designated within the Action Area; therefore, no critical habitat would be affected by the Proposed Action (NMFS, 2007). The projected timeline for this project in its entirety is 50 years.

Table 3: Potentially Affected Protected Species

Common Name	Scientific Name	Federal Status	Expected Seasonal Presence
Seabeach amaranth	*Amaranthus pumilus*	Threatened	All year
Red knot	*Calidris canutus rufa*	Candidate[1]	May - June
Piping plover	*Charadrius melodus*	Threatened	All year
Humpback whale	*Megaptera novaeangliae*	Endangered	September - April
Fin whale	*Balaenoptera physalus*	Endangered	October - January
Right whale	*Eubalaena glacialis*	Endangered	November - May
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	April - November
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	April - November
Loggerhead sea turtle	*Caretta caretta*	Threatened	April - November
Atlantic green sea turtle	*Chelonia mydas*	Threatened	April - November

[1]Although candidate species are not protected under the ESA, NASA was requested by the USFWS to include the Red Knot.

3.2 SEABEACH AMARANTH

3.2.1 Description

Seabeach amaranth (*Amaranthus pumilus*) is an annual plant that grows on sandy beaches along the mid-Atlantic coast of the United States. It is an herbaceous reddish-colored, prostrate, highly branched stems that form clumps, often reaching 30 centimeters (12 inches) in diameter (NatureServe, 2009). Leaves are spinach-green and clustered toward the tips of the stems. Flowers and fruits are inconspicuous. Plants germinate from April to July, initially forming a small sprig, but soon branch and form a clump which binds sand that accumulates at its base. Larger plants may contain over 100 stems which branch from the center and attain a diameter of over a meter, although plants are typically 20 to 40 centimeters (8 to 16 inches) in diameter. Flowering begins in June with seed production in July and until senescence in early winter. Plants are monoecious (having male and female flowers on the same plant).

3.2.2 Distribution

Seabeach amaranth habitat includes barrier islands, mainly on coastal overwash flats at the accreting ends of the islands and lower foredunes and on ocean beaches above mean high tide (occasionally on sound-side beaches). It is intolerant of competition and does not occur on well-vegetated sites. According to Weakley and Bucher (1991), this species appears to need extensive, dynamic, natural areas of barrier island beaches and inlets. Within this dynamic landscape, seabeach amaranth functions as a fugitive species, occupying suitable habitat as it becomes available. Seeds may survive many years buried in the sand and then germinate when brought near the surface by severe storms

3.2.3 Potential Direct and Indirect Effects of the Proposed Action

There have been no recorded occurrences of seabeach amaranth on Wallops Island to date, and no designated protected populations exist in the SRIPP Action Area. However, there is potential habitat on the north end of Wallops Island within the Action Area. As a precautionary measure, NASA has determined that the Proposed Action may affect, but is not likely to adversely affect the seabeach amaranth.

3.2.4 Actions to Reduce Adverse Effects

Since seabeach amaranth does occasionally establish small temporary populations in areas of potential habitat, the potential habitat areas on the north end of the island would be surveyed immediately prior to beach placement activities and prior to excavation in connection with renourishment activities to ensure that the species is not present. In the event that the seabeach amaranth is encountered during project activities, NASA will work with the USFWS to ensure appropriate measures are taken to protect the species and its habitat.

3.3 RED KNOT

3.3.1 Description

The Red Knot is a medium sized, bulky sandpiper. It is a relatively short bird, with short legs. The head and breast are rusty in breeding plumage and grey the rest of the year. Outside of the breeding season, it is found primarily in intertidal, marine habitats, especially near coastal inlets, estuaries, and bays. The Red Knot breeds in drier tundra areas, such as sparsely vegetated hillsides. The Red Knot typically feeds on invertebrates, especially bivalves, small snails, and crustaceans. During the breeding season, the Red Knot also eats terrestrial invertebrates (Harrington, 2001). The species is currently a candidate for Federal listing under the ESA.

3.3.2 Life History and Distribution

The Delaware Bay stopover is the final and spring stopover during the northern migration, because the birds feed on the eggs of spawning horseshoe crabs in preparation for their nonstop flight from there to the Arctic. The birds rest and feed in the Delaware Bay between late April and early June with the population peaking May 15th through 30th (Baker et al., 2004). A study by Cohen et al (2009) reports that the Red Knot population in the Mid-Atlantic Region of the US has declined by 67-88 percent since the 1980's. The population decline has been linked to a decline in horseshoe crabs in the Delaware Bay area

During its northern migration, the Virginia barrier islands provide an important stopover area for a large number of red knots. In the mid-1990s, 3 years of aerial surveys showed that numbers of red knots moving through the barrier islands of Virginia between mid-May and the second week of June reach 8,000 to 10,000 individuals (Watts and Truitt, 2000). During the 2009 migration season, flock sizes of 100 to 145 birds were observed in the Overwash and Hook areas of Assateague Island. In late May 2009, flocks of 5 to 30 individuals were observed on south Assawoman Island. On May 8, 2009, USFWS observed a flock size of almost 1,300 individuals on north Wallops Island (USWS, 2009c). In late May 2009, flocks of approximately 20 to 200 red knots were observed on north Wallops Island (USFWS, 2009c).

3.3.3 Potential Direct and Indirect Effects of the Proposed Action

Temporary noise disturbances from the construction machinery used for seawall extension, movement of beach sand, excavation of the north Wallops Island borrow site, and the dredges could potentially cause adverse effects to these birds; however, these noise levels would be similar to existing noise from daily operations, including occasional flights and rocket launches on Wallops Island. Birds which are startled by construction and dredge noise are likely to temporarily vacate the immediate area, which could disrupt foraging activities. Due to the temporary nature of the noise disturbances, impacts on shore birds like the Red Knot are considered minimal (NASA, 1997). The continued presence of Red Knots at WFF suggests that noise levels from daily operations and construction over the past few decades have not significantly disturbed birds on the island.

Another potential adverse impact on the Red Knot is the disturbance of beach habitat during the placement of sand on Wallops Island shoreline, which may temporarily disturb feeding activities. During beach nourishment, the large amount of sand placed on the beach is anticipated to smother some Red Knot prey species such as crabs and worms, which inhabit the surface layer of sand. However, studies by Nelson (1985, 1993) and Hackney et al., (1996) report an infaunal recovery time ranging from 2 to 7 months following beach nourishment. Therefore, no long-term adverse affects to Red Knot foraging capabilities are anticipated; in fact, the expansion of the beach may lead to additional suitable habitat for many shorebirds, including the Red Knot.

3.3.4 Actions to Reduce Adverse Effects

During the times when the Red Knot may be present, a qualified biologist would conduct surveys and monitor the project area to ensure no birds are directly affected during construction activities.

3.4 PIPING PLOVER

3.4.1 Description

Piping Plovers are small, beige and white shorebirds with a black band across their breast and forehead. Plovers typically feed on invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks. Feeding areas include intertidal portions of ocean beaches, washover areas, mudflats, sandflats, wrack lines, and shorelines of coastal ponds, lagoons, or salt marshes (USFWS, 2000b). The Atlantic Coast Piping Plover population was listed as threatened on January 10, 1986.

3.4.2 Life History and Distribution

The Piping Plover breeds on coastal beaches from Newfoundland and southeastern Quebec to North Carolina and winter primarily on the Atlantic Coast from North Carolina to Florida, although some migrate to the Bahamas and West Indies.

After they establish nesting territories and conduct courtship rituals beginning in late March or early April, Piping Plover pairs form shallow depressions (nests) in the sand to lay eggs. Nests are situated above the high tide line on coastal beaches, sandflats at the ends of sand spits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, and washover areas cut into or between dunes. Nest sites are shallow scraped depressions in substrates ranging from fine grained sand to mixtures of sand and pebbles, shells or cobble. They may also nest on areas where suitable dredge material has been deposited. Nests are usually found in areas with little or no vegetation although, on occasion, Piping Plovers will nest under stands of American beachgrass (*Ammophila breviligulata*) or other vegetation (USFWS, 2000b) and typically lay four eggs that hatch in about 25 days (USFWS, 2007).

WFF has been monitoring the Piping Plover on Wallops Island since 1986. Piping Plover nesting habitat has been delineated on Wallops Island dune and overwash areas at the northern and southern reaches of the property. As southern Wallops Island has experienced substantial erosion (3.3 meters [11 feet]/year), suitable habitat is shrinking. According to Mitchell (2009, pers. comm.), no nesting plovers have been observed on south Wallops Island since at least 2000. Simultaneously, north Wallops Island has been accreting, thus presenting additional potential habitat for plover nesting.

Annually between 1996 and 2008, Piping Plovers were observed feeding, although exact numbers were not recorded. Five nesting attempts were made on north Wallops Island during 2007 and 2008, but none were successful in producing fledglings. During 2006, one pair of plovers nested but the nest was abandoned due to attempted predation by a fox. Nests were also observed in 2005 (2 pairs, 1 nest lost to fox predation and second pair of chicks were lost); 2004 (1 pair with 3 chicks fledged); 2001 (1 pair unsuccessful); 1998 (1 pair unsuccessful); 1996 (3 pairs with 2 chicks total fledged). There were no nests observed in 2003, 2002, 2000, 1999, and 1997 (Table 4).

In 2009, four Piping Plover pairs attempted nests on north Wallops Island. Of these, three have been successful, producing a total of at least seven fledglings (Scharle, 2009).

Table 4: Record of Piping Plover Pairs and Number of Young Fledged at WFF

Year	# Pairs	# Young Fledged	Comments
1986	2	0	All at south end of Island
1987	2	3	1.5 young fledged/pair; All at south end
1988	0	0	No nesting
1989	5	Unknown	All at south end
1990	5	Unknown	All at south end
1991	3	Unknown	All at south end
1992	4	5	1.25 young fledged/pair; All at south end
1993	3	4	1.33 young fledged/pair; All at south end
1994	3	2	0.67 young fledged/pair; All at south end
1995	2	4	2.00 young fledged/pair; All at south end of Island
1996	3	2	0.67 young fledge/pair; 1 pair, 0 fledged at south end
1997	0	0	No nesting
1998	1	0	
1999	0	0	No nesting
2000	0	0	No nesting
2001	1	0	
2002	0	0	No nesting
2003	1	0	A pair of plovers scraped, but made no other attempts at nesting
2004	1	3	3.00 young fledged/pair
2005	2	0	One nest was predated (fox), the other nest hatched but the chicks were later lost
2006	1	0	Nest was set up with enclosure; a fox tried digging under enclosure to get nest but did not succeed. The nest however was abandoned due to this event.
2007	3	0	All nests were enclosed. One nest was predated by a fox, one nest lost to tide
2008	2	0	2 pairs of plovers scraped at north end, but made no other attempts at nesting
2009	4	7	3 pairs successfully produced fledglings, all on the north end.

NASA, 2008

3.4.3 Potential Direct and Indirect Effects of the Proposed Action

The Piping Plover occasionally breeds, nests, and forages along the shoreline of Wallops Island. Temporary noise disturbances from the construction machinery used for seawall extension, movement of beach sand, excavation of the north Wallops Island borrow site, and the dredges could potentially cause adverse effects to these birds; however, these noise levels would be similar to existing noise from daily operations, including occasional flights and rocket launches on Wallops Island. Birds which are startled by construction and dredge noise are likely to temporarily vacate the immediate area, which could disrupt foraging and nesting activities. Due to the short duration of the noise disturbances, impacts on the Piping Plover are considered minimal (NASA, 1997). The continued presence of Piping Plovers at WFF suggests that occasional loud noises over the past few decades have not significantly disturbed plovers on the island.

Another potential adverse impact to the Piping Plover is the disturbance of beach habitat during the placement of sand on Wallops Island shoreline, which may temporarily disturb breeding, nesting, and feeding activities. As described earlier, there is no beach along a large (approximately 4,250 m [14,000 ft]) portion of the existing shoreline. Therefore, the initial sand placement will only disturb the existing beach habitat at the northern and southern extremes of the project area. Sand placed on the beach is anticipated to smother some Piping Plover prey species such as crabs and worms, which inhabit the surface layer of sand. However, studies by Nelson (1985, 1993) and Hackney et al., (1996) report an infaunal recovery time ranging from 2 to 7 months following beach nourishment. Therefore, no long-term adverse affects to foraging capabilities are anticipated, in fact, the expansion of the beach may lead to additional suitable habitat for many shorebirds, including the Piping Plover.

3.4.4 Actions to Reduce Adverse Effects

To ensure that no Piping Plovers are adversely affected, a qualified biologist would conduct regular surveys during sand placement activities. If Piping Plovers or nests are identified, mitigation measures such as avoidance of the nesting area would be implemented to avoid potential impacts.

If north Wallops Island is used for beach renourishment, NASA would work with USFWS to ensure adequate protection for any observed Piping Plovers in the area. In addition, the sand would be transported from the area only during the non-nesting season (September-March).

3.5 HUMPBACK WHALE

3.5.1 Description

The humpback whale is one of the rorquals, a family that also includes the fin whale and blue whale among others. Rorquals have two characteristics in common: dorsal fins on their backs and ventral pleats running from the tip of the lower jaw back to the belly area. The humpback whale was listed as endangered in 1973.

3.5.2 Life History and Distribution

The shape and color pattern on the humpback whale’s dorsal fin and flukes (tail) are as individual in each animal as are fingerprints in humans. This discovery changed the course of cetacean research and the new form of research known as “photo-identification,” in which individuals are identified, catalogued, and monitored, has led to valuable information about humpback whale population sizes, migration, sexual maturity, and behavior patterns (ACS, 2004a).

Humpback whales feed primarily on small schooling fishes including Atlantic herring, mackerel, pollock, and the American sand eel or sand lance (Gaskin, 1982; Katona et al., 1983; Watkins and Schevill, 1979; Wynne and Schwartz, 1999).

Humpback whales are found throughout the oceans of the world, migrating from tropical and subtropical breeding grounds in winter to temperate and arctic feeding and calving grounds in summer (Swingle et al., 1993). Several stocks occur in the northwestern Atlantic. Humpbacks use the Mid-Atlantic as a migratory path to and from calving and mating grounds. Adults and newborns of the Gulf of Maine feeding group migrate from summer feeding grounds off the coast of New England to winter breeding grounds along the Antillean Chain of the West Indies, primarily on the Silver Bank and Navidad Bank north of the Dominican Republic. Some individuals remain in the Gulf of Maine throughout the year.

Until recently, it was thought that humpback whales in the Mid-Atlantic were transients. Few were seen during aerial surveys conducted in the early 1980s (Shoop et al., 1982). However, since 1989, sightings of feeding juvenile humpbacks have increased along the coast of Virginia, peaking from January through March in 1991 and 1992 (Swingle et al., 1993). Studies conducted by the Virginia Marine Science Museum indicate that the whales are feeding on, among other things, bay anchovies and Atlantic menhaden. It is currently believed that non-reproductive animals may utilize the Mid-Atlantic area as a winter feeding range since they do not take part in reproductive activities in the Caribbean. Whales present in the Mid-Atlantic in winter were found to be members of both the Gulf of Mexico and Atlantic Canada feeding groups indicating a mixture of feeding populations in this region. In concert with the increased sightings, strandings of whales increased in the Mid-Atlantic during the same time period, with 32 strandings reported between New Jersey and Florida since January 1989. Sixty percent of those strandings that were closely investigated showed either signs of entanglement or vessel collision (Wiley et al., 1992). Humpback whales can be found in proximity to the Action Area from September to April.

3.5.3 Potential Direct and Indirect Effects of the Proposed Action

Major causes of anthropogenic mortality to humpback whales include collisions with ships and fishing net entanglements. During the dredging cycle, numerous round trips between the borrow area and the pump-out buoy at the placement site will be required. When viewed cumulatively over the 50-year project life, a potential exists for collisions between the dredge ship and humpback whales.

Another potential direct adverse effect to humpback whales is the noise associated with dredging operations. Noise from the dredge may have an effect on whale species that are sensitive to low frequency sound. The noise emitted by a dredge depends on the local environment, especially the sea-bed type. Variability in noise levels is also associated with the different parts of the dredging operations, such as the dredger dragging against the sea floor; the sound of the pump driving the suction through the pipe; noise from deposition of sand into the hopper; and the noise associated with the dredging ship itself. Meteorological conditions will also influence the noise emitted by the dredging operations (MALSF, 2009).

Marine mammals use hearing and sound transmission for all aspects of their life including reproduction, feeding, predator and hazard avoidance, communication and navigation. The introduction of sound into the marine environment from anthropogenic sources has the potential to cause long term or short term effects. Short term effects can include behavioral disruption or temporary habitat displacement; and long-term effects can include extended habitat displacement, physical injury to the auditory system, or in some cases mortality (Richardson et al. 1995). The behavioral responses of marine mammals to noise are highly variable and may depend upon individual hearing sensitivity (animals respond only to sounds they can directly detect), past exposure and habituation to noises, and demographic factors such as the age and sex of the animal. Other factors include the duration of the sound, whether the sound is moving, and environmental factors that affect the sound including habitat characteristics (National Research Council [NRC] 2003).

Under the MMPA, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as "…any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is defined as "…any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering."

Since 1997, NMFS has been using generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (NMFS 2005). NMFS is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (Southall et al. 2007). The current Level A (injury) threshold for impulse noise (e.g., impact pile driving) is 180 dB rms for cetaceans. The current Level B (disturbance) threshold for impulse noise is 160 dB rms for cetaceans.

Under the Proposed Action, underwater noise would be generated through the use of a hopper dredge. The primary noise from hopper dredging is created by the suction pipes used to remove the fill from the seabed. The noise generated by dredgers depends on their operational status, sea bed removal, transit and dumping. In general the noisiest activity is associated with the seabed removal. Dredge noise is strongest at low frequencies (below 1000 Hz). Greene (1987) reported received levels of 142 dB at 0.93 km for loading operations, 127 dB at 2.4 km while underway, and 117 dB at 13,3 km while pumping (at frequencies below 1000 Hz).

Based on these assumptions, underwater noise from the hopper dredge would not reach the Level A threshold and would, therefore, not result in any injury or mortality. Dredge noise may exceed the Level B threshold at a distance of approximately 15 m from the dredge during loading and at a distance of approximately 1 m from the dredge while underway or pumping. Noise from dredging would be audible to the species known to occur in the area and may result in some masking of vocal behavior of the humpback whale,

As summarized in Richardson et al. (1995), there are few studies documenting responses of humpback whales to dredging, other studies indicate responses of humpbacks to vessel depends heavily on their behavior (e.g., feeding humpbacks are less likely to react when actively feeding than when resting) Because dredging has occurred in this area previously and vessels are common, noise impacts are not expected to be significant

Dredging can indirectly affect the feeding ability of the humpback whale by temporarily decreasing feeding success and prey availability in areas of increased turbidity. Turbidity plumes caused by offshore dredging can lead to decreased visibility, which in turn can affect foraging ability by those species that use sight as a primary means to locate prey. These effects can also be expected outside the immediate vicinity of the dredging activity.

Operations using hopper dredges tend to be discontinuous and associated plumes would be dispersed over a larger area. Hopper dredges trigger a small plume at the seabed from the draghead and a larger surface plume from the discharge of overspill of water with suspended sediment from the hopper (MMS 1999). The length and shape of the surface plume generated by the overspill depends on the hydrodynamics of the water and the sediment grain size.

Although the volume of discharged material is much higher, findings about the plume dynamics of suspended sediments are much the same as plumes from trailing hopper dredges during construction aggregate mining (MMS 1999). Detailed investigation of these types of operations off the coast of the UK found that most sediments in the plume settle out within 300 to 500 meters (984 to 1,640 feet) from the dredge over a period of roughly 20 to 30 minutes and that suspended sediment concentrations returned to concentrations close to background level within an hour after completion of dredging (Hitchcock et al., 1998, cited in MMS, 1999). The distance and time increased with decreasing sediment size. In a study off the French coast, particles larger than 0.40 millimeter (0.02 inch) settled within 1.5 kilometers (0.9 mile) from the site. Considering that the average grain size of the potential borrow sites is estimated to range from 0.34 to 0.42 millimeter (0.01 to 0.02 inches), it can be assumed that surface plumes from the hopper dredge should last for no more than a few hours and be no larger than 5 kilometers (3.1 miles).

Because the concentration of the suspended particles in the plume diminishes rapidly with time and distance from the source, the effects on fauna further away from the activity are reduced.

In general, the effects of turbidity on phytoplankton due to light reduction or on pelagic fish and invertebrates, due to gill irritation and reduction of light levels for visual feeders, are considered small (MMS 1999). A suction hopper dredge is usually on-site for 3 to 4 hours during a 24-hour period, with the remaining time spent in travelling and unloading sand. This discontinuous method of offshore dredging allows suspended sediments to dilute, dissipate, and settle. The Action Area could be avoided by whales, which could easily feed in adjacent areas until the disturbance ceased.

No impacts on humpback whales from the construction of the seawall or the placement of sand on the beach are anticipated because the activities will occur in water depths too shallow for these whales to occur.

Therefore, the operations under the Proposed Action of the SRIPP are not anticipated to cause long-term adverse impacts on the habitat, calving areas, or the food resources of the humpback whale.

3.5.4 Actions to Reduce Adverse Effects

According to the September 25, 2007, NMFS BO on the SRIPP, the potential of marine mammal strikes would be mitigated by operating the dredge at speeds below 14 knots. Since the issuance of the 2007 NMFS BO, a Final Rule has been issued regarding vessel speeds along the east coast of the Atlantic seaboard; this rule restricts speeds to no more than 10 knots for all vessels 65 feet or greater (50 CFR 224.105, issued October 10, 2008). Compliance with this rule is expected, as the speed of the dredge is not anticipated to be greater than 3 knots while dredging and 10 knots while empty; therefore, the risk of vessel strike to marine mammals is insignificant. At this low speed, operators would be able to avoid humpback whales by maneuvering the dredge vessel to avoid a whale strike. In addition, there is currently no information to suggest that dredge vessels have ever collided with humpback whales while operating in Atlantic waters.

3.6 FIN WHALE

3.6.1 Description

The fin whale is considered one of the more abundant large whale species, with a worldwide population estimated at around 120,000. In 1970, NMFS declared one population of fin whales in the North Atlantic to be endangered (Waring et al. 1998). This grouping is found from Cape Hatteras northward. The fin whale was placed on the list of federally endangered species in 1973. Perhaps 40,000 are located in the Northern hemisphere; however, only a few thousand fin whales are believed to exist in the North Atlantic (NMFS, 2009a). Estimates of the western North Atlantic population range from 2,362, which is believed to be a low estimate (Waring et al., 2001), to 3,590 to 6,300 (Perry et al., 1999). Hain et al. (1992) put the figure at 5,000.

The fin whale is another member of the rorqual family which exhibits a dorsal fin and throat grooves that expand when the animal is feeding. The fin, or finback whale, is second only to the blue whale in size and weight. It is a swift, streamlined whale 18 to 24 meters (60 to 80 feet) long. Among the fastest of the great whales, it is capable of bursts of speed of up to 37 kilometers per hour (23 miles per hour), resulting in its description as the “greyhound of the sea.” Its most unusual characteristic is the asymmetrical coloring of the lower jaw, which is white or creamy yellow on the right side and mottled black on the left side. A single ridge extends from the blowhole to the tip of the rostrum (upper jaw). There is a series of 50 to 100 pleats or grooves on the underside of its body extending from under the lower jaw to the navel (ACS, 2004b).

3.6.2 Life History and Distribution

Fin whales are found in all oceans of the world, though they seem to prefer temperate and polar waters to tropical seas. They exhibit more complex migratory patterns than humpback or right whales. During the summer in the eastern North Atlantic, fin whales can be found along the North American coast to Greenland. In the winter, their range may extend from the ice edge of the Greenland continental glacier south to the Caribbean and the Gulf of Mexico.

Fin whales are baleen whales and feed mainly on krill and schooling fish. They have been observed circling schools of fish at high speed, rolling the fish into compact balls, and then turning on their right side to engulf the fish. Their color pattern, including their asymmetrical jaw color, may somehow aid in the capture of such prey. They can consume up to 1,800 kilograms (2 tons) of food a day. As a baleen whale, it has a series of 262 to 473 fringed overlapping plates hanging from each side of the upper jaw, where teeth would otherwise be located. These plates consist of a fingernail-like material called keratin that frays out into fine hairs on the ends inside the mouth near the tongue. The baleen on the left side of the mouth has alternating bands of creamy-yellow and blue-gray color. During feeding, large volumes of water and food can be taken into the mouth because the pleated grooves in the throat expand. As the mouth closes, water is expelled through the baleen plates, which trap the food on the inside near the tongue to be swallowed. Fin whales feed on herring, cod, mackerel, pollock, sardines, and capelin, as well as squid (ACS, 2004b).

In the North Atlantic, peak months for breeding are December and January. A single calf, averaging about 6 meters (19 feet) in length, is produced after a gestation period of a little more than 11 months. Fully mature females may reproduce every 2 to 3 years. In the Northern Hemisphere, females reach maturity at lengths of over 18 meters (59 feet); males reach maturity at lengths slightly less than 18 meters. Although fin whales are sometimes found singly or in pairs, they commonly form larger groups of 3 to 10 animals, which may in turn coalesce into larger aggregations, especially in the feeding grounds (Wynne and Schwartz, 1999). After Norway developed the explosive harpoon in 1864, the fin whale became a prime target for commercial whaling and, subsequently, the number of whales in the North Atlantic was quickly depleted.

Fin whales are often spotted in Mid-Atlantic waters. Fin whales are thought to use North Atlantic waters for feeding and southern waters for calving. Evidence supporting this view is scarce, however. Some fin whales were seen off the Delmarva Peninsula during aerial surveys conducted in the early 1980s (Shoop et al., 1982). Since 1989, sightings of feeding juvenile fin whales have increased along the coast of Virginia in the same area as sightings of humpback whales. Strandings of neonate fin whales along the Mid-Atlantic Coast may indicate an offshore calving area (Hain et al., 1992). Fin whales are difficult to study due to their speed. They are larger and faster than humpback or right whales and, therefore, less likely to be found in nearshore areas. However, it is worth noting that a pair of fin whales was spotted approximately 1.5 miles offshore of Wallops Island as recently as December 2006. Fin whales can be found in proximity to the Action Area from October to January.

3.6.3 Potential Direct and Indirect Effects of the Proposed Action

During the dredging cycle, numerous round trips between the borrow area and the pump buoy at the placement site will be required. Major causes of anthropogenic mortality to fin whales include collisions with ships and fishing net entanglements. It is thought that fin whales are struck by large vessels with greater frequency than any other large whale species (Laist et al., 2001). When viewed cumulatively over the 50-year project life, a potential exists for collisions between the dredge ship and fin whales; however, there is currently no information to suggest that dredge vessels have ever collided with fin whales while operating in Atlantic waters.

Another potential direct adverse effect to fin whales is the noise associated with dredging operations. As described in Section 3.5.3, noise from dredging operations may have a similar effect on the fin whale. It should be assumed that dredge noise would cause an avoidance response in the fin whale (MMS, 1999).

Dredging can indirectly affect the feeding ability of the fin whale in several ways. Decreased feeding success and prey availability may temporarily occur in areas of increased turbidity. Turbidity plumes caused by offshore dredging can lead to decreased visibility, which in turn can affect the feeding ability of the fin whale because it uses sight as a primary means to locate and round up schooling fish. This is especially true for this species in the North Atlantic, because they are baleen whales. Increased turbidity can also be expected outside the immediate vicinity of the dredging activity. Operations using hopper dredges tend to be discontinuous and associated plumes would be dispersed over a larger area. However, because the concentration of the suspended particles in the plume diminishes rapidly with time and distance from the source, the effects on fauna further away from the activity are reduced. In general, the effects of turbidity on phytoplankton due to light reduction or on pelagic fish and invertebrates, due to gill irritation and reduction of light levels for visual feeders, are considered small (MMS 1999). A suction hopper dredge is usually on-site for 3 to 4 hours during a 24-hour period, with the remaining time spent in travelling and unloading sand. This discontinuous method of offshore dredging allows suspended sediments to dilute, dissipate, and settle.

No impacts on fin whales from the construction of the seawall or the placement of sand on the beach are anticipated because the activities will be in shallow water, and it is very rare for these whales to occur at those depths.

Therefore, the operations under the Proposed Action of the SRIPP are not anticipated to cause long-term adverse effects on the habitat, calving areas, or the food resources of the fin whale.

3.6.4 Actions to Reduce Adverse Effects

The potential of marine mammal strikes would be mitigated by operating the dredge at speeds below 10 knots. Since the issuance of the 2007 NMFS BO, a Final Rule has been issued regarding vessel speeds along the east coast of the Atlantic seaboard; this rule restricts speeds to no more than 10 knots for all vessels 65 feet or greater (50 CFR 224.105, issued October 10, 2008). Compliance with this rule is expected, as the speed of the dredge is not anticipated to be greater than 3 knots while dredging and 10 knots while empty; therefore, the risk of vessel strike to marine mammals is insignificant. At this low speed, operators would be able to avoid fin whales by maneuvering the dredge vessel to avoid a whale strike.

3.7 RIGHT WHALE

3.7.1 Description

The right whale may have received its name from whalers who thought that it was the “right” whale to harvest because it was correct commercially (oil came from whales), or because it was considered “proper” or “true” which meant typical of whales in general. Right whales were relatively easy targets; they swim slowly and float when dead. The exploitation of the right whale began in the Bay of Biscay in Spain in the 12th century and continued, especially in the North Atlantic, for many centuries. Despite being protected since the 1930s, the right whale is today the most endangered of all the great whales (ACS, 2004c). Current estimates place the total number of remaining animals at less than 600 (NMFS, 1991), with the western North Atlantic population estimated at 300 (+/-10 percent) (Best et al., 2001). Right whales have been protected from commercial whaling in the U.S. since 1949. The right whale was listed as endangered in 1973.

A distinguishing feature of these large baleen (plankton-feeding) whales is that they lack a dorsal fin and ventral grooves. The body is black with various white markings comprising 28 to 33 percent of the body. The rostrum is narrow and highly arched, giving a distinct curvature to the top of the head. There are paired blowholes on the top of the head. The baleen plates are gray with fine bristles; 200-260 plates per side and 2.2 meters (7.2 feet) long (Wynne and Schwartz, 1999). Adult right whales are generally 10.7 to 16.8 meters (35 to 55 feet) long. The largest individuals have measured 18.3 meters (60 feet) long and weighed 106,500 kilograms (117 tons). Females are larger than males.

3.7.2 Life History and Distribution

Western North Atlantic subpopulations of right whales are often found near shore in shallow water and occur from the southeast U.S. to Canada (Waring et al., 2002). They may also be sighted in large bays. Populations concentrate in these areas: coastal Florida; coastal Georgia; the Great South Channel east of Cape Cod (May-June); Cape Cod Bay (February-April); the Bay of Fundy between New Brunswick and Nova Scotia (summer and fall); Stellwagen Bank and Jeffery's Ledge and Browns and Baccaro Banks, south of Nova Scotia (summer and fall). The population appears to migrate seasonally between low latitude winter calving grounds and high latitude summer foraging grounds (Perry et al., 1999). Right whales may be found over the continental shelf during the summer (Mate et al., 1997) as well as in deep water off the continental shelf. Right whales feed upon swarms of planktonic animals, primarily calanoid copepods.

The bulk of their feeding takes place in colder waters off the New England and Nova Scotia coasts, where the dissolved oxygen content is greater than in warm waters, and plankton is most abundant. Migration of the animals occurs in autumn, when they begin their trek south toward Georgia and Florida. In late March and through the spring, they rendezvous off the Nova Scotia coast and the Great South Channel once more, where they spend the summer replenishing their fat stores by feeding on plankton. They also breed during this time.

According to the ESA, as of 1994 three critical habitat areas are designated for the right whale. The areas include portions of Cape Cod Bay and Stellwagen Bank, the Great South Channel, and coastal waters off the eastern coasts of Georgia and Florida. Several studies have indicated a decline in right whale survival in the 1990s compared to the 1980s, especially for females (Caswell et al., 1999; Best et al., 2001; Waring et al., 2002). Clapham et al. (1999) examined modeling data and determined that whale survival rates, especially of females, have declined. These declining survival rates may be due to the fact that this subpopulation is being affected by decreased reproductive rates (Best et al., 2001; Krause et al., 2001) which may be related to a reduction in genetic diversity, pollutants, and nutritional stress.

In February 1983, an animal stranded in New Jersey was identified as a 2-year-old northern right whale that had first been photographed in the Bay of Fundy in 1981 (NMFS, 1991). It is now believed that a portion of the North Atlantic right whale population is migrating along the U.S. East Coast each year from Iceland to Florida. There is growing evidence that calves are born when the whales are at the southern end of their migration, in the Atlantic off northeastern Florida, Georgia, and possibly the Carolinas, from December through March. Very little feeding occurs during this time due to plankton scarcity in these relatively oxygen-poor waters.

A ship strike was likely the cause of death of a pregnant right whale that washed ashore on the Outer Banks of North Carolina in February 2004, after being sighted off the Virginia Beach oceanfront as a floating carcass. It was identified as a previously tagged female known as "Slumpy," an individual documented as having previously given birth to at least five calves (Hampton Roads Pilot Online, 2004a; Federal Register, 2004).

A ship strike was also the suspected cause of the death of another pregnant right whale in November 2004. First sighted by a recreational boater, the injured whale was seen at the mouth of the Chesapeake Bay in Virginia; its tail had been sliced partly off. A necropsy conducted at Ocean Sands, North Carolina, showed that a large vessel had struck the animal in several areas of the body (Hampton Roads Pilot Online, 2004b).

Ship collisions are likely the leading human-caused source of mortality for the right whale. Large, rapidly moving vessels can travel at speeds in excess of 22 knots when at sea. Of 31 animals examined between 1970 and 2002, ship strike was the primary cause of death in 15 cases. More than one-third of all right whale deaths in the Mid-Atlantic, between the years 1991 and 2002, were the result of ship strikes. However, collisions and net entanglements are not necessarily fatal. A study of data from 1935 to 1990 estimated that 61.6% of living right whales show entanglement injuries and 6.4% display collision injuries. The long-term consequences associated with these events are unknown (Hamilton et al., 1998). The right whale north-south migration movement off the Virginia coast takes place from November through April. Right whales can be in proximity to the Action Area between November and May. There is no designated critical habitat for right whales within the Action Area

3.7.3 Potential Direct and Indirect Effects of the Proposed Action

The primary source of potential for a direct effect on right whales would be collision with the dredge vessel. During the dredging cycle, the dredge vessel would make numerous trips between the borrow area and the pump buoy at the placement site. The vessels have the potential to collide with right whales.

Another potential direct adverse effect to right whales is the noise associated with dredging operations. Noise from the dredge may have an affect on whale species that are sensitive to low frequency sound. As with the humpback whale, it should be assumed that this noise would cause an avoidance response in the right whale (MMS, 1999).

Dredging can indirectly affect the feeding ability of the right whale in several ways. Decreased feeding success and prey availability may temporarily occur in areas of increased turbidity. As described previously, turbidity plumes caused by offshore dredging can lead to decreased visibility, which in turn can affect the feeding ability of the right whale, which primarily feeds on plankton and shrimp. Increased turbidity can also be expected outside the immediate vicinity of the dredging activity. Operations using hopper dredges tend to be discontinuous and associated plumes would be dispersed over a larger area. However, because the concentration of the suspended particles in the plume diminishes rapidly with time and distance from the source, the effects on fauna further away from the activity are reduced. In general, the effects of turbidity on phytoplankton due to light reduction are considered small (MMS 1999). A suction hopper dredge is usually on-site for 3 to 4 hours during a 24-hour period, with the remaining time spent in travelling and unloading sand. This discontinuous method of offshore dredging allows suspended sediments to dilute, dissipate, and settle.

No impacts on right whales from the construction of the seawall or the placement of sand on the beach are anticipated because the activities will occur in water depths too shallow for these whales to occur. Therefore, the operations under the Proposed Action of the SRIPP are not anticipated to cause long-term adverse effects on the habitat, calving areas, or the food resources of the right whale.

3.7.4 Actions to Reduce Adverse Effects

The potential of marine mammal strikes would be mitigated by operating the dredge at speeds below 10 knots. Since the issuance of the 2007 NMFS BO, a Final Rule has been issued regarding vessel speeds along the east coast of the Atlantic seaboard; this rule restricts speeds to no more than 10 knots for all vessels 65 feet or greater (50 CFR 224.105, issued October 10, 2008). Compliance with this rule is expected, as the speed of the dredge is not anticipated to be greater than 3 knots while dredging and 10 knots while empty; therefore, the risk of vessel strike to marine mammals is insignificant. At this low speed, operators would be able to avoid right whales by maneuvering the dredge vessel to avoid a whale strike.

3.8 GENERAL SEA TURTLE INFORMATION

Sea turtles, air-breathing reptiles with streamlined bodies and large flippers, are well adapted to life in the marine environment. They inhabit tropical and subtropical ocean waters throughout the world (NMFS, 2009b).

There are two families of sea turtles (Wynne and Schultz, 1999). The Cheloniidae family contains six genera and six distinct species. These species are loggerhead, green, flatback, hawksbill, Kemp's ridley, and olive ridley. The family Dermochelyidae is comprised of only one genus and species, commonly referred to as the leatherback sea turtle.

Sea turtles have short, thick, incompletely retractile necks and legs that have been evolved to become flippers (Bustard, 1972). All species, excepting the leatherback, have a hard, bony carapace (top shell) modified for marine existence by streamlining and weight reduction (Bustard, 1972). The leatherback lacks shell scutes, head and body scales. The shell is covered by leathery skin. The Carapace is divided longitudinally by 7 ridges (Wynne and Schwartz, 1999). These physiological differences are the reason for their separate designation as the only species in the family Dermochelyidae.

Much of a sea turtle's life is spent in the water and males of many species may never leave an aquatic environment (Wynne and Schwartz, 1999). The recognized life stages for these turtles are egg, hatchling, juvenile/subadult, and adult (Hirth, 1971). Reproductive cycles in adults of all species involve some degree of migration in which the animals endeavor to return to nest at the same beach year after year (Hopkins and Richardson, 1984). The nesting season ranges from April through September (Hopkins and Richardson, 1984; Nelson, 1988). It is believed that mating occurs just off the nesting beach, although solid evidence of this is lacking. After mating, the nesting female emerges from the water and digs a flask-shaped nest in the sand with her hind slippers, then lays 50 to 170 (depending on the species) ping-pong ball-shaped eggs. After covering the eggs with sand, she returns to the water. The female sea turtle will nest several times in one season. Incubation periods for sea turtles will vary by species from 45 to 65 days (Nelson, 1988, Wynne and Schwartz, 1999).

Hatchlings break their shells and dig their way out of the nest at night (Wynne and Schwartz, 1999). They orient themselves toward the sea by following the reflected light from the breaking surf (Hopkins and Richardson, 1984). After entering the surf, hatchlings engage in behavior referred to as "swim frenzy," during which they swim in a straight line for many hours (Carr, 1986). Once into the waters off the nesting beach, hatchlings enter a period referred to as the "lost years" where many species live and feed in floating sargassum (Wynne and Schwartz,

1999. They “reappear” as juveniles in feeding grounds shared with adults, or in some cases, migrate to developmental feeding grounds. Some species, such as the leatherback, spend their entire lives in a pelagic existence, coming inshore only to mate and nest (Wynne and Schwartz, 1999).

The functional ecology of sea turtles in the marine and/or estuarine ecosystem varies by species. The Kemp’s ridley sea turtle is omnivorous and feeds on swimming crabs and crustaceans. The green turtle is an herbivore and grazes on marine grasses and algae, while the leatherback is a specialized feeder preying primarily upon jellyfish. The loggerhead is primarily carnivorous and has jaws well-adapted to crushing mollusks and crustaceans, and grazing on organisms attached to reefs, pilings, and wrecks.

Sea turtles are believed to play a significant role in marine and estuarine ecosystems. This role has likely been greatly reduced in most locations as a result of declining turtle populations. Population declines are a result of numerous factors, such as disease and predation, habitat loss, commercial fisheries conflicts, and inadequate regulatory mechanisms for their protection. As a result, all sea turtle species have been classified as endangered or threatened.

Due to complex life histories and multiple habitats used by the various species, sea turtle populations have proven difficult to accurately census (Meylan, 1982). Because of these problems, estimates of population numbers have been derived from various indices, such as numbers of nesting females, numbers of hatchlings per kilometer of nesting beach, and number of subadult carcasses washed ashore (Hopkins and Richardson, 1984).

In a BO issued on September 25, 2007, for the SRIPP activities which included dredging of borrow sites in State waters, NMFS determined that dredging may adversely affect, but is not likely to jeopardize the continued existence of the loggerhead sea turtle; and is not likely to adversely affect the Kemp’s ridley, leatherback, or green sea turtles. The BO included an Incidental Take Statement for loggerhead sea turtles which could be entrained in dredges. Dredging operations that take place inshore (e.g., in a channel), where turtles are known to nest and breed, are more likely to result in significant impacts on sea turtles compared to dredging at offshore sites.

3.8.1 Leatherback Sea Turtle

3.8.1.1 Description

The leatherback is the largest, deepest diving, most migratory, and widest ranging of all sea turtles. The adult leatherback can reach 1.3 to 2.4 meters (4 to 8 feet) in length and 226 to 907 kilograms (500 to 2000 pounds) in weight. Its shell is composed of a mosaic of small bones covered by firm, rubbery skin with seven longitudinal ridges or keels. This blue-black shell may also have variable white spotting (Pritchard, 1983); the plastron is white. Leatherbacks normally weigh up to 300 kilograms (660 pounds), and attain a carapace length (straight line) of 140 centimeters (55 inches) (Pritchard, 1983; Hopkins and Richardson, 1984). A tooth-like cusp is located on each side of the gray upper jaw; the lower jaw is hooked anteriorly. The paddle-like clawless limbs are black with white margins and pale spotting. Hatchlings are predominantly black with white flipper margins and keels on the carapace. The leatherback sea turtle was listed as endangered in 1970.

Morphologically this species can be easily distinguished from the other sea turtles by the following characteristics: 1) a smooth unscaled carapace; 2) a carapace with seven longitudinal ridges; 3) head and flippers covered with unscaled skin; and, 4) no claws on the flippers (Nelson, 1988; Pritchard 1983; Wynne and Schwartz, 1999).

3.8.1.2 Life History and Distribution

Leatherbacks occur in the Atlantic, Indian, and Pacific Oceans. They range as far north as Labrador and Alaska to as far south as Chile and the Cape of Good Hope. They are found farther north than other sea turtle species, probably because of their ability to maintain a warmer body temperature over a longer period of time. They migrate between boreal, temperate, and tropical waters. The diet of the leatherback consists primarily of soft-bodied animals, such as jellyfish and tunicates, with juvenile fishes, amphipods, and other organisms (Hopkins and Richardson, 1984) but they also feeds on sea urchins, squid, crustaceans, blue-green algae, and floating seaweed (USFWS, 2006a).

Recent estimates of global nesting populations indicate 26,000 to 43,000 nesting females annually, which is a dramatic decline from the 115,000 estimated in 1980. This is due to exponential declines in leatherback nesting that have occurred over the last two decades along the Pacific coasts of Mexico and Costa Rica. The Mexico leatherback nesting population, once considered to be the world’s largest leatherback nesting population (65 percent of worldwide population), is now less than one percent of its estimated size in 1980. The largest nesting populations now occur in the western Atlantic in French Guiana (4,500 to 7,500 females nesting/year) and Colombia (estimated several thousand nests annually), and in the western Pacific in West Papua and Indonesia (about 600 to 650 females nesting/year). In the United States, small nesting populations occur on the Florida east coast (35 females/year), New Jersey’s Sandy Point, the U.S. Virgin Islands (50 to 100 females/year), and Puerto Rico (30 to 90 females/year) (USFWS 2006a).

The leatherback may inhabit nearshore environments if there is an abundant jellyfish population. Leatherbacks are susceptible to line entanglements in fishing gear including long-line operations, gillnets, and trawling gear. This may be due to their large size and attraction to potential prey species found on buoy lines or lured by light sticks. Entanglements may result in a decreased ability to feed, dive, or breathe (Balazs, 1985). The U.S. shrimp trawling industry is required to utilize Turtle Exclusion Devices (TEDs) featuring a large enough opening to provide leatherback turtles with an escape route. The species also appears to be very susceptible to marine debris ingestion of plastic and other marine debris which may resemble jellyfish (Balazs, 1985).

Leatherback turtle mating and nesting occurs from April to November on east coast of Florida and the Caribbean and sometimes, though rarely, in Texas, Georgia, South Carolina and North Carolina. Mature females may lay eggs more than 6 times per year, laying 50-170eggs per clutch. Incubation lasts 53-74 days. Little is known about hatchlings and juvenile movements (Wynne and Schwartz, 1999).

3.8.1.3 Leatherback Turtles in the Action Area

The leatherback turtle may pass through the mid-Atlantic during migration. Concentrations may be found between the Gulf of Maine and Long Island (Shoop and Kenney, 1992), in coastal areas of New Jersey and Delaware, and around the mouth of the Delaware Bay (USACE, 1995).

3.8.1.4 Potential Direct and Indirect Effects of the Proposed Action

The proposed dredging is not anticipated to directly affect any leatherback turtles that might enter the Action Area. Being a pelagic species, leatherback turtles prefer habitat located further offshore than the proposed Action Area. Members of the species that move across the Action Area when migrating may risk being struck by a dredge. Leatherback turtles are generally too large to be entrained in the dredge drag head. Dredging and initial placement of the material in the beach restoration area is unlikely to impact nesting areas.

Because leatherbacks occasionally feed on jellyfish in nearshore areas of the Mid-Atlantic, the placement of sand on Wallops Island shoreline could temporarily impair their ability to locate prey in this area due to the temporary increase in turbidity. However, because the leatherback is primarily a pelagic feeder and relatively uncommon in the Wallops Island nearshore area, this is unlikely to lead to adverse impacts on the leatherback. No long-term adverse affects to foraging capabilities in the nearshore area are anticipated.

Leatherback nests are not commonly found as far north as Virginia. In addition, because there is no beach habitat present seaward of the seawall, the proper beach nesting environment for sea turtles is not present. Therefore, it is unlikely that the Proposed Action will adversely impact leatherback nesting activities.

3.8.2 Kemp's Ridley Sea Turtle

3.8.2.1 Description

The Kemp's ridley is the smallest and most seriously endangered of the sea turtles. The species was listed as endangered in 1970. Nearly the entire world population of adult female Kemp's ridley turtles nests annually on stretches of beach in Rancho Nuevo, Tamaulipas, Mexico (Wynne and Schwartz, 1999). A number of films made in 1947 of the nesting aggregations at Rancho Nuevo show that in the late 1940s the female population may have been greater than 40,000 (Hildebrand, 1963). Recent estimates of the total nesting population at this location number no more than 500 (Pritchard, 1990). A very small number of Kemp's ridleys nest consistently at Padre Island National Seashore, Texas (USFWS, 2006b).

This species matures when carapace length reaches about 70 centimeters (27 inches). Weights of adults maximize at 50 kilograms (110 pounds) (Wynne and Schwartz, 1999). Those found in the Chesapeake Bay are juveniles with a carapace length of 20 to 58 centimeters (7 to 23 inches) and weighing less than 20 kilograms (44 pounds) (Lutcavage and Musick, 1985). The plastron and the ventral surfaces of the flippers are white, and the dorsal side of the carapace and the flippers are charcoal gray to an olive green. Older individuals have more white on their dorsal surfaces. The carapace is rounded; this differentiates the species from other sea turtles. Four prefrontal scutes are located on the top of the head, and the species is distinguished by five pleural scutes. In addition, the cervical scute touches the first pleural scute on each side. Kemp's ridleys have four inframarginals each with a posterior pore (Musick, 1988).

3.8.2.2 Life History and Distribution

The migratory patterns of Kemp's ridley hatchlings are not well-defined, although Meylan (1986) suggests that they may live within sargassum beds in the Gulf of Mexico and the North

Atlantic Ocean and move closer to shore as they age. The juveniles are thought to allow the Gulf Stream to transport them up the Atlantic coast. The range of the Kemp's ridley includes the Gulf coasts of Mexico and the U.S., and the Atlantic coast of North America as far north as Nova Scotia and Newfoundland (USFWS, 2006b). After leaving the nesting beach, hatchlings are believed to become trapped in eddies within the Gulf of Mexico, where they are dispersed within the Gulf and Atlantic by oceanic surface currents until they reach about 20 centimeters (7 inches) in length, at which size they enter coastal shallow water habitats**.** Morreale et al. (1992) disagrees, maintaining that this would result in very few individuals and that there must be another mode of transport.

Outside of nesting areas, the major habitat for the Kemp's ridley is the nearshore and inshore waters of the northern Gulf of Mexico, especially Louisiana waters. Kemp's ridleys are often found in salt marsh habitats. The preferred sections of nesting beach are backed up by extensive swamps or large bodies of open water having seasonal narrow ocean connections (USFWS, 2006b).

The Kemp's ridley is thought to actively move northward along the Atlantic Coast to reach the Chesapeake Bay, where they feed in shallow coastal waters. After loggerheads, this species is the second most abundant in Maryland and Virginia waters, with many juveniles entering the Chesapeake Bay. The turtles arrive during May and June (Keinerth et al., 1987; Musick and Limpus, 1997) to feed in the submerged aquatic beds. Their favored prey includes fish, crabs, and mollusks (Pritchard and Marquez, 1973; Bellmund et al., 1987). When approaching maturity, the individuals return to the Gulf of Mexico.

Kemp's ridleys have also been documented to die at sea and wash ashore. The NMFS Sea Turtle Salvage and Stranding Network collects stranded sea turtles along both the Atlantic and Gulf Coasts (NMFS, 1988). Based on 1987 data, 767 Kemp's ridleys were reported by the network. The largest portion was collected from the Gulf Coast (103 turtles) and mostly the western portion of the Gulf. Nearly equal numbers of Kemp's ridleys were reported from the northeast and southeast Atlantic Coasts (64 and 50 turtles, respectively).

Onboard observation of offshore shrimp trawling by NMFS in the southeast Atlantic indicated that over 2,800 Kemp's ridleys are captured in shrimp trawls annually. The estimated number of Kemp's ridley mortalities from this activity was estimated to be 767 turtles annually, and most of these (65 percent) occurred in the western portion of the Gulf of Mexico. TEDs are required on shrimp and other trawlers to reduce mortality. Based on these data it is evident that the population is in danger of extinction. However, under strict protection, the population appears to be in the early stages of recovery (NMFS and USFWS, 2007).

3.8.2.3 Kemp's Ridley Sea Turtles in the Action Area

The Wallops Island Action Area may contain both juvenile and adult Kemp's ridleys, usually during the months of May and June. Juveniles typically feed in inshore beds of submerged aquatic vegetation (SAV), which are not found in the Action Area. Adults are found further offshore and may feed on benthic organisms in the offshore shoal area.

3.8.2.4 Potential Direct and Indirect Effects of the Proposed Action

The hopper dredge's draghead has the potential to kill Kemp's ridleys by entrainment. The Kemp's ridley sea turtle may move across the Action Areas when migrating. The possibility exists that a dredge may strike individual Kemp's ridley turtles, although such incidents have not been documented in the Action Area.

Dredging and placement of the material in the beach restoration area is unlikely to create long-term impacts to food sources or nesting areas, though near shore feeding areas may be temporarily disturbed.

Indirect adverse impacts on Kemp's ridley sea turtles may occur at the offshore shoals due to the removal of benthic prey like crustaceans and mollusks during dredging activities, which may temporarily disturb feeding activities. However, studies by Nelson (1985, 1993) and Hackney et al., (1996) report an infaunal recovery time ranging from 2 to 7 months following beach nourishment. In addition, these turtles are highly motile and can easily forage in adjacent undisturbed areas. Therefore, no long-term adverse affects to foraging capabilities at the offshore shoals are anticipated.

Because the majority of Kemp's ridleys nest along a single stretch of beach in Mexico, it is unlikely that they will use Wallops Island to nest. No Kemp's ridley nests have been documented in the vicinity of the Action Area, so it is unlikely that the Proposed Action will adversely impact Kemp's ridley nesting activities.

3.8.3 Loggerhead Sea Turtle

3.8.3.1 Description

The loggerhead sea turtle is perhaps the most common of the sea turtles in U.S. waters and the only one that still regularly nests on the U.S. Atlantic Coast, on beaches from New Jersey to Texas. This reddish-brown turtle averages 0.9 meter (3 feet) in length and weighs about 136 kilograms (300 pounds). The loggerhead sea turtle's powerful jaws are well suited to eating hard-shelled prey. It feeds on crabs and other crustaceans, mollusks, jellyfish, and sometimes fish and eelgrass (New York DEC, 2006a).

The distinctly heart-shaped carapace of the adult loggerhead turtle averages 92 centimeters (36 inches) in length (Wynne and Schwartz, 1999). Exclusive of hatchlings, loggerheads in Virginia's waters are mostly juveniles with carapace lengths from 20 centimeters (7.8 inches) to more than 120 centimeters (47 inches) and weights from 20 to 40 kilograms (44 to 88 pounds) (Lutcavage, 1981; Lutcavage and Musick, 1985). The top of the carapace and appendages are reddish brown to mahogany, and the plastron (bottom shell) and appendages are cream to yellow (Musick, 1988; Wynne and Schwartz, 1999). It is common to find barnacles and other organisms encrusted on the carapace. Four scutes occur between the eyes (prefrontals), and there are five lateral carpacial scutes on each side. Loggerheads usually have three bridge scutes (Musick, 1988; Wynne and Schwartz, 1999).

The loggerhead sea turtle was listed as threatened in 1978. Loggerheads are the most common of the sea turtles frequenting the Action Area each summer; therefore, they are the species of sea turtle most likely to be adversely impacted by hopper dredge entrainment.

3.8.3.2 Life History and Distribution

Loggerhead sea turtles are found globally, preferring temperate and subtropical waters. In the western Atlantic, they range from the Canadian Maritime Provinces south to Argentina. Within its range, this species inhabits warm waters on continental shelves and areas among islands. Estuaries, coastal streams, and salt marshes are preferred habitats. In the NMFS/USFWS 2008 loggerhead recovery plan, five recovery units for the Northwest Atlantic population of loggerhead sea turtles were designated based on the nesting groups and inclusive of a few other nesting areas. The first four of these recovery units represent nesting assemblages located in the southeast U.S. The fifth recovery unit is composed of all other nesting assemblages of loggerheads within the Greater Caribbean, outside the U.S., but which occur within U.S. waters during some portion of their lives. The five recovery units representing nesting assemblages are: (1) the Northern Recovery Unit (NRU: Florida/Georgia border through southern Virginia); (2) the Peninsular Florida Recovery Unit (PFRU: Florida/Georgia border through Pinellas County, Florida); (3) the Dry Tortugas Recovery Unit (DTRU: islands located west of Key West, Florida); (4) the Northern Gulf of Mexico Recovery Unit (NGMRU: Franklin County, Florida through Texas); and, (5) the Greater Caribbean Recovery Unit (GCRU: Mexico through French Guiana, Bahamas, Lesser Antilles, and Greater Antilles)..

From the beginning of standardized index surveys in 1989 until 1998, the PFRU, the largest nesting assemblage in the Northwest Atlantic by an order of magnitude, had a significant increase in the number of nests. However, from 1998 through 2008, there was a 41% decrease in annual nest counts from index beaches, which represents an average of 70% of the statewide nesting activity (NMFS and USFWS 2008). From 1989 to 2008, the PFRU had an overall declining nesting trend of 26% (95% confidence interval) (NMFS and USFWS, 2008). The NRU, the second largest nesting assemblage of loggerheads in the U.S., has been declining at a rate of 1.3% annually since 1983 (NMFS and USFWS 2008). The NRU dataset included 11 beaches with an uninterrupted time series of coverage of at least 20 years; these beaches represent approximately 27% of NRU nesting (in 2008). Overall, there is strong statistical data to suggest the NRU has experienced a long-term decline.

Loggerhead nesting in the U.S. typically occurs from Florida to Virginia Beach, Virginia. Musick (1988) concluded that occasional nests on beaches as far north as Virginia Beach are beyond the periphery of the normal breeding range. As is common with most turtle species, reproducing females tend to return to the beaches where they were hatched to lay their own eggs. Yntema and Mrosovsky (1979) have shown that incubation temperature is the determining factor in the sex ratio of loggerhead hatchlings. Temperatures between 26º C and 28º C produced all males and temperatures of between 32º C and 34º C produced all females. It is reasonable to conclude that male hatchlings are more likely to be produced north of the North Carolina border, with far fewer females of the species returning to these areas to lay eggs and far more females returning to beaches in more southern areas.

Survival of hatchlings in waters as far north as Wallops Island may be limited due to cold temperatures. Once the animals hatch, usually between August and October, they swim away from land for two or three days. Since the hatchlings have little control over their buoyancy, it is theorized that the nonstop swimming done at this time is an attempt to reach the sargassum rafts. Sea turtle hatchlings that leave Virginia and Maryland beaches must travel great distances to find sargassum rafts, approximately 199 to 399 kilometers (124 to 248 miles) offshore near the Gulf

Stream. During this journey, many are trapped by falling temperatures. Many hatchlings survive predation, only to be surrounded by cooler waters in the range of below 20º C by mid-October, 15º C by November, and as low as 10º C in winter. More fortunate hatchlings arriving from southern beaches probably rest and feed in the floating rafts, travel once or twice around the North Atlantic gyre, until they develop a carapace length of 20 to 40 centimeters (7 to 15 inches), and then move back into inshore benthic communities to feed.

3.8.3.3 Loggerhead Sea Turtles in the Action Area

In Maryland and Virginia waters, loggerheads are the most common sea turtle species. Loggerheads can be found in the Chesapeake Bay from April through November, and the Bay is an important summer feeding ground. Loggerheads can be found in the Bay south of Baltimore within all the major tributaries, along the Virginia and Maryland Atlantic coast, and in the lagoons and channels in the barrier island systems (Lutcavage, 1981; Lutcavage and Musick, 1985; Byles and Dodd, 1989). The lower Chesapeake Bay estuary and the Atlantic Coastline provide important developmental habitat for immature sea turtles because of submergent vegetation beds and a rich diversity of bottom-dwelling fauna that afford cover and forage. Occasionally, adult females use Virginia’s ocean facing beaches as nesting sites (VDGIF, no date). The horseshoe crab is an important benthic food species. This crab species favors water depths from 4 to 20 meters (13 to 67 feet).

One loggerhead sea turtle nest was discovered on north Wallops Island in summer 2008; however, a fall storm inundated the nest and destroyed all of the 170 eggs. No nesting activity was observed on Wallops Island in 2009.

In October or November of each year when the first severe nor’easter arrives in the Bay (Musick, 1986) or when the water temperature drops to around 18º C (Keinath et al., 1987), sea turtles of all species migrate out of the Chesapeake Bay. According to a study conducted by Musick in 1986, loggerheads migrate south along the coast to Cape Hatteras and elsewhere. Some of these turtles from the Bay spend their winters in the warm waters of the Gulf Stream on the Florida continental shelf.

3.8.3.4 Potential Direct and Indirect Effects of the Proposed Action

The Wallops Island Action Area may contain both juvenile and adult loggerheads, depending upon the season and water temperature. The greatest potential for adverse impacts to loggerheads comes from the hopper’s drag head because the centrifugal force of the pump that brings the sand into the dredge hopper can possibly entrain (drawing into the hopper dredge) a turtle. The force of the centrifugal pump, located behind the intake pipe of the drag head, draws sand and any other material in its path into the pipe. Many entrained animals are killed by the pump before being pulled into the hopper. Entrainment is believed to take place primarily when the drag head is operating on bottom sediments; it is likely that the individual animals affected were feeding or resting near the bottom at the time the drag head moved along the bottom. In rare instances, suction can be created when currents flow around the drag head while it is being placed or moved. The feeding behavior of loggerheads also places them at greater risk of entrainment, as they are benthic feeders. However, USACE field tests demonstrated that a rigid turtle deflector, properly installed and operated, blocked 95 percent of mock turtles from entrainment in the dredge (USACE 1997).

Indirect adverse impacts on loggerhead sea turtles may occur in the nearshore environment as well as at the offshore shoals when dredging removes some non-motile benthic prey like crustaceans and mollusks, which cannot easily flee to escape the drag head. Some of these organisms will be killed while others may survive the dredging process only to be transported from the shoal area to the placement site on Wallops Island shoreline during beach nourishment. The large amount of sand placed on the beach is anticipated to smother some loggerhead prey species like crustaceans and mollusks which inhabit the surface layer of sand. This has the potential to temporarily disrupt loggerhead feeding activities. However, studies by Nelson (1985, 1993) and Hackney et al., (1996) report an infaunal recovery time ranging from 2 to 7 months following beach nourishment. Therefore, no long-term adverse affects to foraging capabilities in the nearshore area are anticipated.

The expansion of the beach may lead to additional suitable nesting habitat for sea turtles, including the loggerhead; this future habitat could be affected by the Proposed Action during future renourishment operations.

3.8.4 Atlantic Green Sea Turtle

3.8.4.1 Description

Green turtles are the largest of all the hard-shelled sea turtles, but have a comparatively small head. While hatchlings are just 50 millimeters (2 inches) long, adults can grow to more than 0.91 meter (3 feet) long and weigh 136 to 159 kilograms (300 to 350 pounds). Adult green turtles are unique among sea turtles in that they are herbivorous, feeding primarily on seagrasses, sea lettuce, and algae. Other organisms living on sea grass blades and algae add to the diet (Mager, 1985). This diet is thought to give the turtles greenish colored fat, from which they take their name. A green turtle’s carapace is smooth and can be shades of black, gray, green, brown, and yellow. Their plastron is yellowish white (NMFS 2006).

Green sea turtles are considered threatened throughout the U.S., but the breeding colonies on the Pacific coast of Mexico and along the Florida coast are considered endangered. However, pursuant to NMFS regulations and 50 CFR 223.205, the prohibitions of Section 9 of the Endangered Species Act apply to all green turtles, whether endangered or threatened. As it is difficult to differentiate between breeding populations away from the nesting beaches, NMFS considers green sea turtles in all waters as endangered. Atlantic green sea turtles are rare in the Atlantic portion of their range and are rare in Virginia outside of the Chesapeake Bay.

The carapace is round, and the dorsum of the carapace and the appendages are dark green to brown, often with lines radiating from the posterior margin of each scute. The plastron and the venter are white. The interface between the dorsal and ventral coloration is sometimes yellow. The species is characterized by two prefrontal and four lateral pleural scutes. The cervical scute does not touch the pleural scutes (Wynne and Schwartz, 1999). The species was for many centuries prized as a gourmet food item, with the fat a component of the clear soup that bears the species’ common name.

3.8.4.2 Life History and Distribution

The green turtle is globally distributed and generally found in tropical and subtropical waters along continental coasts and islands between 30 degrees North and 30 degrees south. Nesting occurs in over 80 countries throughout the year (though not throughout the year at each specific location). Green turtles are thought to inhabit coastal areas of more than 140 countries. In U.S. Atlantic and Gulf of Mexico waters, green turtles are found in inshore and nearshore waters from Texas to Massachusetts, the U.S. Virgin Islands, and Puerto Rico. In the western Atlantic, several major assemblages have been identified and studied (Carr et al., 1978).

In the continental U.S., however, the only known green turtle nesting occurs on the Atlantic coast of Florida (Mager, 1985) from June to September (Hopkins and Richardson, 1984). Mature females may nest three to seven times per season at about 10- to 18-day intervals. Average clutch sizes vary between 100 and 200 eggs that hatch usually within 45 to 60 days (Hopkins and Richardson, 1984; Wynne and Schwartz, 1999). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea. At this point, they begin a life stage that is poorly understood but is likely spent pelagically in areas where currents concentrate debris and floating vegetation such as sargassum (Wynne and Schwartz, 1999). When the juveniles reach 20 to 25 centimeters (7.8 to 9.8 inches) carapace length, they leave the pelagic habitat and enter benthic feeding grounds. Juveniles, like adults, are primarily herbivorous, avoiding crustaceans and feeding almost exclusively on algae and seagrasses with an occasional hydrozoan (Bellmund et al., 1987).

The population of green sea turtles before commercial exploitation and the total population since listing are unknown. Records show drastic declines in the Florida catch during the 1800s, and similar declines occurred in other areas (Hopkins and Richardson, 1984).

The principal cause of the historical, worldwide decline of the green turtle is long-term harvest of eggs and adults on nesting beaches and juveniles and adults on feeding grounds. These harvests continue in some areas of the world and compromise species recovery efforts. Incidental capture in fishing gear, primarily in gillnets, but also in trawls, traps and pots, longlines, and dredges is a serious ongoing source of mortality that also adversely affects the species’ recovery. Green turtles are also threatened, in some areas of the world, by a disease known as fibropapillomatosis (NMFS, 2006).

The loss of many nesting beaches, and the smaller number of encounters between humans and green turtles over the past eight decades, provide inferential evidence that populations are generally declining (Hopkins and Richardson, 1984).

3.8.4.3 Atlantic Green Sea Turtles in the Action Area

Green sea turtles are occasionally encountered in the Action Area, but their occurrence is expected to be rare.

3.8.4.4 Potential Direct and Indirect Effects of the Proposed Action

The area being considered as a future sand source for the purpose of this BA is sufficiently offshore and deep enough to not provide a habitat for the SAV eaten by green sea turtles. Sea lettuce and algae do occur in these waters but are uncommon due to the water depths of the Action Area. A benthic study completed as part of the SRIPP studies confirmed that no SAV exists on either of the potential borrow sites. Therefore, there would be no direct effect on foraging habitat.

Green sea turtles move across the Action Area when migrating, though they rarely are seen. The possibility exists that a dredge may collide with a green sea turtle, but this is highly unlikely. The threat to individual green sea turtles of being entrained in the dredge drag head is not likely since turtle deflectors will be part of the normal operating equipment and since the green turtle is not often encountered in the area.

Dredging and placement of the material in the beach restoration area is unlikely to impact food sources or nesting areas.

3.8.5 Actions to Reduce Adverse Effects to Sea Turtles

NASA would conduct regular monitoring of the beach for potential nesting activity using a qualified biologist during sand placement activities if these activities take place during sea turtle nesting season. If a nest is detected, buffers would be established around the nest(s) where no sand placement activities would occur and NMFS/USFWS would be notified.

The greatest danger to sea turtles during dredging operations is entrainment in the hopper dredge. It is believed that entrainment primarily takes place when the drag head is operating on bottom sediments. Affected animals are usually feeding or resting near the bottom at the time the drag head moves along the bottom. In some rare instances, suction may be created when currents flow around the drag head as it is placed or moved.

The USACE has enacted contractual specifications for deflectors on all hopper dredges. They are as follows:

> "Hopper dredge drag heads shall be equipped with sea turtle deflectors that are rigidly attached. No dredging shall be performed without a turtle deflector device that has been approved by the Contracting Officer.
>
> The leading V-shaped portion of the deflector shall have an included angle of less than 90 degrees. Internal reinforcement shall be designed to have a plowing effect of at least 6 inches in depth when the drag head is being operated. Appropriate instrumentation or indicator shall be used and kept in proper calibration to ensure the critical 'approach angle,' which refers to the lower drag pipe relative to the plane of the sediment. If the lower drag head pipe angle varies significantly from the design approach angle, the 6-inch plowing effect does not occur and the deflector does not function to repel the sea turtles. When the deflector is in operation during dredging, operators need to make every effort to maintain the design approach angle and to ensure that the dredge is disengaged before it is lifted from the floor of the ocean."

In a USACE field test experiment, the rigid deflector, properly installed and operated, blocked 95 percent of mock turtles from entrainment in the dredge. This rate is probably lower than what would actually occur, given that live turtles have the ability to flee from danger (USACE 1997). It should be noted, however, that while turtle deflectors have been demonstrated to exclude 95 percent of mock turtles from the dredge, entrainment does still occur with these devices in place. According to NMFS, 55 of the 63 entrainments occurred in dredges with deflectors in place. The rate of entrainment (i.e., sea turtles compared to cubic yards) is much greater for projects within Chesapeake Bay than projects in other areas within the mid-Atlantic (NMFS, 2009c).

Turtle deflectors would be installed on the drag heads during dredging to reduce the risk of entrainment. In addition and as directed by the 2007 BO, NASA would implement the following measures to minimize impacts of incidental take of sea turtles:

1. NASA would ensure that during times of the year when sea turtles are known to be present in the Action Area, hopper dredges are outfitted with state-of-the-art sea turtle deflectors on the drag head and operated in a manner that will reduce the risk of interactions with sea turtles which may be present in the Action Area.
2. A NMFS-approved observer would be present on board the vessel for any dredging occurring in the April 1 – November 30 timeframe.
3. NASA would ensure that dredges are equipped and operated in a manner that provides endangered/threatened species observers with a reasonable opportunity for detecting interactions with listed species and that provides for handling, collection, and resuscitation of turtles injured during project activity.
4. NASA would ensure that all measures are taken to protect any turtles that survive entrainment in the dredge.
5. NMFS would be contacted before dredging commences and again upon completion of the dredging activity.

All interactions with listed species would be properly documented and promptly reported to NMFS/USFWS, as appropriate.

SECTION FOUR: CUMULATIVE EFFECTS

Cumulative effects include the effects of state, tribal, local, or private actions, not involving Federal activities that are reasonably certain to occur in the Action Area. Sources of human-induced adverse effects in cetaceans or turtles in the Action Area include incidental takes in state-regulated fishing activities and vessel collisions. In addition, ingestion of plastics, petroleum products, marine vessel-generated debris, and entanglement and drowning in crab pot lines can occur. The combination of these activities may affect populations of ESA-listed species, preventing or slowing a species recovery. Such incidents can be considered “takes,” but these takes are usually not reported or regulated. Turtles and whales can also be injured by boat propellers and during collisions with recreational vessels.

Dredging

The dredging of the offshore Wallops Island environment will neither diminish nor augment existing threats to fin whales, humpback whales, and right whales. The use of the dredge and associated tow vessels will temporarily increase boat traffic in the Action Area. Dredging operations will not significantly add pollutants or marine debris to the aquatic environment.

Dredging may impact marine mammals through noise generated during sand removal, changes to benthic habitats, and vessel collisions during transport of the material to a pump-out station offshore of the shoreline. Since dredging operations are generally relatively short duration, significant cumulative effects from associated noise are not anticipated. However, NASA would consult with NMFS on appropriate mitigation measures should multiple dredging operations overlap. It is assumed that noise would cause avoidance responses in species. Because the dredging operations will be limited to a small number shoals, it is not expected that multiple dredging operations would result in significant cumulative impacts to prey base of threatened and endangered marine mammals.

MMS (2004) reported on dredging and marine mammal collisions. Vessel collisions with endangered whales are one of the major factors limiting their recovery. There has never been a report of a whale strike or mortality by a hopper dredge in the U.S. (NMFS, 2004), although there is one report of a right whale calf mortality resulting from a strike by a dredging vessel in South Africa (MMS 2004). It is generally thought that hopper dredges move slow enough to minimize the risk of a strike with a marine mammal.

Cumulative effects to sea turtles may occur due to the multiple dredging operations planned in the offshore areas of Maryland and Virginia because turtles are more likely to be directly affected by dredging than other threatened and endangered species in the area. Although no specific data is available on the presence of sea turtles at the borrow sites, the characteristics of the areas to be dredged make them unlikely to be special or unique habitat for sea turtles. Due to depths at typical borrow sites that may be greater than 11 meters (35 feet) below msl, there is no abundant population of spider crabs (or rock crabs), which comprise the bulk of the diet for loggerheads and Kemp’s ridleys in the region (Burke et al., 1992), and no SAV or seagrass beds exist, which are used by green sea turtles. The coarse-grained sandy substrate is a result of strong tidal currents. Thus, within the possible dredge areas, the lack of abundant food resources makes it unlikely that turtles would remain any longer than it takes for them to travel through the area.

Table 5 summarizes the number of sea turtle takes, by month, from projects conducted in the Norfolk District from 1980 to 2009. For the 30 years reported, a total of 63 sea turtle takes were recorded. Of the 63 total takes, 53 were loggerheads. For 2000 to 2009, there have been no recorded takes of sea turtles for projects within the Norfolk District (USACE Sea Turtle Data Warehouse 2009, http://el.erdc.usace.army.mil/seaturtles/). The number of sea turtle takes from the SRIPP will be determined through consultation with NMFS.

Table 5: Sea Turtle Takes by Months Calendar Years 1980 – 2009, USACE Norfolk District

Cumulative Sea Turtle Takes for Norfolk District by Month and Species							
Month	**Greens**	**Hawksbills**	**Kemp's Ridley**	**Leatherbacks**	**Loggerheads**	**Unidentified**	**Total**
Jan	0	0	0	0	0	0	**0**
Feb	0	0	0	0	0	0	**0**
Mar	0	0	0	0	0	0	**0**
Apr	0	0	0	0	2	0	**2**
May	0	0	0	0	8	1	**9**
Jun	1	0	0	0	10	0	**11**
Jul	0	0	0	0	2	1	**3**
Aug	0	0	1	0	7	1	**9**
Sep	0	0	1	0	10	1	**12**
Oct	0	0	3	0	12	0	**15**
Nov	0	0	0	0	2	0	**2**
Dec	0	0	0	0	0	0	**0**
Totals	**1**	**0**	**5**	**0**	**53**	**4**	**63**

Source: USACE, 2009

Sand Placement

As a result of the initial beach placement, habitat may be created for the seabeach amaranth, Piping Plover, Red Knot, and nesting sea turtles in the area seaward of the seawall which currently contains no suitable habitat for these species. It is reasonable to assume these species may nest and utilize this additional habitat at some point after construction. However, it is not possible to predict at this time the potential number or locations of Piping Plover nests or sea turtle nests that may occur on the newly created beach from the restoration project.

Reasonably foreseeable projects such as NASA’s Launch Range Expansion and additional rocket launches may result in potential impacts to Piping Plover nesting on this newly created habitat. It is not possible to predict the number of Piping Plover individuals or nests that may be impacted by these future activities.

Because it is not possible to predict which protected species would use the newly created beach in the future, NASA would re-initiate consultation with USFWS/NMFS as appropriate prior to renourishment activities.

SECTION FIVE: CONCLUSIONS

One plant, two birds, three whale species and four sea turtle species have been evaluated as part of this biological assessment for the Wallops Island Shoreline Restoration and Infrastructure Protection Program.

Since there is potentially suitable habitat for seabeach amaranth on north Wallops Island, NASA has determined that the proposed action may affect, but is not likely to adversely affect seabeach amaranth.

In the long term, the expansion of the beach would likely provide additional suitable habitat for shorebirds such as the Red Knot and the Piping Plover. Construction, excavation of the north Wallops Island area for renourishment fill, and beach fill placement activities would temporarily negatively impact shorebirds with construction noise levels and the movement of construction equipment on areas with existing beach habitat. For activities related to use of the north Wallops Island area for beach renourishment, NASA would work with USFWS on specifying and implementing mitigation measures to ensure adequate protection for Piping Plovers. Since the Red Knot only uses the Action Area as a stop over for migration, NASA has determined that project may affect but is not likely to adversely affect the Red Knot. Because the Action Area serves as a breeding and nesting area for the Piping Plover, NASA has determined that the project may affect and is likely to adversely affect this species.

The three listed whale species assessed in this BA (humpback, fin, and right whale) may traverse near or through the Action Area during migration although they tend to prefer deeper habitats than those of the Action Area. As such, there exists a small potential for incidental take should a collision with a dredge occur. However, dredge speeds are relatively low (no greater than 3 knots while dredging and 10 knots while empty). This should enable the operators to avoid whales by maneuvering to avoid a whale strike. Therefore, NASA concludes that the proposed action may affect, but is not likely to adversely affect the three listed whale species during the months they would possibly be in the Action Area.

Four listed sea turtle species (leatherback, Kemp's ridley, loggerhead, and Atlantic green) were assessed in this BA. Because these turtles are not known to successfully nest on Wallops Island beaches, the Proposed Action would not affect sea turtle nesting. Entrainment in drag heads is the primary risk regarding incidental take of sea turtles, although for the larger leatherback this is not a concern. Turtle deflectors, although not 100 percent effective, have been successfully used on dragheads to reduce the risk of sea turtles being captured and killed. The ranges and migratory movements of sea turtles are largely correlated with water temperature. Sea turtles are likely to be found in the Action Area between April and November of each year. Leatherback turtles are less affected by cold water temperatures and may stay in northern regions throughout the year. Therefore, NASA has determined that the Proposed Action may affect, and is likely to adversely affect the loggerhead and Kemp's ridley sea turtles, and may affect, but is not likely to adversely affect the leatherback or Atlantic green sea turtles.

Table 6 summarizes NASA's determination of effects to federally protected species under the ESA.

Table 6: Determination of Effects to Federally Protected Species

Species	Jurisdiction	NASA's Determination
Seabeach amaranth	USFWS	May affect, not likely to adversely affect
Red knot	USFWS	May affect, not likely to adversely affect
Piping Plover	USFWS	May affect, likely to adversely affect
Humpback whale	NMFS	May affect, not likely to adversely affect
Fin whale	NMFS	May affect, not likely to adversely affect
Right whale	NMFS	May affect, not likely to adversely affect
Leatherback sea turtle	NMFS/USFWS	May affect, not likely to adversely affect
Kemp's ridley sea turtle	NMFS/USFWS	May affect, likely to adversely affect
Loggerhead sea turtle	NMFS/USFWS	May affect, likely to adversely affect
Atlantic green sea turtle	NMFS/USFWS	May affect, not likely to adversely affect

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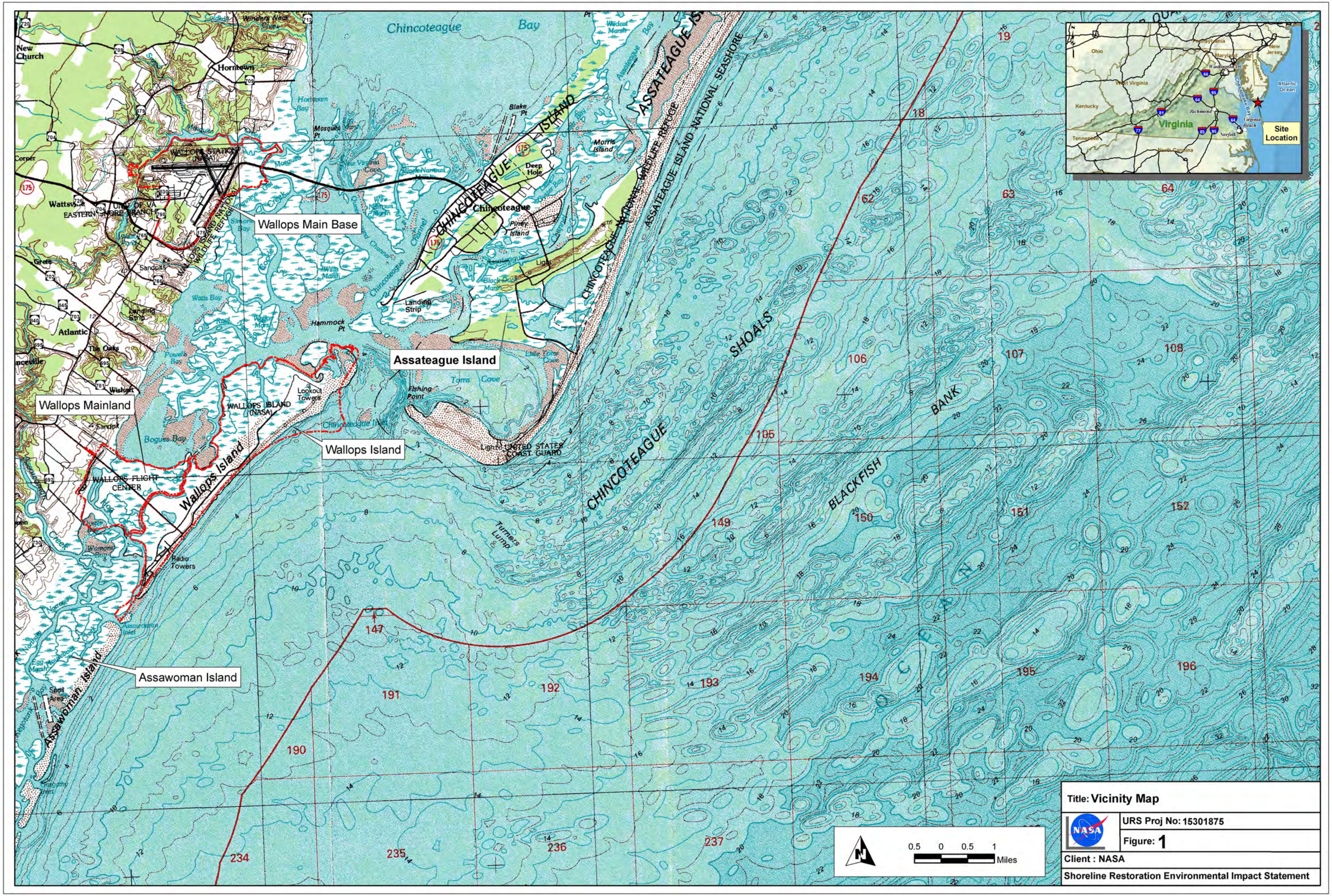
FIGURES



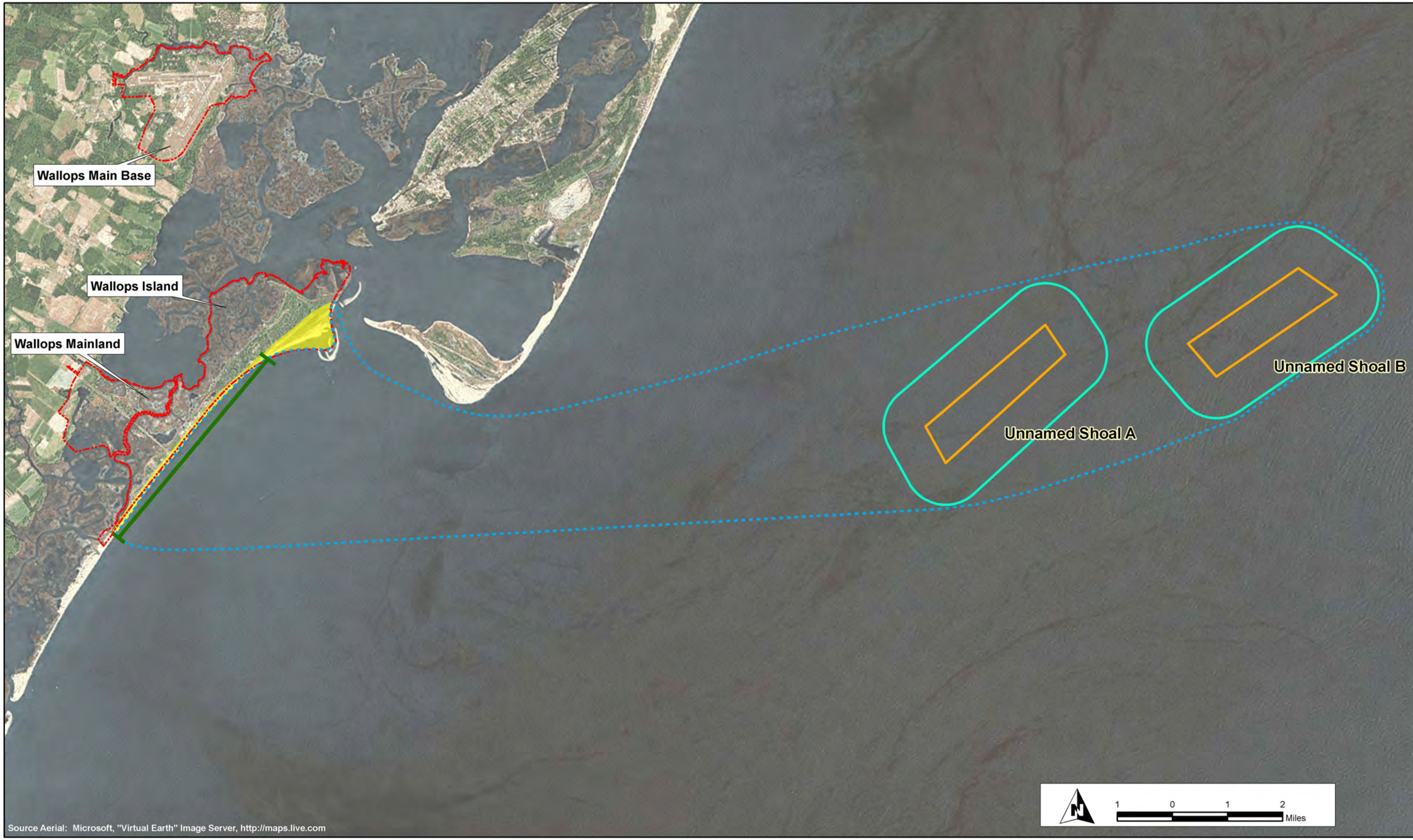
Title: Vicinity Map

URS Proj No: 15301875

Figure: 1

Client : NASA

Shoreline Restoration Environmental Impact Statement



Beach Fill Extent
Shoal Location
4000 Foot Buffer Around Shoal
Shoreline Action Area
WFF Boundary
Offshore Action Area

Title: Action Area
URS Proj No: 15301785
Figure: 2
Client : NASA
Shoreline Restoration Environmental Impact Statement

Title: Wallops Island Viewed from the South

URS Proj No:15301785

Figure: 3

Client : NASA

Shoreline Restoration Environmental Impact Statement

Title: Protected Species in the Vicinity of Wallops Island

URS Proj No: 15301785

Figure: 4

Client : NASA

Shoreline Restoration Environmental Impact Statement

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
6669 Short Lane
Gloucester, Virginia 23061

JUL 30 2010

Mr. Joshua A. Bundick
Code 250.W
Goddard Space Flight Center's Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, Virginia 23337

Re: Programmatic Biological Opinion on the Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program

Dear Mr. Bundick:

This document transmits the U.S. Fish and Wildlife Service's (Service) programmatic biological opinion based on our review of National Aeronautics and Space Administration's (NASA) proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP) at the Wallops Flight Facility (WFF) in Accomack County, Virginia, and its effects on the federally listed endangered green sea turtle (*Chelonia mydas*) and leatherback sea turtle (*Dermochelys coriacea*) and the threatened Atlantic population of the piping plover (*Charadrius melodius*), loggerhead sea turtle (*Caretta caretta*), and seabeach amaranth (*Amaranthus pumilus*) in accordance with section 7 of the Endangered Species Act (16 U.S.C. 1531-1544, 87 Stat. 884), as amended (ESA). On March 16, 2010 a proposed rule was published in the Federal Register to reclassify the loggerhead sea turtle through determination of the appropriate listing status for each of nine distinct populations of loggerhead sea turtle worldwide. Based on this proposed rule, the population affected by the proposed action is the north Atlantic population, and it is proposed for listing as endangered (72 FR 12598). Your February 12, 2010 request for formal consultation was received on February 18, 2010.

NASA has developed a draft Programmatic Environmental Impact Statement (PEIS) on the SRIPP. The purpose of the 50-year SRIPP is to reduce the potential for damage to or loss of infrastructure and assets critical to the missions of NASA, the U.S. Navy, and the Mid-Atlantic Regional Spaceport (MARS) on Wallops Island from wave impacts associated with storm events. Under this program, NASA plans to complete construction of a seawall along the entire shoreline at WFF and rebuild an eroded beach between the seawall and the Atlantic Ocean to aid in buffering the property from waves. Following completion of the seawall and beach, NASA plans subsequent beach renourishment cycles throughout the 50-year life of the SRIPP as needed to provide the necessary protection to infrastructure as determined by the proposed monitoring program. The location, magnitude, and extent of future renourishment and repair activities are unknown and will vary due to the frequency and severity of storm activity and resulting shoreline erosion.

The U.S. Army Corps of Engineers (Corps) and the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) have participated in the development of the PEIS as cooperating agencies, and both agencies are involved in the proposed action. NASA will require authorizations from both the Corps and the BOEMRE for the SRIPP. Under the Clean Water Act (33 U.S.C. 1251-1375, 86 Stat. 816)the Corps has jurisdiction over the disposal of dredged and fill material in waters of the U.S., and under Section 10 of the Rivers and Harbors Act of 1899, the Corps has jurisdiction over dredging conducted in navigable waters of the U.S. The Corps designed the SRIPP and will manage construction during project implementation, including hiring and overseeing contractors. BOEMRE has jurisdiction over mineral resources on the outer continental shelf (OCS), and has authority to convey, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration projects, or for use in construction projects funded or authorized by the Federal government. A memorandum of agreement will be negotiated between BOEMRE and NASA to allow dredging of sand from the OCS for the SRIPP. NASA is the lead federal agency for this consultation and the activities of the other two agencies that are included in the implementation of this program are incorporated into this consultation.

This biological opinion considers the effects of the entire program on listed species based on the extent and bounds of the proposed action discussed in the SRIPP draft PEIS to ensure that the implementation of the program will not jeopardize listed species. The proposed program only projects future beach renourishment activities based on average expected shoreline erosion rates, taking into account the effects of sea level rise, to the degree that it is appropriate to project. Because this projection is general and limited to current abilities to predict inherently unpredictable events, it is unlikely that the proposed action and scenario described in the draft PEIS will ever accurately reflect the actual implementation of this program beyond the initial fill. As a result, the assumptions used in conjunction with the description of the proposed program to conduct the jeopardy analysis are described herein, but this opinion does not provide for incidental take beyond the implementation of the initial beach and seawall construction and associated sand management and monitoring measures. Future renourishment events proposed under this program will require consultation under section 7 of the ESA.

This programmatic biological opinion is based on information provided in the February 2010 SRIPP draft PEIS (NASA 2010a), the February 2010 SRIPP biological assessment (BA) (NASA 2010b), the April 2009 draft environmental assessment (EA) for the expansion of WFF (NASA 2009), the January 2005 final site-wide EA (NASA 2005), telephone conversations, meetings, field investigations, and other sources of information. A complete administrative record of this consultation is on file in this office.

NASA determined in its BA that the proposed action "may affect, and is likely to adversely affect" the piping plover, Kemp's ridley sea turtle (*Lepidochelys kempi*), and loggerhead sea turtle. Effects of the proposed action on those species will be discussed in this biological opinion. NASA determined in its BA that the proposed actions "may affect, but are not likely to adversely affect" red knot (*Calidris canutus rufa*), seabeach amaranth, leatherback sea turtle, Atlantic Green sea turtle, fin whale (*Balaeanoptera physalus*), right whale (*Eubalaena glacialis*), and humpback whale (*Megaptera novaeangliae*). The Service does not concur with the "not likely to adversely affect" determination for seabeach amaranth, leatherback sea turtle, and green sea turtle as presented in the BA and the effects of the proposed action on these species are included in this opinion. Because the Kemp's ridley sea turtle is not known to nest within Virginia, that species is not included in this biological opinion. The effects of the proposed action on the Kemp's ridley sea turtle, fin whale, right whale, and humpback whale and the effects to all sea turtles while at sea are addressed through NASA's section 7 consultation with National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), and these species and effects are not discussed further in this biological opinion.

NASA did not make a determination on the federally listed threatened roseate tern (*Sterna dougalli*) in their BA. This species may occur in the vicinity of the proposed project during migration, but is considered a rare migrant along the east coast south of New Jersey (Nisbet 1984). Band recoveries suggest that roseate terns are a primarily trans-oceanic migrant. The effects of the proposed action on this species are expected to be limited to potential temporary disturbance to individuals during migration when terns may pass near or encounter vessels involved in dredging operations. Terns may alter their flight paths to avoid vessels and disturbance. These effects are expected to be insignificant and discountable and this species is not discussed further in this biological opinion.

The red knot, a candidate species, has not yet been proposed for listing and therefore will not be addressed further in this document. However, we appreciate NASA's consideration of this species and any conservation measures implemented to minimize or avoid threats to this species will contribute to its conservation. The Service would like to work with NASA to develop a candidate conservation agreement for the red knot.

CONSULTATION HISTORY

03-01-07 NASA transmitted a BA to the Service for the SRIPP.

04-24-07 The Service responded to NASA that the proposed SRIPP would not be likely to adversely affect listed species.

May 2007 NASA released a programmatic EA on a proposed SRIPP.

11-20-08 The Service participated in a stakeholder and regulatory agency meeting for the project which revised the proposed action identified in the previous EA. At this meeting, the Service recommended that NASA plan to conduct section 7 consultation on the project in conjunction with its planning process. NASA expressed their intent to develop a programmatic EIS.

04-01-09	The Service received a letter requesting comments related to NASA's Notice of Intent (NOI) to prepare an EIS and conduct public scoping.
05-11-09	The Service submitted a letter to NASA providing comments and recommendations related to the project during the public comment period in the NOI.
02-10-10	The Service received email notification of the release of NASA's SRIPP draft PEIS. The document included a BA.
04-12-10	The Department of Interior sent NASA comments on the SRIPP draft PEIS during the public comment period on behalf of the Service and other DOI agencies under the National Environmental Policy Act (NEPA) process.
03-30-10	The Service attended a meeting about the SRIPP with NASA and other regulatory agencies involved in reviewing the project. The Service again recommended that NASA rescind its request for formal consultation due to the lack of detailed information about project implementation and engage further in informal consultation to allow for accurate consideration of effects to listed species. NASA responded that they wanted to continue with their request for formal consultation despite lacking information due to scheduling necessities. NASA responded that the Service had all the information available about the project.
05-11-10	The Service notified NASA that we would provide the completed biological opinion by September 22, 2010, later than the prescribed 135 days as a result of workload and staffing limitations.
06-09-10	The Service notified NASA that the biological opinion would be expedited to help meet NASA's scheduling needs, as expressed by Congressional representatives, and would be delivered on July 16, 2010.
06-28-10	The Service received an email confirmation that the project description remained the same as that included in the EIS, but that work at night would occur. The Service responded to request additional details about the type and extent of work that would occur at night.
07-07-10	NASA provided via email a clarification that night work would include dredging, sand pumpout, and grading.
07-08-10	The Service received a telephone call from NASA providing notification that sand fence was added to the project design for the beach and dune. NASA requested any Service recommendations for sand fence placement to minimize potential impacts to listed species. NASA provided via email detailed design drawings and

cross-sections of the seawall, beach, and dune that showed sand fence on both the landward and seaward sides of the beach.

07-09-10 The Service provided two documents to NASA that included recommended sand fence construction and maintenance to minimize impacts to wildlife.

07-15-10 The Service received an email from NASA providing the description of the sand fence that was added to the proposed action and new information about the schedule for implementing the seawall and initial beach construction. The Service notified NASA that the opinion would be delayed slightly to incorporate the updated information.

07-19-10 The Service had a telephone conversation with NASA engineer Paul Bull to confirm the extent of seawall and beach/dune construction during initial project construction, seawall and beach design drawings and intended construction methods regarding placement of materials, excavation for seawall placement, and materials used for seawall construction.

07-21-10 The Service provided notification that the opinion would be delivered by July 30, 2010. Additional time was needed to incorporate new information about the project design and implementation.

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

The purpose of the proposed action is to reduce the potential for damage to, or loss of, NASA, U.S. Navy, and MARS assets on Wallops Island from wave impacts associated with storm events. The proposed action is intended to use a multi-tiered approach to reduce damages to Wallops Island facilities from ongoing beach erosion and storm wave damage incurred during normal coastal storms including tropical systems and nor'easters. The goal of the proposed action is to move the zone of breaking waves away from vulnerable infrastructure and withstand storm surge that accompanies large coastal storms. This plan is not intended to protect against inundation flooding, wind damage, and other impacts during major hurricanes and exceptional nor'easters. Other NASA projects separate from this proposed action will address flood protection and other potential weather-related damage to infrastructure.

NASA has identified the project's design target performance of providing significant defense against a 100-year return interval storm with respect to storm surge and waves. The performance is provided by a combination of the reconstruction of a beach, berm, and dune which will help to absorb and dissipate wave energy before it nears NASA infrastructure, and a rock seawall embedded within the dune that will protect against the most severe energy.

A seawall composed of large rock is currently located along 15,900 feet (ft) of the Wallops Island shoreline. This seawall was built in 1992 and protects WFF infrastructure within the northern portion of the eroding shoreline from damage due to storms and large waves. The wall has prevented overwash and storm damage, but erosion of the shoreline seaward of the wall has continued, resulting in an increased risk of damage to the seawall. NASA's draft PEIS includes repairing the existing seawall and extending Wallops Island's existing rock seawall a maximum of 4,600 ft south of its southernmost point. Appendix 1 includes figures identifying the extent and location of proposed project features.

NASA proposes an initial beach reconstruction that would entail placement of 3.2 million cubic yards (yd^3) of sand seaward of the existing and new seawall along 4.2 miles of shoreline during the initial nourishment (Appendix 1). This effort would return a beach with a stable profile to the shoreline seaward of the seawall and add significantly to the storm buffering capability of the shoreline.

For these features to provide reliable protection for the project's design lifetime of 50 years, the beach must be maintained routinely throughout the project's lifetime. The shoreline on the southern end of Wallops Island has been retreating at a rate of approximately 10 ft per year as a result of erosion (Corps 2010). To maintain a beach and dune at a fixed location in a condition to effectively buffer wave energy, the beach will require routine renourishment over the 50-year project lifetime. Under the SRIPP, following reconstruction of the beach and dune, renourishment will occur approximately every 3-5 years for the life of the project. The timing and amount of the renourishment will be determined through monitoring for changes in the beach and dune that would reduce the project's effectiveness for storm protection.

The SRIPP proposed action also includes and incorporates the ongoing NASA operations and mission-related activities on Wallops Island and their interaction with the SRIPP. The Service's May 10, 2010 biological opinion describes and addressed the effects of NASA's operations on listed species on Wallops Island. This opinion includes by reference the NASA activities considered in the May biological opinion and considers additional effects to listed species that may result from construction of the SRIPP in conjunction with NASA activities.

<u>Initial Shoreline Reconstruction</u>

Seawall – The rock seawall extension would be the first feature built, and the draft PEIS described this component as extending up to 4,600 ft. In its July 15, 2010 email regarding the planned implementation of the project, NASA clarified that the initial project construction phase will extend the seawall 1,315 ft from the current southernmost terminus of the seawall, which would extend the seawall to just south of launch pad 0-B. Additional extension of the seawall may be included in future project modifications. The seawall extension would be placed approximately in line with and adjacent to the end of the existing seawall and would be installed in a straight line parallel to the shoreline. The location of the seawall would be primarily slightly seaward of the existing geotubes. In addition to the extension, the existing seawall may be repaired or have sections replaced to ensure its functional integrity to the extent necessary to provide the intended protection.

For the seawall extension, the footprint will be excavated to a depth of approximately 2 ft below existing grade to build a stable base. Geotextile fabric will be placed on the sand bottom in the excavated area, an approximately 1 ft thick marine mattress will be placed above the geotextile fabric, and the area will be back-filled with stones ranging from approximately 2-6 inches. Larger stone will be placed on top of this base material. The seawall core will be composed of 600-1,600 pound stones, and the armor stone will be placed above the core material. The armor stone will be placed in a thickness of at least 9 ft above the core stone, but at both the landward and seaward toe of the structure, a single layer of armor stone will be placed directly on the marine mattress base to provide a stable configuration and prevent erosion and scour at the toe of the structure. The seawall will be faced with rocks weighing 5 to 7 tons each. Rocks would be piled to be approximately 12 to 13 ft above the existing beach, depending on the extent of existing shoreline retreat at the time of construction.

Rock will be delivered to the work site by truck and may be stockpiled in one of several potential stockpile areas near but landward of the existing seawall. NASA has already stockpiled enough armor stone in uplands adjacent to their facilities on Wallops Island for most of the planned construction, but some additional armor material may be needed. The core stone and the marine mattress fill material will be delivered to the site prior to construction using existing roads. Stabilized construction access roads will be built of stone underlain by geotextile fabric and will extend from existing paved access roads to the work area at regular intervals for the length of the project area. The construction access roads will be removed seaward of the seawall when construction is complete. Access points landward of the seawall may be left in place. Rock and materials will be delivered to the work area through these construction access roads. Heavy equipment, including tracked excavators, bulldozers, and similar equipment will excavate sand and prepare the base for the seawall construction. Excavators will be used to place the large stones for the seawall core and armor. Construction and site preparation will be conducted as much as possible during periods of low tide when the work area is not inundated to the extent practicable. However, it is likely that some of the construction activities will occur in the water. Silt fences will be deployed landward of the project area, but because of the wave action on the seaward side, no measures are expected to be deployed to prevent or control sediment suspension.

Repair of the existing seawall may occur within limited areas of the existing seawall. In these cases, the existing seawall will be removed and replaced with a seawall with design and specifications similar to the extension, including placement of geotextile and a marine mattress below the structure. The existing steel sheeting bulkhead that is within the existing seawall will be maintained, but may be reduced in height to conform to the current design and will be encased within the seawall. Ground base elevations in these repair sections will differ on either side of the bulkhead, but both sides will be excavated to provide a solid foundation, and the depth of stone fill will differ, with greater depth on the seaward side so that the final profile of the seawall will be consistent and similar to that of the seawall extension. Rock removed from repaired sections of seawall will be recycled and used to face the landward surface of the seawall. Smaller repairs consisting of reconfiguring rocks or adding soil to fill voids may also occur.

When completed, both the seawall extension and repair areas will have relatively smooth faces on both landward and seaward faces. The slope of the seaward side will be 2:1 (run: rise) and the landward side will be slightly steeper with a slope of 1.5:1. Appendix 1 includes schematics of the proposed seawall, including example cross-sections of both the extension and repair sections.

Additional maintenance of the existing seawall may include operation of heavy equipment and placing or replacing dirt and/or rock in previously disturbed areas behind the seawall to maintain and augment the function of the existing seawall and the protection resulting from these features.

Beach Reconstruction – The initial beach nourishment/reconstruction would start approximately 1,500 ft north of the Wallops Island-Assawoman Island property boundary and extend north for approximately 3.7 miles, to the northern extent of the existing seawall. When completed, the beach will extend approximately 70 ft seaward from the seawall in a 6 ft high berm, and then slope underwater along the design equilibrium profile for an additional 170 ft seaward. The total distance of the fill profile from the current shoreline would be 240 ft. At the landward side of the berm, the fill profile would include a 14 ft high dune that would encase the seawall. As described above, the seawall may not extend the full length of the beach and dune reconstruction area. From approximately launch pad 0-B, where the seawall extension is planned to terminate, southward, the beach and dune will be constructed entirely of sand, with no stone core within the dune. NASA proposes to place a total of 3.2 million yd^3 of sand to build the berm, dune, and beach seaward of the seawall along 4.2 miles of shoreline during the initial nourishment. During storm events, the new beach would provide a surface to dissipate wave energy and provide additional sediment in the nearshore system. This initial fill volume includes an advance fill amount (or a sacrificial amount that is expected to erode away) and an additional amount to accommodate anticipated changes due to sea level rise while allowing the project to maintain its full shoreline protection function for an anticipated 8 years (dependent on weather).

Sand for the initial beach nourishment will be dredged from within an approximately 1,280 acre area located approximately 7 miles west of Wallops Island, referenced as unnamed shoal A (Appendix 1). The sand from this site matches closely with the target sand grain size of 0.29 millimeters (mm). This sand grain size was targeted because its relatively large size will help to reduce erosion losses over time. Smaller sand grain sizes may require additional sand overfill volume to achieve similar project performance (Corps 2010). Hopper dredges with a capacity of approximately 4,000 $yd^3$of sand are expected to be used to collect sand as a slurry from within the borrow area, and transport the sand along the 14-mile transit route from shoal A to a pumpout location approximately 2 miles offshore of Wallops Island at a depth of approximately 30 ft. Dredged material would then be pumped onto the beach through a pipe. A booster pump may be required to pump the sand the full distance from the pumpout location to the renourishment area, and the booster pump would be positioned either on the shore or on a barge or other vessel. The sand from the dredge will be pumped as slurry onto the shore. Based on the expected dredge material and performance parameters, NASA estimates that 1,000 to 1,100 dredge round trips would be required to provide the target amount of sand for the initial beach reconstruction. Once the sand has been placed on the shore, it will be positioned and contoured using bulldozers and/or other heavy earth-moving equipment to meet the design specifications. Following the complete contouring of the beach and dune, American beachgrass (*Ammophila breviligulata)* would be planted on the crests and seaward and landward (where applicable) dunes sideslopes to aid in stabilizing the sand.

Sand Fence – In addition to planting beachgrass, sand fence will be placed near the interface between the dune and the berm to aid in reducing the loss of sand from winds and to aid in maintaining the dune profile. The sand fence will be installed to conform to recommended guidelines to minimize potential impacts to wildlife. Sand fence will be placed in 10 ft long sections, oriented at a 45 degree angle from the shoreline (sections oriented southeast to northwest). Fence sections are placed 7 ft apart. This orientation maintains the function of the sand fence while reducing the chance of interfering with wildlife movement and entrapment.

Construction Timing and Sequencing – The initial beach reconstruction, including the seawall extension, is expected to occur over 2 to 3 years and will be funded through three fiscal years. The seawall extension and repair will be the first component initiated. It is expected to be initiated and completed within an approximately 9 month period, including a margin of uncertainty. While the timing is contingent on several factors, this component is planned to be initiated in early spring, with completion in late fall/early winter. Placement of sand may be initiated within a month or less of the completion of the seawall, but there may be a delay of several months or more between construction of the seawall extension and the placement of sand.

The initiation of the beach/dune construction is dependent on the completion of the NEPA process and completion of the Memorandum of Agreement among BOEMRE, the Corps, and NASA for the use of OCS sand. The sand placement and beach/dune construction is planned to be funded through two fiscal years and under two separate contracts administered through the Corps. The construction activity is intended to be implemented seamlessly between the two contracts to prevent incurring the additional costs of mobilization/demobilization, but because the implementation is dependent on funding and contracting, the seamless implementation cannot be assured. If implemented seamlessly, the completion of the project is anticipated to take 8 months, with demobilization possibly requiring an additional 60 days. Any changes project implementation will require additional time for completion.

To meet the project timelines for construction completion and to ensure that contracts may be implemented seamlessly, construction activity for all phases of the project may occur during all hours of the day or night. Particularly during the sand placement, dredging and moving sand material on the beaches are expected to occur continuously.

Monitoring – As an integral part of the SRIPP, NASA is planning a shoreline monitoring program to record and document the changes in the shoreline characteristics over time as the project is implemented and subjected to normal weathering and storm events. The monitoring effort will begin prior to initiating any construction of the seawall, beach, or dune to establish a baseline condition and record any changes that occur between design and implementation.

A monitoring survey of the shoreline in the vicinity of Wallops Island would be conducted twice a year. The first monitoring event would be conducted along the entire lengths of Wallops and Assawoman Islands, a distance of approximately 8.5 miles. The second of the two annual surveys would be limited to the length of shoreline from Chincoteague Inlet south to the former Assawoman Inlet, which defines the south end of Wallops Island. In the cross-shore direction, elevation data would be collected from behind the dune line to seaward of the depth of closure (the eastern edge of the underwater fill profile), estimated to be at approximately -15 to -20 ft below mean low water (MLW). Near Chincoteague Inlet the ebb shoal complex creates a large shallow offshore area; therefore, surveys in this area shall extend a maximum of 2 miles offshore if the depth of closure is not reached. The monitoring would preferably be conducted once at the end of summer (August to October) and once at the end of winter (March to May).

Cross-sections of the beach would be taken along new and/or previously established baselines on set stations every 500 ft from Chincoteague Inlet to Assawoman Inlet and every 1,000 ft from Assawoman Inlet to Gargathy Inlet. The beach survey would extend from the baseline to a depth of -4 ft below MLW offshore. An offshore hydrographic survey along the previously established baseline on set stations every 500 ft would be conducted. The offshore survey would extend from -3 ft below MLW to the depth of closure, anticipated to be between -15 to -20 ft below MLW. If possible (weather permitting), the hydrographic survey would be conducted within 2 weeks of the beach survey.

LIDAR data would be obtained for the monitoring area approximately once a year. Both horizontal and vertical survey datum would be obtained. The survey of the beach, surf zone, and offshore area, as described below, would document changes in the Wallops Island shoreline in addition to areas adjacent to Wallops Island.

The results of these monitoring efforts would be used to measure shoreline change to evaluate the performance of the project, potential impacts to resources, and to aid in planning renourishment when needed to ensure continued project function.

In conjunction with construction activities, qualified biologists will regularly survey the beaches in the vicinity of the project for use by sea turtles, piping plovers, and other species. If nesting activity of protected species is recorded, NASA will avoid work in the areas where the nesting occurs and/or implement other appropriate mitigation measures.

Renourishment and Long-Term Project Maintenance

Following the initial beach reconstruction, NASA plans subsequent beach renourishment cycles throughout the 50-year life of the SRIPP as determined by the proposed monitoring program. Because the renourishment and repair will be conducted as needed, the location, extent, and magnitude of renourishment events may vary significantly as a result of the frequency and severity of storm activity and subsequent shoreline erosion. The availability of funding, logistical constraints, and other issues may also affect the implementation of renourishment over time.

Based on available modeling of project performance over time, the draft PEIS identifies an expected renourishment frequency of approximately every 5 years for the life of the project. Based on the general characterization of function, the draft PEIS estimates that each renourishment cycle would require approximately 806,000 yd^3 of sand placed on the beach in each of the 9 renourishment events, for a total expected renourishment volume of 7,254,000 yd^3 of sand over the life of the project, excluding the amount required for the initial beach and dune reconstruction.

The projected renourishment frequency and amounts are based on the modeled average rates of sand loss, with models that are based on the historic meteorological conditions recorded at and near the project area. If the project is affected by a particularly large storm, renourishment may be required at an interval much shorter than the planned 5 years. Similarly, if the frequency or intensity of storms is significantly greater than what was incorporated into modeled projections based on the period of record, more frequent renourishment will be required. Using similar assumptions, renourishment may be needed less frequently if there are fewer storms and storms of lower intensity, or if there are other changes in the processes affecting erosion and sand transport.

Renourishment may also occur less frequently based on NASA's availability of resources and assessment of need. Even if renourishment is needed based on the modeled project performance and intent, NASA may choose to forego or delay renourishment because the project will retain most of its intended and designed storm protection function even if renourishment is not implemented as envisioned in the draft PEIS.

Several other factors may also influence the future renourishment. If future renourishments use sand that is of smaller size or reduced quality, more frequent renourishment or larger volumes of sand may be required. If there are changes in the pattern of sand movement along the shoreline, such as reduced southerly transport over time, renourishment may be needed less frequently. In the draft PEIS, NASA considers the addition of breakwater or groin, and while not included in the current proposed action, addition of these features may result in reduced sand requirements.

The Wallops Island shoreline will experience the effects of future sea level rise, and this has been anticipated in planning the implementation of the project by providing an additional sediment volume during each renourishment event that would raise the level of the entire beach fill by an amount necessary to keep pace with the projected rise rate (Corps 2010). Applying the Corps' standard sea level rise equation based on local measurements to a 50 year project at Wallops Island yields sea level elevations that are between 0.84 ft and 2.53 ft above present levels. For project planning purposes, a target fill volume that was 85% of the upper estimates of the amount needed to match the 50-year projected sea level rise was selected, but the SRIPP includes adding that volume in constant increments over time instead of in a pattern that would match anticipated increases. This would mean that in the early years of the project the amount of fill being added would exceed the amount necessary to match the expected amount with the cross over point being in the 28th year of the project (2038). This way, the sea level fill volume could be increased, if needed, during the later renourishment events. The Sea Level Rise Volume which is an additional amount that will be needed to be added during each renourishment event (assuming a 5-year interval between events) is 112,000 yd^3. Deviations from existing modeled or projected sea level rise scenarios may also change the amount of sand needed for renourishment.

The number of uncertainties included in the projections resulting from the modeling, model assumptions, limitations of the records of past meteorological and climatological measurements in the area, our understanding of meteorological and climatic patterns, and the future decisions of NASA and other agencies are all likely to result in deviations from the projected renourishment.

Sources of Sand for Renourishment – Three borrow sites have been identified as sources for potential future beach renourishment: the on-shore north Wallops Island borrow area, unnamed shoal A (the source of material for the initial beach/dune reconstruction), and unnamed shoal B (located east of shoal A). All of these sites have been determined to be consistent with the project purpose and suitable, but all have different costs and concerns associated with their use that must be evaluated prior to use in each proposed future renourishment.

The north Wallops Island borrow site is located on NASA property in the sand accretion zone on the northern end of Wallops Island. It is delineated for planning purposes as the seaward-most portion of the beach area where sand has accreted in recent years. The borrow area is approximately 150 acres in size. Excavation depth is expected to be limited to about 3.5 ft below the ground surface due to tidal fluctuations and the high permeability of the soil. Up to half of the projected fill volume for each renourishment cycle could be provided by the north Wallops Island borrow site. The remaining half of the expected needed volume, or the entire volume, would be obtained from one of the offshore borrow areas. The mean grain size (0.20 mm) at the north Wallops Island borrow area is the smallest of the three sites considered and is currently below the target grain size for renourishment (but is still within the suitable range). The average grain size in this borrow area is expected to increase following placement of material from shoal A in the initial beach and dune reconstruction as this larger material is transported to this accretion area.

Unnamed shoal A, the source of sand for the initial reconstruction, may also be used as the source for renourishment. The shoal covers an area of approximately 1,800 acres, and the total predicted volume of shoal A is approximately 40 million yd^3. The sand grain size (0.46 mm) is the largest of the three sources.

Unnamed shoal B is located offshore approximately 12 miles east of the southern portion of Assateague Island. This shoal covers an area of approximately 3,900 acres. The total predicted sand volume of this shoal is approximately 70 million yd^3. The average sand grain size is 0.34 mm and the transit distance from the shoal to the pumpout location is approximately 19 miles.

Material from a combination of the sources may also be feasible for future renourishments, subject to the constraints of future funding, permitting, logistical constraints, and other considerations.

Sand Removal Methods – The proposed sand removal, transportation, and placement of sand from either of the two offshore sites for future renourishment is planned to be the same as that discussed for the initial beach reconstruction project.

Sand from north Wallops Island would be removed from the beach using a pan excavator or other heavy earth-moving equipment. Sand would be stockpiled, loaded onto trucks, trucked to the off-loading point on the beach, and spread by bulldozers. Off-road dump trucks would likely be used and would travel up and down the beach from the stockpile area to the fill site. However, road dump trucks could also be used in some circumstances. No constraints have been placed on the timing and methods of excavation at the north Wallops Island borrow area, but NASA has identified the intent to avoid excavation and disturbance near any piping plover nests, sea turtle nests, or occurrences of seabeach amaranth.

Seawall Extension – Additional extension of the seawall beyond the 1,315 ft proposed as part of the initial beach/dune reconstruction may be implemented in the lifetime of the project up to the maximum considered of 4,600 ft beyond the existing seawall. There are no available details about the timing, extent, or design of any such future seawall construction and the details will be provided in conjunction with detailed plans under this program. Effects of additional seawall extension will be considered in additional consultation following detailed design.

Addition of Related Features – The draft PEIS includes analysis and consideration of an offshore breakwater and a groin in conjunction with the SRIPP to aid in sand retention and reduce renourishment requirements. While not part of the proposed action, the draft PEIS does identify the intent to consider the need for sand retention structures through the monitoring and evaluation of project performance. Because there are no designs specified, any such feature would be considered through additional consultation on detailed design of such a feature.

Implementing Future Renourishment – NASA has identified the intent to prepare tiered NEPA documents, in conjunction with the Service and other stakeholders, that provide detailed analysis of future actions that will be implemented under this program. The uncertainty in the design, extent, magnitude, timing, and other characteristics of such future actions, in addition to the lack of identification of potential sand material preclude detailed analysis or description of future actions and their effects. The future tiered NEPA documents and the detailed plans for future actions under this program will serve as the basis for detailed analysis of potential effects to listed species. Because design details are not available, the effects of future renourishment projects under this program will be considered through future additional consultations when that design information is available.

Action Area

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action. The Service has determined that the action area for this project includes the entire land area of Wallops Island, the shoreline and beaches of Assawoman Island, which will be affected by littoral transport of sand placed on Wallops Island, the aquatic environment adjacent to these lands, and the three borrow sites including unnamed shoals A and B and north Wallops Island, and the waters through which dredges will transit from borrow sites to pumpout areas. The action area also includes the Hook and overwash segments of Assateague Island (see map below).

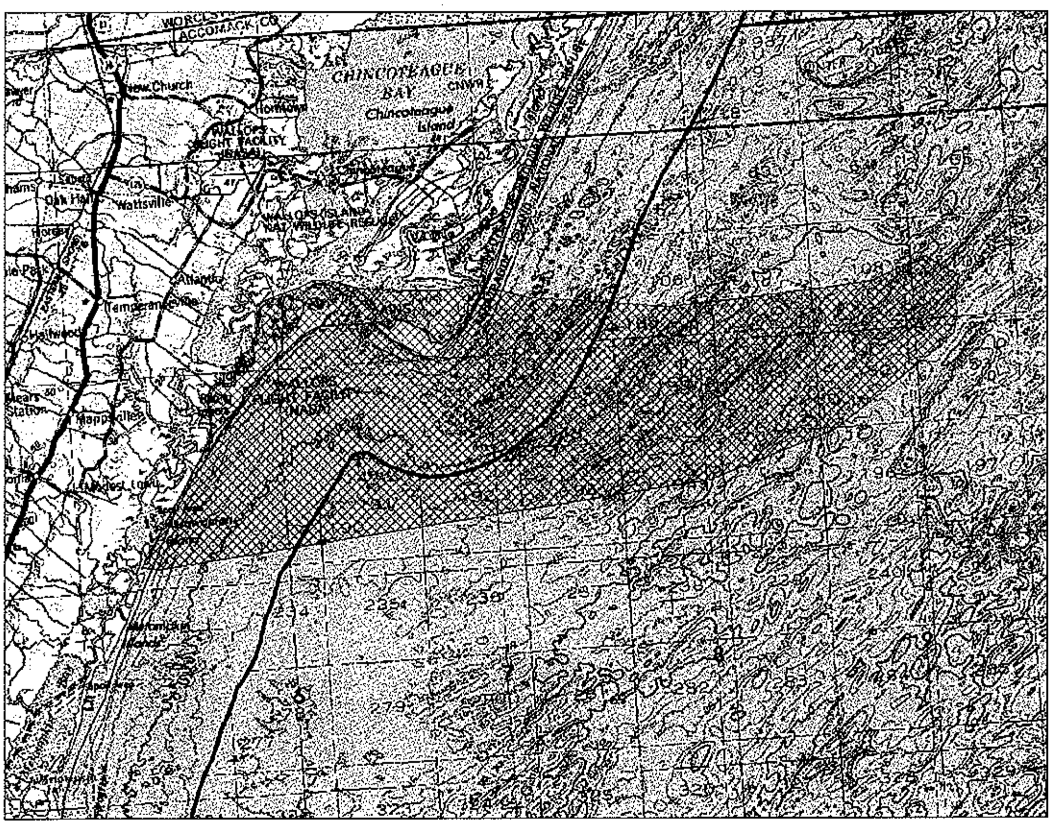


Figure 1. The cross-hatched area on the map delineates the project action area.

STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

PIPING PLOVER

On January 10, 1986, the piping plover was listed as endangered or threatened in various parts of its range pursuant to the ESA. Three separate breeding populations have been identified, each with its own recovery criteria: Atlantic Coast (threatened), Great Lakes (endangered), and Northern Great Plains (threatened). The Atlantic Coast population is the focus of this biological opinion. No critical habitat has been proposed or designated for piping plovers in the Atlantic Coast breeding area.

The recovery plan for the Atlantic Coast population of the piping plover (Service 1996a) delineates four recovery units or geographic subpopulations within the population: Atlantic Canada, New England, New York-New Jersey, and Southern (Delaware, Maryland, Virginia, and North Carolina). Recovery criteria established within the recovery plan defined population and productivity goals for each recovery unit, as well as for the population as a whole. Attainment of these goals for each recovery unit is an integral part of a piping plover recovery strategy that seeks to reduce the probability of extinction for the entire population by: (1) contributing to the population total, (2) reducing vulnerability to environmental variation (including catastrophes, such as hurricanes, oil spills, or disease), (3) increasing likelihood of genetic interchange among subpopulations, and (4) promoting recolonization of any sites that experience declines or local extirpations due to low productivity or temporary habitat succession.

Species Description - Piping plovers are small, sand-colored shorebirds, approximately 17 centimeters (cm) (7 inches) long with a wingspread of about 38 cm (15 inches) (Palmer 1967). The Atlantic Coast population breeds on sandy, coastal beaches from Newfoundland to North Carolina, and winters along the Atlantic Coast from North Carolina south, along the Gulf Coast to Texas, and in the Caribbean (Service 1996a). Additional detailed information on the piping plover, its life history, and the population dynamics of the Atlantic population are provided in the species' recovery plan (Service 1996a).

Life History - Piping plovers generally begin returning to their Atlantic Coast nesting beaches in mid-March (Coutu et al. 1990, Cross 1990, Goldin 1990, MacIvor 1990, Hake 1993). Males establish and defend territories and court females (Cairns 1982). Piping plovers are monogamous, but usually shift mates between years (Wilcox 1959, Haig and Oring 1988, MacIvor 1990), and less frequently between nesting attempts in a given year (Haig and Oring 1988, MacIvor 1990, Strauss 1990). Plovers are known to begin breeding as early as one year of age (MacIvor 1990, Haig 1992); however, the percentage of birds that breed in their first adult year is unknown.

Piping plovers nest on the ground above the high tide line on coastal beaches, on sand flats at the ends of sand spits and barrier islands, on gently sloping foredunes, in blowout areas behind primary dunes, and in washover areas cut into or between dunes. In the central portions of their Atlantic Coast range, the birds may also nest on areas where suitable dredge material has been deposited. Nest sites are shallow, scraped depressions in substrates ranging from fine-grained sand to mixtures of sand and pebbles, shells or cobble (Bent 1929, Burger 1987, Cairns 1982, Patterson 1988, Flemming et al. 1988, MacIvor 1990, Strauss 1990). Nests are usually found in areas with little or no vegetation although, on occasion, piping plovers will nest under stands of American beachgrass or other vegetation (Patterson 1988, MacIvor 1990). Plover nests may be very difficult to detect, especially during the six to seven day egg-laying phase when the birds generally do not incubate the eggs within the nest cup (Goldin 1994).

Eggs may be present on the beach from early April through late July. Clutch size for an initial nest attempt is usually four eggs, one laid every other day. Eggs are pyriform in shape, and variable buff to greenish brown in color, marked with black or brown spots. The incubation period usually lasts 27-28 days. Full-time incubation usually begins with the completion of the clutch and is shared equally by both sexes (Wilcox 1959, Cairns 1977, MacIvor 1990). Eggs in a clutch usually hatch within four to eight hours of each other, although the hatching period of one or more eggs may be delayed by up to 48 hours (Cairns 1977, Wolcott and Wolcott 1999).

Piping plovers generally fledge only a single brood per season, but may renest several times if eggs are lost. Chicks are precocial, meaning they immediately can run from the nest cup upon hatching (Wilcox 1959, Cairns 1982). They may move with their parents hundreds of meters from the nest site during their first week of life (Service 1996a), and chicks may increase their foraging range up to 1,000 m before they fledge (are able to fly) (Loegering 1992). At CNWR, Daisey (2006) found that brood movements averaged 60.1 $\pm$ 28.0 m/day in 2004 and 68.8 m/day in 2005 (range = 5.4 – 120.8 m/day; 28.9 – 122.2 m/day, respectively). Chicks remain together with one or both parents until they fledge at 25 to 35 days of age. Depending on their date of hatching, flightless chicks may be present from mid-May until late August, although most fledge by the end of July (Patterson 1988, Goldin 1990, MacIvor 1990, Howard et al. 1993).

Cryptic coloration is a primary defense mechanism for this species; eggs, adults, and chicks all blend in with their typical beach surroundings. Chicks sometimes respond to vehicles and/or pedestrians by crouching and remaining motionless (Cairns 1977, Tull 1984, Goldin 1993, Hoopes 1993). Adult piping plovers respond to intruders (avian and mammalian) in their territories by displaying a variety of distraction behaviors, including squatting, false brooding, running, and injury feigning, in an effort to lure the predators away from the nest or chicks. Distraction displays may occur at any time during the breeding season but are most frequent and intense around the time of hatching (Cairns 1977).

Plovers feed on invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks (Bent 1929, Cairns 1977, Nicholls 1989). Important feeding areas include intertidal portions of ocean beaches, washover areas, mudflats, sand flats, wrack lines, sparse vegetation, and shorelines of coastal ponds, lagoons, or salt marshes (Gibbs 1986, Coutu et al. 1990, Hoopes et al. 1992, Loegering 1992, Goldin 1993, Elias-Gerken 1994). The relative importance of various feeding habitat types may vary by site (Gibbs 1986, Coutu, et al. 1990, McConnaughey et al. 1990, Loegering 1992, Goldin 1993, Hoopes 1993, Elias-Gerken 1994) and by stage in the breeding cycle (Cross 1990). Adults and chicks on a given site may use different feeding habitats in varying proportion (Goldin 1990). Feeding activities of chicks are particularly important to their survival. Most time budget studies reveal that chicks spend a high proportion of their time feeding. Cairns (1977) found that chicks typically tripled their weight during the first two weeks post-hatching; chicks that failed to achieve at least 60 percent of this weight gain by the twelfth day post-hatching were unlikely to survive.

During courtship, nesting, and brood rearing, feeding territories are generally contiguous to nesting territories (Cairns 1977), although instances where brood-rearing areas are widely separated from nesting territories are not uncommon. Feeding activities of both adults and chicks may occur during all hours of the day and night (Burger 1993), and at all stages in the tidal cycle (Goldin 1993, Hoopes 1993).

Both spring and fall migration routes of Atlantic Coast breeders are believed to occur primarily within a narrow zone along the Atlantic Coast (Service 1996a). Relatively little is known about migration behavior or habitat use within the Atlantic Coast breeding range (Service 1996a), but the pattern of both fall and spring counts at migration sites along the southeastern Atlantic Coast demonstrates that many piping plovers make intermediate stopovers lasting from a few days up to one month during migration (National Park Service [NPS] 2003, Noel et al. 2005, Stucker and Cuthbert 2006).

A growing body of information shows that habitats on overwash beaches, accessible bayside flats, unstabilized and recently healed inlets, and moist sparsely vegetated barrier flats are especially important to piping plover productivity and carrying capacity in the New York-New Jersey and Southern recovery units.

In New Jersey, Burger (1994) studied piping plover foraging behavior and habitat use at three sites that offered the birds access to ocean, dune, and backbay habitats. The primary focus of the study was on the effect of human disturbance on habitat selection, and the author found that both habitat selection and foraging behavior correlated inversely with the number of people present. In the absence of people on an unstabilized beach, plovers fed in ocean and bayside habitats in preference to the dunes.

Loegering and Fraser (1995) found that chicks on Assateague Island, Maryland, that were able to reach bayside beaches and the island interior had significantly higher fledgling rates than those that foraged solely on the ocean beach. Higher foraging rates, percentage of time spent foraging, and abundance of terrestrial arthropods on the bay beach and interior island habitats supported their hypothesis that foraging resources in interior and bayside habitats are key to reproductive rates on that site. Their management recommendations stressed the importance of sparsely vegetated cross-island access routes maintained by overwash, and the need to restrict or mitigate human activities that reduce natural disturbance during storms.

Dramatic increases in plover productivity and breeding population on Assateague since the 1991-1992 advent of large overwash events corroborate Loegering and Fraser's (1995) conclusions. Piping plover productivity on Assateague, which had averaged 0.77 chicks per pair during the five years before the overwash events, averaged 1.67 chicks/pair in 1992-96. The nesting population on the northern five miles of the island also grew rapidly, doubling by 1995 and tripling by 1996, when 61 pairs nested there (MacIvor 1990). Habitat use is primarily on the interior and bayside of this island.

In Virginia, Watts et al. (1996) found that piping plovers nesting on 13 barrier islands between 1986 and 1988 were not evenly distributed along the islands. Beach segments used by plovers had wider and more heterogeneous beaches, fewer stable dunes, greater open access to bayside foraging areas, and proximity to mudflats. They note that characteristics of beaches selected by plovers are maintained by frequent storm disturbance.

At Cape Lookout National Seashore in North Carolina, 13 to 45 pairs of plovers have nested on North and South Core Banks each year since 1992 (NPS 2007). While these unstabilized barrier islands total 44 miles long, nesting distribution is patchy, with all nests clustered on the dynamic ends of the barrier islands, recently closed and sparsely vegetated "old inlets," expansive barrier mudflats, or new ocean-to-bay overwashes. During a 1990 study, 96 percent of brood observations were on bay tidal flats, even though broods had access to both bay and ocean beach habitats (McConnaughey et al. 1990).

At Cape Hatteras National Seashore, North Carolina, distribution of nesting piping plovers is also "clumped," with nesting areas characterized by a wide beach, relatively flat intertidal zone, brackish ponds, and temporary pools formed by rainwater and overwash (Coutu et al. 1990).

Notwithstanding the importance of bayside flats, ephemeral pools, and sparsely vegetated barrier flats for piping plover nest site selection and chick foraging, ocean intertidal zones are used by adults and chicks of all ages. A three-year study of piping plover chick foraging activity at six sites on four Virginia barrier islands (Cross and Terwilliger 2000) documented chick use of the ocean intertidal zone at three of six study sites. Intensive observations at CNWR Overwash Zone in 2004, where chicks had unimpeded access to a large undisturbed bayside flat, documented occasional visits to the ocean intertidal zone by six of eleven broods ranging in age from one to 24 days (Hecht 2004 in litt.).

Population Dynamics/Status and Distribution - Historical population trends for the Atlantic Coast piping plover have been reconstructed from scattered, largely qualitative records. Nineteenth-century naturalists, such as Audubon and Wilson, described the piping plover as a common summer resident on Atlantic Coast beaches (Haig and Oring 1985). However, by the beginning of the 20th Century, egg collecting and uncontrolled hunting, primarily for the millinery trade, had greatly reduced the population, and, in some areas along the Atlantic Coast, the piping plover was close to extirpation. Following passage of the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 7 03-712), and changes in the fashion industry that no longer exploited wild birds for feathers, piping plover numbers recovered to some extent (Haig and Oring 1985).

Available data suggest that the most recent population decline began in the late 1940s or early 1950s (Haig and Oring 1985). Starting in 1972, the National Audubon Society's "Blue List" of birds with deteriorating status included the piping plover (Tate 1981). Johnsgard (1981) described the piping plover as ". . . declining throughout its range and in rather serious trouble." The Canadian Committee on the Status of Endangered Wildlife in Canada designated the piping plover as "Threatened" in 1978 and elevated the species status to "Endangered" in 1985 (Canadian Wildlife Service 1989).

Reports of local or statewide declines between 1950 and 1985 are numerous and many are summarized by Haig and Oring (1985). While Wilcox (1939) estimated more than 500 pairs of piping plovers on Long Island, New York, the 1989 population estimate was 191 pairs (Service 2010). There was little focus on gathering quantitative data on piping plovers in Massachusetts through the late 1960s because the species was commonly observed and presumed to be secure. However, numbers of piping plover breeding pairs declined 50 to 100 percent at seven Massachusetts sites between the early 1970s and 1984 (Griffin and Melvin 1984). Recent experience of biologists surveying piping plovers has shown that counts of these cryptically colored birds sometimes go up with increased census effort, suggesting that some historic counts of piping plover numbers by one or a few observers, who often recorded occurrences of many avian species simultaneously, may have underestimated the piping plover population. Thus, the magnitude of the species' decline may have been more severe than available numbers imply.

Appendix 2 summarizes nesting pair counts for the Atlantic Coast piping plover population since listing in 1986 through 2009. Final range-wide numbers for the 2009 breeding season are not yet available, and 2009 data are considered preliminary at this time. The apparent increase in numbers of plover pairs between 1986 and 1989 is thought, at least partially, to reflect the effects of increased survey efforts following the proposed listing of the species in 1986.

The Atlantic Coast population has increased from 790 pairs since listing to over 1,800 pairs each year since 2007 (Service 2010). Population growth has been greatest in the New England and New York-New Jersey recovery units, with a more modest and recent increase in the Southern unit and a smaller increase in Atlantic Canada.

<u>Productivity</u> - Productivity needed to maintain a stable population for Atlantic Coast piping plovers is estimated at 1.24 fledged chicks per pair (Melvin and Gibbs 1994). Small populations may be highly vulnerable to extirpation due to variability in productivity and survival rates. The average productivity needed for a stable population may be insufficient to assure a high probability of species survival. To compensate for small populations, the recovery plan establishes productivity goals needed to assure a secure 2,000-pair population at 1.5 chicks per pair in each of the four recovery units, based on data from at least 90 percent of each recovery unit's population.

Appendix 2 provides a summary of piping plover productivity from 1987 to 2009. Both regional population trends and productivity rates have been uneven. The 10-year (1997-2009) average productivity for piping plovers on the U.S. Atlantic Coast is below the recovery target of 1.5 chicks per pair. Peak productivity in the U.S. occurred in 1994 when average productivity exceeded the recovery plan goal of 1.5 chicks per pair. In most years, average productivity across the Atlantic population remained below the target. While weather events were contributors to egg and chick losses in some years (Service 1998, 2002a), such periodic natural events are inevitable, and they underscore the need to reduce the species' vulnerability by increasing the breeding population and protecting the species against human caused factors that affect productivity.

Southern Recovery Unit Status and Distribution - The Southern Recovery Unit (a portion of the Atlantic Coast population) includes Delaware, Maryland, Virginia, and North Carolina. Some limited plover nesting has occurred in South Carolina. There were approximately 158 plover pairs in the Southern Recovery Unit in 1986 and approximately 302 pairs in 2009 (Appendix 2). The 2007 total (333) is the highest recorded within the Southern Recovery Unit to date. However, the Southern Recovery Unit, which includes CNWR, continues to fall short of its recovery goal of 400 pairs. During the period of monitoring, the population size has declined in some years, but has consistently rebounded following declines. The numbers have shown an increasing trend over the last 10 years, from 182 pairs in 1999 to 302 pairs in 2009 (Service 2010; Appendix 2).

In the Southern Recovery Unit, productivity has varied substantially over the past 10 years, with a low of 0.67 chicks per pair recorded in 2008 and a high of 1.96 in 2004 (Appendix 2). Overall, plover productivity has generally increased in Virginia and throughout the Southern Recovery Unit since 1999, despite declines in some years. High productivity in Virginia from 2000 to 2005 has contributed to population increases in Virginia and in the Southern Recovery Unit (Service 2010). Continued productivity at or above levels identified in the recovery plan are attainable with ongoing intensive management efforts, and are expected to result in additional increases in plover populations.

Factors Affecting the Species - Intensive management measures to protect piping plovers from disturbance by beach recreationists and their pets have been implemented for the Atlantic population at many nesting sites in recent years. In 2004, about 30 percent of the U.S. Atlantic Coast population of piping plovers nested on federally owned beaches where some protection is afforded under section 7 of the ESA (within the Southern Recovery unit, the majority of plovers occur on public or private conservation lands). The remaining 70 percent of the birds nested on state, town, or privately-owned beaches where plover managers are implementing protections in the face of increasing disturbance from recreation and development. Recreational activities and public use of some federally owned beaches have also increased. Pressure on Atlantic Coast beach habitat from development and human disturbance continues (Service 1996a). Piping plover protection is dependent on the efforts of Federal, State, and local government agencies, conservation organizations, and private landowners.

Recreational activities can be a source of both direct mortality and harassment of piping plovers. Pedestrians may flush incubating plovers from nests (Flemming et al. 1988, Cross 1990, Cross and Terwilliger 1993), exposing eggs to predators or excessive temperatures. Repeated exposure of shorebird eggs on hot days may cause overheating, killing the embryos (Bergstrom 1991); excessive cooling may kill embryos or retard their development, delaying hatching dates (Welty 1982). Pedestrians can also disturb unfledged chicks (Strauss 1990, Burger 1991, Loegering 1992, Hoopes 1993, Goldin 1993), forcing them out of preferred habitats, decreasing available foraging time, and causing expenditure of energy.

Concentrations of pedestrians may deter piping plovers from using otherwise suitable habitat. In Jones Beach Island, New York, Elias-Gerkin (1994) found less pedestrian disturbance in areas selected by nesting piping plovers than areas unoccupied by plovers. Burger (1991, 1994) found that presence of people at several New Jersey sites caused plovers to shift their habitat use away from the ocean front to interior and bayside habitats, and that the time plovers devoted to foraging decreased and the time spent alert increased when more people were present. Burger (1991) also found that when plover chicks and adults were exposed to the same number of people, chicks spent less time foraging and more time crouching, running away from people, and being alert than did adult birds.

Fireworks are highly disturbing to piping plovers (Howard et al. 1993). Plovers are also intolerant of kites, particularly as compared to pedestrians, dogs, and vehicles. This may be because plovers perceive kites as potential avian predators, such as gulls, crows, or raptors (Hoopes 1993).

Motorized vehicle use on beaches is an extreme threat to piping plovers, as well as other shorebirds that nest on beaches and dunes. Vehicles can crush eggs, adults, and chicks (Wilcox 1959, Tull 1984, Burger 1987, Patterson et al. 1991). In Massachusetts and New York, 18 piping plover chicks and 2 adults were killed by off-road vehicles in 14 documented incidents (Melvin et al. 1994). Goldin (1993) compiled records of 34 chick mortalities (30 on the Atlantic Coast and 4 on the Northern Great Plains) due to vehicles. Biologists who monitor and manage piping plovers believe that vehicles kill many more chicks than are found and reported (Melvin et al. 1994).

Beaches used by recreational vehicles during nesting and brood-rearing periods generally have fewer breeding plovers than available nesting and feeding habitat can support. In contrast, plover abundance and productivity has increased on beaches where recreational vehicle restrictions during chick-rearing periods have been combined with protection of nests from predators (Goldin 1993).

Once hatched, piping plover broods are mobile and may not remain near the nesting area. Wire fencing placed around nests to deter predators (Rimmer and Deblinger 1990, Melvin et al. 1992) is ineffective in protecting chicks from vehicles because chicks typically leave the nest within a day after hatching and move extensively along the beach to feed. Typical behaviors of piping plover chicks increase their vulnerability to vehicles. Chicks frequently move between the upper berm or foredune and feeding habitat within the wrack line and intertidal zone. Chick use of the ocean intertidal zone is lower in the Southern recovery unit compared with more northerly portions of the breeding range. Data from Assateague Island Seashore in Maryland and from CNWR demonstrates that many broods make sporadic use of ocean intertidal zone habitat (Hecht 2004 in litt.). These movements along the beach and intertidal zone place chicks in the paths of vehicles. Chicks stand, walk, and run along tire ruts, and sometimes have difficulty crossing deep ruts or climbing out of them (Eddings et al. 1990, MacIvor 1990, Strauss 1990, Hoopes et al. 1992, Goldin 1993, Howard et al. 1993, Hoopes 1994). Chicks sometimes stand motionless or crouch as vehicles pass by or do not move quickly enough to get out of the way (Tull 1984, Hoopes et al. 1992, Goldin 1993).

Vehicles may also significantly degrade piping plover habitat or disrupt normal behavior patterns by crushing wrack into the sand and making it unavailable as cover or foraging substrate (Hoopes et al. 1992, Goldin 1993). Vehicles that are driven too close to the toe of the dune may destroy vegetation that may provide piping plover cover habitat (Elias-Gerken 1994).

Substantial evidence shows that human activities exacerbate natural predation on piping plovers, their eggs, and chicks (Service 1996a). Where Wilcox (1959) had observed 92 percent hatching success of nests observed between 1939-1958 on Long Island, New York, and loss of only 2 percent of nests to crows (*Corvus* sp.), Elias-Gerken (1994) documented loss of 21 percent of nests in her study area to crows in 1992-1993 as a result of increased human activity. Other important predators of plover eggs and chicks in the recovery unit include foxes (*Vulpes vulpes*), raccoons (*Procyon lotor*), Norway rats (*Rattus norvegicus*), herring gulls (*Larus argentatus*), great black-backed gulls (*Larus marinus*), domestic and feral dogs (*Canis familiaris*) and cats (*Felis catus*), and ghost crabs (*Ocypode quadrata*) (Riepe 1989, Jenkins and Nichols 1994, Jenkins et al. 1999, Canale 1997, Service 1996a).

Predators can be a major source of loss of eggs and juvenile plovers. For example, predators accounted for over half of all piping plover nest losses in New Jersey from 1995-1998 (Jenkins et al. 1999). A variety of techniques have been employed to reduce predation on plovers. Most notably, the use of predator exclosures (fences around nests) has demonstrated success to reduce predation on piping plover eggs (Melvin et al. 1992, Rimmer and Deblinger 1990) and has been credited with an important role in population increases in some parts of their range (Jenkins and Nichols 1994, Jenkins et al. 1999). However, these same devices have also been associated with serious problems including entanglements of birds in the exclosure netting, and attraction of "smart" predators that have learned there is potential prey inside. The downside risks may include not only predation or nest abandonment, sometimes at rates exceeding those that might occur without exclosures, but also induced mortality of adult birds. Exclosures provide no protection for mobile plover chicks, which generally leave the exclosure within a day of hatching and move extensively along the beach to feed.

Although exclosures are contributing to improved productivity and population increases in some portions of the Atlantic Coast range, problems have been noted in some localities. Loegering (1992) reported loss of six nests in exclosures without tops in Maryland in 1988, but nest loss stopped after string tops were added. Cross (1991) found that exclosed nests hatched significantly more often than unexclosed nests over three years on three sites at CNWR, but hatch rates were not significantly improved at all sites or in all years; furthermore, two instances of foxes depredating adult plovers occurred in the vicinity of exclosures. Due to the magnitude of predation threats to plovers and limitations associated with all currently available solutions, the piping plover recovery plan strongly recommends that on-site managers employ an integrated approach to predator management that considers a full range of management techniques (Service 1996a).

As effectiveness of exclosures has declined, managers have increased selective predator removal activities at many sites throughout the Atlantic Coast range (e.g., U.S. Department of Agriculture

[USDA] 2006, NPS 2007, Cohen et al. 2009). Most predator removal efforts have focused on mammalian predators, but gulls and crows have been targeted at some sites (e.g., Brady and Inglefinger 2008, USDA 2006). Boettcher et al. (2007) state that predator management is "one of the most important and expensive avian conservation measures being implemented on Virginia's barrier islands." Cohen et al. (2009) found that the number of chicks fledged per pair at Westhampton, New York increased with the annual number of cats and foxes trapped. Mean productivity at Maine sites where predator management was conducted was approximately double the productivity at sites without predator management in both 2007 and 2008 (USDA 2008). Productivity of piping plovers at Plymouth Beach, Massachusetts, averaged 1.67 fledged chicks per pair during three years when foxes were removed, compared with 0.86 chicks per pair during the preceding seven years (Service 2009a). Following selective crow removal at Crane Beach in Ipswich, Massachusetts, in 2008, piping plover productivity was the highest since 1999 and exceeded 1.25 fledglings per pair for first time since 2002 (Brady and Inglefinger 2008).

A detailed discussion of threats to Atlantic Coast piping plovers including contaminants, wind turbines, effects of climate change and sea level rise, and the reliability of effort and expenditures for conservation measures is found in the piping plover 5-year status review (Service 2009b).

SEABEACH AMARANTH

In 1993, seabeach amaranth was listed as a threatened species (58 FR 18035). The listing was based upon the elimination of seabeach amaranth from two-thirds of its historic range and continuing threats to the 55 populations that were known at the time (58 FR 18035).

Species Description - Seabeach amaranth is an annual plant and a member of the Amaranth family (*Amaranthaceae*). Upon germination, the plant initially forms a small, unbranched sprig, and soon begins to branch profusely, forming a low-growing mat. Seabeach amaranth's fleshy stems are prostrate at the base, erect or somewhat reclining at the tips, and pink, red, or reddish in color. The leaves are small, rounded, and fleshy, spinach-green in color, with a characteristic notch at the rounded tip. Leaves are approximately 1.3 to 2.5 cm in diameter, and clustered towards the tip of the stem (Weakley and Bucher 1992). The foliage turns deep red in the fall (Snyder 1996). Plants often grow to 30 cm in diameter, consisting of 5 to 20 branches, but occasionally reach 90 cm in diameter, with 100 or more branches. Flowers and fruits are inconspicuous, borne in clusters along the stems. Seeds are 2.5 mm in diameter, dark reddish-brown, and glossy, borne in low-density, fleshy, indehiscent utricles (bladder-like seed capsules or fruits), 4 to 6 mm long (Weakley and Bucher 1992). The seed does not fill the utricle, leaving an air-filled space (Service 1996b).

Habitat – Seabeach amaranth occupies a narrow beach zone that lies at elevations from 0.2 to 1.5 m above mean high tide, the lowest elevations at which vascular plants regularly occur. Seaward, the plant grows only above the high tide line, as it is intolerant of even occasional flooding during the growing season. Landward, seabeach amaranth does not occur more than approximately 1 m above the beach elevation on the foredune, or anywhere behind it, except in overwash areas. The species is, therefore, dependent on a terrestrial, upper beach habitat that is not flooded during the growing season. This zone is generally absent on beaches experiencing high rates of erosion. Seabeach amaranth is not found on beaches where the foredune is scarped by undermining water at high or storm tides (Weakley and Bucher 1992).

The species' primary habitat consists of overwash flats at accreting ends of barrier islands, and lower foredunes and upper strands of non-eroding beaches. This species occasionally establishes small and temporary populations in secondary habitats including sound side beaches, blowouts in foredunes, and sand or shell dredge spoil or beach nourishment material (Weakley and Bucher 1992).

Seabeach amaranth usually occurs on a pure silica sand substrate, occasionally containing shell fragments. The Natural Resources Conservation Service classifies the habitat of seabeach amaranth as either Beach-Foredune Association or Beach (occasionally flooded). Seabeach amaranth habitat occurs within a wetland system classified by Cowardin et al. (1979) as Marine System, Intertidal Subsystem, Unconsolidated Shore Class (Weakley and Bucher 1992).

The habitat of seabeach amaranth is sparsely vegetated with annual herbs and, less commonly, perennial herbs (mostly grasses) and scattered shrubs. The number and type of vegetative associates vary with specific habitat type (i.e., overwash flat, accreting barrier island end, or lower foredune) (Chicone undated). The most constant associates of seabeach amaranth, with which the species almost always co-occurs, are sea rocket (*Cakile edentula*) and seabeach spurge (*Chamaesyce polygonifolia*) (Weakley and Bucher 1992).

Biogeography and Range - Seabeach amaranth is limited by its habitat requirements to a narrow strip of barrier islands and mainland oceanfront beach strands along the Atlantic coast. The original range of this species extended from Cape Cod in Massachusetts to central South Carolina, a stretch of coast approximately 1,600 km (994 miles) long. This stretch correlates with a geographic range of low tidal amplitude. Tidal amplitude and the relative importance of tidal versus wave energy in shaping coastal morphology are thought to limit the geographic range of seabeach amaranth, rather than availability of sandy beach substrates or sea water temperatures. The range of seabeach amaranth is characterized by islands developed by high wave energy, low tidal energy, frequent overwash, and frequent breaching by hurricanes with resulting formation of new inlets (Weakley and Bucher 1992). Some authors have observed that seabeach amaranth tends to occur on south or southeast facing coasts (Weakley and Bucher 1992, Snyder 1996), but a range-wide analysis of beach orientation has not been conducted.

Historic records of seabeach amaranth are known from nine states. Largely due to human activities, the species was eliminated from seven of these states by the 1980s, remaining only in North and South Carolina. Since 1990, the species has been rediscovered in four states from which it had previously been considered extirpated. Seabeach amaranth is still considered extirpated from two states: Massachusetts and Rhode Island. Table 1 gives the dates of rediscovery and the last previously known occurrence of the plant in each state.

Table 1. Rediscovery Dates of Seabeach Amaranth in Four States.

State	Date Rediscovered	Date of Last Previously Known Occurrence
New York	July 2000	1950 (Van Schoik and Antenen 1993)
Delaware	August 2000	1913 (Service 1996b)
Maryland	August 1998	1875 (McAvoy 2000)
Virginia	September 2001	1973 (Service 1996b)

To date, explanations for seabeach amaranth's rediscovery in the northern part of its range remain speculative. Sites in these five states may have been re-colonized by long-distance transport of seeds by wind or currents. At some sites, seeds may have been long buried in sediments used in beach nourishment projects. This hypothesis requires that seeds can remain viable after prolonged off-shore burial, an unknown factor. In Maryland's Assateague Island National Seashore, the NPS has allowed a previously stabilized foredune system to return to more natural conditions. This change in beach management and the possible existence of a persistent seed bank have been cited as factors in the species' return to the area (Ramsey et al. 2000).

The current range of naturally occurring seabeach amaranth is from Water Mill Beach on Long Island, New York, south to Dewees Island in South Carolina; a few reintroduction efforts south of Dewees Island have been unsuccessful (Young 2001; Hamilton 2000a; E. Eudaly, Service, Charleston, South Carolina , personal communication 2008).

Life History - Seabeach amaranth occupies a highly specific and restricted niche as a "fugitive" species in the narrow upper beach zones of newly formed, accreting barrier island ends and non-eroding beach strands. A dynamic, early successional pioneer species, seabeach amaranth is termed a "fugitive" because its populations are constantly shifting to newly disturbed areas. The plant is eliminated from existing habitats by competition and erosion, and colonizes newly formed habitats by dispersal and (probably) long-lived seed banks. A poor competitor, seabeach amaranth is eliminated from sites where perennials have become established, probably because of root competition for scarce water and nutrient supplies (Weakley and Bucher 1992). Seabeach amaranth acts as a capable sand binder (Weakley and Bucher 1992), which is typical of pioneer beach plants. The species is not likely to be a young or recently evolved species, considering its isolation within the genus (it has no apparently close relatives) and its possession of numerous adaptations to the peculiar environment in which it grows (Service 1996b).

Seabeach amaranth habitat exists in dynamic conditions. The same physical forces (e.g., storms, extreme high tides) that create the plant's specific and ephemeral coastal habitat also destroy it. Coastal storms are probably the single most important natural limitation on the abundance of seabeach amaranth. Existing habitat is eroded away, but new habitat is created by island overwash and breaching. Therefore, seabeach amaranth requires extensive areas of barrier island beaches and inlets, functioning in a relatively natural and dynamic manner. Such conditions allow the species to move around in the landscape, occupying suitable habitat as it becomes available (Service 1996b).

Density and Distribution - Density of seabeach amaranth is extremely variable within and between populations. The species generally occurs in a sparse to very sparse distribution pattern, even in the most suitable habitats. A typical density is 100 plants per linear km of beach, though occasionally on accreting beaches, dense populations of 1,000 plants per km can be found. Island-end sand flats generally have higher densities than oceanfront beaches (Weakley and Bucher 1992). Comparing overwash flats, accreting barrier island ends, and lower foredunes, Chicone (undated) found that seabeach amaranth plants growing in foredune habitats tended to be larger, healthier, and have fewer associates. Seabeach amaranth has a strongly clumped distribution (Hancock 1995).

Within its primary habitats, seabeach amaranth tends to be concentrated in the line of wrack material deposited by high tides (Mangels 1991, Weakley and Bucher 1992, Hancock 1995, McAvoy 2000). Observations from New Jersey and Maryland suggest that plants within the wrack line tend to be larger (Service 2002b). Pauley et al. (1999), however, found that plots centered on seabeach amaranth had a lower percent area covered by litter material than random plots, suggesting that litter material may be an advantageous microhabitat for seabeach amaranth only when it contains higher levels of organic material and moisture than bare sand, as in the wrack line.

Life Cycle and Phenology - Individual plants live one season, with a single opportunity to produce seed. The species over-winters entirely as seeds. Germination of seedlings begins in April and continues at least through July. In the northern part of the range, germination occurs slightly later, typically late June through early August. Reproductive maturity is determined by size rather than age, and flowering begins as soon as plants have reached sufficient size. Flowering sometimes begins as early as June in the Carolinas, but more typically commences in July and continues until the death of the plant. Seed production begins in July or August and reaches a peak in most years in September. Seed production likewise continues until the plant dies. Senescence and death occur in late fall or early winter (Service 1996b).

Seabeach amaranth seems capable of essentially indeterminate growth (Weakley and Bucher 1992). However, predation and weather events, including rainfall, hurricanes, and temperature extremes, have significant effects on the length of the species' reproductive season. As a result of one or more of these influences, the flowering and fruiting period can be terminated as early as June or July (58 FR 18035).

Reproduction - As an annual, seabeach amaranth reproduces solely by sexual reproduction by seed, with no vegetative or clonal form of reproduction. The species is monoecious (male and female flowers on the same plant), and, based on morphology of the flower and inflorescence, most likely wind pollinated. Seabeach amaranth is capable of self fertilization, an advantageous adaptation for a pioneer species, allowing the founding of a new colony by a single propagule. Self fertilization likely plays a large, probably dominant, role in seed production (Weakley and

Bucher 1992). Once it reaches maturity, seabeach amaranth flowers and fruits continuously until death or senescence. Late season plants may continue flowering and fruiting with few or no leaves, sometimes producing an aberrant, dense, terminal inflorescence (Weakley and Bucher 1992). Even very small plants produce flowers under conditions of a short (12-hour) photoperiod (Jolls and Sellars 2000), likely an opportunistic adaptation to permit small, late germinating plants to reproduce at the end of the growing season.

Nearly all adult seabeach amaranth plants produce seeds, and fertility is assumed to be high (Weakley and Bucher 1992). Fruit production is correlated with plant weight (Hancock 1995), and large plants are estimated to produce several thousand fertile seeds over a fruiting season (Weakley and Bucher 1992). Within the genus *Amaranthus*, this is a low reproductive rate, but seabeach amaranth has apparently evolved a strategy of producing fewer, larger seeds than other members of its genus. Under favorable conditions, seabeach amaranth shows good reproductive success (Weakley and Bucher 1992).

Seed Dispersal - Seabeach amaranth seeds are dispersed by a variety of mechanisms. The fleshy tissues and air pocket of the utricle cause the fruit to have a lower density than the bare seed. Seeds retained in utricles are easily blown about, deposited in depressions, the lee behind plants, or in the surf. Naked seeds are also commonly encountered in the field, and are also dispersed by wind, but to a much lesser degree than seeds retained in utricles. Naked seeds tend to remain in the lee of the parent plant or get moved to nearby depressions (Weakley and Bucher 1992). Observations from South Carolina indicate that seabeach amaranth seeds are also dispersed in the guts of birds and deposited with their droppings (Hamilton 2000b).

Many utricles remain attached to the parent plant and are never dispersed, leading to *in situ* "planting." This phenomenon has also been observed in sea rocket and may be an adaptation to dynamic beach conditions. If conditions remain favorable at the site of the parent plant, the seed source for retention of that site is guaranteed. If conditions become unsuitable, other seeds have been dispersed to colonize new sites (Weakley and Bucher 1992).

Germination - Fresh seabeach amaranth seeds are physiologically dormant (Baskin and Baskin 1994, 1998). The tough seedcoat requires some physical modification before germination can occur. The primary mechanism(s) for breaking seed dormancy in the field is not known, but possible factors include abrasion, cold, imbibing water, and gradual breakdown over time (Weakley and Bucher 1992; Hancock 1995; Baskin and Baskin 1994, 1998; Hamilton 2000c; Jolls and Sellars 2000). Once dormancy is broken, light and high temperatures (25-35° C) are required for germination (Hancock 1995; Baskin and Baskin 1994, 1998). This high temperature requirement causes seabeach amaranth to germinate later in the season than other dune associates, and limits the time in which new seedlings can grow. Rainfall is also significant in promoting germination (Hancock 1995).

Initial studies have found that seabeach amaranth seedlings cannot emerge from a depth of more than 1 (Hancock 1995) or 2 cm (Service 2002b). Results of these studies, combined with the finding that light is required for germination, are strong evidence that deep burial may completely prevent germination and seedling emergence (Jolls et al. 2001). Seabeach amaranth may have less opportunity to emerge and become established compared to other dune species such as sea rocket, as mean emergence of seedlings (growth rate of the newly sprouted seed) is less than predicted for the species' seed mass (Hancock 1995).

Natural Limiting Factors - Except where suitable habitat has persisted long enough for perennials to become established, the primary limiting factors of seabeach amaranth under natural conditions are abiotic. Abiotic limiting factors are expected for a fugitive species that occupies dynamic, early successional habitats. Weather is an important limiting factor, given the relatively narrow temperature and rainfall requirements for germination and seedling establishment. Flooding, drought, or unseasonable temperatures may impair survival and reproduction. Weather also limits abundance through wind, which may cause burial of seeds and plants by sand. In addition to decreasing germination and seedling establishment, burial may also impact reproduction by covering adult plants prior to seed set. This effect was observed in South Carolina (Hamilton 2000b) and may have occurred in Maryland (Service 2002b).

Under natural conditions interspecific competition for water and nutrients, especially with perennials, may be a significant biotic limiting factor of seabeach amaranth. Weakley and Bucher (1992) cite intraspecific competition as a possible factor in the mortality of young plants, but Hancock (1995) found no evidence of intraspecific density effects. If intraspecific competition limits seabeach amaranth abundance its effects are likely small compared to the effects of competition with perennial species, which possess superior abilities to extract water and nutrients from porous sand. Predators and disease are discussed below under threats.

Population Dynamics - Although the longevity of seabeach amaranth seeds is unknown, several lines of evidence suggest that seed banks may be an important factor in this species' life history (Weakley and Bucher 1992, Baskin and Baskin 1998). The relative roles of fresh and banked seeds are unknown (Service 1996b). In experimental plots in Maryland, a few late-season seedlings emerged from the current year's seed crop (Service 2002b); however the contribution of same-season seed to the current year's population and seed crop is likely small. For a sexually reproducing annual plant, natality is comprised of two components, the seed production rate (or fecundity) and the germination rate.

The viability rates of both fresh and banked seeds are uncertain; more is known about mortality of the plants. Substantial mortality of young plants occurs in some years, prior to reproduction. Hancock (1995) found seven percent survival of seedlings to 40 days of age, with mortality caused primarily by high tide flooding. Flooding resulted in almost 100 percent mortality of propagated plants at three of six experimental transplant sites in South Carolina in 1999. At a fourth site, drifting sand covered most of the transplants, with 10 of 196 plants (about 5 percent) surviving to produce seed (Hamilton 2000b). Burial by blowing sand may have also affected reproduction in New Jersey and Maryland in 2000 (Service 2002b). Unfavorable conditions early in the growing season, including drought, burial, and especially flooding and other storm damage, may reduce seed production by 90 (Weakley and Bucher 1992) to 98 percent (Hancock 1995).

Once past the stage of germination and early growth, mortality rates are generally lower. In the Carolinas, mortality of older plants tends to be caused primarily by webworm predation (Weakley and Bucher 1992). Larger plants may be able to withstand saltwater inundation better than smaller plants; however, prolonged salt water inundation kills almost all plants, regardless of size (Hancock 1995). Storms later in the growing season can effectively and abruptly curtail reproduction for the year (Weakley and Bucher 1992). Plants that have not died from other causes senesce and die in late fall or early winter.

Genetic Variability - Preliminary results from two initial genetic studies of seabeach amaranth suggest that the species' genetic variability is low. A study by Salisbury State University looked for genetic differences in nuclear DNA within and across three groups: propagated plants from Maryland, wild plants from Maryland, and wild plants from Delaware. Overall, genetic variability was low. Wild and propagated Maryland plants were similar, as might be expected, since the propagated plants were produced from wild plants taken from the same area (Service 2002b). Higher levels of genetic variability were found within the sample of plants from Delaware. A second study by Strand (2002) analyzed non-coding regions of nuclear and chloroplast DNA taken from seed and dry leaf samples from New York, New Jersey, North Carolina, and South Carolina. This study found no observable genetic variation among any of the samples. Although the results of these two studies are consistent, these results must be interpreted with caution. Lack of detection does not prove a lack of genetic variability, which might be present in other regions of the genome, or detectable through other techniques (Jolls and Sellars 2000, Strand 2002, Service 2002b).

Population Status and Distribution - As might be expected for a fugitive annual plant of dynamic barrier beach habitats, populations of seabeach amaranth at any given site are extremely variable (Weakley and Bucher 1992). Population size at a site often fluctuates by several orders of magnitude from year to year. The primary reasons for the natural variability of seabeach amaranth are the dynamic nature of its habitat, and the significant effects of stochastic factors such as weather and storms on mortality and reproductive rates. Although wide fluctuations in species populations tend to increase the risk of extinction, variable population sizes are a natural condition for seabeach amaranth, and the species is well adapted to its ecological niche.

Because variability in population size is so great among years, a single survey is a poor measure of a population's health. Assessing site-specific population trends is difficult even with several years of surveys. Weakley and Bucher (1992) suggest that a 5 to 10 year average is a more meaningful measure for assessing the vigor of a seabeach amaranth population. However long-term, consecutive, annual data are available for only a few sites in New York. Estimates of population sizes for seabeach amaranth across its range are imprecise, given available survey data. Early (pre-1987) survey data are limited. Rangewide surveys were conducted in 1987, 1988, and 1990 (excluding states where the species was considered extirpated at the time). Annual statewide surveys have been conducted subsequently in New York, but no comprehensive surveys in North or South Carolina have been carried out since 1990. Suitable areas in New Jersey, Delaware, and Maryland were thoroughly surveyed in 2000, but these efforts did not necessarily extend state-wide. Approximately 14 locations in Virginia were surveyed in 2000, and no seabeach amaranth was found (Belden 2000). In 2001, seabeach amaranth was found on Assateague Island, Virginia, most likely the result of a restoration program in Assateague Island National Seashore in Maryland (Service 2002b).

Since 2000, the number of plants in each state has fluctuated greatly (Table 2). In Delaware numbers have always been low, with a high count for 2002 of 423 plants. New York has always produced the highest number of plants, with the 2000 numbers also being the highest count for the state (244,608 plants). In 2006, 1,551 plants were counted in Maryland and Virginia. Of these 1,551 plants, all but 13 were found on the Maryland side of Assateague Island. Numbers of plants within CNWR (see Virginia numbers in Table 2) have experienced major fluctuations since the species' rediscovery in 2001.

Factors Affecting the Species

Habitat Loss and Degradation - In the geologic past, seabeach amaranth has persisted through even relatively rapid episodes of sea level rise and barrier island retreat. A natural barrier island landscape, even a retreating one, contains localized accreting areas, especially in the vicinity of inlets (Service 1996b).

Erosion is accelerated in many areas by human-induced factors such as reduced sediment loads reaching coastal areas due to damming of rivers and beach stabilization structures. When the shoreline is "hardened" by artificial structures (e.g., seawalls, bulkheads) overwash and inlet formation is curbed. Erosion may also be increasing due to sea level rise and increased storm activity caused by global climate change (58 FR 18035).

Table 2. Seabeach amaranth numbers by year and state.

Year	New York	Delaware	New Jersey	Maryland	Virginia	North Carolina	South Carolina	Total
1987	0	0	0	0	0	3,395	1,341	4,736
1988	0	0	0	0	0	4,433	1,800	6,233
1989	0	0	0	0	0	0	0	0
1990	331	0	0	0	0	1,127	188	1,646
1991	2,251	0	0	0	0	1,170	0	3,421
1992	422	0	0	0	0	32,160	15	32,597
1993	195	0	0	0	0	22,214	0	22,409
1994	182	0	0	0	0	13,964	560	14,706
1995	599	0	0	0	0	33,514	6	34,119
1996	2,263	0	0	0	0	8,357	0	10,620
1997	11,918	0	0	0	0	1374	2	13,294
1998	10,699	0	0	2	0	11,490	141	22,332
1999	31,196	0	0	1	0	588	196	31,981
2000	244,608	32	1,039	4	0	103	2,312	248,098
2001	205,233	83	5,813	869	9	5037	231	217,275
2002	193,412	423	10,908	801	56	4440	0	210,040

2003	114,535	13	5,084	459	22	11,290	1,381	132,784
2004	30,942	4	6,820	531	2	11,213	2,110	51,622
2005	16,813	6	5,795	489	69	19,976	671	43,819
2006	32,553	40	6,522	1,538	13	3,190	721	44,577
2007	3,914	19	2,189	2176	3	872	60	9233
2008	4,416	40	1,139	1041	7	1,575	11,786	19974

Attempts to halt beach erosion through hard structures (i.e., sea walls, jetties, groins, bulkheads) appear invariably to destroy habitat for seabeach amaranth. In the Carolinas, seabeach amaranth is not found on shorelines where bulkheads, sea walls, or rip rap zones have been constructed. Such armoring generally occurs in the primary habitat of the plant, and water and wind erosion lower the profile of the beach seaward of the armoring. The upper beach habitat required by seabeach amaranth (above inundation by tidal action) ceases to exist as the beach is steadily eroded. Groins have mixed effects on seabeach amaranth. Immediately updrift from a groin, accretion sometimes provides or maintains, at least temporarily, habitat for seabeach amaranth; immediately downdrift, erosion usually destroys seabeach amaranth habitat. In the long term, groins (if they are successful) stabilize updrift beaches, allowing succession to perennials, and rendering even the updrift side only marginally suitable for seabeach amaranth. Widespread construction of sea walls, jetties, and other hard stabilization structures in New Jersey, New York, and other northern states is associated with the extirpation of seabeach amaranth from the northern part of its range (Service 1996b).

Even minor structures and non-structural beach stabilization techniques, such as sand fences and beachgrass planting, are generally detrimental to seabeach amaranth (58 FR 18035). Dune stabilization and vertical sand accretion caused by sand fences appear to be detrimental to seabeach amaranth. The effects of dune stabilization by planting vegetation are similar (Service 1996b). Seabeach amaranth very rarely occurs when sand fences and vegetative stabilization have taken place and, in these situations, is present only as rare, scattered individuals or short-lived populations (Weakley and Bucher 1992).

Beach nourishment can have positive site-specific impacts on seabeach amaranth. Although more study is needed before the long-term impacts can be accurately assessed, seabeach amaranth has colonized several nourished beaches and has thrived in some sites through subsequent re-applications of fill material (58 FR 18035). However, on the landscape level, beach nourishment is similar to other beach stabilization efforts in that it stabilizes the shoreline and curtails the natural geophysical processes of barrier islands. These effects are detrimental to the rangewide persistence of the species. In addition, beach nourishment may cause site-specific adverse effects by crushing or burying seeds or plants, or by altering the beach profile or upper beach micro-habitats in ways not conducive to colonization or survival. Deeply burying seeds during any season can have serious effects on populations; this also applies to the placement of dredge spoil (Service 1996b). Burial of the seed bank may be particularly detrimental to isolated populations, as no nearby seed sources are available to re-colonize the nourished site. Adverse effects of beach nourishment may be compounded if accompanied by artificial dune construction and stabilization with sand fencing and/or beach grass, or if followed by high levels of erosion and scarping of the upper beach.

As a fugitive species dependent on a dynamic landscape and large-scale geophysical processes, seabeach amaranth is vulnerable to habitat fragmentation and isolation of small populations (58 FR 18035). Rendering 50 to 75 percent of a coastline permanently unsuitable may doom seabeach amaranth, because any given area will become unsuitable at some time due to natural forces. If a seed source is no longer available in the vicinity, seabeach amaranth will be unable to reestablish itself when the area once again provides suitable habitat. In this way, the species can be progressively eliminated even from generally favorable stretches of habitat surrounded by permanently unfavorable areas. Fragmentation of habitat in the northern part of the species range contributed to the regional extirpation during the last century. Areas of suitable habitat were separated from one another by distances too great to allow recolonization following natural catastrophes (Weakley and Bucher 1992).

Recreational Impacts - Intensive recreational use of beaches can threaten seabeach amaranth populations, both through direct damage and mortality of plants and by impacting habitat. Light pedestrian traffic, even during the growing season, usually has little effect on seabeach amaranth (58 FR 18035). Substantive impacts generally occur only on narrow beaches or beaches which receive heavy recreational use. In such areas, populations are sometimes eliminated or reduced by repeated trampling. While pedestrian traffic appears to be a minor problem in the Carolinas, the heavier traffic borne by northern beaches near major population centers may have been partially responsible for the past extirpation of seabeach amaranth in those regions (Service 1996b).

Vehicle use on the beach during the growing season can have detrimental effects on the species, as the fleshy stems of this plant are brittle and easily broken. Plants generally do not survive even a single pass by a truck tire (Weakley and Bucher 1992). Sites where vehicles are allowed drive on beaches often show severe population declines. Dormant season vehicle use has shown little evidence of significant detrimental effects, unless it results in massive physical erosion or degradation of the site, such as compacting or rutting of the upper beach. In some cases, winter vehicle traffic may actually provide some benefits for the species by setting back succession of perennial grasses and shrubs with which seabeach amaranth cannot compete successfully. However, extremely heavy vehicle use, even in winter, may have some negative impacts, including pulverization of seeds (Weakley and Bucher 1992).

Beach grooming, more common on northern beaches, may also have contributed to the previous extirpation of seabeach amaranth from that part of its range. Motorized beach rakes, which remove trash and vegetation from bathing beaches, do not allow seabeach amaranth to colonize long stretches of beach (Service 1996b). In New Jersey, plants were found along a nearly continuous length of beach, noticeably interrupted by stretches that are routinely raked.

Herbivory - Predation by webworms (caterpillars of small moths) is a major source of mortality and lowered fecundity in the Carolinas, often defoliating plants by early fall (58 FR 18035).

Defoliation at this season appears to result in premature senescence and mortality, reducing seed production, the most basic and critical parameter in the life cycle of an annual plant. Webworm predation may decrease seed production by more than 50 percent (Weakley and Bucher 1992). In the Carolinas, four species of webworm collected from seabeach amaranth have been identified: beet webworm (*Loxostege similialis*), garden webworm (*Achyra rantalis*), southern beet webworm (*Herpetogramma bipunctalis*), and Hawaiian beet webworm (*Spoladea recurvalis*). Webworm herbivory of seabeach amaranth has not been documented in Delaware or Maryland. Although the four webworms so far identified on seabeach amaranth are native species, their use of barrier islands has probably been altered by changes in the coastal plain landscape (i.e., extensive agricultural use), development of barrier islands, and introduction of weedy plants that can also serve as host plants. All four webworms are probably much more abundant now than in pre-Columbian times. For this reason, the level of predation that seabeach amaranth is experiencing is likely unnaturally high (Service 1996b). Webworm herbivory is probably a contributing, rather than a leading factor in the decline of seabeach amaranth. However, in combination with extensive habitat alteration, severe herbivory could threaten the existence of the species (Weakley and Bucher 1992).

Utilization and Collection - Seabeach amaranth is generally not threatened by over-utilization or collection, as it does not have showy flowers and is not a component of the commercial trade in native plants. However, because the species is easily recognizable and accessible, it is vulnerable to removal, vandalism, and incidental trampling by curiosity seekers. Seabeach amaranth is an attractive and colorful plant, with a prostrate growth habit that could lend itself to planting on beach front lots. The species' effectiveness as a sand binder could make it even more attractive for this purpose. In addition, seabeach amaranth is being investigated by the USDA and several universities and private institutes for its potential use in crop development and improvement. Over-collection and the development of genetically altered, domesticated varieties are potential, but currently unrealized, threats to the species (58 FR 18035).

New Threats - New threats have been documented since the species was listed in 1993. These factors are lesser threats than habitat modification, but may increase the risk of extinction by compounding the effects of other, more severe threats.

Several additional herbivores of seabeach amaranth have been observed including deer (*Odocoileus virginianus*), Sika deer/elk (*Cervus nippon*), eastern cottontail (*Sylvilagus floridanus*), and migratory song birds (Van Schoik and Antenen 1993), as well as feral horses in Maryland (Service 2002b). Hancock (1995) suggests that grasshoppers may feed on seabeach amaranth, but does not indicate whether this was actually observed. There is also strong circumstantial evidence for seabeach amaranth herbivory by grasshoppers (Service 2002b). Minor insect damage was noted on a few New Jersey plants in 2000, and larval insects were observed feeding on seabeach amaranth in 2001; to date, no species have been identified. In addition, a cluster of New Jersey plants appeared to have been damaged by a congregation of loafing gulls (*Larus* spp.), based upon feathers and droppings. As with webworms, the abundance of these newly documented predators on barrier islands is increased by human activities.

Asiatic sand sedge (*Carex kobomugi*) has been suggested as another potential threat. This sedge is strongly rhizomatous and dune-forming (NPS and Maryland Natural Heritage Program 2000). Asiatic sand sedge was introduced to the east coast (New Jersey to Virginia) from East Asia in the 1930s for erosion control and as a sand stabilizer. The species is known to crowd out native dune species (Virginia Department of Conservation and Recreation and Virginia Native Plant Society undated). Asiatic sand sedge may be detrimental to seabeach amaranth by direct competition, and by reducing habitat suitability through sand stabilization and dune building. Control programs have been implemented in managed natural areas where this species occurs.

The first known disease of seabeach amaranth was documented in South Carolina in 2000. During the 2000 growing season, a fungus (*Albugo* sp.) was observed on seabeach amaranth in several South Carolina sites (Strand and Hamilton 2000). This pathogen is a white rust or water mold. Lesions developed on the leaves during flowering, starting in July; leaves later fell off (Service 2002b). Effects on infected individuals were significant, resulting in death of the plants two to four weeks after lesions were first observed. Anecdotal observations suggest that isolated plants tended to avoid infection (Strand and Hamilton 2000).

<u>Rangewide Trends</u> - Total population trends can disguise important regional trends. Recent population increases have occurred almost entirely in the northern part of the species' range (Table 2). Seabeach amaranth has undergone a geographic expansion, reappearing in five states over 11 years, after decades of extirpation from the entire northern portion of its range. New York sites account for virtually all of the recent increases in total population size rangewide, offsetting lower numbers in the south. Although natural population variability and survey effort must be considered, the recent trend in North Carolina appears downward. The low 1999 and 2000 plant totals in that state are especially noteworthy given the relatively high survey effort in these years (approximately 75 percent of known sites visited). In South Carolina, the species experienced a 90 percent reduction in that state following 1988 storms, including Hurricane Hugo. However, survey efforts since 1998 suggest that populations may have recovered in some areas of South Carolina.

Despite the natural variability of seabeach amaranth's population size and distribution and inconsistent survey efforts, some trends can be discerned from the available data. The species has undergone a significant geographic expansion, both in terms of the number and distribution of occupied states and counties. Since the first intensive surveys in 1987, the species' extant range has increased approximately 650 km (404 miles) to the north, but contracted about 50 km (31 miles) to the south. Numerically, the population has seen a dramatic increase. Equally notable is the geographic shift of the species' stronghold (in terms of total numbers) from North Carolina to New York.

Despite the geographic expansion and booming New York populations, seabeach amaranth is still vulnerable to local and regional extirpation. The primary threat to seabeach amaranth, habitat alteration, has not significantly diminished since the species was listed and new threats have been subsequently discovered. Small population sizes in many locations increase the risk that seabeach amaranth will become locally extirpated. Almost 44 percent of sites documented in 2000 contained fewer than 10 plants, including more than 60 percent of sites in North Carolina (Hamilton 2000a; Jolls and Sellars 2000; McAvoy 2000; NPS 2001a, 2001b; U.S. Army Corps of Engineers 2001; Young 2001).

One final trend of note is the propagation of seabeach amaranth in greenhouses and laboratories and the transplanting of propagated individuals or seed back into the wild. Such programs have been undertaken in Delaware, Maryland, North Carolina, and South Carolina (McAvoy 2000, NPS and Maryland Natural Heritage Program 2000, Jolls and Sellars 2000, Hamilton 2000b). These efforts have met with mixed results; thus a long term trend cannot be predicted.

LOGGERHEAD SEA TURTLE, GREEN SEA TURTLE, and LEATHERBACK SEA TURTLE

The loggerhead sea turtle was listed as threatened in the U.S. in 1978 (NMFS and Service 1991a), the green sea turtle was listed as endangered in 1978 (NMFS and Service 1991b), and the leatherback sea turtle was listed as endangered in 1970 (NMFS and Service 1992). In March 2010, the Service and NMFS published a proposed rule in the Federal Register to recognize nine distinct populations of loggerhead sea turtles worldwide. Under this proposed rule, the loggerhead sea turtle population that would be affected by the proposed actions is the north Atlantic population and it is proposed to be listed as endangered (72 FR 12598). There is designated critical habitat outside of Virginia for the green and leatherback sea turtles, but none has been designated for the loggerhead sea turtle.

This account emphasizes sea turtle nesting and breeding biology, which is the subject of this biological opinion. Additional information about the life history of these sea turtle species and their habitat use, behavior, and survival at sea can be found in other documents, including the recovery plans (NMFS and Service 1991a, 1991b, 1992), five-year statues reviews (NMFS and Service 2007a, 2007b, 2007c), and other sources (National Research Council 1990).

Species Description - The loggerhead is the smallest of the three turtles, with a mean carapace length of 92 cm and a mean mass of 133 kg (NMFS and Service 1991a), compared to 102 cm and 136 kg for the green sea turtle (National Research Council 1990). Green sea turtles nest primarily in the tropics and are rarer nesters at higher latitudes, while loggerheads have significant nesting populations outside the tropics (National Research Council 1990). Leatherback sea turtles are the largest turtle and the largest living reptile in the world. Mature males and females can be as long as 6.5 ft and weigh almost 2,000 pounds. The leatherback is the only sea turtle that lacks a hard, bony shell. The U.S. Caribbean, primarily Puerto Rico and the U.S. Virgin Islands, and southeast Florida support minor nesting colonies of the leatherback, but represent the most significant nesting activity within the U.S. (James et al. 2005).

Life History and Population Dynamics - Loggerhead females are believed to reach sexual maturity at a minimum age of 30 years (Snover 2002). At the start of the breeding season, they migrate from foraging areas on the continental shelf to mating areas in the waters near their nesting beaches (Schroeder et al. 2003). Reproductive females exhibit the desire to return to their birthplace to lay their eggs (Miller et al. 2003). Females may be inseminated by multiple males (Bollmer et al. 1999). After mating, males return to their foraging areas while females remain in the waters near their natal beaches to emerge onto their nesting beaches to lay eggs. The following account of nesting biology is a synopsis of Miller et al. (2003).

Loggerhead females tend to nest on high wave energy, sandy ocean beaches. Gravid females emerge from the wash zone and crawl toward the dune line until they encounter a suitable nest site, typically on open sand at the seaward base of a dune, but sometimes in vegetation. The female clears away surface debris with the front flippers, creating a "body pit," then excavates a flask-shaped nest cavity with her hind flippers. Loggerheads lay an average of 112 eggs per nest. After laying, the female covers the nest with sand using all four flippers. Once the nest-covering phase is complete, she crawls back into the sea. Individual females may nest 1 to 6 times per nesting season, at intervals of 12-16 days, during the late spring to late summer. Intervals between nesting shorter than 10 days indicate that the previous nest attempt was likely aborted due to disturbance. Mature loggerheads nest every two to three years, on average (Schroeder et al. 2003). Nest incubation period (from laying to hatching) depends on temperature and ranges from 48 to 90 days at the extremes. Emergence of hatchlings from the nest cavity usually occurs within four days of hatch, but may take up to two weeks longer. Hatchling emergence from nests usually occurs at night when temperatures are lower and diurnal predators are inactive. Hatching success typically approaches 80 percent; after hatchlings leave the beaches, they typically fall prey to a variety of predators, including birds, fish, and sharks (National Research Council 1990).

Sex ratio of hatchlings depends on temperature during incubation. Below 84° Fahrenheit (29° Celsius), more males are produced than females and above that temperature more females are produced (Carthy et al. 2003). Furthermore, fluctuating incubation temperatures often produce more females than stable temperatures, and temperature, hydration, and gas exchange during incubation can determine hatchling size, early swimming behavior, growth rate, and hatchling robustness (Carthy et al. 2003). Newly emerged hatchlings immediately head for the sea, most likely orienting toward the water by moving toward the brightest horizon and away from dark silhouettes (Lohmann and Lohmann 2003). Sea turtles are most negatively sensitive to blue and green light and loggerheads in particular are averse to yellow light (Witherington and Martin 1996). Once in the sea, hatchling loggerheads swim into the waves and eventually enter the open ocean, where they will spend the first 6.5 to 11.5 years of their lives primarily at the top of the water column, until finally moving to foraging areas on the continental shelf (Bolten 2003).

Green sea turtles nest in two, three, or four year intervals, and may lay as many as nine clutches within a nesting season (NMFS and Service 1991b). Clutch size varies from 75-200 eggs, and incubation ranges from about 45-75 days (NMFS and Service 1991b).

Leatherback sea turtles nest in two to three year intervals, and average five to seven clutches per nesting season (NMFS and Service 1992). Leatherbacks average fewer eggs per clutch, 70-80 eggs, and incubation ranges from 55-75 days (NMFS and Service 1992).

Nesting habitat - Less is known about factors that cue nest site selection than about anthropogenic disturbances that discourage nesting (Miller et al. 2003). Typical nesting areas are sandy, wide, open beaches backed by low dunes, with a flat, sandy approach from the sea (Miller et al. 2003). Nesting is nonrandom along the shoreline, but studies of the physical characteristics associated with nests versus random or non-nesting sites on the beach have produced varying results. Some factors found to determine nest selection are beach slope (3 of 3 studies), temperature (2 of 3 studies), distance to ocean (1 of 3 studies), sand type (2 of 2 studies), and moisture (1 of 3 studies), although the results were occasionally contradictory (Miller et al. 2003). Data indicates that the leatherback sea turtle prefers beaches with proximity to deep water and generally rough seas (NMFS and Service 1992). Other factors examined but not found to be significant were sand compaction, erosion, pH, and salinity. Although the process of nest site selection is not well understood, a successful nest must be laid in a low salinity, high humidity, and well-ventilated substrate that is not prone to flooding or burying due to tides and storms and where temperature is optimal for development (Miller et al. 2003).

Status and Distribution – Approximately 58,000 loggerhead nests were estimated in the U.S. Atlantic in 1983 (NMFS and Service 1991a) and between 53,000 and 92,000 nests from 1989 to 1998 (Turtle Expert Working Group 2000). Within the northern subpopulation (north Florida to Virginia), studies in South Carolina and Georgia have documented a decline in number of nests (Ehrhart et al. 2003). Based on genetic evidence, male loggerheads disperse freely among sites within the U.S. Atlantic population, while females are faithful to their natal sites (Bowen et al. 2005). Because sex ratio is determined by temperature during incubation (Miller et al. 2003), the northern part of the U.S. Atlantic population, which includes Virginia, apparently provides a disproportionate number of males to the larger population (Mrosovsky et al. 1984, Hanson et al. 1998, Hawkes et al. 2007).

"Analyses of historic and recent abundance information by the Marine Turtle Specialist Group (MTSG) indicate that extensive population declines for the green sea turtle have occurred in all major ocean basins. The MTSG analyzed population trends at 32 index nesting sites around the world and found a 48-65percent decline in the number of mature females nesting annually over the past 100-150 years. The two largest nesting populations of green turtles are found at Tortuguero, on the Caribbean coast of Costa Rica, and Raine Island, on the Great Barrier Reef in Australia, where an annual average of 22,500 and 18,000 females nest per season, respectively. In the U.S., green turtles nest primarily along the central and southeast coast of Florida; present estimates range from 200 - 1,100 females nesting annually" (NMFS 2008). In the southeast U.S., the majority of green turtle nesting occurs in Florida. The green turtle nesting population of Florida appears to be increasing based on 19 years (1989-2007) of index nesting data from throughout the state (http://research.myfwc.com/features/view_article.asp?id=27537).

"Because adult female leatherbacks frequently nest on different beaches, nesting population estimates and trends are especially difficult to monitor. In the Pacific, the International Union for the Conservation of Nature (IUCN) notes that most leatherback nesting populations have declined more than 80. In other areas of the leatherback's range, observed declines in nesting populations are not as severe, and some population trends are increasing or stable. In the

Atlantic, available information indicates that the largest leatherback nesting population occurs in French Guyana, but the trends are unclear. Some Caribbean nesting populations appear to be increasing, but these populations are very small when compared to those that nested in the Pacific less than 10 years ago. Nesting trends on U.S. beaches have been increasing in recent years." (NMFS 2008). Similar to the green turtle, in the southeast U.S., the majority of leatherback nesting occurs in Florida. The leatherback nesting population of Florida appears to be increasing based on 19 years (1989-2007) of index nesting data from throughout the state (http://research.myfwc.com/features/view_article.asp?id=27537).

Factors Affecting the Species – Numerous factors affect sea turtle growth, survival, and behavior while at sea from when they leave natal beaches as hatchlings until they mature and return to beaches to breed. These factors are discussed in detail in the 5-year status reviews for the three turtle species (NMFS and Service 2007a, 2007b, 2007c). The discussion herein is limited to factors affecting turtle nesting. Threats to the loggerhead sea turtles on the nesting grounds are similar to those faced by the green and leatherback sea turtles. The following threats affect all three species, though there may be some differences in susceptibility among the three turtle species.

Weather and Tides - Storm events may erode beaches and destroy nests or cause nest failure due to flooding or piling of eroded sand on the nest site. Beach erosion due to wave action may also decrease the availability of suitable nesting habitat (Steinetz et al. 1998), leading to a decline in nesting rate on a particular beach. Sea level rise, often in combination with human development along beaches, is contributing to erosion, changes in beach characteristics, and more intensive management of many beaches

Predation - Predation of eggs and young by mammals, birds, and ghost crabs may eliminate up to 100 percent of the nests and any hatchlings that emerge on beaches where predation is not managed (National Research Council 1990). This is a natural phenomenon that has always affected sea turtle populations, but due to reduced turtle population sizes, reduced turtle habitat availability, and unnatural population increases of nest predators in some areas, predation is a significant threat to remaining breeding populations and is actively controlled through predator exclusion and predator control on most beaches where turtles nest.

Human Activities - Crowding of nesting beaches by pedestrians can disturb nesting females and prevent laying (NMFS and Service 1991a). Furthermore, the use of flashlights and campfires may interfere with sea-finding behavior by hatchlings. Beach driving, including pedestrian traffic, vehicle use, and beach cleaning pose a risk of injury to females and live stranded turtles, can leave ruts that trap hatchlings attempting to reach the ocean (Hosier et al. 1981, Cox et al. 1994), can disturb adult females and cause them to abort nesting attempts, and can interfere with sea-finding behavior if headlights are used at night (NMFS and Service 1991a). Driving directly over incubating egg clutches can cause sand compaction, which may decrease hatching and emergence success and directly kill pre-emergent hatchlings (NMFS and Service 2007a). Artificial lighting on human structures may affect turtle behavior in a similar manner (Witherington and Martin 1996). Beach cleaning can directly destroy nests. Poaching is a problem in some countries and occurs at a low level in the U.S. (NMFS and Service 2007a). An increased human presence may also lead to an increase in the presence of domestic pets that can depredate nests and an increase in litter that may attract wild predators (National Research Council 1990).

The rate of habitat loss due to erosion and escarpment formation may be increased when humans attempt to stabilize the shoreline, either through renourishment (Dolan et al. 1973) or placement of hard structures such as sea walls or pilings (Bouchard et al. 1998). Vehicle traffic may alter the beach profile leading to steeper foredunes (Anders and Leatherman 1987), which may be unsuitable for nesting. Improperly placed erosion control structures such as drift fencing can act as a barrier to nesting females. Humans may also introduce exotic vegetation in conjunction with beach development, which can overrun nesting habitat, make the substrate unsuitable for digging nest cavities, invade nests and desiccate nests, or trap hatchlings.

Reduced nesting success on constructed/augmented beaches could result due to sand compaction, escarpment formation, and changes in the beach profile. Sand compaction has been shown to negatively impact sea turtles, particularly concerning beach nourishment projects. Research has shown that placement of very fine sand and/or the use of heavy machinery can cause sand compaction on nourished beaches (Nelson et al. 1987, Nelson and Dickerson 1988). Significant reductions in nesting success (i.e., false crawls occurred more frequently) have been documented on severely compacted nourished beaches (Nelson and Dickerson 1987, Nelson et al. 1987), and increased false crawls may result in increased physiological stress to nesting females. Sand compaction may also increase the length of time required to excavate nests and result in increased physiological stress (Nelson and Dickerson 1988).

ENVIRONMENTAL BASELINE

Status of the Species Within the Action Area

Piping Plover - Piping plovers use wide sandy beaches on Assawoman, Wallops, and Assateague Islands for courtship, nesting, and raising chicks. Suitable habitat has a variable distribution along the seaward edge of islands within the action area year to year due to the competing effects of erosion and vegetation succession. Annual piping plover production within the action area indicates that all islands possess some nesting habitat, with the greatest areas of suitable beach occurring on Assawoman Island and in the Hook and Overwash portions of Assateague Island. Little potential nesting habitat is available on the south end of Wallops Island, but the north end of Wallops Island has been rapidly accreting and appears to offer increasing quantities of wide sandy beach which is suitable for nesting.

CNWR, Virginia Department of Game and Inland Fisheries (VDGIF), The Nature Conservancy (TNC), and USDA Wildlife Services personnel conduct piping plover nest surveys on islands within the action area and observe fledgling production to determine fledgling production per nesting pair. Results of the 2005-2009 piping plover nest surveys within the action area are shown in Tables 3-6 below.

Table 3. Piping Plover Nesting Trends - Assateague (Overwash) Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	8	12	16	2.00
2006	8	10	4	0.50
2007	6	8	6	1.00
2008	6	6	5	0.84
2009	3	5	3	1.00

Table 4. Piping Plover Nesting Trends - Assateague (Hook) Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	32	39	58	1.81
2006	27	30	37	1.37
2007	22	30	24	1.09
2008	30	36	21	0.70
2009	23	33	12	0.52

Table 5. Piping Plover Nesting Trends - Wallops Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	2	5	0	0.00
2006	1	1	0	0.00
2007	3	3	0	0.00
2008	0	0	0	0.00
2009	4	5	10	2.50

Table 6. Piping Plover Nesting Trends - Assawoman Island (Service 2009c).				
Year	Nesting Pairs	Nest Attempts	Chicks Fledged	Fledglings/Pair
2005	30	37	34	1.14
2006	23	25	28	1.22
2007	23	25	40	1.74
2008	26	35	30	1.15
2009	26	27	31	1.19

The 2010 piping plover season is underway while this opinion is being written. Piping plover breeding activity appears to be similar to past years at most sites. NASA has initiated a more formal monitoring program in 2010, and documented 4 plover nests to date on the northern end of Wallops Island (Figure 2). One of these nests fledged chicks successfully (4 chicks – J. Mitchell, NASA Wallops Environmental, personal communication 2010).

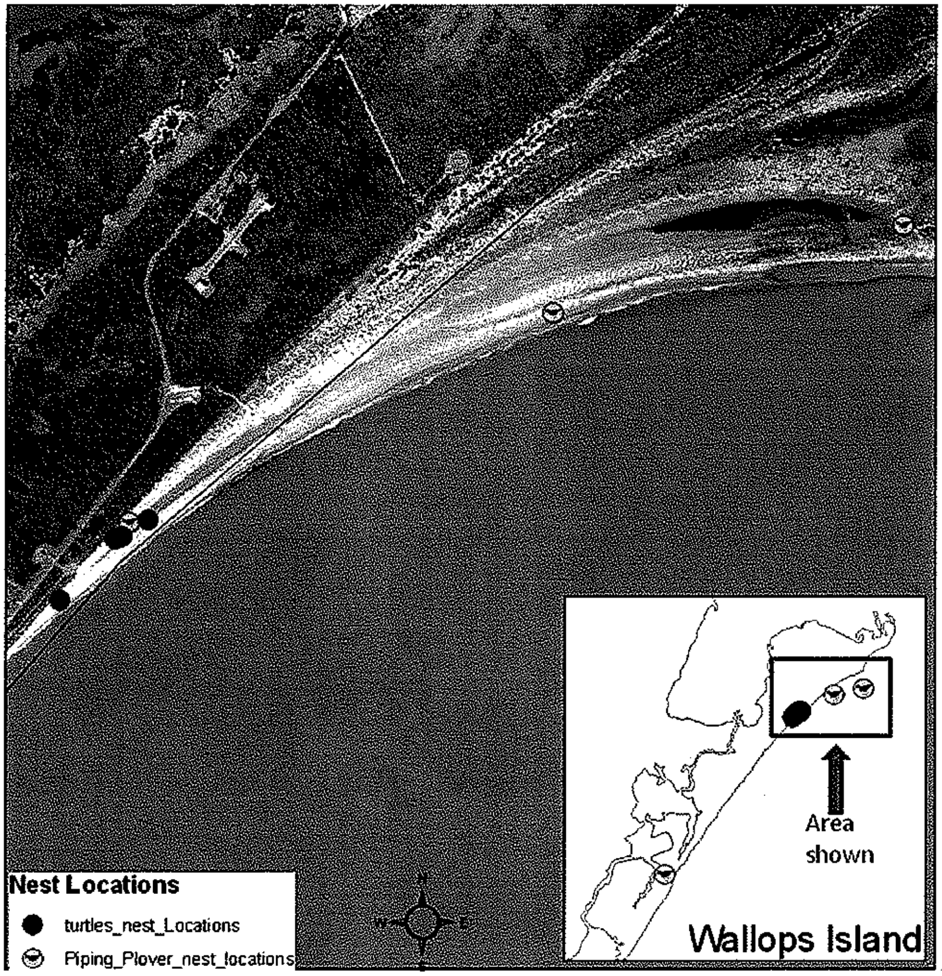


Figure 2. Sea turtle and plover nest locations on north Wallops Island in 2010.

During migration most of the plovers that nest farther north within the Atlantic population likely pass through the action area. This may involve birds passing through in flight, but many of these birds may stop and roost or feed on the beaches, tidal flats, and overwash areas within the action area. Little is known about the extent of use of the action area by migrating plovers beyond knowledge that they use the area.

Seabeach Amaranth - Seabeach amaranth surveys have been conducted on Assateague Island 12 times since 1966, with 9 of those surveys performed on an annual basis between 2001 and 2009. All surveys were negative except for a single plant discovered in the Hook in 2004. Assawoman and Metompkin Islands were surveyed for the first time in 2009 and no plants were found. No additional occurrences are known within the action area. Seabeach amaranth routinely occurs on the Wild Beach portion of Assateague Island just north of the action area. No surveys for this species have been conducted on Wallops Island to date, and the species has not been documented there despite the presence of suitable habitat.

Sea Turtles - Loggerhead sea turtles have occasionally nested within the action area. In mid-July 2008, a loggerhead nest was discovered by NASA personnel on north Wallops Island. Following flood inundation from several fall storms, CNWR personnel recovered approximately 170 eggs from the nest in October 2008. None were viable. In addition to this nest occurrence on WFF, a low level of loggerhead sea turtle nesting has become relatively common on CNWR.

Although green sea turtles and leatherback sea turtles are not known to have nested within the action area, the action area falls within the geographic range in which both species have shown nesting behavior. In 1996, a leatherback was seen displaying nesting behavior in daylight on the Maryland portion of Assateague Island National Seashore. Although a possible egg cavity was found on the beach, no eggs were discovered (Rabon et al. 2003). In 2006, a leatherback carcass was discovered on the southern tip of Assawoman Island at Gargatha Inlet.

A green sea turtle nest was recorded near Sandbridge, Virginia in 2005 outside of the action area (SeaTurtle.org 2006). Green sea turtles are present within the waters of the action area and there may be potential for nesting within the action area.

Nesting behavior is most often detected by the presence of crawl tracks turtles leave in the sand as they traverse the beach. CNWR staff document evidence of sea turtle nesting within the action area as tracks are discovered and conduct surveys for turtle nesting primarily in conjunction with plover monitoring. The following table presents recorded nesting behavior for sea turtles within the action area (Service 2009d).

Table 7. Sea Turtle Nest Activity 1974-2009 (Service 2009d).

Location	False Crawls	Nests	Unknown Crawl Type	Total Activity
Assawoman	1	0	0	1
Wallops	7	5	0	12
Hook	18	3	0	21
Overwash	6	4	0	10

To date in 2010, NASA personnel and contractors have reported four loggerhead sea turtle nests on north Wallops Island within NASA's recreational beach area (Figure 2). All of the nests have had the presence of eggs confirmed. In addition, NASA personnel documented a false crawl in the narrow beach in front of the seawall near the northern extent of the existing seawall. The turtle crawled ashore, but did not appear to nest. The tracks indicated that it encountered the seawall on at least three attempts to move farther landward before returning to sea.

Factors Affecting Species Environment Within the Action Area

A suite of existing actions affect listed species on Wallops Island; these involve flight operations and support operations associated with WFF. Of those, some are performed by NASA while others are performed by various military branches, MARS, and private contractors of these organizations. The activities include ongoing rocket launches and related training, testing, and preparation; maintenance of existing buildings and infrastructure, including the existing shoreline stabilization structures; and operation of UAVs and aircraft overhead, primarily launched from Wallops Main Base. NASA and its contractors also conduct security patrols, surveys and monitoring for a variety of species and resources to support planning future actions, and other similar activities peripheral to NASA's primary mission also occur on Wallops Island. Many of these ongoing operations are considered in the Service's May 2010 biological opinion on NASA's Launch Range Expansion.

On Service lands, personnel actively manage invasive vegetation within action area. Phragmites (*Phragmites australis*) is found on the Hook and Overwash areas of Assateague Island. The Service, VDGIF, TNC, contractors, and universities conduct surveys for breeding birds, sea turtle nests, and seabeach amaranth throughout the action area each year. Predator control to benefit piping plovers and sea turtles during the nesting season affects both plover and sea turtle reproduction within the action area. Mammalian and avian predator control is conducted on Wallops Island.

Recreational use of the northern portion of Wallops Island (NASA personnel after-hours recreational area) occurs seasonally, with most activity occurring in spring and summer months. On CNWR, limited seasonal use of vehicles on the beach occurs. Other recreational use includes wildlife observation, sunbathing, and other typical beach recreation. CNWR staff posts signage and implement closures to aid in protecting sensitive resources and routinely patrol the beach and recreational use areas.

Storms and ocean currents contribute to erosion, accretion, and sand transport along the islands within the action area. Storms occur frequently, with widely varying effects on the shoreline and beach habitats. Both tropical storms and nor-easters (winter low pressure systems that tend to hug the Atlantic coast) can greatly alter the profile and amount of beach habitat among years, and these storms are what creates and maintains the overwash areas where most plovers nest. The existing seawall protects WFF from damage from storms and large waves. Little to no sandy beach exists on the seaward side of the wall and the shoreline seaward of the wall has been steepened by the presence of the seawall and the scour that results when waves encounter the seawall.

NASA reports an erosion rate of 3.3 m/year on southern Wallops Island, and there is little to no beach remaining seaward of the geotubes and seawall installed to protect sensitive infrastructure. In contrast, the beach on the north end of Wallops Island has been rapidly accreting. The beach and dune habitat found on the seaward side of the north end of Wallops Island is prone to natural beach stabilization and vegetation succession proceeding from sheltered areas toward areas more exposed to overwash and erosion during storms. This can render areas unsuitable for piping plover use and sea turtle nesting. The feature known as Fishing Point, the southernmost point of land on the Hook section of CNWR, has also been rapidly accreting. This mass movement of sand dictates where exposed sandy beach habitat will be available for piping plovers and sea turtles in any given year.

Sea level rise has affected the shoreline and beach habitats in the region. Combined with coastal storms, sea level rise has contributed to accelerated coastal erosion and shoreline change within the past few decades. The effects of sea level rise and climate change are difficult to distinguish from the natural coastal processes, but will continue to contribute to coastal change.

Wild bean (*Strophostyles holvola*) has been discovered on the southern end of Assawoman Island. The growth habit of this native plant may limit piping plover nesting habitat on the island in the future. Asiatic sand sedge has been found on the beach dune near the southern end of Wallops Island. This invasive exotic species has not spread significantly from where it was first observed, but it represents a potential threat because of its potential to spread and reduce the suitability of habitat for plovers, seabeach amaranth, and possibly sea turtles.

Recreational boating and fishing is common immediately offshore of all of the islands within the action area, and some boat landings and recreational use of the otherwise inaccessible beaches occurs, both permitted and illegally. The Chincoteague inlet is a maintained channel that provides boat passage from the ocean to Chincoteague Bay, and this well-used channel is located between CNWR and Wallops Island. These activities may result in disturbance to listed species on the beach, and boat traffic results in incremental increases in risk of contaminants (e.g., fuel and oil spills).

Navy and NASA facilities on Wallops Island are equipped with exterior lights at ground level, along catwalks, and at Federal Aviation Administration mandated heights for aircraft orienteering. Exterior lights can disorient hatchling sea turtles and may cause them to crawl toward the light rather than into the surf (NASA 2010a).

EFFECTS OF THE ACTION

The effects of the proposed action are discussed separately for the initial beach reconstruction, which includes the seawall extension and repair, placement of sand, and creation of a beach; expansion of WFF and ongoing operations; and the subsequent renourishment for the 50-year life of the project. To be conservative with respect to the species in this analysis when there is uncertainty in the range or type of effects that may result from the proposed action, we assess the effects that are most detrimental.

INITIAL BEACH RECONSTRUCTION

Seawall Extension and Repair - Construction of the seawall is expected to result in disturbance to any plovers and sea turtles that occur in the vicinity of the narrow beach where the construction activities will occur. During the period when plovers are nesting, they are not expected to occur in the area because of the limited amount of suitable nesting habitat. During migration and after nesting, plovers may occasionally forage along the beach or fly through the area while traveling among other foraging areas in the region. The construction activity, including noise, operation of vehicles, and presence of construction personnel may result in temporary disturbance. In response, plovers are expected to fly away from the location where the activity is occurring or alter their flight path to avoid the activity.

During the period when sea turtles are nesting they are expected to occur in the area, but not in abundant numbers because of the limited amount of suitable nesting habitat. The noise and vibrations from heavy equipment may temporarily disturb sea turtles in the area. Any sea turtles in the vicinity are expected to move away from the immediate vicinity of construction activity. Because construction will occur in areas that may become shallowly inundated during high tides or periods of heavy wave action, the construction activity is expected to result in nearshore sediment suspension that will increase the turbidity and reduce visibility within the nearshore environment. Small quantities of fuel and oil (< 1 gallon) are also expected to enter the water as a result of equipment working in wetted areas. Any sea turtles in these areas or moving through these areas may experience temporary reductions in visibility resulting from the turbidity; less frequently, temporary reductions in visibility may occur from contaminants. Small quantities of fuel and oil may result in death or impairment of invertebrate prey of piping plovers within very limited areas. While toxicity to plovers is unlikely to occur, reduction in prey may reduce the suitability of habitat in affected areas.

These effects, if they occur, are expected primarily in spring, summer, and fall months when these species are expected to occur in the region. During the winter, these effects are not anticipated because the species are not expected to occur in the area.

If any seabeach amaranth plants occur within the construction area, they are likely to be killed, crushed, or uprooted by construction activity. Outside of the growing season, amaranth seeds may be buried or moved into unsuitable conditions as a result of construction activity. Because seabeach amaranth is not known to occur in the project area and the construction area does not include likely amaranth habitat, these potential effects are unlikely to occur.

Once completed, the presence of the seawall is expected to change local patterns of erosion and the characteristics of the shoreline and beach in the vicinity of the seawall. The increased scour in the immediate area is expected to result in loss of sediment near the seaward toe of the seawall and steepening of the shoreline in front of the seawall. At the southern terminus of the seawall extension, erosion is expected to increase due to the altered wave action and eddying that occurs when waves encounter an object. The Corps (2010) modeling indicated that the presence of the seawall will result in a loss of approximately 13.2 ft of beach within the first 3,000 ft south of the terminus of the seawall in their projections for a 1,500 foot extension which is most similar to the proposed design. This increased erosion is expected to extend approximately 5,000 ft southward, to just south of the Assawoman Inlet. The beach immediately south of the seawall extension is narrow and degraded due to erosion, and geotubes were placed in this area several years ago. The increased erosion is expected to further erode the shoreline seaward of the geotubes and reduce its already limited suitability for plovers and seabeach amaranth. No sea turtle nesting is expected in the vicinity.

Because the proposed action includes beach and dune renourishment following the seawall extension, the effects of the increased erosion are expected to be of relatively short duration. If the addition of sand is accomplished within one year of the seawall completion, it is unlikely that the accelerated erosion will result in the extent of beach loss predicted in the Corps (2010) document.

Dredging/Sand Placement - Because the operation of the dredge is limited to offshore areas and will not affect the shoreline beyond the delivery of sand, it will not affect the species considered in this opinion under the Service's jurisdiction; the effects to sea turtles at sea are addressed through NASA's section 7 consultation with NMFS.

The operation of heavy equipment on Wallops Island, the presence of personnel on the beach in conjunction with sand placement, the presence of surveyors, and associated support activities will result in disturbance to piping plovers using the area for foraging or passing through the area while moving among foraging areas in the vicinity. Any plovers using these areas are expected to temporarily cease normal foraging, roosting, or flight behavior and fly to adjacent suitable areas where there is not disturbance or alter their flight paths to avoid areas where activity is occurring. Similarly, sea turtles during nesting season may be temporarily disturbed by on-shore construction activities and move to other nearby areas where there is no disturbance. The suitability of the beach for plovers and sea turtles in the area where these activities will be occurring is low, and these effects are consequently expected to be small.

The placement of sand may bury any seabeach amaranth plants that occur on the beach. Because of the low likelihood of seabeach amaranth occurring within the construction area, this potential effect is unlikely. Seeds of seabeach amaranth may be similarly buried, preventing their germination or transport to other areas of more suitable habitat.

Pumping of sand slurry to the beach will result in increased turbidity in the nearshore waters as suspended fines return to sea leaving the heavier sand on the beach. Turbidity is expected to occur during sand pumpout, as well as a period after pumpout when the fine sediments left in or on the newly created beach following pumpout are resuspended by normal wave action or by storm-associated wave action. This increased turbidity may affect sea turtle behavior as they prepare to come ashore to nest, and may affect behavior and orienting of any hatchling sea turtles entering the nearshore waters. Depending on the location and extent of turbidity, sea turtles may also avoid adjacent beaches. Because nearshore sediment movement is northward along the northern section of Wallops Island, the turbidity may reduce the likelihood of turtles nesting on the north Wallops beach where nesting occurred in 2010, and may affect the survival of any hatchlings that result from nesting in that area.

The operation of heavy earthmoving equipment and other equipment involved in pumping and moving sand is expected to result in small amounts of fuel, oil, lubricants, and other contaminants entering the water. Small quantities of these substances may result in death or impairment of invertebrate prey of piping plovers within limited areas. While toxicity to plovers is unlikely to occur, reduction in prey may reduce the suitability of habitat for plovers in affected areas.

The addition of sand dredged from the offshore shoal may result in a beach that is similar to a natural beach in appearance, but will be significantly different from a natural beach in sand density and compaction, grain size and assortment, and beach-associated fauna, including invertebrates, and the nutrients and chemical characteristics of the sand. A review of the effects of renourishment on beach fauna, including piping plover, sea turtles, and seabeach amaranth is provided within the Committee on Beach Nourishment and Protection, National Research Council (1995), and the discussion below describes many of the factors addressed in the book as they relate to this project.

The existing beach and associated plants and animals that occur within the area prior to beach reconstruction will be buried deeply during placement of sand, and many of them will only return to the beach through recolonization from adjacent areas. Some species are likely to recolonize the area within a few months, but other species, such as some of the flies, insects, and crustaceans may require much longer as a result of long life cycles. These species are prey for piping plovers and as a result of this difference in the beach habitat, suitability for plovers is expected to be significantly lower than at a natural beach of similar size and configuration. Over time, the faunal characteristics of a natural beach are expected to return as the created beach is recolonized by beach-associated fauna and plants, and as wave action, wind, rain, and other natural forces weather the beach. After recolonization of the beach by invertebrates, the beach may become higher quality foraging habitat for plovers than surrounding natural beaches because the beach will remain free from vegetation for a period of time (Melvin et al. 1991) and may be higher and wider than nearby eroding beaches.

The physical characteristics of the beach will affect the suitability for sea turtle nesting. Because of the relatively extensive beach following reconstruction and the relatively high elevation of the proposed berm compared to many natural beaches in the area, the newly created beach may be appealing as a nesting area to sea turtles in the area. In 2010, a false crawl and a nest occurred at the location where the beach will be placed, and some sea turtle nesting on the beach is expected.

Because the sand differs from other beaches in the area (sand grain size is almost twice that of the natural beach on north Wallops Island), the suitability for sea turtle nesting may differ from natural beaches. NASA stated in the draft PEIS that the sand placed on the beach would be similar to sand on the beaches in the area, but information on sand characteristics is not available with the exception of information on sand grain size which indicated that the sand to be used for initial beach reconstruction from shoal A was over twice the average diameter of sand on north Wallops Island.

Crain et al. (1995) conclude that the effects of a beach renourishment on sea turtle nesting is not predictable based on other renourishments, and potential effects should be considered on a case-by-case basis. The sand characteristics following beach and dune reconstruction are unlikely to be similar to those that occur on natural beaches in the area, especially shortly after deposition.

The characteristics that may be important to sea turtle nesting include gas exchange, moisture characteristics (drainage, desiccation, water potential), temperature, soil cohesion/shear characteristics, compaction, and others (Crain et al. 1995, Byrd 2004). The material that is placed will likely differ in some or all of these characteristics.

Based on the large grain size of the sand from shoal A, the relatively long distance from the water line to the berm/dune interface where turtles would be expected to nest, and that sand will be placed over and around the rock seawall for most of the project area, desiccation may be expected because the sand will likely drain quickly, the rock seawall will interfere with maintaining a natural moisture gradient, and the area may be infrequently affected by waves. The sand color is expected to be similar to that which occurs on the beaches of the area because the material that occurs in the offshore shoals is eventually transported to the beaches and likely originates from the same material as that which occurs on the beach. However, any differences in color, grain size, and moisture content may affect sand temperatures. Because the gender of sea turtles is determined by incubation temperatures, even relatively slight changes in sand temperature may alter the sex ratio of hatchlings. The large grain size is expected to maintain gas exchange that is appropriate for sea turtle egg development. The cohesiveness and shear characteristics of the sand are likely to differ from natural beaches in the area due to the relatively large grain size, and less cohesiveness and lower sheer strength are expected. This characteristic is not expected to interfere with adult females excavating an egg chamber, but it may reduce the ability of nestlings to emerge from the egg chamber under some conditions. Compaction of the sand is expected to occur as a result of the use of heavy equipment and pumping of heavy slurry during sand placement. The amount of equipment use and the associated degree of compaction is not known, but due to the need to place sand over the seawall and contour the beach to design specifications, compaction is expected to occur. This compaction can reduce the ability of females to excavate an egg chamber, and can also reduce gas exchange, drainage, and other sand characteristics.

Crain et al. (1995) and Byrd (2004) note that differences in turtle use and turtle nest success between nourished and natural beaches reduce over time. As wave action weathers the beach profile and re-sorts the sediments, the suitability for turtle nesting changes. Because the characteristics and the relative suitability of the beaches in the area for sea turtle nesting are not well known it is not possible to accurately predict the success of sea turtle nesting attempts that may occur within the area following beach and dune reconstruction. It is possible that the beach will be more suitable for sea turtle nesting than other beaches in the area due to its relatively high elevation and different sand characteristics, and nest attempts may be successful. However, nest failure and reduced rates of hatchling emergence are expected to occur on this beach due to one or more of the factors described above.

Following placement of the sand, beachgrass planting and sand fence installation will occur on the seaward side of the dune adjacent to the new beach. Depending on the timing of the installation, it may result in disturbance to piping plovers and sea turtles utilizing the beach shortly after construction. This disturbance is expected to cause plovers to flush and move to other areas and sea turtles nesting may result in false crawls and selection of other sites for nesting. Planting and sand fence installation are expected to occur shortly after construction of the beach and dune. Consequently, these activities will occur before seabeach amaranth has a chance to become established, and no effects to seabeach amaranth are expected.

The presence of sand fence may affect sea turtles and plovers. The planned installation of the sand fence is expected to allow movement of adult sea turtles above the berm and into the dune area, and if turtles enter this area for nesting the sand fence design will not inhibit them from returning to sea. If nestling sea turtles hatch landward of the sand fence they will be able to move around sand fence sections to reach the sea, but because of their small size and relatively limited mobility on land, sand fence has the potential to entrap a small fraction of hatchling turtles, particularly if sand fence is not maintained or if other debris becomes entangled in the sand fence that prevents hatchling movements. The presence of sand fence may also deter plover nesting close to the sand fence and may increase the risk of plover depredation by providing cover for predators in close proximity to plover nests. Presence of sand fence may capture and retain seeds of seabeach amaranth, but may also collect sand at a rate that prevents seabeach amaranth from becoming well established.

Following the initial placement of sand on the beach and dune, some portion of this material will be transported onto the natural beaches adjacent to the project area. Because of the expected sand transport patterns, the sand is expected to move to the north and be deposited on north Wallops Island and portions of CNWR, and also to the south, where it will be deposited on Assawoman Island. The amount and degree of deposition on these islands is unknown and is dependent on the environmental conditions, storms, wave action, and other factors that may affect littoral sand transport. Over time, the deposition of the relatively large sand grains will affect the mean sand grain size and other physical characteristics of these beaches. These changes may either improve or reduce the suitability of beaches for plover nesting and foraging, seabeach amaranth establishment and survival, and sea turtle nesting and nest success. These changes will result in degradation of habitat, reducing the nesting success of plover and sea turtles and reducing use of the adjacent beaches by sea turtles, plovers, and seabeach amaranth.

EXPANSION OF WALLOPS FLIGHT FACILITY AND ONGOING OPERATIONS

The beach and dune reconstruction and renourishment as proposed will create foraging habitat for plovers or nesting habitat for plovers and sea turtles. This new and more suitable foraging and nesting habitat in the vicinity of the existing seawall is likely to result in increased use of this area by plovers and sea turtles, and an increased likelihood of seabeach amaranth occurring. The proximity of this new beach habitat to NASA activities and infrastructure increases the potential effects of NASA and Navy activities affecting these species. The Service's May 2010 biological opinion analyzed the effects of NASA's WFF Expansion and Infrastructure Improvements and ongoing operations on sea turtles, piping plovers, and seabeach amaranth. The types of effects discussed in that biological opinion will occur with greater intensity/severity and increased frequency as a result of the placement of potential habitat in close proximity to the activities considered in that biological opinion.

Through the 50 year life of the project, the amount and suitability habitat in close proximity to NASA's primary operations is expected to change. Erosion is expected to begin to reduce the amount of habitat adjacent to NASA facilities as soon as the initial beach reconstruction is completed, and over time, the beach is likely to become unsuitable for plover nesting and possibly sea turtle nesting as well. Following each beach renourishment event, the amount of habitat will increase such that it may again support plover and turtle nesting and conditions appropriate for establishment of seabeach amaranth. As these changes in habitat occur, the amount of effect is also expected to change as a result of changes in habitat use by the listed species. Because the use of the habitat is not readily predictable, we assume that an elevated level of effect occurs as long as a beach remains seaward of the seawall. The increased level of effects resulting from NASA's operations is discussed below. Additional description of the types of effects can be found in the May 10, 2010 biological opinion.

Noise - Ignition of rocket engines for orbital launches or static tests would produce instantaneous noise audible for a considerable distance from Launch Complex 0. In close proximity to the launch sites, within the area where the beach and dune reconstruction will occur, the noise generated will be high intensity across a broad range of frequencies. Sound intensity may exceed 160 dB on the beach and dune in close proximity to launch sites. The WFF Range Safety Office, using the NASA rocket size/noise equation (NASA 2009), estimated noise levels expected to occur during launches of envelope vehicles from each launch pad in the complex. An LMLV-3(8) rocket launched from pad 0-B will produce a noise level of 129 dB at 1.1 km, attenuating to 108 dB up to 12.6 km from pad 0-B. As many as 12 such launches could be performed per year at pad 0-B. Noise levels from Taurus 2 rockets launched from pad 0-A would reach 124 dB within a 1.55 km radius, attenuating to 108 dB at a distance of 9.6 km from pad 0-A. Static tests would produce noise levels identical to those of Taurus 2 launches from pad 0-A. As many as 6 launches and 2 static tests could be performed per year at pad 0-A. These noise levels are expected to be sustained for 30 to 60 seconds during a launch and for up to 52 seconds during a static test. Following the beach reconstruction, piping plovers and sea turtle nests may occur within 100 m of the launch sites, and when they occur between 100 m and 1.55 km of launches, they will be subjected to high intensity sound.

Deafening is not expected at the decibel levels predicted at 1.1 to 1.5 km from launches, but progressively closer to the rockets, the noise intensity may reach levels that could cause tissue damage. While not known in birds specifically, sound intensity of near 180 dB can result in nearly instantaneous tissue damage (McKinley Health Center 2007). Exposure to noises within these radii could deafen piping plovers present during ignition if exposed to high intensity noise. Deafness would significantly impair a piping plover's ability to breed, shelter, and behave normally. In addition to deafening, low frequency and high intensity sound that would be expected in very close proximity to the launch sites may be debilitating and cause disorientation or loss of balance, but these effects are not well established (Leventhall et al. 2003). Birds may be able to recover from sound-induced deafening over time (Adler et al. 1995), but some period of deafness may result from loud noises. Birds may recover from disorientation and other sound-induced effects, but the amount of time required is not known for piping plovers. While debilitated, birds will be subject to increased vulnerability to predators and physiological stress resulting from inability to detect and avoid predators, feed, care for eggs/young, and seek shelter.

Burger (1981) demonstrated startle effects in birds exposed to anthropogenic sound pressure of 108 dB. Within the area of the beach and dune reconstruction, sound of much greater intensity is expected to occur frequently during launches of the several different types of rockets. Plovers that are not debilitated by high intensity noise are expected to be disturbed by launches. Plovers exposed to these levels of sound are expected to exhibit a startle response that interferes with normal behaviors, including breeding, feeding, and sheltering. This may include flushing from nests when incubating eggs, interruption of feeding or courtship, or similar responses. Because most of the noises are of short duration, plovers are expected to return to normal behavior within a few minutes of the noise. The combination of the sound with a visual stimulus such as a rocket in flight is expected to exacerbate the startle response of the plovers, particularly for those in close proximity to the launch sites for which the visual and auditory disturbance will be very close together, likely resulting in additive disturbance. Because of the intensity of sound and proximity to the launches, plovers that nest within the new beach area may permanently abandon nests, or they may flush from nests temporarily.

Atmospheric noise has been demonstrated to prevent sea turtles from entering an area. Considering the close proximity of potential sea turtle nesting habitat, high intensity noise that occurs during rocket launches is expected to prevent sea turtles from coming ashore to nest near the launch pads. The intensity of noise close to launch pads may be sufficient to impair the development of sea turtle eggs. Sand above the eggs is expected to attenuate the sound, but the degree of attenuation is not known. Noise is not expected to have an effect on seabeach amaranth.

Vibration - Some energy from rocket launches and static tests on Wallops Island will manifest as vibration in the ground near the launch pad. Vibration may be significant from rocket launches, engine tests, and open burns. Effects from vibrations are likely to be confined to an additive disturbance to adult piping plovers and nesting sea turtles that may cause birds and turtles to temporarily cease normal behaviors. The close proximity of potential habitat to launch sites may result in vibrations significant enough to affect egg viability for both sea turtles and plovers nesting within the new beach. Vibrations are not expected to have an effect on seabeach amaranth.

Rocket Exhaust - Rocket exhaust from Pad 0-B is directed out over the Atlantic Ocean by a vent located in the base of the gantry. Exhaust from launches and static tests at Pad 0-A will be directed out over the Atlantic Ocean through a flame trench in the launch pad. Wildlife within 200 to 300 m of the exhaust ports during engine ignition is expected to be injured or killed. Piping plovers or sea turtles exposed directly to the exhaust could be burned by hot gas or by caustic combustion products.

Combustion products in solid propellant rocket exhaust include aluminum oxide particles and hydrogen chloride. These contaminants have the potential to affect wildlife in areas subjected to the highest concentrations of these contaminants. Because the flame trench will direct the exhaust directly over portions of the newly created beach, on the new beach near the launch pads combustion products may reach a concentration that is toxic to piping plovers, sea turtles, or seabeach amaranth (NASA 2005, 2009), potentially resulting in physiological stress, injury, impairment, or death.

Aluminum oxide particles in the atmosphere are efficient scavengers of water vapor and hydrogen chloride, and these particles produce hydrochloric acid. Hydrogen chloride vapor may exist in hazardous quantities in the immediate vicinity of launch pad 0-B at the completion of a launch. Piping plovers, sea turtles, and their nests, as well as seabeach amaranth that occurs on the new beach near launch pads may be adversely affected (NASA 2005, 2009). In high concentrations, hydrogen chloride may damage tissues causing impairment, injury, or death. Carbon monoxide concentrations may temporarily reach levels that could affect plovers and sea turtles, but the concentrations are expected to decrease rapidly to levels that will be unlikely to cause significant effects. However, carbon monoxide may have a small additive adverse effect resulting in temporary impairment.

Aircraft Operation - Most of the effects of aircraft noise to listed species are similar to the effects of rocket noise discussed above. Plovers may be additionally disturbed by the operation of aircraft maneuvering or overflying the area where nesting occurs. In a 2004 letter, the Service concurred that operation of UAVs would not be likely to adversely affect plovers if they avoided known nesting areas by at least 1,000 ft. However, operation of aircraft, including UAVs, has potential to affect plovers outside of nesting season, and during nesting season if nests are not detected and avoided. Plovers are thought to be susceptible to this type of disturbance because they perceive aircraft as potential avian predators. Balloons may have a similar effect on plovers. However, not all aircraft operation is likely to result in disturbance, and plovers are most likely to be disturbed by flights at low altitude down the beach or just offshore. Because the new beach will be located immediately adjacent to the existing UAV runway, UAV operation is expected to disturb plovers attempting to use the area. Effects to plovers may include flushing from nests when incubating eggs, interruption of feeding or courtship, or similar responses. Because most of the aircraft activity is of short duration, plovers are expected to return to normal behavior after aircraft depart the area. Aircraft operations may also disturb sea turtles that are attempting to nest on the new beach or near the UAV runway. Effects to sea turtles may include aborted nesting attempts, delayed nesting attempts, or similar responses. Aircraft operations are not expected to affect seabeach amaranth.

Rocket and Equipment Transportation and Construction - Support activities prior to a rocket launch may disturb sea turtles attempting to nest and nesting plovers on the sound end of Wallops Island. Construction noise will be confined to the vicinity of Pad 0-A and existing infrastructure within Wallops Island and is not expected to result in more than minor behavioral responses. These activities are expected to result in temporary increases in ambient noise, lighting, and human activity, but these activities are mostly distant from beaches and suitable habitat. Any effects to sea turtles and piping plovers that result from the construction of these facilities or transportation of rocket parts between them and the launch complex on the south end of the island are expected to be insignificant and discountable. Because these activities do not occur on the beach, they are not expected to adversely affect the seabeach amaranth.

Lighting - Rockets staged at Launch Complex 0 are uplit with metal halide lighting for two days prior to and two days following a launch. Other structures within the launch complex use amber LEDs or low pressure sodium bulbs for exterior night lighting. The close proximity of several facilities to the newly created beach is likely to result in elevated levels of light. Anthropogenic light sources have had documented negative effects on sea turtles. Adult females looking for nesting beaches seek dark stretches of suitable shoreline. Unshielded lights can deter females from crawling onto a beach to nest. Bright full-spectrum or white lighting within view from the beach can cause female sea turtles to abandon nest attempts. At hatching, juveniles emerge and seek the nearest available light source, which on an undeveloped beach is the horizon over the ocean. Bright full-spectrum or white lighting shining in the vicinity of a nest can disorient emerging hatchlings, leading them away from the ocean and leaving them more vulnerable to predation, desiccation, or crushing by vehicles. Hatchlings that have reached the surf can also become disoriented by lighting and have been documented to leave the surf (NMFS and Service 2007a). Some of these behavioral effects on adult turtles and disorientation of young turtles are expected to occur. Lighting is not expected to have an effect on seabeach amaranth.

Monitoring, Maintenance, and Security Patrols - Monitoring activities, maintenance activities, and security patrols on the newly created beach have similar effects on listed species because they may involve operation of vehicles on the beach, in addition to people on foot in areas where plovers, seabeach amaranth, and sea turtles may occur. Security patrols have been ongoing at WFF for a number of years, and have likely presented some level of disturbance to piping plovers and nesting sea turtles, and perhaps seabeach amaranth. The presence of vehicles or humans on foot is known to disturb piping plovers and sea turtles.

Effects of human activity to nesting piping plovers can range from relatively minor disturbance that temporarily interferes with normal breeding, feeding, and sheltering behavior to injury or death of plover chicks or destruction of an entire plover nest, or sustained disturbance resulting in nest abandonment. The presence of people near plover nests can result in disturbance, and foot traffic and vehicle use on the beach could crush nests, eggs, or hatchlings. Vehicles can also create ruts capable of trapping hatchlings.

Closure of a plover nesting area will avoid these effects within that area to the extent that the closure is observed, but plovers are expected to nest outside of the established closure area in some cases. In these cases, monitoring, placing nest exclosures, and posting signage will minimize the potential effects, but not avoid them. After hatching, young plovers may move away from nesting areas, making them vulnerable to these effects throughout a much larger area. Even with surveys and monitoring conducted at a high frequency, there is potential to disturb nesting that is not detected and injure or kill young plovers. Outside of the nesting season, it is likely that there is some small impact to plovers that migrate along the barrier islands during fall migration to their wintering grounds. This impact would be from interference with foraging due to human activity and vehicle use on the beaches.

Similar effects are expected for nesting sea turtles. Personnel conducting monitoring and maintenance, as well as security patrols may inadvertently disturb nesting females, crush eggs within the egg cavity, or crush, entrap, or disturb hatchlings attempting to leave the nest. Vehicle use on the beaches may compact beach sand and/or injure, kill, or disturb female turtles attempting to nest. Monitoring for turtle activity followed by erecting exclosures to protect nests will avoid some adverse impacts, but is not sufficient to avoid all impacts.

Indirect effects to piping plovers and sea turtles could include an increased predation rate due to human activity. Human activity may result in trash on the ground, which could both attract predators and increase the carrying capacity of the predators due to increased food availability. The increased numbers of predators may increase risk of disturbance, nest loss, and adult mortality of plovers and increase losses of sea turtle eggs and nests. Plovers may expend more energy in predator surveillance and avoidance and that energy expenditure could decrease overall fitness.

Crushing of seabeach amaranth plants by maintenance and monitoring personnel, security patrols, or other vehicles may occur in some circumstances. Conducting surveys to identify and protect plants will help to minimize these effects, but are not sufficient to avoid the adverse effects.

Interaction of Effects - Frequent disturbance to plovers and sea turtles resulting from mission preparation and support may disturb the species to the extent that they avoid use of the area. If they avoid use of the area, listed species may not be subjected to the most intense and severe effects expected to occur during rocket launches. In addition, because the suitability of the newly created beaches is expected to be relatively low for a period following placement, use by plovers and sea turtles may be reduced and as a result some of the most severe effects resulting from launches may be reduced. However, because some migrant plovers and nesting sea turtles use the beach only for limited periods of time, frequent disturbance and/or low habitat suitability is not expected to completely prevent the most severe impacts from occurring. Because seabeach amaranth is not affected by noise or disturbance, the interactions of effects are limited to plovers and sea turtles.

Summary of Effects – Initial Beach Reconstruction and Expansion of Wallops Flight Facility and Ongoing Operations

Because there is little or no suitable habitat for listed species in the project area currently, the direct effects are likely to be minimal. However, the indirect effects that result from creating beach and dune habitat of unknown quality and quantity in close proximity to an area that will be subjected to frequent and occasionally severe impacts from NASA operations is likely to result in effects including injury and death of individual piping plovers and sea turtles, and possibly seabeach amaranth. The indirect effects to piping plovers and sea turtles are expected to include increased disturbance and interference with normal behavior resulting in reduced feeding, breeding, and sheltering activity, and destruction/loss of eggs and young or failure of nests. The indirect effects to seabeach amaranth are limited to changes in the suitability of potential habitat resulting from contaminants and disturbance. The lack of certainty in the suitability of these habitats and the manner and extent of the interactions among the different effects that are likely to occur makes accurate prediction of the effects impossible.

As a result of the low likelihood that leatherback and green sea turtles will occur in the action area and be adversely affected by the on-going and proposed actions described above, we believe that effects described above are insignificant and discountable for these species.

FUTURE BEACH RENOURISHMENT

Most of the types of effects of future renourishment are similar to those discussed for the initial placement of material. The operation of equipment involved in sand pumpout and placement may disturb piping plover breeding, feeding, and sheltering; interfere with sea turtle nesting; and effect seabeach amaranth seed germination and transport. Because future beach renourishment will likely occur when a beach is present, the effects on species are likely to be greater than those that occur during the initial beach and dune reconstruction.

When renourishment is conducted, the beach and berm are expected to have eroded to the point where nesting by plovers is unlikely within the area identified to receive renourishment. Consequently, the effects of renourishment are expected to be limited to disturbance to migrant plovers that may be using the area for feeding and sheltering. Sea turtle nesting may still occur on the beaches when renourishment is planned, but NASA expects to avoid sand placement that may affect nests, and monitoring is expected to determine the locations of nests prior to placement. These nests may be subject to reduced hatch success as a result of changes in the moisture regime, gas exchange, and physical characteristics of the beach that result from adjacent sand placement and operation of heavy equipment in the general vicinity of the nests.

Seabeach amaranth may occur on the beaches where renourishment is planned. Because most of the plants would be expected to occur on the upper berm or dune, NASA intends to avoid placement of sand that would kill plants, and renourishment is not expected to directly affect plants, with the exception of any individuals that are not identified. However, renourishment is expected to affect seeds, and will likely result in burying or destruction of approximately half of the seeds that occur on the renourished beach.

Use of North Wallops Island Borrow Area - In future renourishment efforts, NASA may obtain up to half of the sand for renourishment from the north Wallops Island borrow area instead of from offshore shoals. Because the delineated borrow area either includes or is immediately adjacent to areas where piping plovers and sea turtles nest and to seabeach amaranth habitat, this borrow activity has the potential to directly and indirectly affect these species.

The operation of heavy equipment on the beach will result in disturbance of all plovers that use the area for foraging or nesting. Outside of the nesting season this disturbance is expected to result in frequent alteration of feeding and sheltering behavior for plovers, causing physiological stress and increased vulnerability to predators. If the activity is conducted during nesting season, it is expected to interfere with all aspects of breeding including territory establishment, courtship, nesting, egg-laying, incubation, brooding, and feeding. This is expected to result in lack of nesting, failure of nests, or mortality of chicks.

Similarly, such activity is expected to deter sea turtle nesting through frequent disturbance or result in reduced hatch success and hatchling survival by increasing the chance of crushing nests, eggs, and hatchlings; compacting the sand in the nesting area; and trapping hatchling turtles in vehicle ruts. Equipment use on the beach at night may result in injury or death of female sea turtles attempting to nest and hatchling turtles on the beach.

Sand excavation and operation of heavy equipment on the beach may also uproot or crush seabeach amaranth and remove, bury, or destroy seeds that may be present.

Following completion of the sand excavation, the resulting changes in the beach profile will decrease its suitability for all listed species. Because the borrow area is the most seaward portion of the beach, the remaining beach will have a steeper initial profile, be more vegetated, and have different physical properties (e.g., sand grain characteristics, drainage) than a natural beach. These characteristics make it less suitable for use by sea turtles, plovers, and seabeach amaranth. As wave action and weathering affect the beach position and profile, vegetation is killed or uprooted by wave action, and the beach contour, sediment stratification, and other characteristics return, the new beach suitability and the amount of available potential habitat is expected to improve. The beach conditions are expected to be completely unsuitable for use by nesting plovers and sea turtles during the first year following sand excavation, with limited amounts of suitable habitat available one year following excavation, and returning to conditions similar to those that existed prior to excavation by three years following excavation.

Accretion of the beach in the borrow area, which has been occurring for several years, is expected to continue, resulting in gradual expansion of the beach following each sand excavation action. However, the use of the north Wallops Island borrow area is expected to prevent any expansion or increase in the availability, occupancy, or use of habitat on north Wallops Island by plovers, sea turtles, or seabeach amaranth.

Sand Transport and Renourishment - Movement of sand material from the borrow area to the renourishment area along the beach using heavy equipment will result in extensive sand compaction on the beaches of both north Wallops Island and in the renourished area. This compaction is expected to reduce the suitability for sea turtle nesting for a period of at least two years. Similar to the effects identified in the initial beach /dune reconstruction, the sand that is placed on the renourished beach will initially be unsuitable for use by the invertebrates and plants characteristic of natural beaches, and much of the fauna on the beach will be killed or adversely impacted by the renourishment. Use of the north Wallops Island borrow area may allow some faster recovery of flora and fauna if seeds or fauna in the sand survive transportation and placement, but because at least half of the renourishment material will originate from offshore shoals the difference is not expected to significantly improve the recovery time of beach-associated flora and fauna.

In NASA's BA and draft PEIS, they state that renourishment activities will avoid direct impacts to nesting plovers and sea turtles. The extensive amount of time that may be required to conduct renourishment may not always allow NASA to complete renourishment outside of periods when these species are nesting, but through NASA's monitoring program, nesting activity will be located prior to construction and areas where nesting is occurring will be avoided. Avoiding direct impacts to plover and sea turtle nesting activity and seabeach amaranth during the excavation of sand from the north Wallops Island borrow area and the placement of sand on the beach will reduce impacts, but the increased activity in the vicinity of the listed species may still result in reduced nesting success and survival.

For the purposes of the analysis, the effects of the future renourishment, including both excavation of sand from the north Wallops Island borrow area as described in the draft PEIS and the placement of the sand, is expected to result in loss of up to four piping plover nests (up to 16 eggs/chicks) in the first breeding season following each renourishment cycle. If borrow and renourishment is conducted during breeding season, that season is the one in which complete reproductive failure is expected. The action is also expected to result in loss of two plover nests (up to 8 eggs/chicks), through either nest failure or adults failing to nest, in the year following renourishment for each renourishment cycle.

Failure of up to two sea turtle nests, including all eggs, is expected to occur within the first year following each beach renourishment cycle, and one additional nest is expected to fail in the second year following each beach renourishment. In addition, injury or death of one adult sea turtle during beach renourishment and associated activities is expected to occur within each beach renourishment cycle.

Because detailed plans of future renourishment activities are not available, the actual effects that result may vary significantly. For example, if the north Wallops Island borrow area is not used and future renourishments are conducted using only material from offshore shoals, almost all of the direct adverse effects could be avoided. Additionally, because of the general nature of the consideration of future renourishment within the draft PEIS, it is foreseeable that the effects could exceed those anticipated in some or all of the future renourishment actions. As a result, the analysis of effects is limited to the general scenario described and considered within the draft PEIS, and it is not possible to consider the detailed effects that may result. Consequently, consultation will be required on all future proposed renourishment actions in conjunction with the detailed design of each project and the development and consideration of each NEPA evaluation that is tiered to the SRIPP PEIS.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. The Service is unaware of any cumulative effects to listed species within the action area.

CONCLUSION

After reviewing the status of the piping plover, green sea turtle, leatherback sea turtle, loggerhead sea turtle, seabeach amaranth, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program, as proposed, is not likely to jeopardize the continued existence of these species and is not likely to destroy or adversely modify designated critical habitat. Critical habitat has been designated for the piping plover and sea turtles, but no critical habitat occurs within the action area for these species.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by NASA for the exemption in section 7(o)(2) to apply. NASA has a continuing duty to regulate the activity covered by this incidental take statement. If NASA (1) fails to assume and implement the terms and conditions or (2) fails to require any applicant/contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to any permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, NASA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.

Regarding the seabeach amaranth, sections 7(b)(4) and 7(o)(2) of the ESA generally do not apply to listed plants. However, limited protection of listed plants from take is provided to the extent that the ESA prohibits the removal and reduction to possession of federally listed endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service anticipates incidental take of piping plovers and sea turtles will be difficult to determine for the following reasons: finding a dead or injured individual may be difficult to detect and take may be masked by seasonal fluctuations in numbers and other environmental factors. The amount of take anticipated is based on historic and recent use of the action area by these species and the effects that are expected to occur as a result of the proposed actions.

Incidental take is discussed below in three sections as analyzed and discussed in the "Effects of the Proposed Action" section above. The amount of take anticipated in each section is not interchangeable. Take will be considered exceeded if the effects in one section or effects of a particular activity in one section result in a greater amount of take than is anticipated for that section or specific type of activity, respectively.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

INITIAL BEACH RECONSTRUCTION

Piping plover - No plover nesting is expected to occur within the construction area prior to construction, and consequently, no take of breeding plovers, nests, eggs, or young is anticipated to occur during initial beach reconstruction. Take in the form of harassment is anticipated when migrant plovers, which includes adults and young-of-the year, use the beach reconstruction area and adjacent areas for foraging and roosting after the end of the breeding season. Take in the form of harm is anticipated as habitat is lost due to increased erosion resulting from the seawall extension, the reduction in prey resulting from contaminants associated with construction activities, and the lack of prey in sand initially placed to create the beach/dune. Because of the low quality of habitat within and immediately adjacent to the construction area, the amount of incidental take is expected to be small. Therefore, take of up to one post-fledging plover per year for three years beginning when construction of the seawall is initiated may occur as a result of harassment and harm.

Sea turtles - The initial beach reconstruction is anticipated to result in take in the form of injury or death of one adult loggerhead sea turtle through crushing a female that has come up on the beach to nest. In addition, take of one loggerhead sea turtle nest is anticipated as a result of reconstruction activity on the beach encountering a nest that had not been identified through surveys and monitoring. This could occur as inadvertent excavation, operation of equipment over the nest resulting in compaction or crushing of the contents, burying to a depth that would prevent egg development or hatchling emergence, or placement of equipment and materials such as slurry pipes, sand stockpile embankments, or similar features.

Take in the form of harassment is anticipated during initial beach reconstruction through increased turbidity in nearshore waters that affect the likelihood adult loggerhead sea turtles will come ashore to nest, and affect the ability of hatchling loggerhead sea turtles to orient in the nearshore waters once they depart the shore. The amount of take anticipated is one nest per year for three years beginning when construction of the seawall is initiated. The take can be manifest as the failure of one adult female loggerhead sea turtle to nest or as the loss of up to all hatchlings from one loggerhead sea turtle nest, or an equivalent number of hatchlings from several nests due to disorientation, increased susceptibility to predators, and similar effects. If take occurs as injury or death of hatchlings, the number of hatchlings equivalent to one nest is assumed to be 128.

Take in the form of harm is anticipated as a result of erosion occurring adjacent to the seawall extension prior to placing sand and following placement of sand on the beach and dune if the material is unsuitable to support all aspects of nesting. This includes loss of nests due to erosion of the beach as the beach profile adjusts to the local wave action and changes in physical and environmental characteristics resulting from construction. This includes incidental take resulting from females being unable to excavate an adequate egg chamber; characteristics of gas exchange, soil moisture, temperature, or other factors that prevent normal embryonic development; and soil characteristics that prevent hatchlings from digging out of the egg chamber to the sand surface. Take of four nests per year for the first three years following the initiation of sand placement is anticipated as a result of these factors.

No green sea turtle or leatherback sea turtle take or nest loss is expected to occur due to the low likelihood of nesting or occurrence of these species on Wallops Island, and no incidental take of these species is anticipated.

<u>EXPANSION OF WALLOPS FLIGHT FACILITY AND ONGOING OPERATIONS</u>

The Service's May 10, 2010 biological opinion, which addressed the Wallops Flight Facility Expansion and Infrastructure Improvement and ongoing NASA operations, anticipated incidental take. This opinion provides additional incidental take for the adverse effects that will result from the placement of suitable habitat in close proximity to NASA launch facilities, the UAV runway, and additional infrastructure. This incidental take begins when sand placement associated with the beach and dune reconstruction is initiated and ends either when renourishment of the reconstructed beach is initiated or10 years following the placement of sand, whichever occurs first. The incidental take does not extend beyond that period because after 10 years, the sand placed during initial beach and dune reconstruction is expected to have eroded sufficiently to preclude most use by plovers and sea turtles and consequently avoid the incidental take considered in this section. Future conditions beyond this period are sufficiently uncertain such that the amount of incidental take is not reasonably foreseeable due to anticipated changes in habitat conditions and characteristics.

<u>Piping Plover</u> - Incidental take in the form of injury or death of adult and post-fledging young plovers is anticipated from the effects of launch-related activities immediately adjacent to the beach, resulting from intense sound, exposure to rocket exhaust and contaminants, and similar launch activities. Take of two plovers per year is anticipated.

Take in the form of harassment is anticipated as a result of mission-related and maintenance activities in close proximity to the new beach and dune. Take of one adult or post-fledging young plover per year and three plover nests (or 12 plover chicks) per year is anticipated. This is expected to occur due to severe disturbance to plovers nesting near NASA facilities during rocket launches, UAV operations, and similar activities, and also due to disturbance to nesting plovers and their young and inadvertent crushing of chicks or nests that may occur as a result of proposed shoreline monitoring and maintenance of the SRIPP conducted in conjunction with this project.

Sea Turtles - Incidental take in the form of injury or death of two adult loggerhead sea turtles is anticipated, resulting from exposure to intense sound or exhaust gases and contaminants released during launch of rockets. Incidental take in the form of harassment, injury, or death of eggs or young, including hatchlings, of four loggerhead sea turtle nests is anticipated, resulting from the noise, vibration, and contaminants that may affect hatch success and survival. Incidental take in the form of harassment of two nests per year is anticipated as a result of adult female loggerhead sea turtles being disturbed by activity to the extent that they fail to nest, and disorientation of hatchling turtles resulting by mission-related lighting such as up-lighting of rockets prior to and following launches. The take can be manifest as the failure of two adult female loggerhead sea turtles to nest or as the loss of up to all hatchlings from two loggerhead sea turtle nests, or an equivalent number of hatchlings from several nests due to disorientation, increased susceptibility to predators, and similar effects. If take occurs as injury or death of hatchlings, the number of hatchlings equivalent to two nests is assumed to be 256.

No green sea turtle or leatherback sea turtle take or nest loss is expected to occur due to the low likelihood of nesting or occurrence of these species on Wallops Island, and no incidental take of these species is anticipated.

FUTURE BEACH RENOURISHMENT

No incidental take is anticipated in this biological opinion for the effects of future beach renourishment. The SRIPP draft PEIS provides the expectation that future renourishment, if and when it is conducted, will be designed based on the needs and conditions at the time and evaluated in tiered EAs. Incidental take will be anticipated, if appropriate, in future consultations on these projects based on their specific designs and characteristics. Any future incidental take resulting from the effects of mission-related activities on listed species that may use the renourished beaches will be addressed in future biological opinions.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat. The action area encompasses a relatively small portion of the rangewide habitat of each of the species addressed in this opinion and a small portion of each species' population. The proposed action includes a variety of protective measures that are intended to minimize incidental take. For these reasons, the effect of the take anticipated in this biological opinion is not expected to significantly affect any of the species considered.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of listed species:

1. Conduct routine surveys and monitoring for the species addressed in this biological opinion and implement measures to avoid potential impacts whenever possible.

2. Conduct surveys and monitoring to determine the effects of the proposed action on listed species and their habitat.

3. Actively manage habitats and human activity on the beaches to avoid and minimize potential impacts to listed species.

TERMS AND CONDITIONS

To be exempt from the prohibitions of section 9 of the ESA, NASA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

1. Fully implement the activities related to listed species within chapter five of the SRIPP draft PEIS: Mitigation and Monitoring Plan, for seawall extension, offshore dredging, and sand placement activities. NASA must provide an annual report summarizing the survey and monitoring efforts, the location and status of all occurrences of protected species that are recorded, and any additional relevant information. Reports will be provided to the Service's Virginia Field Office in digital format, at the address, provided on the letterhead by December 31 of each year.

2. Develop a training and familiarization program for all personnel conducting construction activities and NASA operations in areas where listed species may occur. This training program shall include basic biological information about all listed species and be sufficient to allow personnel to tentatively identify the species and its likely habitat to allow them to incorporate appropriate avoidance and minimization measures into their activities.

3. Excavation of sand from the north Wallops Island borrow area for future renourishments must occur outside of plover and sea turtle nesting season (March 15 through November 30 or the last date of potential sea turtle hatchling emergence based on laying dates of all nests). Sand may be stockpiled outside of the north Wallops Island borrow area, and

outside of potential nesting habitat for plovers and sea turtles prior to placement for renourishment.

4. Following launches of rockets that produce an expected sound intensity > 150 dB seaward of the dune or seawall, surveys must be conducted for injured, dead, or impaired birds and wildlife. These surveys must be conducted as soon as possible following launches and within 2 hours of the launch or the first daylight following launch. If surveys cannot be conducted within this period, NASA shall place remotely operated video cameras on the beach to document and record the responses of plovers and similar birds and any sea turtles following launches. Cameras will be placed a maximum of 100 meters apart and extend to the limit of the projected area where sound intensity is expected to exceed 150 dB. Surveys for dead, injured, or impaired wildlife must still be conducted as soon as possible following a launch, in addition to the use of cameras. Reports/DVDs will be provided to the Service's Virginia Field Office in digital format, at the address provided on the letterhead, within 15 days of each launch event.

5. Concentrations of contaminants (hydrogen chloride, aluminum oxide, and other potentially toxic substances) predicted to occur within rocket exhaust gases must be measured on the beach in closest proximity to the flame trench following launches involving use of solid propellants. Measurements must be made daily until the levels reach background levels or conservative estimated non-toxic levels of these contaminants for birds, sea turtles, and other wildlife species. This information must be used to develop accurate expectations of exposure to contaminants on the beaches over time following a launch. Measurements must be made, analyzed, and submitted to the Service for at least the first five launches that occur following the placement of beach and dune adjacent to NASA infrastructure. Reports will be provided to the Service's Virginia Field Office in digital format, at the address provided on the letterhead, within 30 days of each launch event.

6. Report any evidence of potential nesting activity of green sea turtles or leatherback sea turtles on Wallops Island to the Service's Virginia Field Office, at the address provided on the letterhead, within one business day of observing the activity.

7. Care must be taken in handling any dead specimens of proposed or listed species that are found to preserve biological material in the best possible state. In conjunction with the preservation of any dead specimens, the finder has the responsibility to ensure that evidence intrinsic to determining the cause of death of the specimen is not unnecessarily disturbed. The finding of dead specimens does not imply enforcement proceedings pursuant to the ESA. The reporting of dead specimens is required to enable the Service to determine if take is reached or exceeded and to ensure that the terms and conditions are appropriate and effective. Upon locating a dead specimen, notify the Service's Virginia Law Enforcement Office at 804-771-2883, 7721 South Laburnum Avenue, Richmond, Virginia 23231, and the Service's Virginia Field Office at 804-693-6694 at the address provided on the letterhead above.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to further minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. The Service recommends that NASA work with the Service to develop a candidate conservation agreement for the red knot. The information provided in the BA and the NASA Protected Species Management Plan will provide a good foundation for such an agreement.

2. NASA should develop an integrated habitat conservation and management plan for Wallops Island. Due to the significance of the area for the conservation of migratory birds and other species, nearly all of the habitats that occur on WFF provide value to these species, and active efforts to manage them, including activities such as control of non-native invasive plants and similar activities may significantly improve the value of these areas as habitat.

3. NASA is encouraged to collect data on the characteristics of beaches and habitat where sea turtle nests and plover nests occur and share this information with the Service and VDGIF, or work with other interested parties to develop protocols for data collection and analysis throughout Virginia to improve our understanding of important habitat characteristics.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If you have any questions, please contact Tylan Dean of this office at 804-693-6694, extension 166.

Sincerely,

Cynthia A. Schulz

Cindy Schulz
Supervisor
Virginia Field Office

Enclosures

cc: USACE, Norfolk VA (attn: Robert Cole, Craig Seltzer)
BOEMRE, Herndon, VA (attn: Dirk Herkhof)
FWS, Chincoteague NWR, Chincoteague, VA (attn: Lou Hinds)
VDGIF, Richmond, VA (attn: Ruth Boettcher, Ray Fernald)
VDACS, Richmond, VA (attn: Keith Tignor)
VDCR, Richmond, VA (attn: Rene Hypes)
TNC, Charlottesville, VA (attn: Gwynn Crichton)

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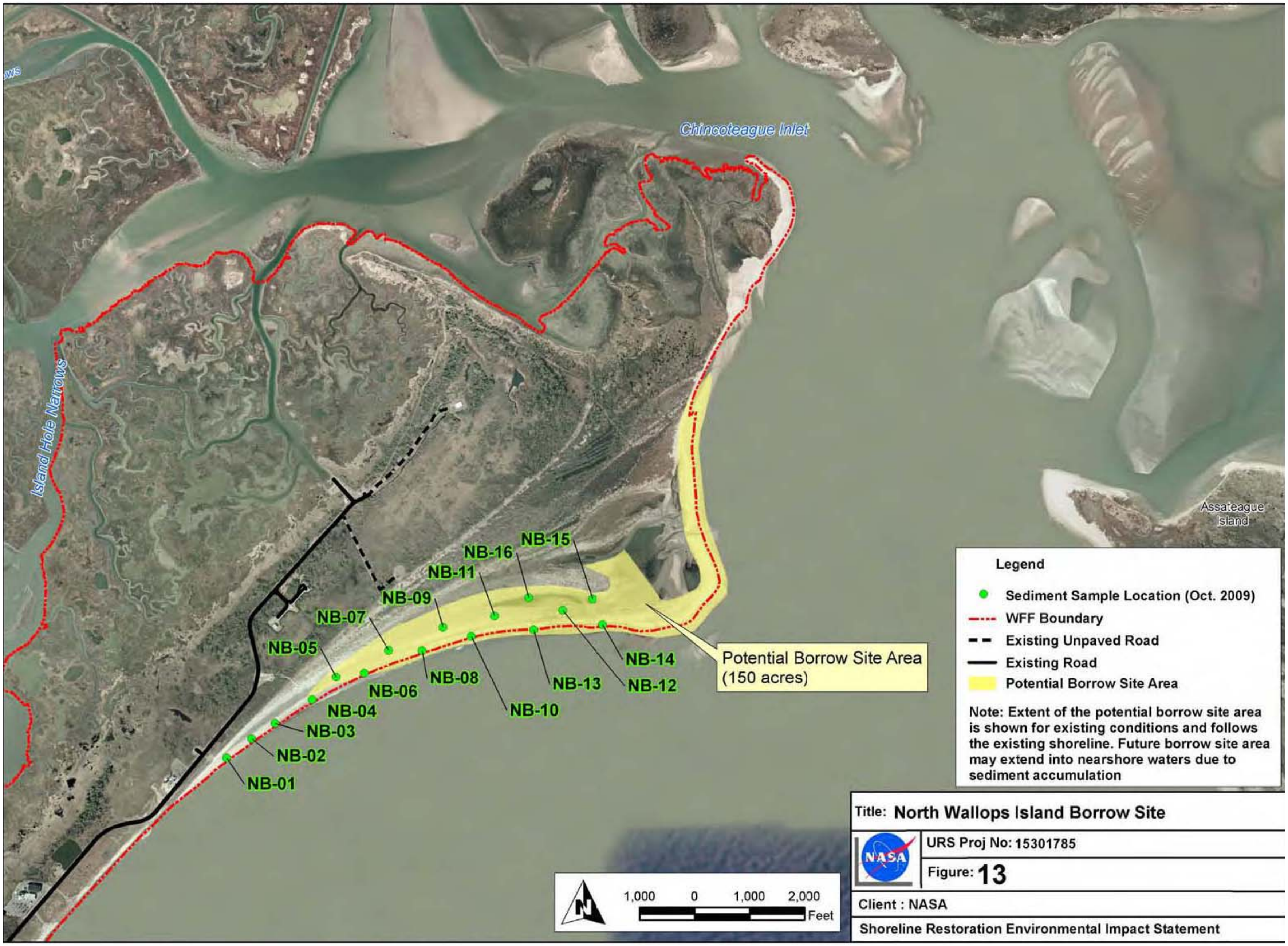
APPENDIX 1

LOCATION, EXTENT, AND DESIGN OF SRIPP PROJECT FEATURES

LOCATION AND EXTENT OF PROPOSED SEAWALL AND BEACH RECONSTRUCTION

LOCATION OF PROPOSED OFFSHORE SAND BORROW AREAS

LOCATION AND EXTENT OF PROPOSED NORTH WALLOPS ISLAND BORROW AREA



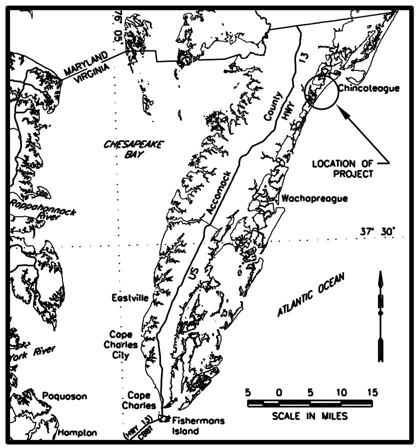
SHORELINE DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
NASA WALLOPS ISLAND
ACCOMACK COUNTY, VIRGINIA
JUNE 2010

LEGEND

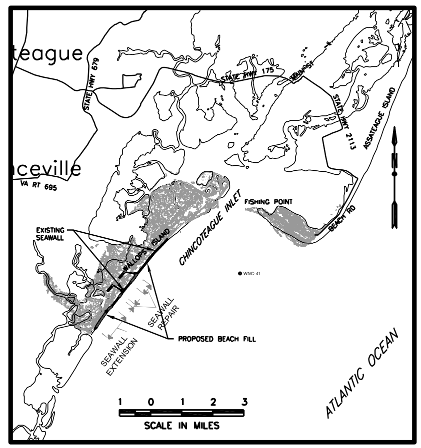
ITEM	EXISTING	PROPOSED
LIMIT OF DISTURBANCE	N/A	LOD
IMPERVIOUS SURFACED ROAD, DRIVE OR LOT		N/A
FENCE		x x x
DRAINAGE DITCH OR SWALE		N/A
EMBANKMENT SIDESLOPES (DOWN)		
CONTOUR	5	4.0
ELEVATION SPOT SHOT	x 6.50	5.00
BENCH MARK		N/A
PROPERTY LINE		N/A
CONSTRUCTION LINE	N/A	
TRAVERSE POINT & LINE		N/A
BUILDING OR STRUCTURE		N/A
SILT FENCE	N/A	SF
STABILIZED CONSTRUCTION ENTRANCE	N/A	SCE
STONE		
GRAVEL DRIVE		N/A

LIST OF ABBREVIATIONS

ADC	ALEXANDRIA DRAFTING COMPANY
AMA	ANDREWS, MILLER & ASSOCIATES
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
CD	CONSTRUCTION DOCUMENTS
DIA	DIAMETER
D.I.P	DUCTILE IRON PIPE
E	EAST
EIS	ENVIRONMENT IMPACT STATEMENT
ELEV	ELEVATION
H	HORIZONTAL
INV	INVERT
LB.	POUNDS
LOD	LIMIT OF DISTURBANCE
MEC	MUNITIONS & EXPLOSIVES OF CONCERN
MHW	MEAN HIGH WATER
MLW	MEAN LOW WATER
N	NORTH
NAVD	NORTH AMERICAN VERTICAL DATUM
NASA	NATIONAL AERONAUTICS & SPACE ADMINISTRATION
OCEW	ON CENTER EACH WAY
O.D.	OUTSIDE DIAMETER
RCP	REINFORCED CONCRETE PIPE
SCE	STABILIZED CONSTRUCTION ENTRANCE
SF	SILT FENCE
STA	STATION
TYP.	TYPICAL
USACE	UNITED STATES ARMY CORPS OF ENGINEERS
V	VERTICAL



VICINITY MAP



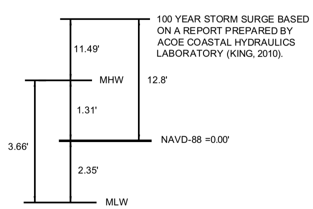
LOCATION MAP

GENERAL NOTES

1. THE EXISTING UTILITIES AND OBSTRUCTIONS SHOWN ARE FROM THE BEST AVAILABLE RECORDS AND SHALL BE VERIFIED BY THE CONTRACTOR TO HIS SATISFACTION PRIOR TO CONSTRUCTION.
2. NECESSARY PRECAUTIONS SHALL BE TAKEN BY THE CONTRACTOR TO PROTECT EXISTING SERVICES AND STRUCTURES. ANY DAMAGE TO THEM SHALL BE REPAIRED IMMEDIATELY AT HIS OWN EXPENSE.
3. IT SHALL BE DISTINCTLY UNDERSTOOD THAT FAILURE TO MENTION SPECIFICALLY ANY WORK WHICH WOULD NATURALLY BE REQUIRED TO COMPLETE THE PROJECT SHALL NOT RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITY TO COMPLETE SUCH WORK.
4. PUBLISHED MEAN TIDAL RANGE IS 3.66 FEET.
5. TOPOGRAPHIC & BATHYMETRIC DATA WAS PROVIDED BY USACE AND IS BASED UPON NAVD 88. LIMITED SURVEYING LOCATED LANDWARD OF THE SEAWALL WAS PERFORMED BY AMA IN MAY 2010.
6. HORIZONTAL MERIDIAN IS BASED UPON NAD 83, VIRGINIA STATE PLANE, SOUTH
7. VERTICAL CONTROL IS BASED UPON NAVD 88.
8. PROPERTY LINES SHOWN ARE APPROXIMATE ONLY. THIS PLAN IS NOT INTENDED TO BE A PROPERTY LINE SURVEY.
9. DISTURBED AREAS WILL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND. THIS INCLUDES THE TEMPORARY STAGING AND STONE STOCKPILE AREAS.
10. THE EXISTING BOTTOM AND SEAWALL PROFILES, BEACH CONTOUR AND/OR BANK ALIGNMENT SHOWN ON THE DRAWINGS WERE CORRECT WHEN SURVEYED. HOWEVER, BECAUSE OF THE INTERIM EROSION AND LITTORAL TRANSPORT, <u>THE CONTRACTOR SHALL SATISFY HIMSELF AS TO ALL CONDITIONS AT THE TIME OF BIDDING THIS PROJECT AND INCLUDE IN HIS PROPOSAL ANY CHANGES THAT WOULD BE NECESSARY TO ACCOMPLISH A COMPLETE AND FUNCTIONAL PROJECT.</u>

SCOPE OF WORK

BASE BID: SEAWALL EXTENSION (STA. 33+00A to STA. 46+15 = 1315 L.F.) LUMP SUM
OPTION 1: SEAWALL REPAIR (STA. 66+98 to STA. 73+48 = 650 L.F.) LUMP SUM
OPTION 2: SEAWALL REPAIR (STA. 97+08 to STA. 115+08 = 1800 L.F.) LUMP SUM
OPTION 3: SEAWALL EXTENSION (STA. 35+00 to STA. 0+15 = 3485 L.F.) LUMP SUM FOR EACH 100 L.F. CONTIGUOUS INCREMENT.



DATUM COMPARISON
NOT TO SCALE

INDEX TO DRAWINGS

SHEET NO.	TITLE	FILE NUMBER
C-1	COVER SHEET	
C-2	KEY SHEET	
C-3	PLAN VIEWS (3a,3b) : Sta. 0+15 to Sta. 19+47 (OPTION 3)	
C-4	PLAN VIEWS (4a,4b) : Sta. 19+47 to Sta. 42+00 (OPTION 3 / BASE BID)	
C-5	PLAN VIEWS (5a,5b) : Sta. 42+00 to Sta. 46+15 (BASE BID) Sta. 66+98 to Sta. 73+48 (OPTION 1)	
C-6	PLAN VIEWS (6a,6b) : Sta. 97+00 to Sta. 115+00 (OPTION 2)	
C-7	DETAILS	
C-8	SECTIONS (BASE BID / OPTION 3)	
C-9	SECTIONS (OPTION 1)	
C-10	SECTIONS (OPTION 2)	
C-11	SECTIONS (OPTION 2)	

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDICATED ON INDEX OF DRAWINGS.

RECOMMENDED:
PROJECT MANAGER
APPROVED:
CHIEF, DESIGN BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
APPROVED:
COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER
APPROVED FOR:

DATE:

US Army Corps of Engineers
Norfolk District

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: AS SHOWN
PROJECT NO.: 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO.: | SPECIFICATION NO.

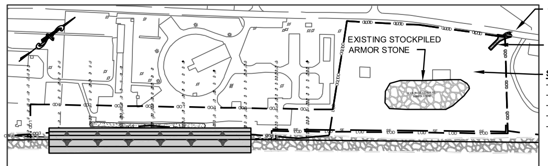
NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

COVER SHEET
NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-1
SHEET 1 OF 11

PRE-FINAL SUBMITTAL

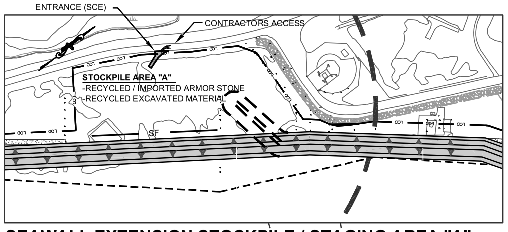


SEAWALL REPAIR STOCKPILE / STAGING AREA "B"

Scale: 1" = 200'

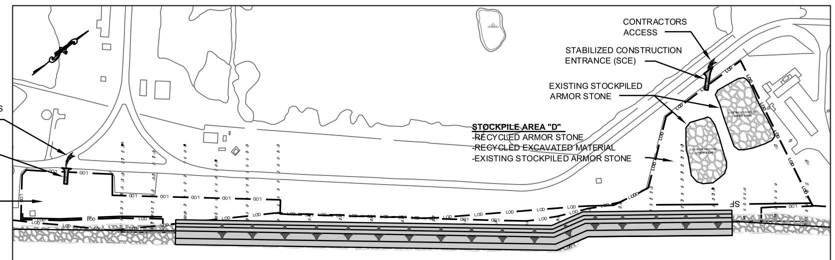
NOTES:

1. CONTRACTOR SHALL COORDINATE THE SPECIFIC LIMITS AND USAGE OF THE STOCKPILE AREAS WITH THE CONTRACTING OFFICER.
2. STOCKPILE SANDY MATERIAL EXCAVATED FOR THE NEW SEAWALL'S CONSTRUCTION FOR FUTURE USE AS BEACH FILL MATERIAL AT THE STOCKPILE AREAS SHOWN AND AS APPROVED BY THE CONTRACTING OFFICER. PLACE A SILT FENCE WITH WIRE SUPPORT AROUND THE PERIMETER OF THE STOCKPILED SANDY MATERIAL.
3. STOCKPILE ARMOR STONE REMOVED FROM DECONSTRUCTION OF THE EXISTING SEAWALL (FOR REUSE INTO THE NEW SEAWALL AS SPECIFIED IN "TYPICAL SEAWALL EXTENSION SECTION" AND "TYPICAL SEAWALL REPAIR SECTION"). PLACE A SILT FENCE WITH WIRE SUPPORT AROUND PERIMETER OF EXCESS ARMOR STONE THAT IS STOCKPILED AND NOT UTILIZED UNDER THIS CONTRACT.
4. AT THE CONCLUSION OF THE PROJECT, THE STOCKPILE AREAS AND DISTURBED AREAS SHALL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND AT THE START OF CONSTRUCTION AS APPROVED BY THE CONTRACTING OFFICER.



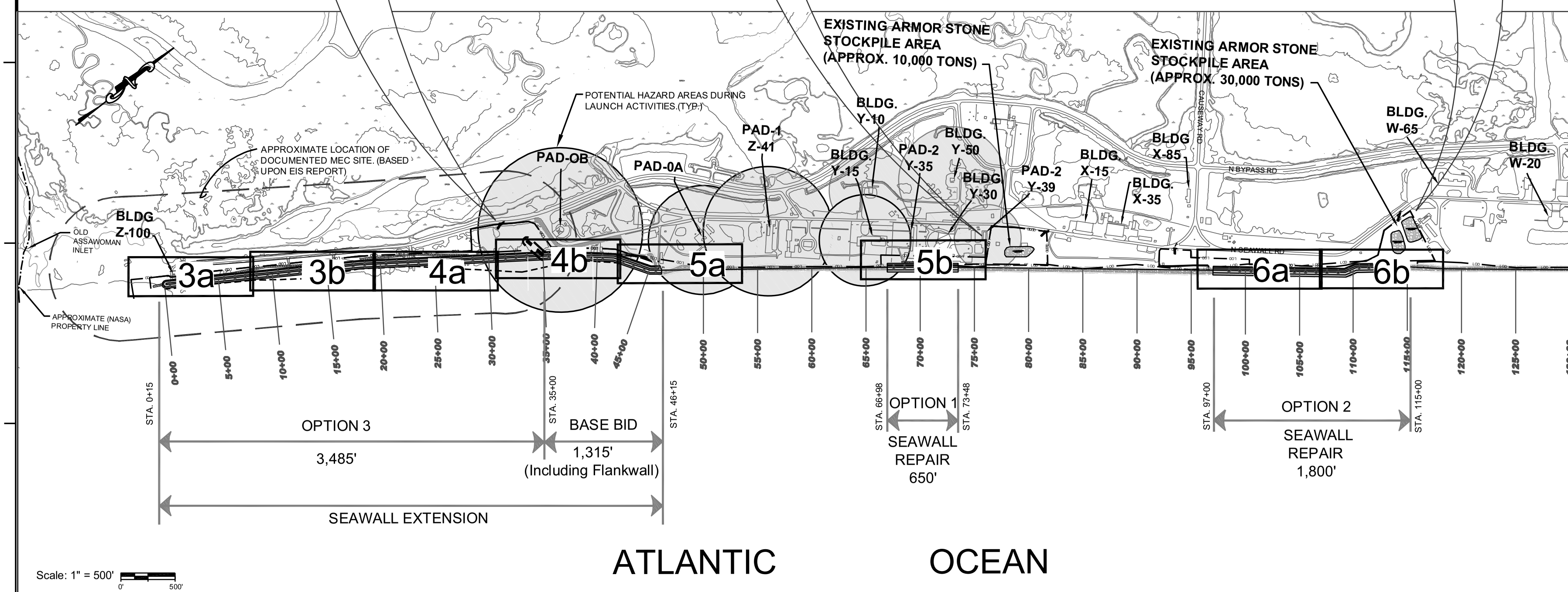
SEAWALL EXTENSION STOCKPILE / STAGING AREA "A"

Scale: 1" = 200'



SEAWALL REPAIR STOCKPILE / STAGING AREAS "C" & "D"

Scale: 1" = 200'



Scale: 1" = 500'

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APP

DESIGNED: E.T.F.	CHECKED: G.O.W.
DRAWN: J.S.B.	DATE: 22 June 2010
SUBMITTED: 6/22/10	SCALE: As Shown
PROJECT NO. 00000	NORFOLK DISTRICT FILE NO.
DRAWING NO.:	SPECIFICATION NO.

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CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
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CAMBRIDGE, MARYLAND 21613

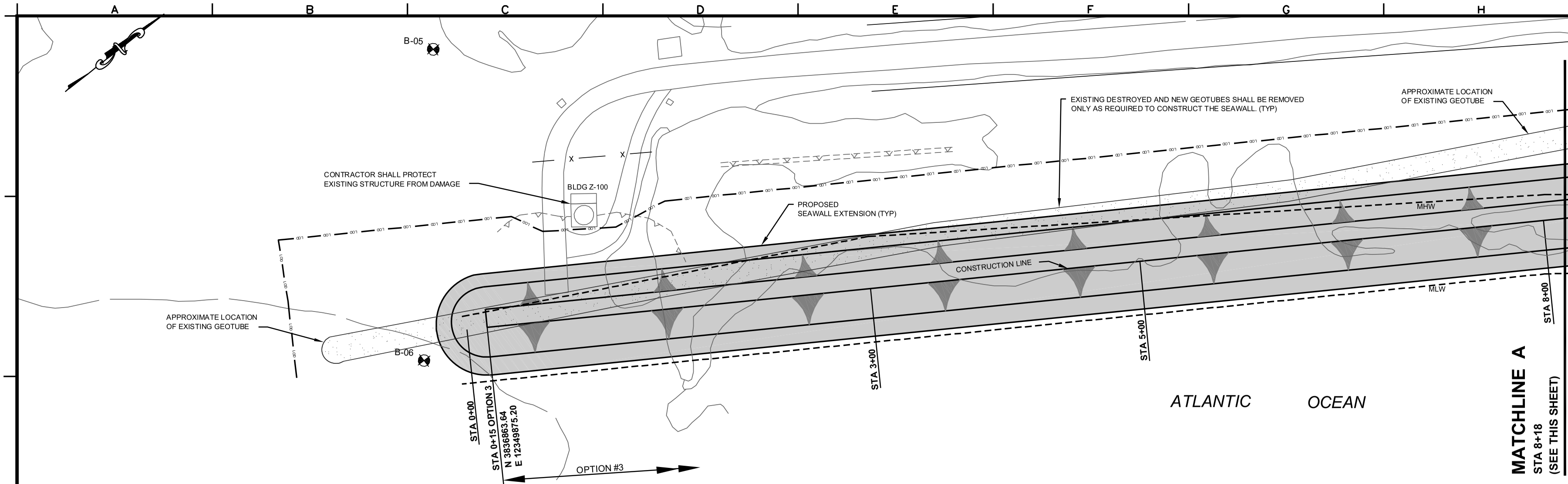
KEY SHEET

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT SEAWALL REPAIR AND EXTENSION

ACCOMACK COUNTY, VIRGINIA

C-2
SHEET 2 OF 11

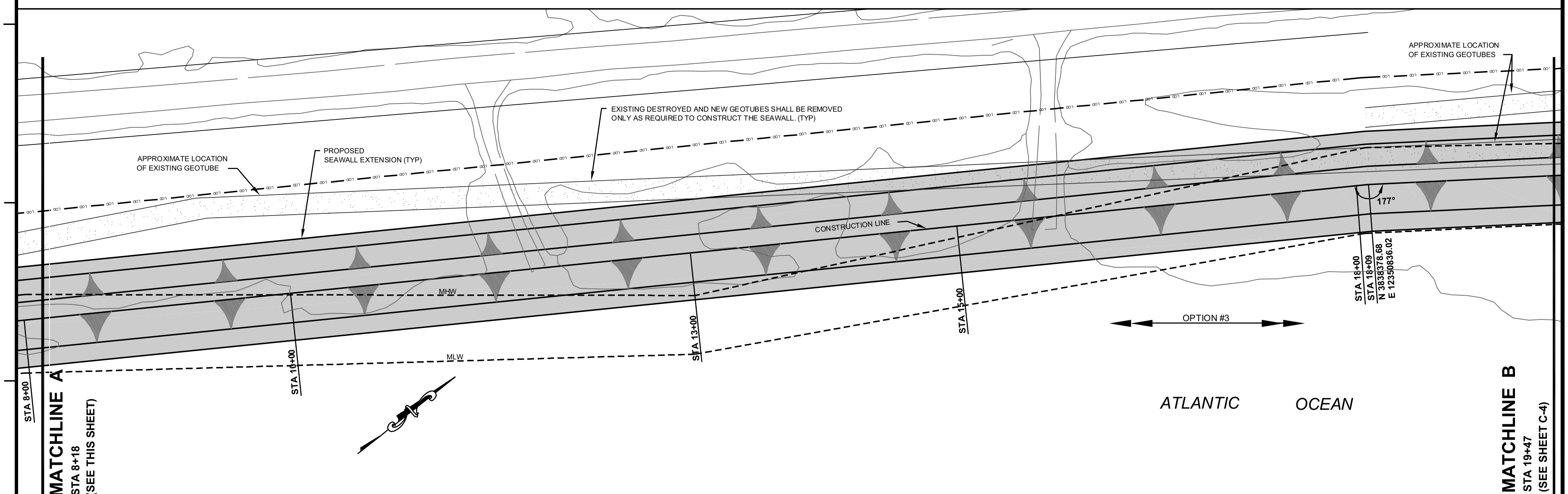
PRE-FINAL SUBMITTAL



PLAN VIEW (3a) STA. 0+15 TO 8+18 (OPTION 3)

SCALE : 1" = 40' 0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.



PLAN VIEW (3b) STA. 8+18 TO 19+47 (OPTION 3)

SCALE : 1" = 40' 0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APP

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=40'
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.

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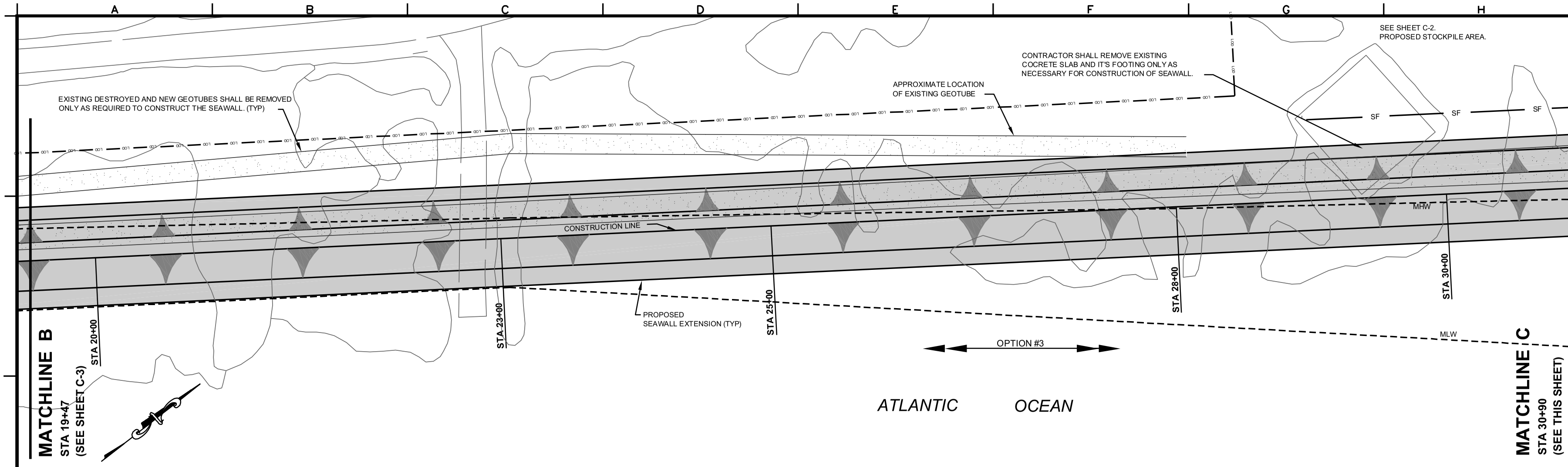
PLAN VIEWS : 3a & 3b STA 0+15 TO STA 19+47

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-3
SHEET 3 OF 11

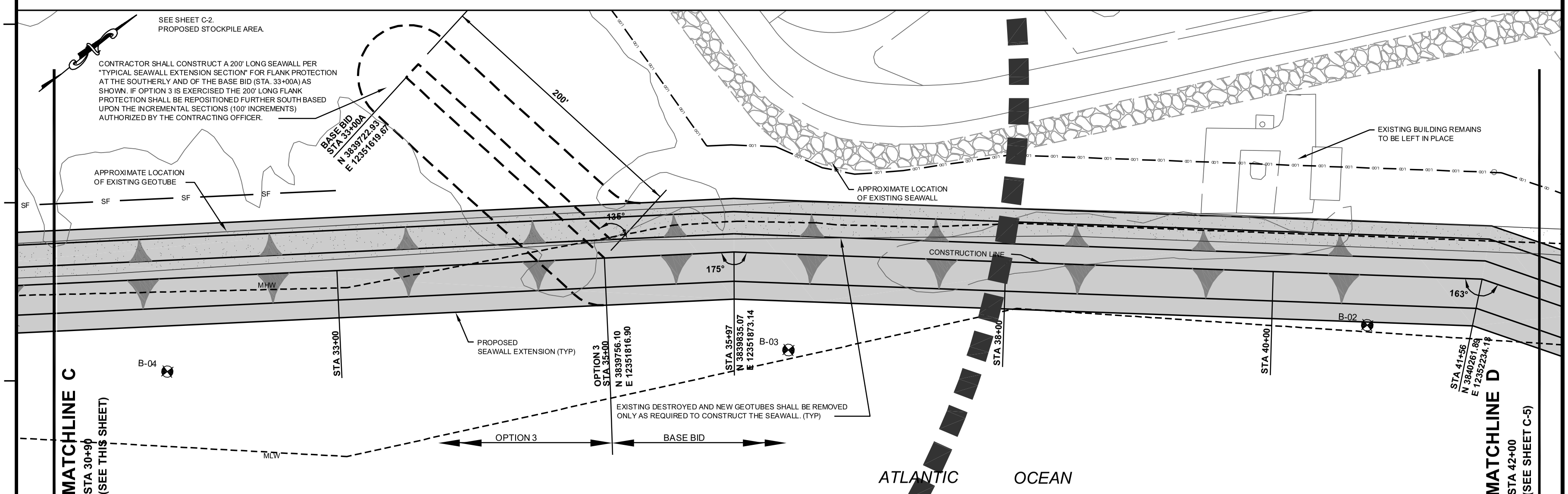
PRE-FINAL SUBMITTAL



PLAN VIEW (4a) STA. 19+47 TO 30+90 (OPTION 3)

SCALE : 1" = 40' 0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.



PLAN VIEW (4b) STA. 30+90 TO 42+00 (OPTION 3 / BASE BID)

SCALE : 1" = 40' 0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APP

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=40'
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.
LAST REVISED ON: | Plot Scale 1:1

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

PLAN VIEWS : 4a & 4b STA 19+47 TO STA 42+00

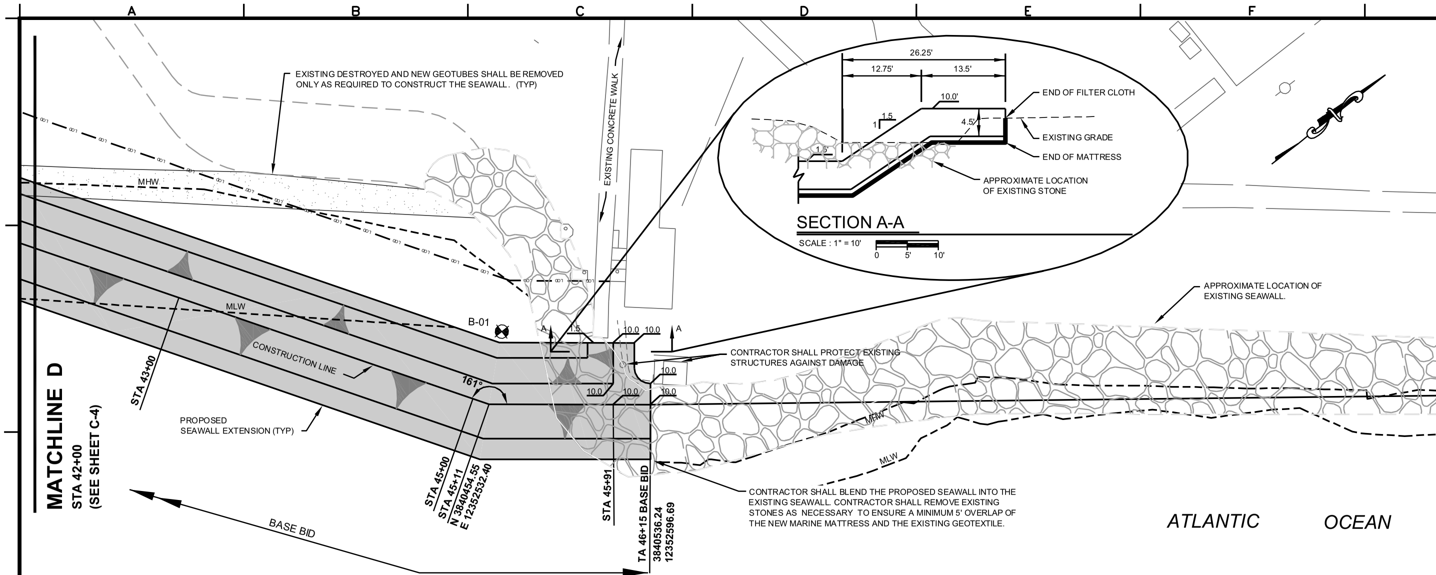
NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT SEAWALL REPAIR AND EXTENSION

ACCOMACK COUNTY, VIRGINIA

C-4

SHEET 4 OF 11

PRE-FINAL SUBMITTAL

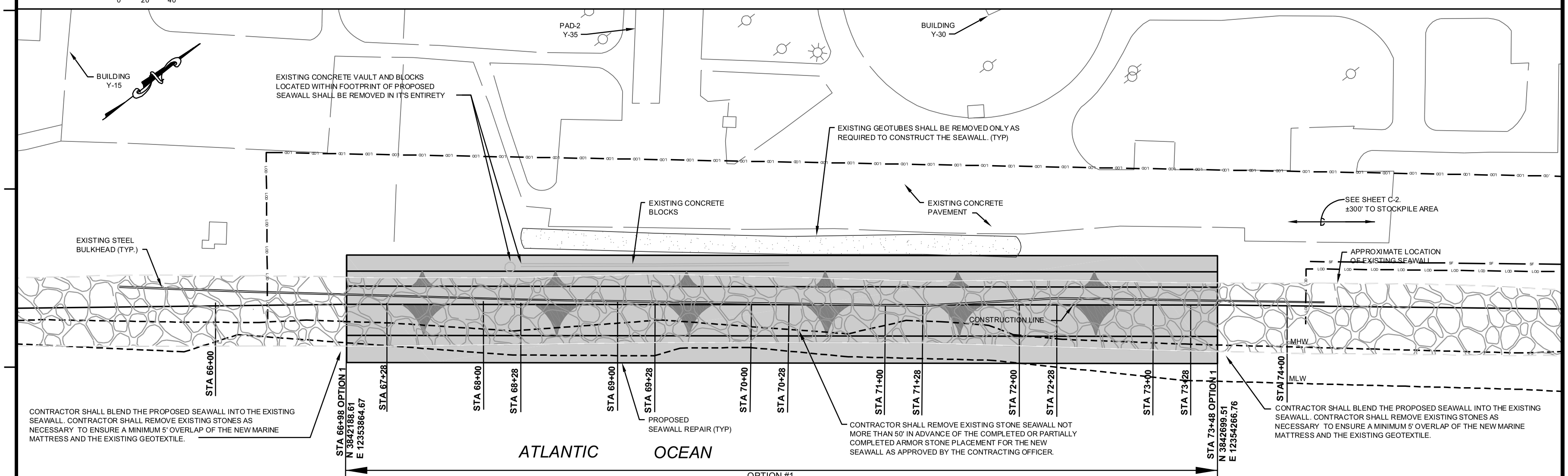


PLAN VIEW (5a) STA. 42+00 TO 46+15 (BASE BID)

SCALE : 1" = 40'

0 20' 40'

NOTE: AT THE TIME OF AMA'S SURVEY, THE FACILITY WAS ACTIVELY PLACING NEW GEOTUBE ALONG THE SHORELINE. THE CONTRACTOR SHALL DETERMINE THE EXTENT OF NEW GEOTUBE PLACEMENT PRIOR TO SUBMITTING HIS BID.



PLAN VIEW (5b) STA. 66+98 TO 73+48 (OPTION 1)

SCALE : 1" = 40'

0 20' 40'

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APP

DESIGNED: E.T.F.	CHECKED: G.O.W.	DATE: 22 June 2010	
DRAWN: J.S.B.	SUBMITTED: 6/22/10	SCALE: 1"=40'	
PROJECT NO. 00000	NORFOLK DISTRICT FILE NO.		
DRAWING NO.	SPECIFICATION NO.		

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NORFOLK, VIRGINIA

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401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

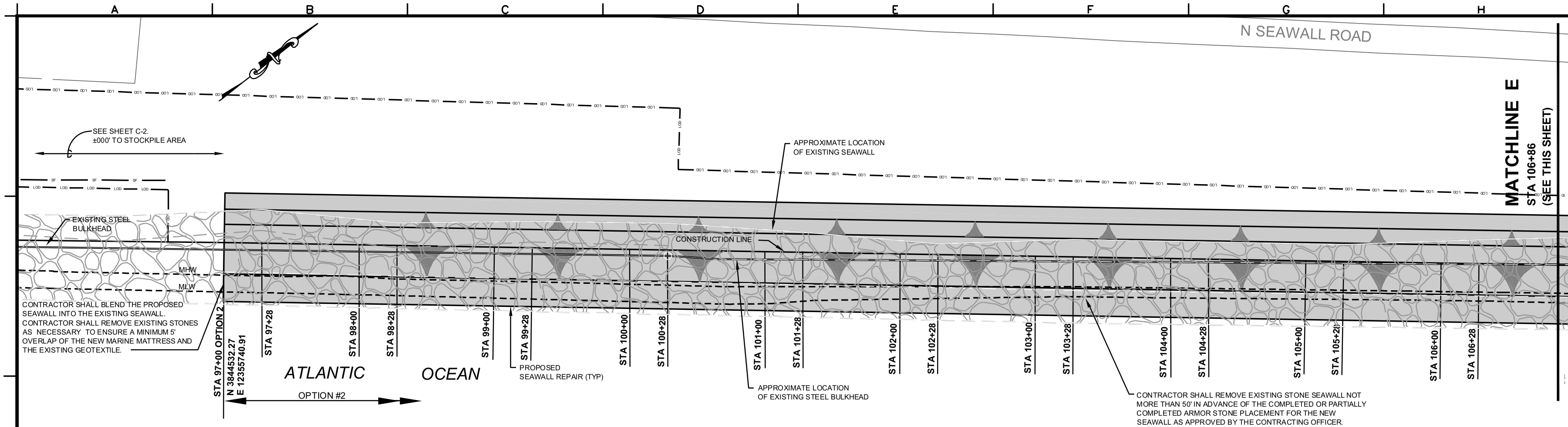
PLAN VIEWS : 5a STA 42+00 TO STA 46+15 / 5b STA 66+98 TO STA 73+48

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT SEAWALL REPAIR AND EXTENSION

ACCOMACK COUNTY, VIRGINIA

C-5
SHEET 5 OF 11

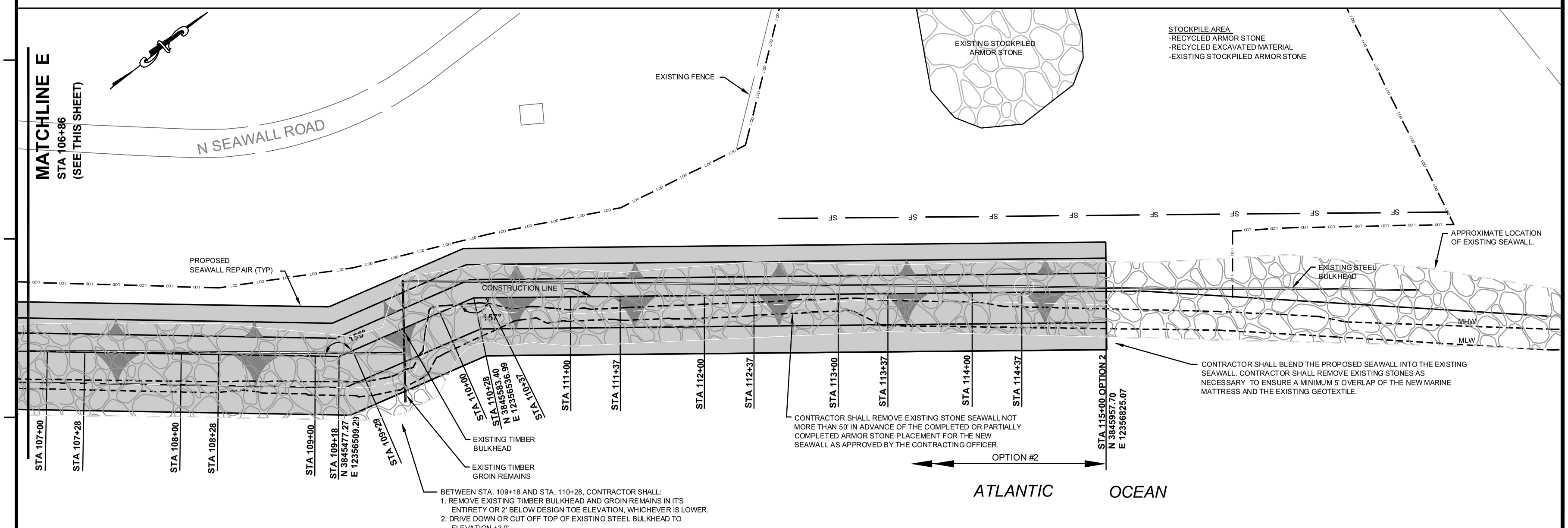
PRE-FINAL SUBMITTAL



PLAN VIEW (6a) STA. 97+00 TO 106+86 (OPTION 2)

SCALE : 1" = 40'

0 20' 40'



PLAN VIEW (6b) STA. 106+86 TO 115+00 (OPTION 2)

SCALE : 1" = 40'

0 20' 40'

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APP

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=40'
PROJECT NO. 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO. | SPECIFICATION NO.

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

PLAN VIEWS : 6a & 6b STA 97+00 TO STA 115+00

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-6
SHEET 6 OF 11

PRE-FINAL SUBMITTAL

STONE CONSTRUCTION ENTRANCE

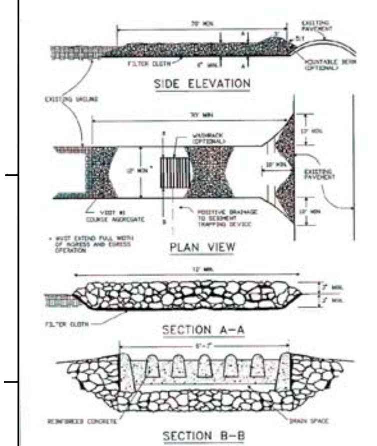


TABLE 3.02-A

CONSTRUCTION SPECIFICATIONS FOR FILTER CLOTH UNDERLINER

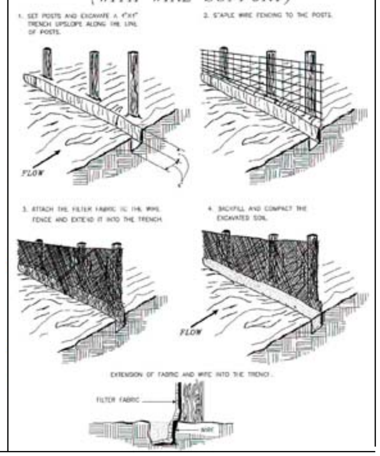
Fabric Properties[1]	Light-Duty Entrance[2] (Graded Subgrade)	Heavy-Duty Entrance[3] (Rough Graded)	Test Method
Grab Tensile Strength (lbs.)	200	220	ASTM D1682
Elongation at Failure (%)	50	220	ASTM D1682
Mullen Burst Strength (lbs.)	190	430	ASTM D3786
Puncture Strength (lbs.)	40	125	ASTM D751 (modified)
Equivalent Opening Size (mm)	40-80	40-80	U.S. Standard Sieve CW-02215

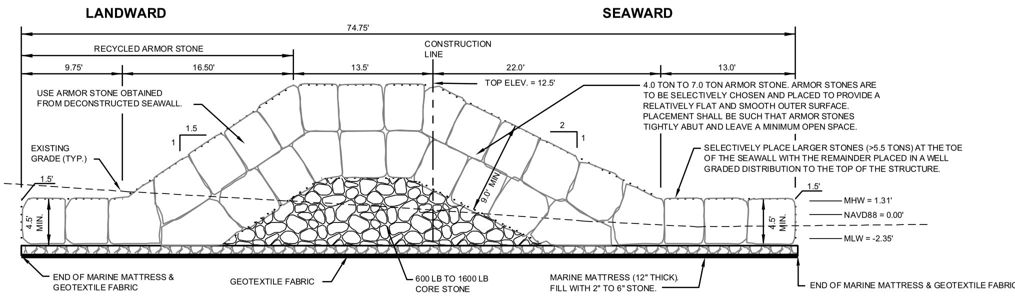
[1] Fabrics not meeting these specifications may be used only when design procedure and supporting documentation are supplied to determine aggregate depth and fabric strength.

[2] Light Duty Entrance: Sites that have been graded to subgrade and where most travel would be single axle vehicles and an occasional multi-axle truck. Examples of fabrics which can be used are: Trevira Spunbond 1115, Mirafi 100X, Typar 3401, or equivalent.

[3] Heavy Duty Entrance: Sites with only rough grading and where most travel would be multi-axle vehicles. Examples of fabrics which can be used are: Trevira Spunbond 1135, Mirafi 600X, or equivalent.

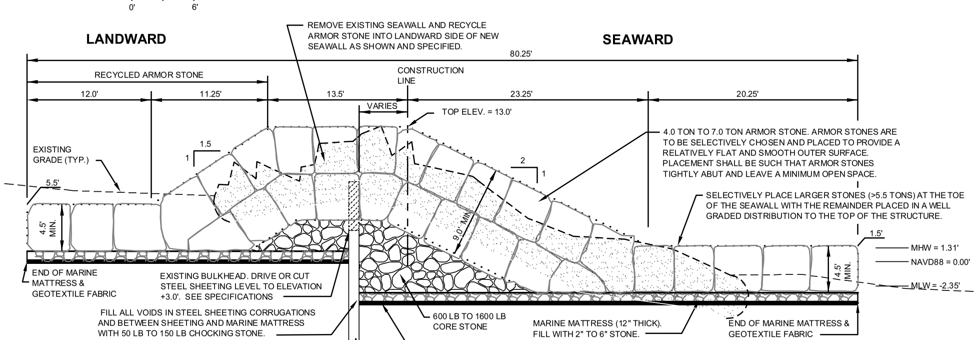
CONSTRUCTION OF A SILT FENCE (WITH WIRE SUPPORT)





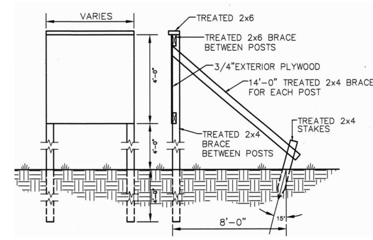
TYPICAL SEAWALL EXTENSION SECTION

Scale: 1" = 6'



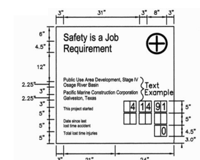
TYPICAL SEAWALL REPAIR SECTION

Scale: 1" = 6'



TYPICAL SIGN ERECTION DETAIL

Not To Scale



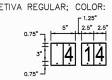
ALL TYPOGRAPHY IS FLUSH LEFT AND RAGGED RIGHT, UPPER AND LOWER CASE WITH WITH INITIAL CAPITALS ONLY AS SHOWN. LETTER AND WORD SPACING TO FOLLOW COPRS STANDARDS (EP 310-1-6a AND 6b).

LEGEND GROUP 1: STANDARD TWO-LINE TITLE "SAFETY IS A JOB REQUIREMENT" WITH (8" od.) SAFETY GREEN FIRST AID LOGO. TYPEFACE 3" HELVETIVA BOLD; COLOR: BLACK.

LEGEND GROUP 2: ONE TO TWO-LINE PROJECT TITLE LEGEND DESCRIBES THE WORK BEING DONE UNDER THIS PROJECT AND NAME OF HOST PROJECT. TYPEFACE: 1.5" HELVETIVA REGULAR; COLOR: BLACK; MAXIMUM LINE LENGTH: 42".

LEGEND GROUP 3: ONE TO TWO-LINE IDENTIFICATION: NAME OF PRIME CONTRACTOR AND CITY, STATE ADDRESS. TYPEFACE: 1.5" HELVETIVA REGULAR; COLOR: BLACK; MAXIMUM LINE LENGTH 42".

LEGEND GROUP 4: STANDARD SAFETY RECORD CAPTIONS AS SHOWN. TYPEFACE 1.25" HELVETIVA REGULAR; COLOR: BLACK.



REPLACEABLE NUMBERS TO MOUNTED ON WHITE 0.060 ALUMINUM PLATE AND SCREW-MOUNTED TO BACKDROP. TYPEFACE: 3" HELVETIVA REGULAR; COLOR: BLACK; PLATE SIZE: 2.5" X 4.5".

TYPICAL SAFETY SIGN

Not To Scale

US Army Corps of Engineers
Norfolk District

DESIGNED: E.T.F.	CHECKED: G.O.W.	DATE: 22 June 2010
DRAWN: J.S.B.	SUBMITTED: 6/22/10	SCALE: AS SHOWN
PROJECT NO.: 00000	NORFOLK DISTRICT FILE NO.	
DRAWING NO.:	SPECIFICATION NO.	

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

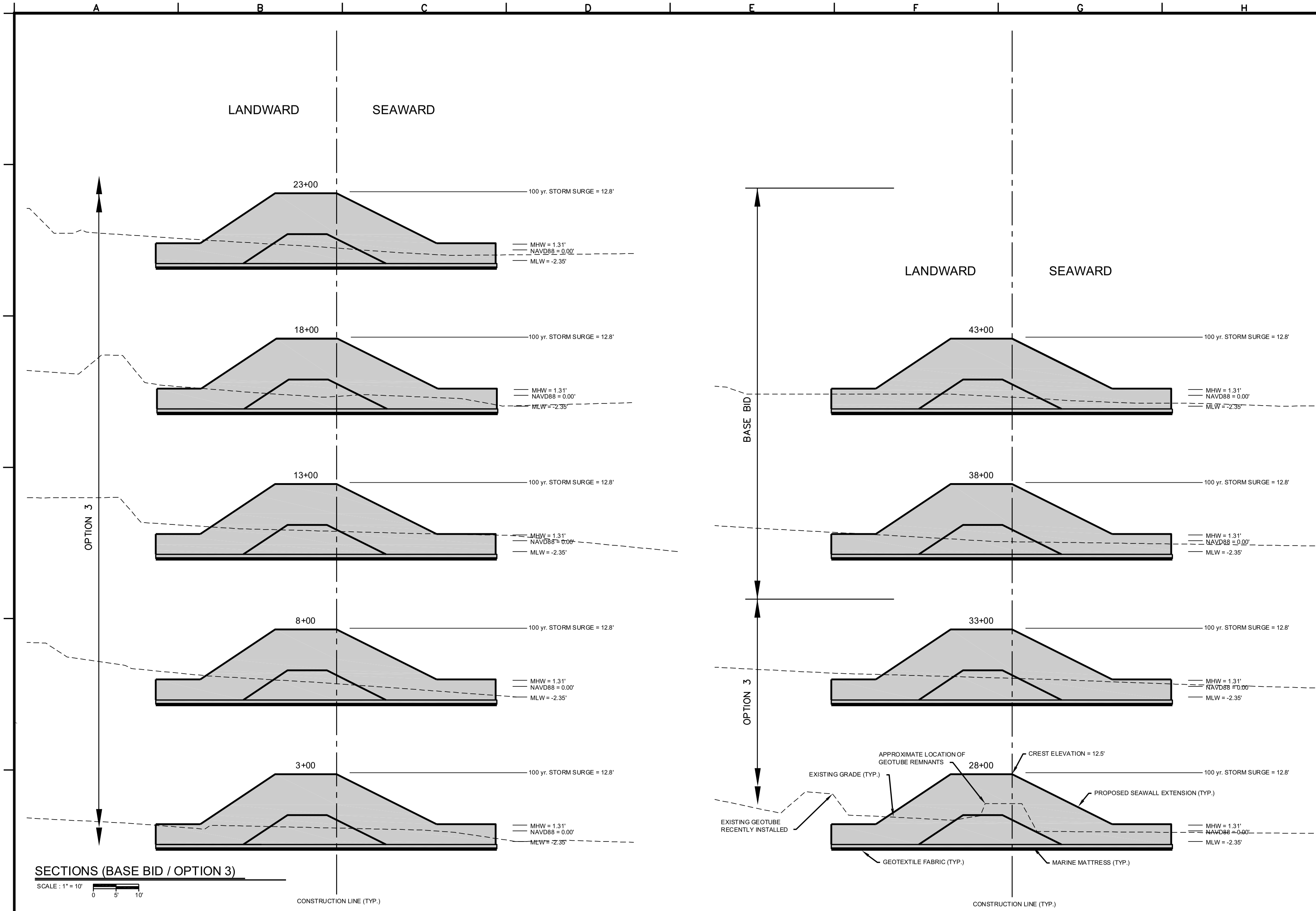
ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

DETAILS

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-7
SHEET 7 OF 11

PRE-FINAL SUBMITTAL



US Army Corps of Engineers Norfolk District

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=10'
PROJECT NO.: 00000

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

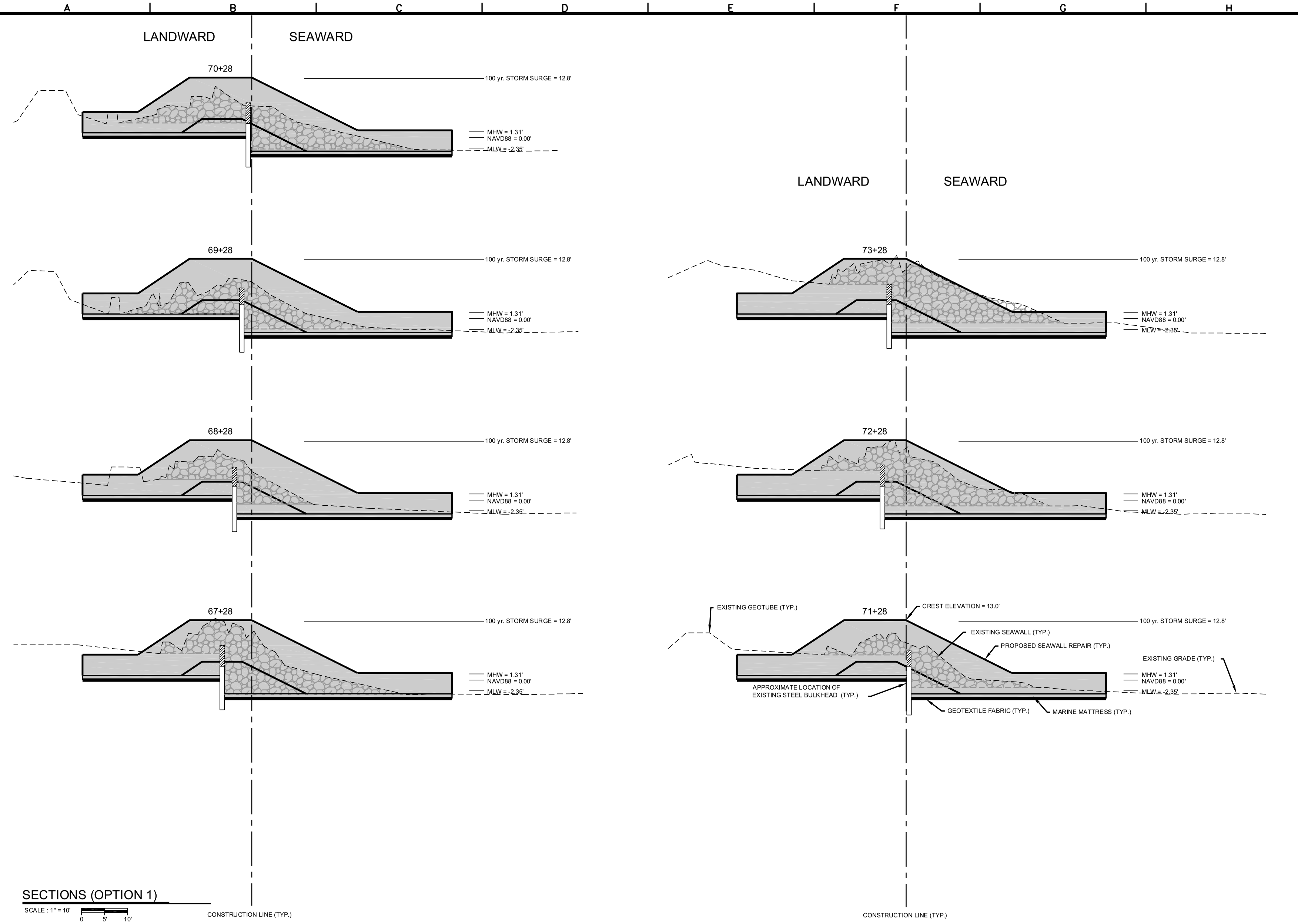
ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

SEAWALL EXTENSION SECTIONS : BASE BID/OPTION 3

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-8
SHEET 8 OF 11

PRE-FINAL SUBMITTAL



SECTIONS (OPTION 1)

SCALE : 1" = 10'   0   5'   10'

US Army Corps of Engineers Norfolk District

REV.	DATE	DESCRIPTION	BY	APP.

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=10'
PROJECT NO.: 00000 | NORFOLK DISTRICT FILE NO.:
DRAWING NO.: | SPECIFICATION NO.:
LAST MODIFIED ON: | Plot Scale: 1:1
FILE NAME: /2857K001-Sections/Plan.dwg

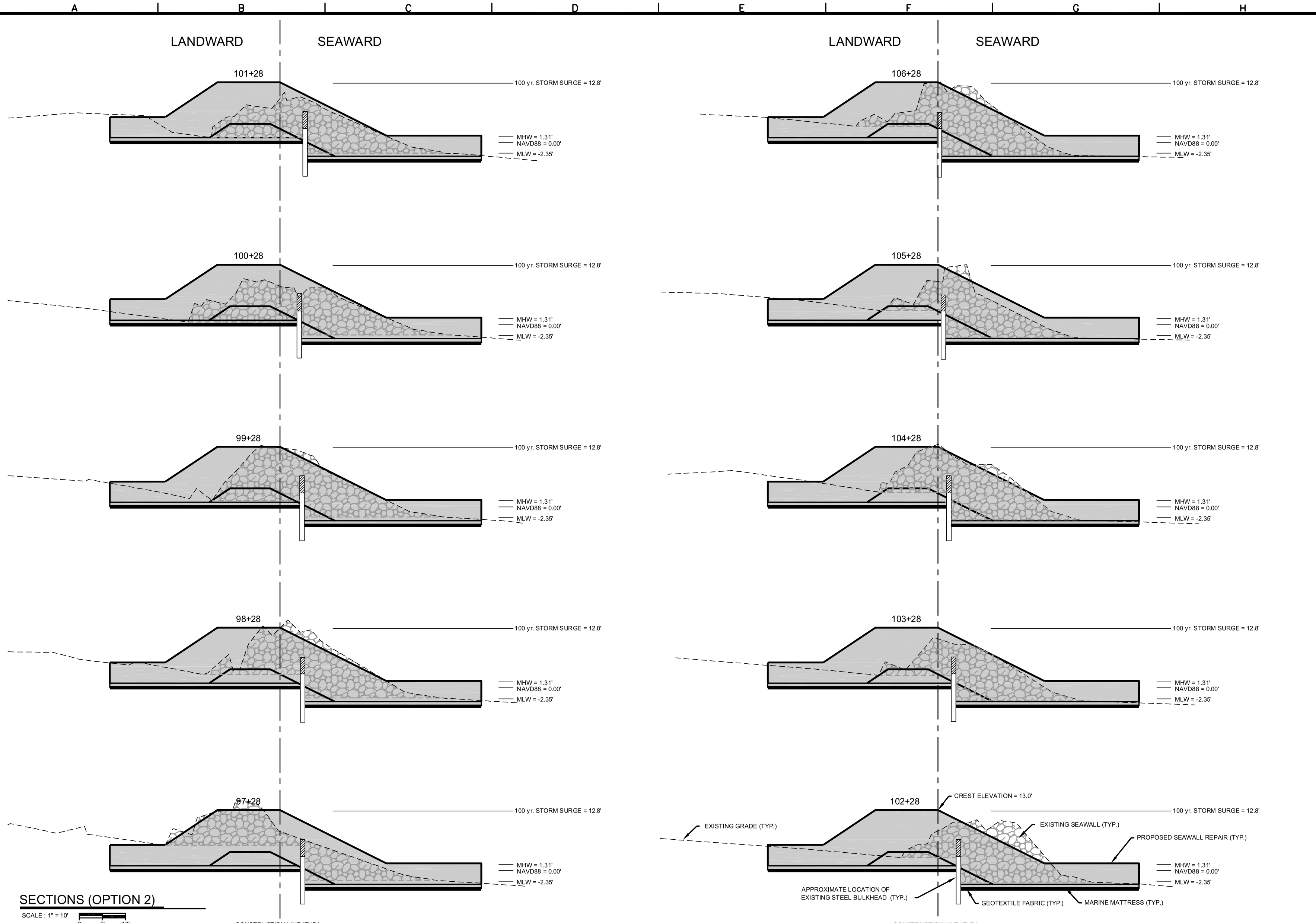
NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

SEAWALL REPAIR SECTIONS (OPTION 1)
NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-9
SHEET 9 OF 11

PRE-FINAL SUBMITTAL



US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APP.

DESIGNED: E.T.F. CHECKED: G.O.W. DATE: 22 June 2010
DRAWN: J.S.B. SUBMITTED: 6/22/10 SCALE: 1"=10'
PROJECT NO.: 00000 NORFOLK DISTRICT FILE NO.
DRAWING NO. SPECIFICATION NO.

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

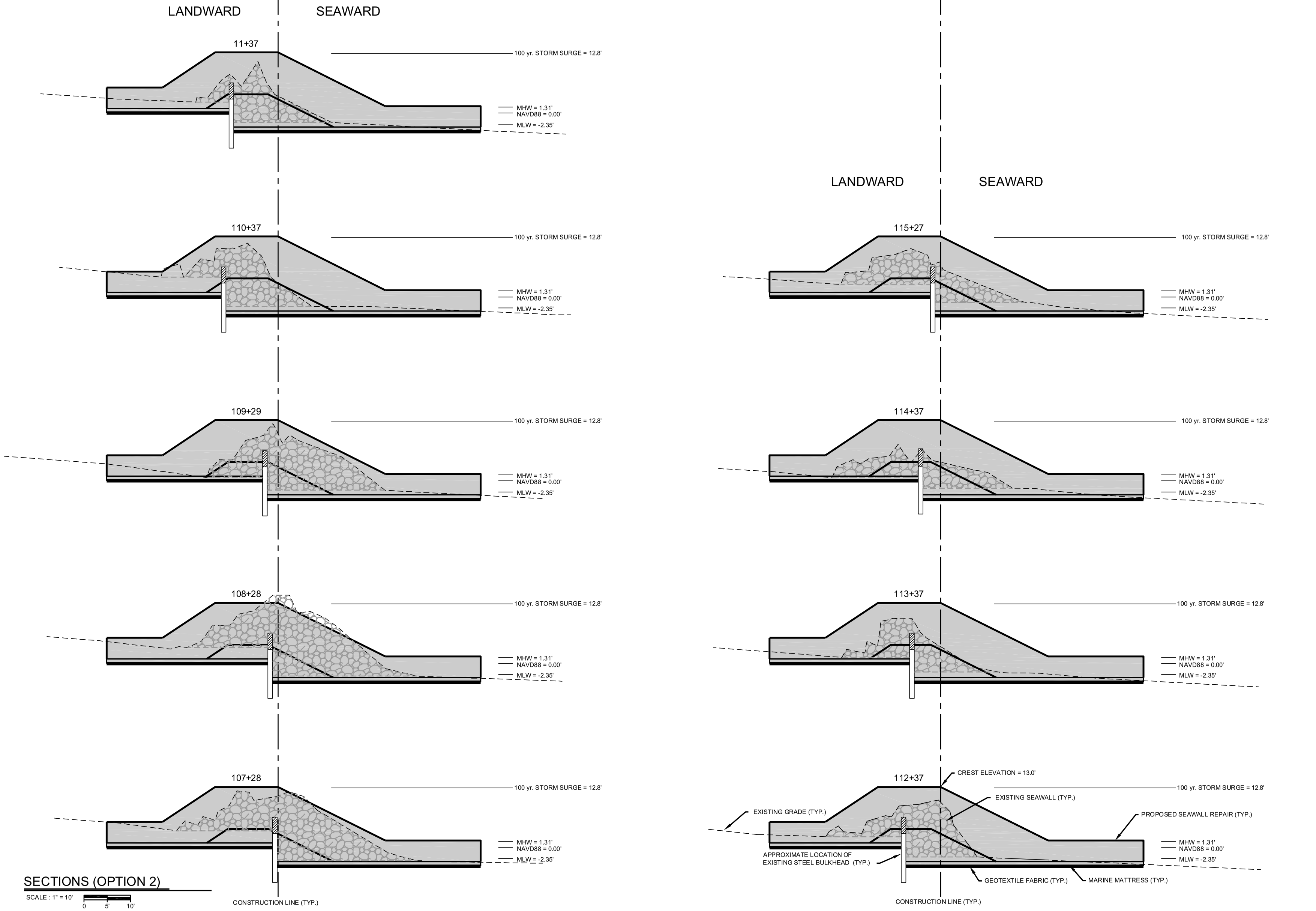
ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

SEAWALL REPAIR SECTIONS (OPTION 2)

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-10
SHEET 10 OF 11

PRE-FINAL SUBMITTAL



SECTIONS (OPTION 2)

SCALE : 1" = 10'

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APP.

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=10'
PROJECT NO.: 00000

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

SEAWALL REPAIR SECTIONS (OPTION 2)

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
SEAWALL REPAIR AND EXTENSION
ACCOMACK COUNTY, VIRGINIA

C-11
SHEET 11 OF 11

PRE-FINAL SUBMITTAL

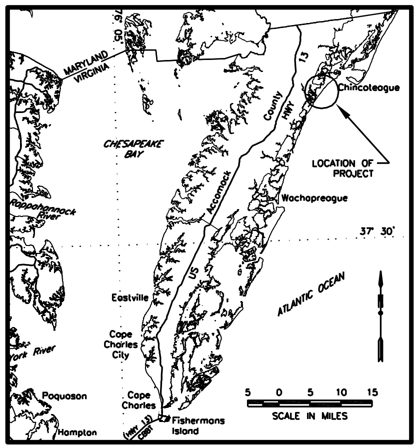
SHORELINE DAMAGE REDUCTION PROJECT
BEACH FILL
NASA WALLOPS ISLAND
ACCOMACK COUNTY, VIRGINIA
JUNE 2010

LEGEND

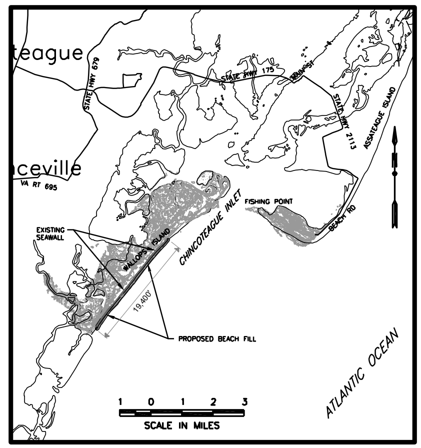
ITEM	EXISTING	PROPOSED
LIMIT OF DISTURBANCE	N/A	LOD
IMPERVIOUS SURFACED ROAD, DRIVE OR LOT		N/A
FENCE		
DRAINAGE DITCH OR SWALE		N/A
EMBANKMENT SIDESLOPES (DOWN)		
CONTOUR	5	4.0
ELEVATION SPOT SHOT	x 6.50	5.00
PROPERTY LINE		N/A
CONSTRUCTION LINE	N/A	
BUILDING OR STRUCTURE		N/A
SILT FENCE	N/A	SF
STABILIZED CONSTRUCTION ENTRANCE	N/A	SCE
STONE		N/A
BEACHGRASS PLANING	N/A	

LIST OF ABBREVIATIONS

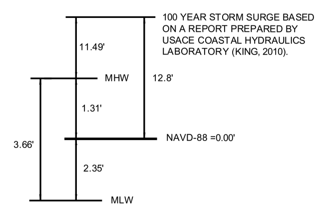
ADC	ALEXANDRIA DRAFTING COMPANY
AMA	ANDREWS, MILLER & ASSOCIATES
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
CD	CONSTRUCTION DOCUMENTS
DIA	DIAMETER
D.I.P	DUCTILE IRON PIPE
E	EAST
EIS	ENVIRONMENT IMPACT STATEMENT
ELEV	ELEVATION
H	HORIZONTAL
INV	INVERT
LB.	POUNDS
LOD	LIMIT OF DISTURBANCE
MEC	MUNITIONS & EXPLOSIVES OF CONCERN
MHW	MEAN HIGH WATER
MLW	MEAN LOW WATER
N	NORTH
NAVD	NORTH AMERICAN VERTICAL DATUM
NASA	NATIONAL AERONAUTICS & SPACE ADMINISTRATION
OCEW	ON CENTER EACH WAY
O.D.	OUTSIDE DIAMETER
RCP	REINFORCED CONCRETE PIPE
SCE	STABILIZED CONSTRUCTION ENTRANCE
SF	SILT FENCE
STA	STATION
TYP.	TYPICAL
USACE	UNITED STATES ARMY CORPS OF ENGINEERS
V	VERTICAL



VICINITY MAP



LOCATION MAP



DATUM COMPARISON
NOT TO SCALE

GENERAL NOTES

1. THE EXISTING UTILITIES AND OBSTRUCTIONS SHOWN ARE FROM THE BEST AVAILABLE RECORDS AND SHALL BE VERIFIED BY THE CONTRACTOR TO HIS SATISFACTION PRIOR TO CONSTRUCTION.
2. NECESSARY PRECAUTIONS SHALL BE TAKEN BY THE CONTRACTOR TO PROTECT EXISTING SERVICES AND STRUCTURES. ANY DAMAGE TO THEM SHALL BE REPAIRED IMMEDIATELY AT HIS OWN EXPENSE.
3. IT SHALL BE DISTINCTLY UNDERSTOOD THAT FAILURE TO MENTION SPECIFICALLY ANY WORK WHICH WOULD NATURALLY BE REQUIRED TO COMPLETE THE PROJECT SHALL NOT RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITY TO COMPLETE SUCH WORK.
4. PUBLISHED MEAN TIDAL RANGE IS 3.66 FEET.
5. TOPOGRAPHIC & BATHYMETRIC DATA WAS PROVIDED BY USACE AND IS BASED UPON NAVD 88. LIMITED SURVEYING LOCATED LANDWARD OF THE SEAWALL WAS PERFORMED BY AMA IN MAY 2010.
6. HORIZONTAL MERIDIAN IS BASED UPON NAD 83, VIRGINIA STATE PLANE, SOUTH
7. VERTICAL CONTROL IS BASED UPON NAVD 88.
8. PROPERTY LINES SHOWN ARE APPROXIMATE ONLY. THIS PLAN IS NOT INTENDED TO BE A PROPERTY LINE SURVEY.
9. DISTURBED AREAS WILL BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND. THIS INCLUDES THE TEMPORARY STAGING AND STONE STOCKPILE AREAS.
10. THE EXISTING BOTTOM AND SEAWALL PROFILES, BEACH CONTOUR AND/OR BANK ALIGNMENT SHOWN ON THE DRAWINGS WERE CORRECT WHEN SURVEYED. HOWEVER, BECAUSE OF THE INTERIM EROSION AND LITTORAL TRANSPORT, THE CONTRACTOR SHALL SATISFY HIMSELF AS TO ALL CONDITIONS AT THE TIME OF BIDDING THIS PROJECT AND INCLUDE IN HIS PROPOSAL ANY CHANGES THAT WOULD BE NECESSARY TO ACCOMPLISH A COMPLETE AND FUNCTIONAL PROJECT.

SCOPE OF WORK

BEACH FILL - 3.2 Million C.Y. (19,400 L.F.)
- DESIGN TEMPLATE: 1.8 Million C.Y.
- CONSTRUCTION TEMPLATE: 1.4 Million C.Y.

SAND FENCE - 39,600 L.F.

BEACH GRASS - 38 AC.

INDEX TO DRAWINGS

* TO BE INSERTED AT FINAL DESIGN LEVEL
** SURVEY DATA AND FILE NUMBERS TO BE PROVIDED BY USACE.

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDICATED ON INDEX OF DRAWINGS.

RECOMMENDED:

PROJECT MANAGER

APPROVED:

CHIEF, DESIGN BRANCH

APPROVED:

CHIEF, ENGINEERING DIVISION

APPROVED:

COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

APPROVED FOR:

DATE:

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APP.

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: AS SHOWN
PROJECT NO.: 00000 | NORFOLK DISTRICT FILE NO.:
DRAWING NO.: | SPECIFICATION NO.:
LAST SCALE ON: | Plot Scale 1:1

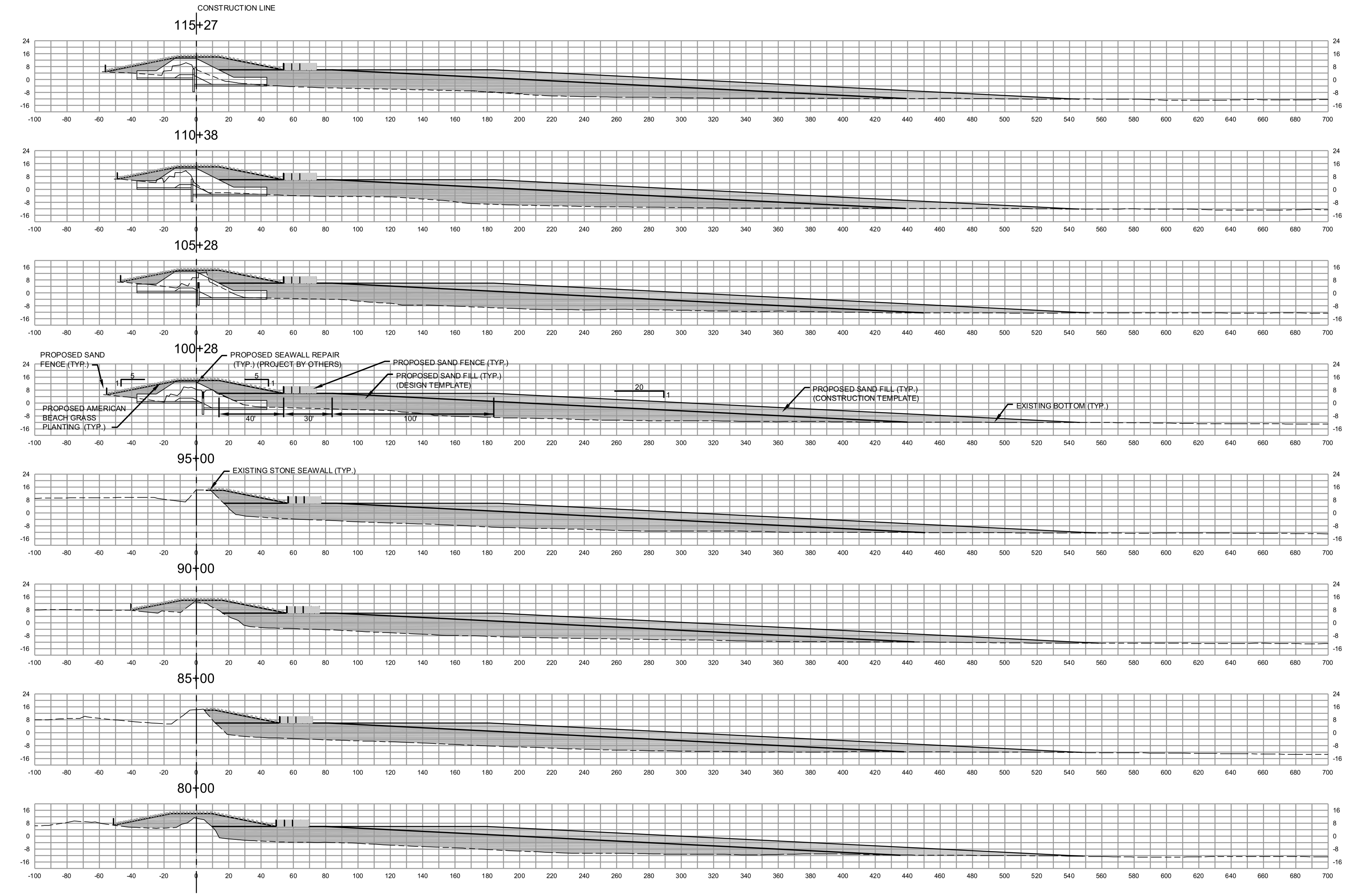
NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

COVER SHEET
NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
BEACH FILL
ACCOMACK COUNTY, VIRGINIA

C-1
SHEET 1 OF 12

PRE-FINAL SUBMITTAL



SECTIONS

SCALE : 1" = 30'

NOTE: DUE TO FUNDING LIMITATIONS CONSTRUCTION SCOPE OF THE STONE SEAWALL EXTENSION AND / OR STONE SEAWALL REPAIR MAY NOT EXTEND TO THE LIMITS SHOWN. SEAWALL EXTENSION AND REPAIR WORK IS A SEPARATE PROJECT TO BE PERFORMED BY OTHERS AND COMPLETED PRIOR TO PLACEMENT OF BEACH FILL.

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APP.

DESIGNED: E.T.F.	CHECKED: G.O.W.
DRAWN: J.S.B.	SUBMITTED: 6/22/10
PROJECT NO.: 00000	
DATE: 22 June 2010	SCALE: 1"=30'
DRAWING NO.:	SPECIFICATION NO.:
NORFOLK DISTRICT FILE NO.:	Plot Scale: 1:1

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

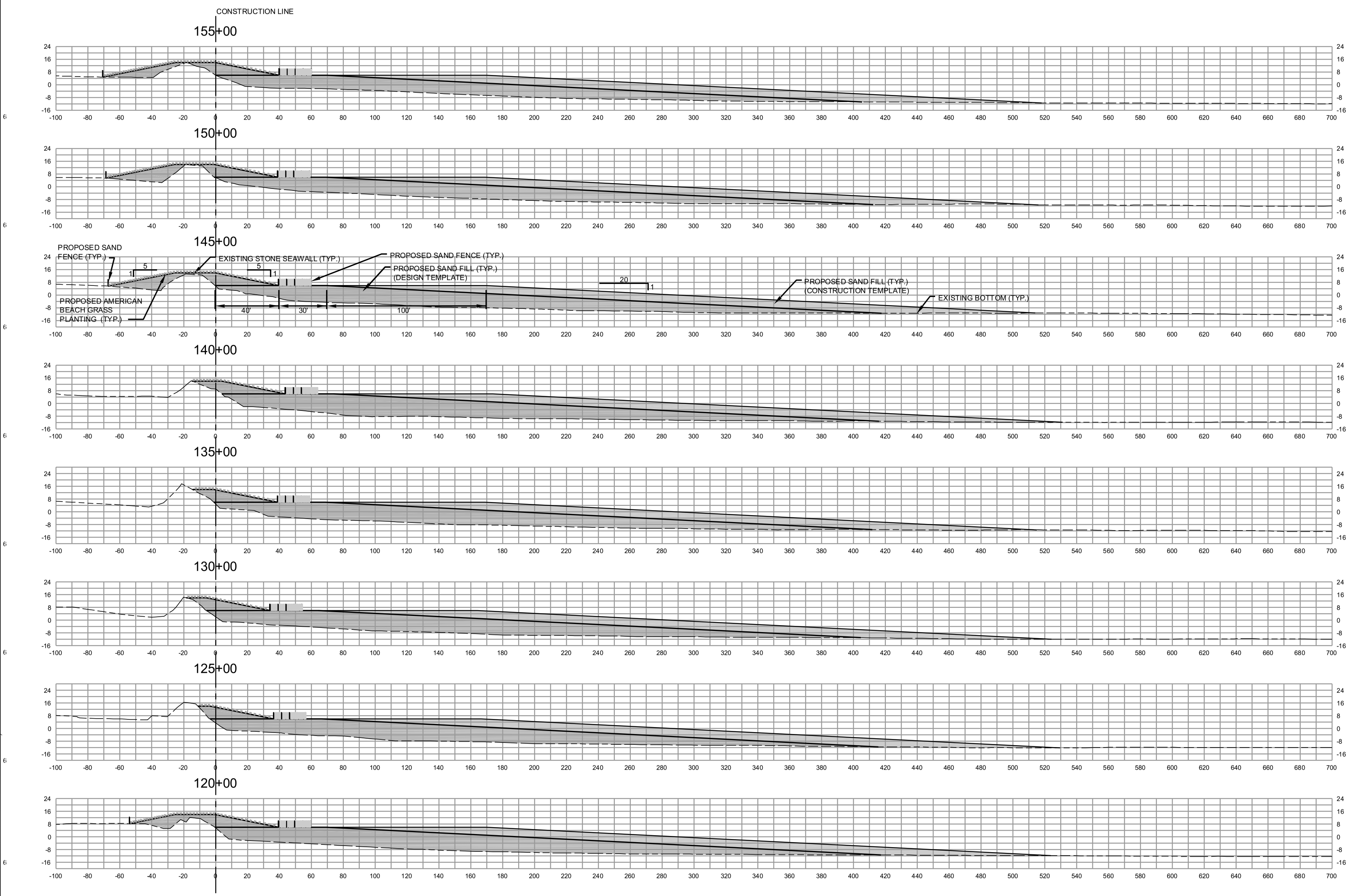
ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

SECTIONS : (STA. 80+00 to STA. 115+27)

NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
BEACH FILL
ACCOMACK COUNTY, VIRGINIA

C-10
SHEET 10 OF 12

PRE-FINAL SUBMITTAL



SECTIONS
SCALE : 1" = 30'

US Army Corps of Engineers Norfolk District

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

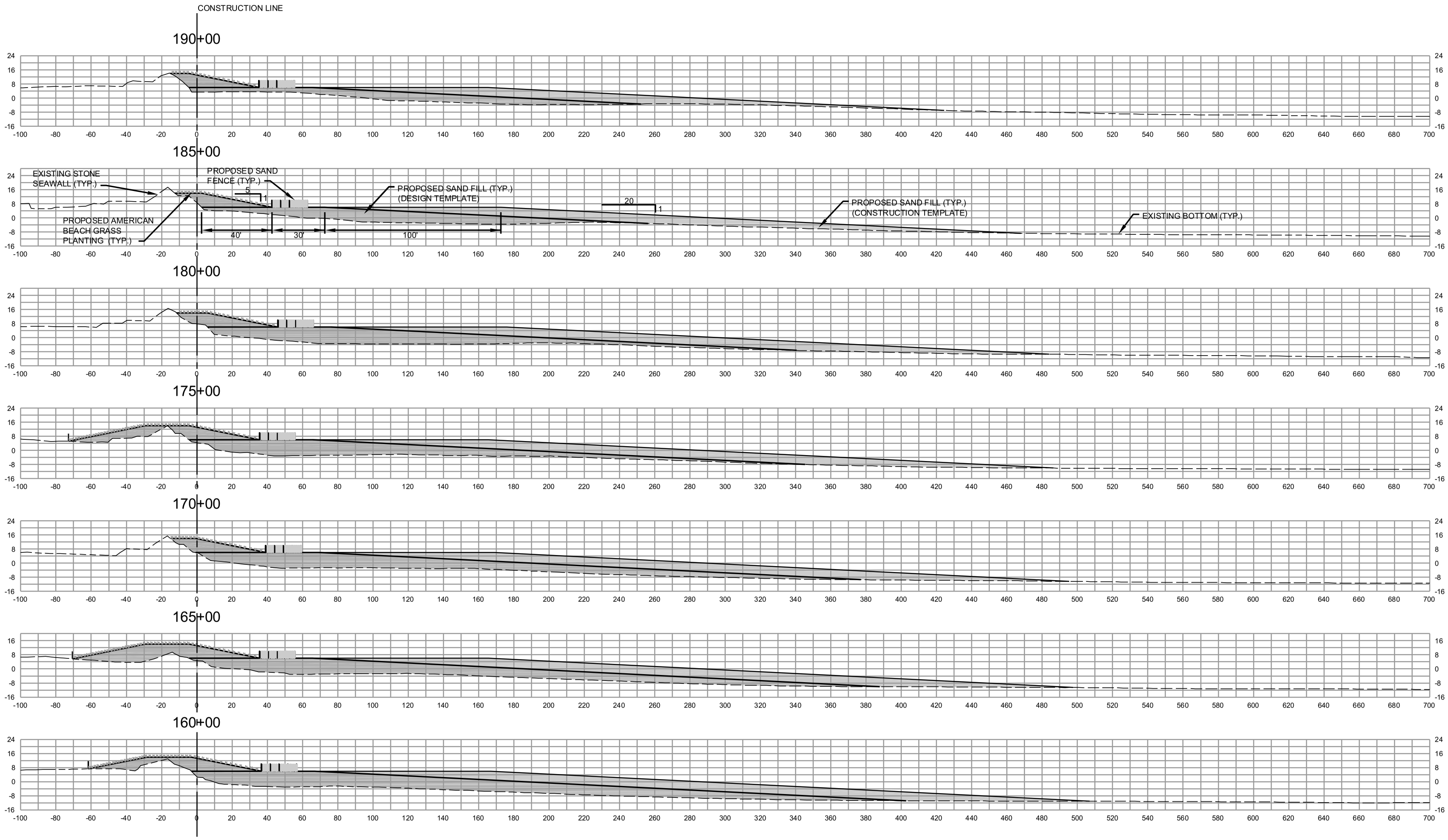
ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

DESIGNED: E.T.F. CHECKED: G.O.W. DATE: 22 June 2010
DRAWN: J.S.B. SUBMITTED: 6/22/10 SCALE: 1"=30'
PROJECT NO.: 00000

SECTIONS : (STA. 120+00 to STA. 155+00)
NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT BEACH FILL
ACCOMACK COUNTY, VIRGINIA

C-11
SHEET 11 OF 12

PRE-FINAL SUBMITTAL



SECTIONS

SCALE : 1" = 30'

US Army Corps of Engineers Norfolk District

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: 1"=30'
PROJECT NO.: 00000

SECTIONS : (STA. 160+00 to STA. 190+00)

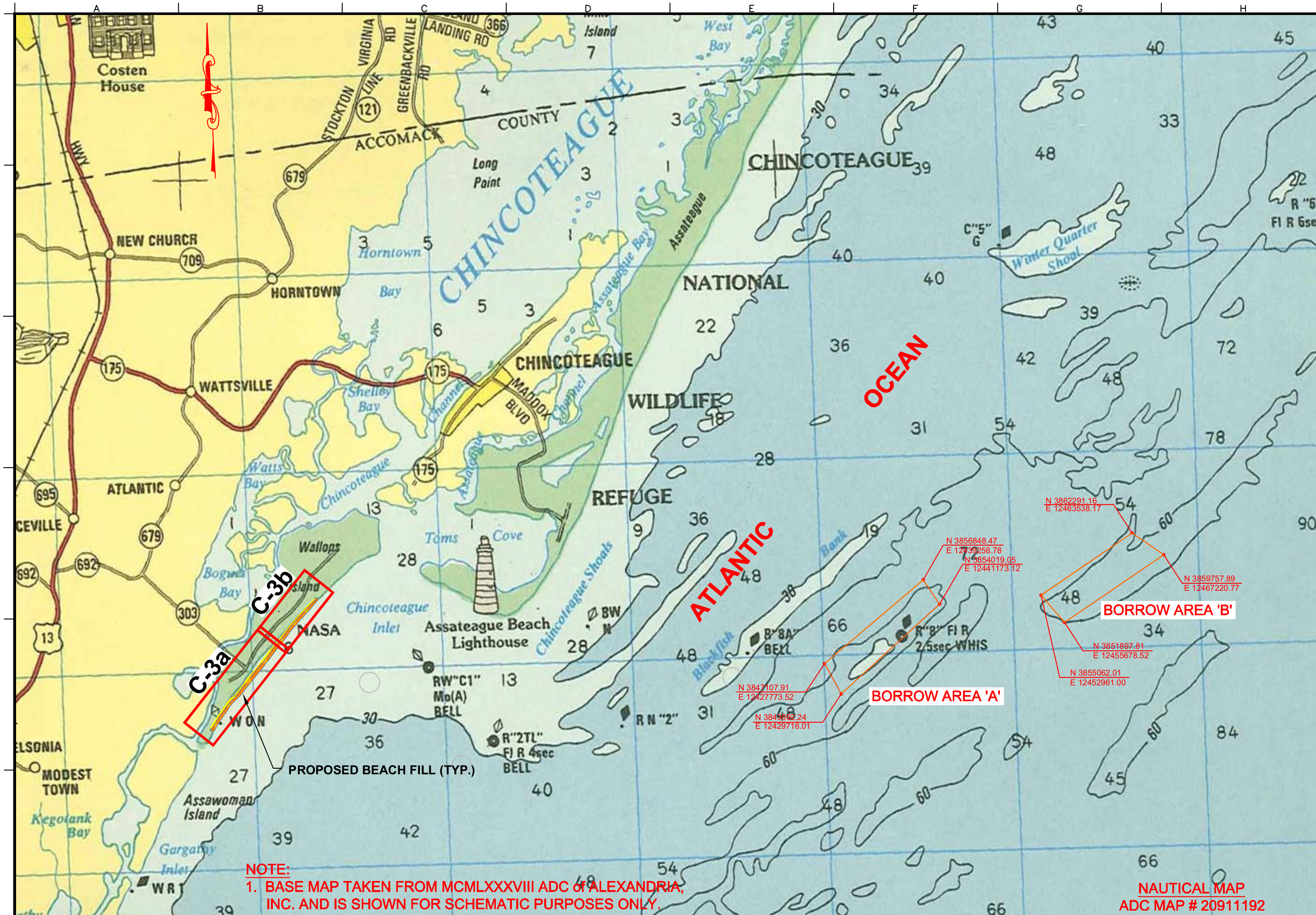
NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT BEACH FILL

ACCOMACK COUNTY, VIRGINIA

C-12

SHEET 12 OF 12

PRE-FINAL SUBMITTAL



NOTE:
1. BASE MAP TAKEN FROM MCMLXXXVIII ADC of ALEXANDRIA, INC. AND IS SHOWN FOR SCHEMATIC PURPOSES ONLY.

US Army Corps of Engineers Norfolk District

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

DESIGNED: E.T.F.	CHECKED: G.O.W.	DATE: 22 June 2010
DRAWN: J.S.B.	SUBMITTED: 6/22/10	SCALE: 1"=1Mile
PROJECT NO.: 00000		

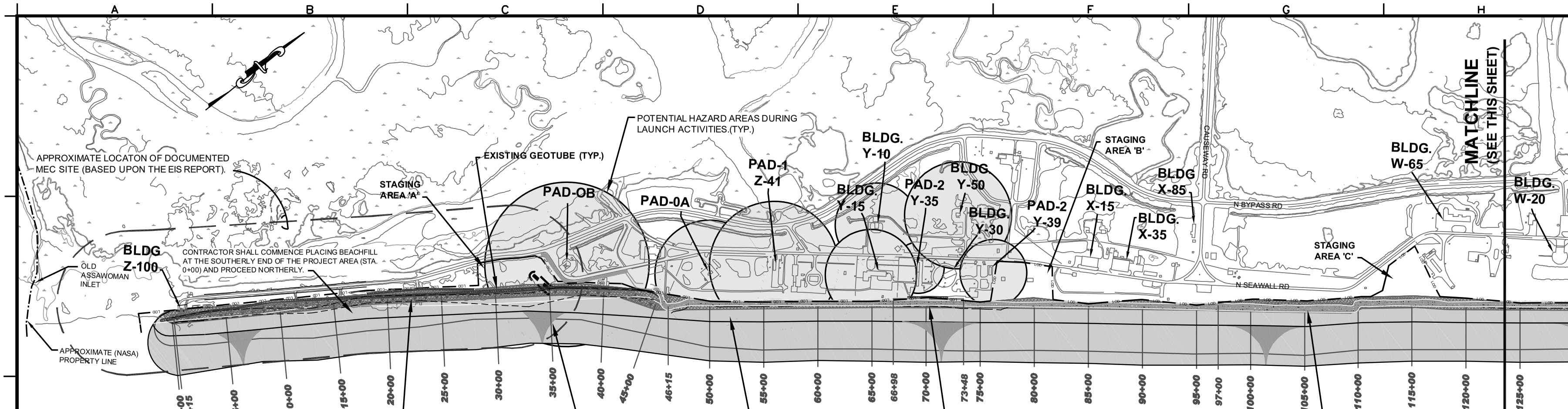
KEY SHEET

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT BEACH FILL

ACCOMACK COUNTY, VIRGINIA

C-2
SHEET 2 OF 12

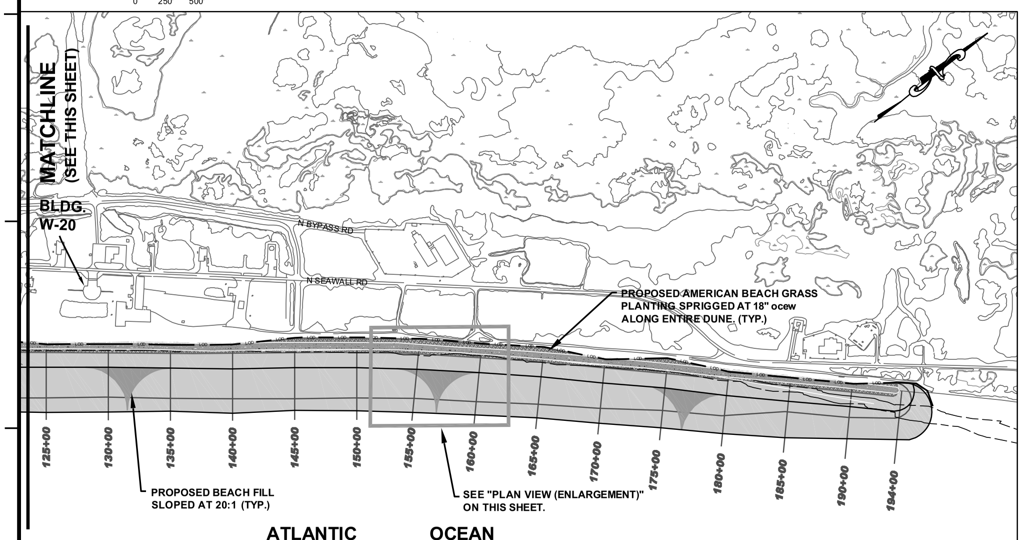
PRE-FINAL SUBMITTAL



NOTE:
1. DUE TO FUNDING LIMITATIONS CONSTRUCTION SCOPE OF THE STONE SEAWALL EXTENSION AND/OR STONE SEAWALL REPAIR MAY NOT EXTEND TO THE LIMITS SHOWN. SEAWALL EXTENSION AND REPAIR WORK IS A SEPARATE PROJECT TO BE PERFORMED BY OTHERS AND COMPLETED PRIOR TO PLACEMENT OF BEACH FILL.
2. ANY STOCKPILED SAND FROM SEAWALL EXTENSION AND REPAIR WORK SHALL BE INCORPORATED IN THE BEACH FILL.
3. CONTRACTOR SHALL PLACE SAFETY FENCE TO KEEP PERSONNEL FROM DISCHARGE END OF DREDGE PIPELINE AS OUTLINED IN THE SPECIFICATIONS, THE CONTRACTOR'S "SAFETY AND ACCIDENT PREVENTION PLAN" AND AS APPROVED BY THE CONTRACTING OFFICER.

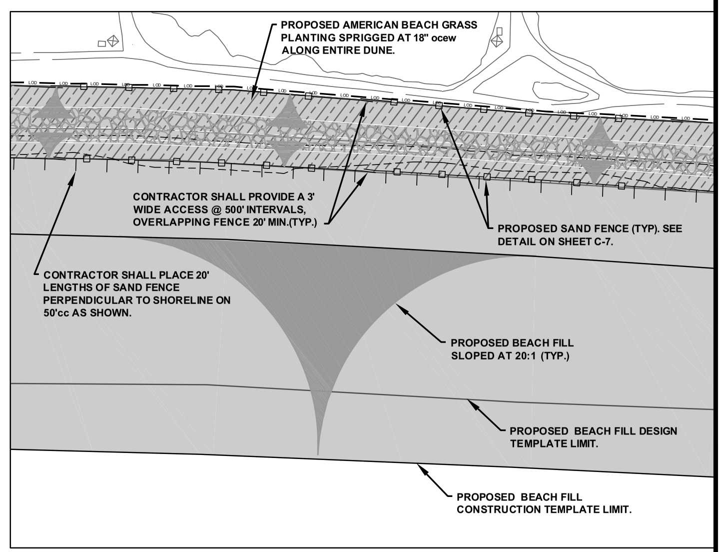
PLAN VIEW (3a) STA. 00+00 TO 123+00

SCALE : 1" = 500' 0 250' 500'



PLAN VIEW (3b) STA. 123+00 TO 194+00

SCALE : 1" = 500' 0 250' 500'



TYPICAL PLAN VIEW (ENLARGEMENT)

SCALE : 1" = 100' 0 50' 100'

US Army Corps of Engineers Norfolk District

REV.	DATE	DESCRIPTION	BY	APP

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: As Shown
PROJECT NO. 00000

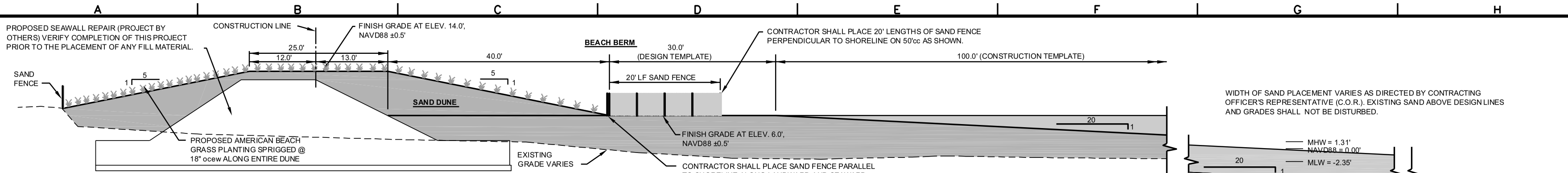
NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

PLAN VIEW (BEACH FILL)
NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
BEACH FILL
ACCOMACK COUNTY, VIRGINIA

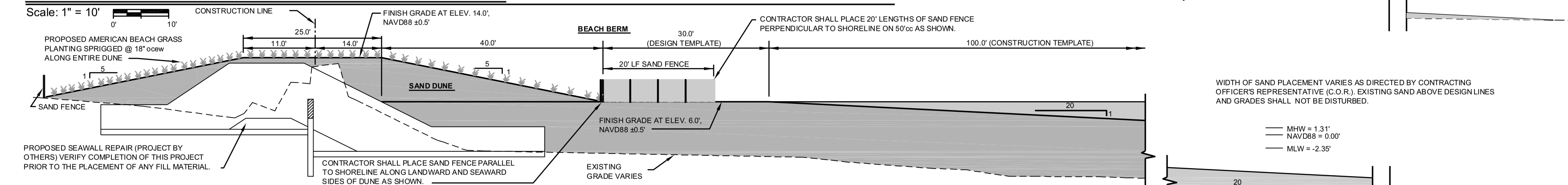
C-3
SHEET 3 OF 12

PRE-FINAL SUBMITTAL



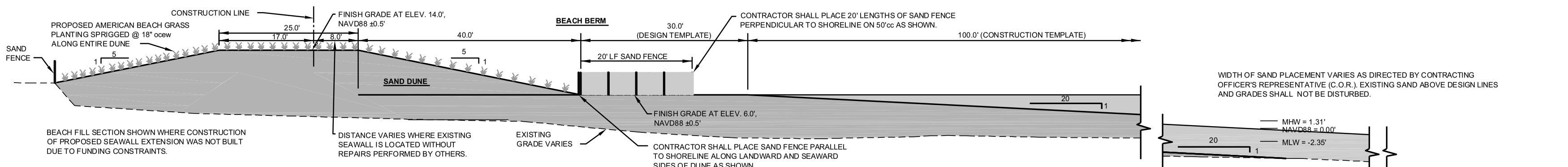
TYPICAL REVETMENT EXTENSION AREA BEACH FILL SECTION

Scale: 1" = 10'



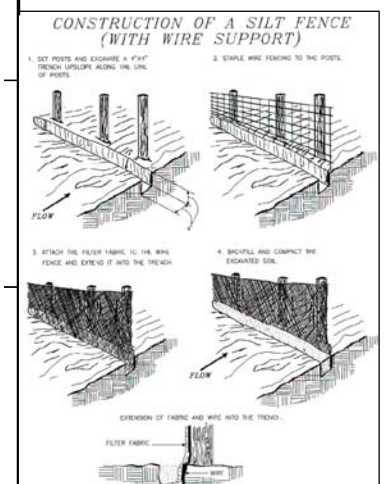
TYPICAL REVETMENT REPAIR AREA BEACH FILL SECTION

Scale: 1" = 10'



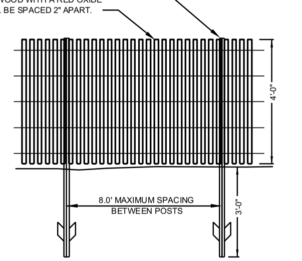
TYPICAL BEACH FILL SECTION

Scale: 1" = 10'



POSTS SHALL BE HOT DIPPED GALVANIZED STEEL "T" TYPE MADE OF RIGID, HEAVY-GAUGE STEEL. POSTS SHALL HAVE STUDDED GROOVES FOR WIRE ATTACHMENT AND AN ANCHOR PLATE NEAR THE BASE.

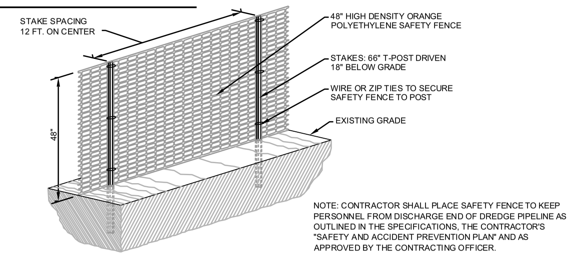
SAND FENCE SLATS SHALL BE 48" x 1-1/2" x 3/8" SPRUCE OR ASPEN WOOD WITH A RED OXIDE FINISH. SLATS SHALL BE SPACED 2" APART.



1. CONTRACTOR SHALL PLACE SAND FENCE PARALLEL TO SHORELINE ALONG LANDWARD AND WATERWARD SIDES OF DUNE AS SHOWN.
2. CONTRACTOR SHALL PLACE 20' LENGTHS OF SAND FENCE PERPENDICULAR TO SHORELINE ON 50'cc AS SHOWN.
3. CONTRACTOR SHALL PROVIDE A 3' WIDE ACCESS @ ± 500' INTERVALS, OVERLAPPING FENCE 20' MIN. (TYP.)

TYPICAL SAND FENCE DETAIL

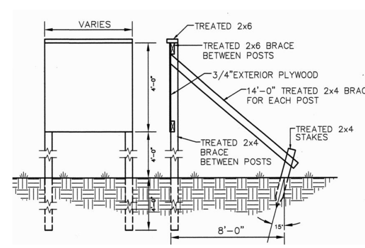
Scale: 1" = 2'



NOTE: CONTRACTOR SHALL PLACE SAFETY FENCE TO KEEP PERSONNEL FROM DISCHARGE END OF DREDGE PIPELINE AS OUTLINED IN THE SPECIFICATIONS, THE CONTRACTOR'S "SAFETY AND ACCIDENT PREVENTION PLAN" AND AS APPROVED BY THE CONTRACTING OFFICER.

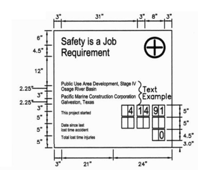
ORANGE SAFETY FENCE DETAIL

Not To Scale



TYPICAL SIGN ERECTION DETAIL

Not To Scale



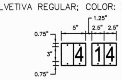
ALL TYPOGRAPHY IS FLUSH LEFT AND RAGGED RIGHT, UPPER AND LOWER CASE WITH WITH INITIAL CAPITALS ONLY AS SHOWN. LETTER AND WORD SPACING TO FOLLOW COPRS STANDARDS (EP 310-1-6a AND 6b).

LEGEND GROUP 1: STANDARD TWO-LINE TITLE "SAFETY IS A JOB REQUIREMENT" WITH (8" od.) SAFETY GREEN FIRST AID LOGO. TYPEFACE 3" HELVETIVA BOLD; COLOR: BLACK.

LEGEND GROUP 2: ONE TO TWO-LINE PROJECT TITLE LEGEND DESCRIBES THE WORK BEING DONE UNDER THIS PROJECT AND NAME OF HOST PROJECT. TYPEFACE: 1.5" HELVETIVA REGULAR; COLOR: BLACK; MAXIMUM LINE LENGTH: 42".

LEGEND GROUP 3: ONE TO TWO-LINE IDENTIFICATION: NAME OF PRIME CONTRACTOR AND CITY, STATE ADDRESS. TYPEFACE: 1.5" HELVETIVA REGULAR, COLOR: BLACK; MAXIMUM LINE LENGTH 42".

LEGEND GROUP 4: STANDARD SAFETY RECORD CAPTIONS AS SHOWN. TYPEFACE 1.25" HELVETIVA REGULAR; COLOR: BLACK.



REPLACEABLE NUMBERS TO MOUNTED ON WHITE 0.060 ALUMINUM PLATE AND SCREW-MOUNTED TO BACKDROP. TYPEFACE: 3" HELVETIVA REGULAR; COLOR: BLACK; PLATE SIZE: 2.5" X 4.5".

TYPICAL SAFETY SIGN

Not To Scale

US Army Corps of Engineers
Norfolk District

REV.	DATE	DESCRIPTION	BY	APPR.

DESIGNED: E.T.F. | CHECKED: G.O.W. | DATE: 22 June 2010
DRAWN: J.S.B. | SUBMITTED: 6/22/10 | SCALE: AS SHOWN
PROJECT NO.: 00000 | NORFOLK DISTRICT FILE NO.
DRAWING NO.: | SPECIFICATION NO.

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

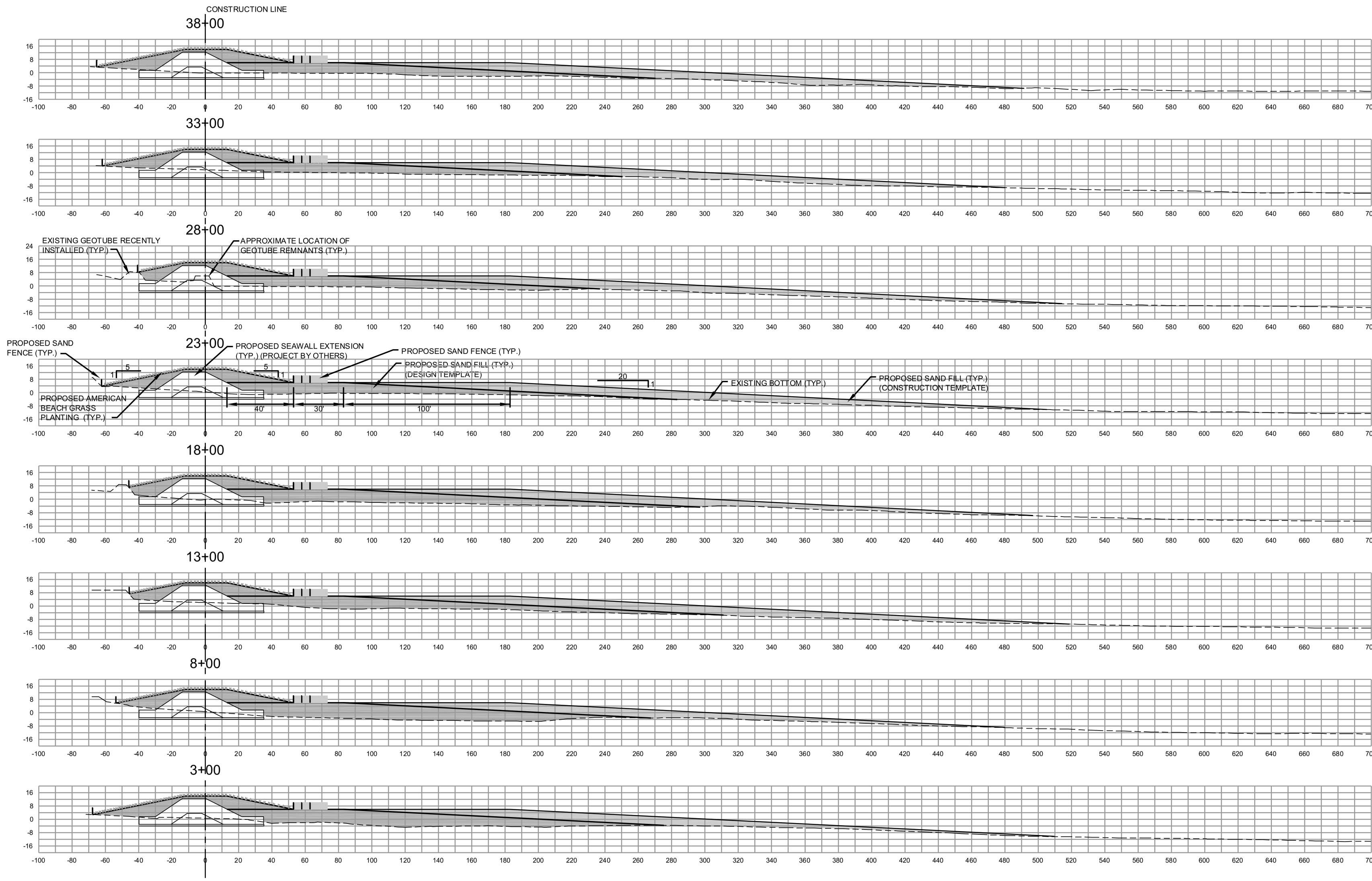
ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

DETAILS

NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT
BEACH FILL
ACCOMACK COUNTY, VIRGINIA

C-7
SHEET 7 OF 12

PRE-FINAL SUBMITTAL



NOTE: DUE TO FUNDING LIMITATIONS CONSTRUCTION SCOPE OF THE STONE SEAWALL EXTENSION AND / OR STONE SEAWALL REPAIR MAY NOT EXTEND TO THE LIMITS SHOWN. SEAWALL EXTENSION AND REPAIR WORK IS A SEPARATE PROJECT TO BE PERFORMED BY OTHERS AND COMPLETED PRIOR TO PLACEMENT OF BEACH FILL.

SECTIONS

SCALE : 1" = 30'

US Army Corps of Engineers Norfolk District

DESIGNED: E.T.F. CHECKED: G.O.W. DATE: 22 June 2010
DRAWN: J.S.B. SUBMITTED: 6/22/10 SCALE: 1"=30'
PROJECT NO.: 00000

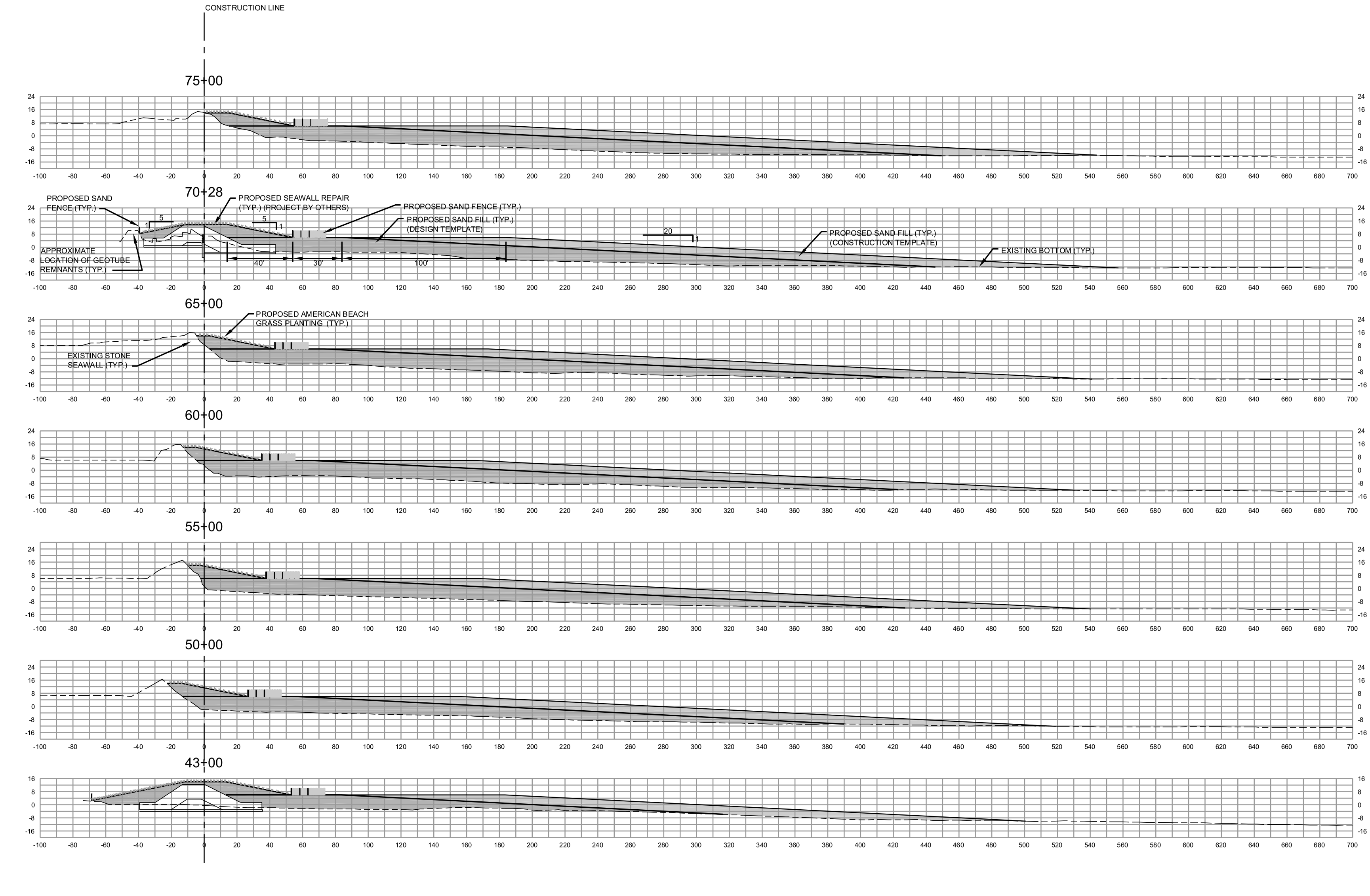
NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

SECTIONS : (STA. 3+00 to STA. 38+00)
NASA WALLOPS ISLAND SHORELINE DAMAGE REDUCTION PROJECT
BEACH FILL
ACCOMACK COUNTY, VIRGINIA

C-8
SHEET 8 OF 12

PRE-FINAL SUBMITTAL



SECTIONS

SCALE : 1" = 30'

US Army Corps of Engineers Norfolk District

REV.	DATE	DESCRIPTION	BY	APP.

DESIGNED: E.T.F. CHECKED: G.O.W. DATE: 22 June 2010
DRAWN: J.S.B. SUBMITTED: 6/22/10 SCALE: 1"=30'
PROJECT NO.: 00000

NORFOLK DISTRICT
CORPS OF ENGINEERS
NORFOLK, VIRGINIA

ANDREWS, MILLER & ASSOCIATES
401 ACADEMY STREET, SUITE 1
CAMBRIDGE, MARYLAND 21613

SECTIONS : (STA. 43+00 to STA. 75+00)
NASA WALLOPS ISLAND SHORELINE
DAMAGE REDUCTION PROJECT
BEACH FILL
ACCOMACK COUNTY, VIRGINIA

C-9
SHEET 9 OF 12

PRE-FINAL SUBMITTAL

APPENDIX 2

ATLANTIC PIPING PLOVER POPULATION SIZE AND NESTING SUCCESS

APPENDIX 2

Estimated abundance of breeding pairs of Atlantic Coast piping plovers, 1986 – 2009

PARENTHESES DENOTE PRELIMINARY ESTIMATES

State/RECOVERY UNIT	Pairs																							
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Maine	15	12	20	16	17	18	24	32	35	40	60	47	60	56	50	55	66	61	55	49	40	35	24	27
New Hampshire												5	5	6	6	7	7	7	4	3	3	3	3	5
Massachusetts	139	126	134	137	140	160	213	289	352	441	454	483	495	501	496	495	538	511	488	467	482	558	566	(575)
Rhode Island	10	17	19	19	28	26	20	31	32	40	50	51	46	39	49	52	58	71	70	69	72	73	77	84
Connecticut	20	24	27	34	43	36	40	24	30	31	26	26	21	22	22	32	31	37	40	34	37	36	41	44
NEW ENGLAND	184	179	200	206	228	240	297	376	449	552	590	612	627	624	623	641	700	687	657	622	634	705	711	(735)
New York	106	135	172	191	197	191	187	193	209	249	256	256	245	243	289	309	369	386	384	374	422	457	443	(437)
New Jersey	102	93	105	128	126	126	134	127	124	132	127	115	93	107	112	122	138	144	135	111	116	129	111	105
NY-NJ	208	228	277	319	323	317	321	320	333	381	383	371	338	350	401	431	507	530	519	485	538	586	554	(542)
Delaware	8	7	3	3	6	5	2	2	4	5	6	4	6	4	3	6	6	6	7	8	9	9	10	10
Maryland	17	23	25	20	14	17	24	19	32	44	61	60	56	58	60	60	60	59	66	63	64	64	49	45
Virginia	100	100	103	121	125	131	97	106	96	118	87	88	95	89	96	119	120	114	152	192	202	199	208	193
North Carolina	30	30	40	55	55	40	49	53	54	50	35	52	46	31	24	23	23	24	20	37	46	61	64	54
South Carolina	3		0		1	1		1			0					0						0		
SOUTHERN	158	160	171	199	201	194	172	181	186	217	189	204	203	182	183	208	209	203	245	300	321	333	331	302
U.S. TOTAL	550	567	648	724	752	751	790	877	968	1150	1162	1187	1168	1156	1207	1280	1416	1420	1421	1407	1493	1624	1596	(1579)
EASTERN CANADA*	240	223	238	233	230	252	223	223	194	200	202	199	211	236	230	250	274	256	237	217	256	266	253	(252)
ATLANTIC COAST TOTAL	790	790	886	957	982	1003	1013	1100	1162	1350	1364	1386	1379	1392	1437	1530	1690	1676	1658	1624	1749	1890	1849	(1831)

* includes 1-5 pairs on the French Islands of St. Pierre and Miquelon, reported by CWS

Estimated productivity of Atlantic Coast piping plovers, 1987 – 2009 **PARENTHESES DENOTE PRELIMINARY ESTIMATES**

State/RECOVERY UNIT	Chicks fledged/pair																						
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Maine	1.75	0.75	2.38	1.53	2.50	2.00	2.38	2.00	2.38	1.63	1.98	1.47	1.63	1.60	1.98	1.39	1.28	1.45	0.55	1.35	1.06	1.75	1.70
New Hampshire											0.60	2.40	2.67	2.33	2.14	0.14	1.00	1.00	0.00	0.67	0.33	2.00	0.40
Massachusetts	1.10	1.29	1.59	1.38	1.72	2.03	1.92	1.81	1.62	1.35	1.33	1.50	1.60	1.09	1.49	1.14	1.26	1.38	1.14	1.33	1.25	1.41	(0.90)
Rhode Island	1.12	1.58	1.47	0.88	0.77	1.55	1.80	2.00	1.68	1.56	1.34	1.13	1.79	1.20	1.50	1.95	1.03	1.50	1.43	1.03	1.48	1.68	1.46
Connecticut	1.29	1.70	1.79	1.63	1.39	1.45	0.38	1.47	1.35	1.31	1.69	1.05	1.45	1.86	1.22	1.87	1.30	1.35	1.62	2.14	1.92	2.49	1.68
NEW ENGLAND	1.19	1.32	1.68	1.38	1.62	1.91	1.85	1.81	1.67	1.40	1.39	1.46	1.62	1.18	1.53	1.26	1.24	1.40	1.15	1.34	1.30	1.51	(1.04)
New York	0.90	1.24	1.02	0.80	1.09	0.98	1.24	1.34	0.97	1.14	1.36	1.09	1.35	1.11	1.27	1.62	1.15	1.46	1.44	1.55	1.15	1.21	(0.93)
New Jersey	0.85	0.94	1.12	0.93	0.98	1.07	0.93	1.16	0.98	1.00	0.39	1.09	1.34	1.40	1.29	1.17	0.92	0.61	0.77	0.84	0.67	0.64	1.05
NY-NJ	0.86	1.03	1.08	0.88	1.04	1.02	1.08	1.25	0.97	1.07	1.02	1.09	1.35	1.19	1.28	1.49	1.07	1.23	1.28	1.36	1.03	1.10	(0.96)
Delaware		0.00	2.33	2.00	1.60	1.00	0.50	2.50	2.00	0.50	1.00	0.83	1.50	1.67	1.50	1.17	2.33	1.14	1.50	1.44	1.33	0.30	1.30
Maryland	1.17	0.52	0.90	0.79	0.41	1.00	1.79	2.41	1.73	1.49	1.02	1.30	1.09	0.80	0.92	1.85	1.56	1.86	1.25	1.06	0.78	0.41	1.42
Virginia		1.02	1.16	0.65	0.88	0.59	1.45	1.66	1.00	1.54	0.71	1.01	1.21	1.42	1.52	1.19	1.90	2.23	1.52	1.19	1.16	0.87	1.19
North Carolina			0.59	0.43	0.07	0.41	0.74	0.36	0.45	0.86	0.23	0.61	0.48	0.54	0.50	0.17	0.46	0.65	0.92	0.87	0.26	0.30	0.70
SOUTHERN	1.17	0.85	0.88	0.72	0.68	0.62	1.18	1.37	1.05	1.34	0.68	0.99	1.04	1.09	1.22	1.27	1.63	1.95	1.38	1.12	0.92	0.67	1.14
U.S. (average)	1.04	1.11	1.28	1.06	1.22	1.35	1.47	1.56	1.35	1.30	1.16	1.27	1.45	1.17	1.40	1.34	1.24	1.43	1.24	1.30	1.13	1.19	(1.03)
EASTERN CANADA*		1.65	1.58	1.62	1.07	1.55	0.69	1.25	1.69	1.72	2.10	1.84	1.74	1.47	1.77	1.18	1.62	1.93	1.82	1.82	1.14	1.47	(1.22)

* includes St. Pierre and Miquelon, reported by CWS

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

JUL 2 2 2010

Joshua A. Bundick
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337-5099

Dear Mr. Bundick,

Enclosed is the biological opinion (Opinion), issued under Section 7(a)(2) of the Endangered Species Act (ESA), for the National Aeronautics and Space Administration's (NASA) proposal for shoreline restoration and sediment management at the Goddard Space Flight Center's Wallops Flight Facility on Wallops Island, Virginia. NASA is working with the US Army Corps of Engineers (ACOE) and the Minerals Management Service (MMS) to obtain the appropriate permits for this activity. NASA has been designated as the lead Federal agency for this project. This Opinion is based in part upon NOAA's National Marine Fisheries Service's (NMFS) independent evaluation of the following: the 2010 Biological Assessment (BA) and the Programmatic Environmental Impact Statement (PEIS) for NASA's Wallops Flight Facility Shoreline Restoration Project, correspondence with NASA, and other sources of information. The Opinion concludes that the proposed project may adversely affect but is not likely to jeopardize the continued existence of loggerhead and Kemp's ridley sea turtles and is not likely to adversely affect leatherback or green sea turtles or right, humpback or fin whales. NMFS has also concluded that the action will not affect hawksbill turtles as these species are unlikely to occur in the action area. NMFS has assessed the project's impacts on listed species over the project's proposed 50 year lifetime.

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement. The Incidental Take Statement (ITS) accompanying this Biological Opinion, pursuant to Section 7 (b)(4) of the ESA, exempts the incidental taking of no more than 1 sea turtle for approximately every 1.5 million cy of material removed from the borrow areas. NMFS has estimated that at least 90% of these turtles will be loggerheads. As such, over the course of the project life, NMFS expects that a total of 9 sea turtles will be killed, with no more than 1 being Kemp's ridleys and the remainder being loggerheads. No take of any other species of sea turtle is exempted.

NMFS anticipates that the dredging may collect an additional unquantifiable number of previously dead sea turtles or sea turtle parts. Provided that NMFS concurs with NASA's determination regarding the state of decomposition, condition of the specimen, and likely cause of mortality, the collection of previously dead sea turtle parts will not be attributed to the incidental take level for this action.

The ITS specifies six reasonable and prudent measures (RPMs) and sixteen Terms and Conditions necessary to minimize and monitor take of listed species. The RPMs outlined in the ITS are non-discretionary, and must be undertaken so that they become binding conditions for the exemption in section 7(o)(2) to apply. Failure to implement the terms and conditions through enforceable measures may result in a lapse of the protective coverage of section 7(o)(2). Monitoring that is required by the ITS will continue to supply information on the level of take resulting from the proposed action.

This Opinion concludes consultation for the proposed shoreline restoration and sediment management project at the Goddard Space Flight Center's Wallops Flight Facility on Wallops Island, Virginia. Reinitiation of this consultation is required if: (1) the amount of taking specified in the ITS is exceeded; (2) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) project activities are subsequently modified in a manner that causes an effect to the listed species that was not considered in this biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified actions.

We look forward to continuing to work cooperatively with your office to minimize the effect of dredging projects on listed species. For further information regarding any consultation requirements, please contact Danielle Palmer at (978) 282-8468 or by e-mail (Danielle.Palmer@noaa.gov). Thank you for working cooperatively with my staff throughout this consultation process.

Sincerely,

Patricia A. Kurkul
Regional Administrator

EC: Bundick, NASA
Silbert, NASA
Cole, ACOE Norfolk
Palmer - F/NER3
Herkhof, MMS
O'Brien, F/NER4

File Code: Section 7 NASA Wallops Island SRIPP
PCTS: F/NER12010/00534

NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Agency: National Aeronautics and Space Administration, Corps of Engineers Norfolk District, and Minerals Management Service

Activity: Wallops Island Shoreline Restoration and Infrastructure Protection Program (F/NER/2010/00534)

Conducted by: National Marine Fisheries Service
Northeast Regional Office

Date Issued: July 22, 2010

Approved by:

This constitutes the biological opinion (Opinion) of NOAA's National Marine Fisheries Service (NMFS) on the effects of the National Aeronautics and Space Administration's (NASA) proposed Wallops Island Shoreline Restoration and Infrastructure Protection Program (SRIPP) on threatened and endangered species in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). This Opinion is based on information provided in the Biological Assessment (BA) and the Programmatic Environmental Impact Statement (PEIS) for NASA's Wallops Flight Facility Shoreline Restoration Project, correspondence with NASA, and other sources of information. A complete administrative record of this consultation will be kept on file at the NMFS Northeast Regional Office. Formal consultation was initiated on February 18, 2010.

CONSULTATION HISTORY

In October 2006, NASA informed NMFS that it was preparing National Environmental Policy Act (NEPA) documentation for the proposed Wallops Island SRIPP (the project). On a November 13, 2006 conference call, NASA provided an explanation of the proposed project and informed NMFS that while multiple Federal agencies would be involved in the project, NASA would be the lead federal agency for the proposed project[1]. Also during this call, the need for formal consultation pursuant to Section 7 of the ESA was discussed. Representatives from NASA and the Norfolk district of the Army Corps of Engineers (USACE) agreed that consultation was necessary and that NASA would be the lead agency for conducting the consultation with NMFS.

In February 2007, NMFS received a draft BA from NASA and NMFS provided comments on the draft BA. In a letter dated May 9, 2007, NASA requested formal consultation on the effects of the proposed project on listed species and submitted the final BA. A Biological Opinion (Opinion) was

1 The US Army Corps of Engineers Norfolk District will be issuing a permit, pursuant to Section 10 of the Rivers and Harbors Act, to authorize the proposed dredging and placement of sand on the beach.

issued by NMFS to NASA and the USACE on September 25, 2007. In this Opinion, NMFS concluded that the proposed action was likely to adversely affect but was not likely to jeopardize the continued existence of loggerhead and Kemp's ridley sea turtles and was not likely to adversely affect leatherback or green sea turtles or right, humpback, and fin whales. NMFS also concluded that the action would not affect hawksbill turtles as this species is unlikely to occur in the action area. The Opinion included an Incidental Take Statement (ITS) exempting the incidental taking of no more than 1 sea turtle for approximately every 2,000,000 cy of material removed from the borrow areas, which over the life of the project exempted the take of 28 sea turtles, with no more than 3 being Kemp's ridleys and the remainder being loggerheads. The action considered in the September 25, 2007 Opinion was never initiated by NASA, and NASA has now redesigned the Wallop's Island SRIPP.

Reinitiation of consultation is required and shall be requested by the Federal agency or by NMFS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) if the amount or extent of incidental take is exceeded; (b) a new species is listed or critical habitat designated that may be affected by the identified action; (c) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the consultation; or (d) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered.

In October 2009, NMFS received a draft BA from NASA. NMFS provided comments on the draft BA and on February 12, 2010, NMFS received a letter from NASA reinitiating consultation due to the actions previously considered in the September 25, 2007 Opinion being modified in manner that will cause effects to listed species or critical habitat that were not considered in the 2007 Opinion. These modifications included the construction/extension of the existing seawall; the relocation of the borrow site to offshore sites located in Federal waters; and the reduction of the amount of material removed during the initial dredge cycle and subsequent renourishment cycles throughout the 50 year life of the SRIPP. In addition to the February 12, 2010 letter, NASA supplied additional information in the form of a BA and PEIS for the proposed SRIPP. NASA has made the preliminary determination that the proposed action may adversely affect listed species. On February 18, 2010, NMFS initiated formal consultation. As NASA is funding and carrying out the proposed action, NASA will serve as the lead Federal agency for purposes of this consultation. Other Federal agencies involved in authorizing, funding or carrying out the proposed action include the US Army Corps of Engineers (USACE) and the Minerals Management Service (MMS). The USACE will be issuing a permit to NASA pursuant to Section 10 of the Rivers and Harbors Act. The MMS will be issuing a non-competitive lease to NASA pursuant to the Outer Continental Shelf Lands Act. These actions will be considered in this consultation.

DESCRIPTION OF THE PROPOSED ACTION

NASA's Wallops Flight Facility (WFF) is located in the northeastern portion of Accomack County, Virginia on the Delmarva Peninsula. NASA has occupied the WFF since the 1940s and is currently used by NASA, the US Coast Guard (USGS), the US Navy, NOAA, and the Mid-Atlantic Regional Spaceport (MARS). Wallops Island is bounded by Chincoteague Inlet to the north and Assawoman Inlet to the south. Chincoteague Inlet is dredged annually to a depth of 12 feet. The predominant direction of longshore sediment movement is from north to south. This longshore movement of sediment has caused sand pits to grow. The consequence of the sand traps is that Wallops Island and the barrier islands to the south have been deprived of sediment and their shorelines have eroded.

From 1857 to 1994, the southern part of Wallops Island has retreated approximately 400 meters (1300 feet), with an average rate of retreat of 12 feet per year. This encroachment of the ocean has threatened the existence of launch pads, infrastructure, and test and training facilities belonging to NASA, the Navy, and to MARS. In the 1960s and 1970s, NASA installed wooden groins to attempt to prevent shoreline retreat and keep sand on the beach. By the mid-1980s, the groins were almost completely gone as a result of the lack of replenishing sand. In 1992, a stone seawall, approximately 15,900 feet long, was constructed along the center of the island; however, the seawall has failed to provide adequate protection against the loss of sand as the current seawall is porous and has allowed sediment to flow out of the area without allowing replenishment. The integrity of the seawall is also at risk due to the lack of protective beach sand. Currently, beach only exists seaward of the northern portion of the seawall. There is no beach along approximately 14,000 feet of the seawall. In 2007, NASA installed geotextile tubes along the shoreline south of the existing seawall as an emergency measure to slow down the transport of sand off the beach and help protect onshore assets from wave action. Despite these efforts, the ocean has continued to encroach toward the infrastructure on Wallops Island. These conditions have lead to the currently proposed SRIPP by NASA. Under the SRIPP, NASA is proposing to construct and extend the existing seawall, as well as rebuild the beach along the Goddard Space Flight Center's Wallops Flight Facility (WFF), thereby moving the zone of wave break away from launch pads, infrastructure, and testing and training facilities. This will require dredging of offshore borrow sites and/or an area on the northern end of Wallops Island over the life of the SRIPP (50 years) in order to obtain sand to renourish and maintain the newly formed beach. Within the first 3 years of the 50-year life of the SRIPP, seawall construction and initial beach nourishment will be completed.

Year One: Seawall Extension
Prior to beach nourishment, the seawall extension will be constructed on the beach parallel to the shoreline in the approximate location of the existing geotextile tubes. The new seawall will be constructed landward of the shoreline and will extend 4600 feet south of the existing seawall and will consist of 5-7 ton rocks placed on the beach. The top of the seawall will be approximately 14 feet above the normal high tide level.

Year 2-3: Dredging and Beach Fill
Description of Borrow areas
Initial site work conducted in May 2007 identified 3 potential offshore shoals (Blackfish Bank Shoal, Unnamed Shoal A and Unnamed Shoal B) (Appendix A) located in Federal waters where beach compatible sand could be removed for the purposes of beach nourishment along the shoreline of the Wallops Flight Facility. In addition, an area located on the northern end of Wallops Island has also been identified as a borrow area for renourishment purposes only. Blackfish Bank Shoal was removed from consideration as a borrow area due to adverse impacts on the Assateague Island shoreline and due to the public perception that dredging within this shoal would negatively impact commercial and recreational fishing communities. As result, NASA identified Unnamed Shoal A as the source of sand for initial beach nourishment along the shoreline of Wallops Flight Facility, and

Unnamed Shoal B and the beach area located on the northern portion of Wallops Island (North Wallops Island beach borrow site) as potential sites to obtain sand during subsequent cycles of beach renourishment.

The southwest end of Unnamed Shoal A is located approximately 7 miles east of Assateague Island and approximately 11 miles northeast of Wallops Island. The total predicted volume of sand at Unnamed Shoal A is approximately 31 million m^3 (40 million yd^3) and covers an area of approximately 1,800 acres. Depths at Unnamed Shoal A range from 25-40 feet. The sediments within Unnamed Shoal A consist of well sorted medium sand with a median composite grain size of 0.24-0.78mm (USACE 2010a). The borrow area has never been dredged.

Unnamed Shoal B is located approximately 10 miles east of Assateague Island. The southwest end of Unnamed Shoal B is located approximately 12 miles east of Assateague Island and approximately 13 miles northeast of Wallops Island. The total predicted volume of Unnamed Shoal B is approximately 57 million m^3 (70 million yd^3) and covers an area of approximately 3,900 acres. Depths within Unnamed Shoal B range from 29-50 feet. The sediments within Unnamed Shoal B consist of well sorted, medium sand with a median composite grain size of 0.17-0.0.47mm (USACE 2010a). The borrow area has never been dredged.

The North Wallops Island beach borrow site is being considered by NASA as an additional area for obtaining sand for renourishment cycles. The sediments in this area general consist of poorly graded fine to medium sand with trace shell fragments and silt (USACE 2009b). The median grain sizes of all samples were between 0.18-0.27mm. Although not an optimal grain size for use as beach fill material, the northern end of Wallops Island would offer potential renourishment material without the mobilization and operational costs associated with offshore dredging. Based on current vegetation and wildlife habitat constraints, the total potential area for sand removal is approximately 150 acres. This area of Wallops Island has never been excavated.

Offshore Dredging

In year 2 (2011) and 3 (2012) of the SRIPP, approximately 3,998,750 yd^3 of sand are expected to be removed from Unnamed Shoal A and placed as beach nourishment along the shoreline of the Wallops Flight Facility, which will aid in restoring the underwater area in front of the seawall to its equilibrium condition (USACE 2010a). Renourishment cycles are expected to occur every 5 years, with 1,007,500 yd^3 of material removed during each cycle from either of two offshore borrow sites (Unnamed Shoal A and Unnamed Shoal B) and/or the north end of Wallop's Island. Approximately 9 renourishment cycles are proposed to occur over the 50 year life of the SRIPP, with a total of approximately 13,066,250 cubic yards of material removed during this period.

A trailer suction hopper dredge will be used to dredge the offshore borrow sites throughout the 50 year life of the SRIPP. These dredges are self propelled and hydraulically operated and are equipped with two dragheads and a hopper. High speed centrifugal pumps are employed to excavate the sediment and dispose of it into a storage hopper. The intake end of the suction pipe is fitted with a draghead, the function of which is to strip off a layer of sediment (approximately 0.3 m (1 foot) in depth) from the seabed and entrain those sediments into the suction pipe. Material dislodged from the ocean floor by the suction is suspended in water in the form of a slurry and then passed through the centrifugal pump to the storage hopper. Once the dredge hopper is filled, the dredge will transport the material to a pump-out buoy or station that will be placed at a water depth of approximately 30 feet, which is located approximately 2 miles offshore of the placement area. The pathway from Unnamed Shoal A and B to the pump-out buoy is not a straight line, but instead is a dogleg shape with a turning point so as to avoid Chincoteague Shoal and Blackfish Bank. The distance from the turning point to the pump-out buoy is approximately 8 miles. The one-way distance from Unnamed Shoal A to the proposed pump-out buoy is approximately 14 miles and the corresponding transit distance from Unnamed Shoal B to the proposed pump-out buoy is approximately 19 miles. Booster pumps may be needed to aid the offloading of sand from the pump-out buoy to the shoreline. Two dredges will be operating at the same time, with one dredge operating at the offshore site and while the other is transiting to the pump out-station. This pattern would alternate within a 24-hour period, with dredges spending approximately 3-4 hours on site at the shoal and the remainder of time traveling and unloading sand. In general, about three round trips per day will be accomplished with the dredge operating at speeds of 3 knots while dredging and 10 knots when transiting to and from the borrow areas.

On-Shore Excavation

The north Wallops Island borrow site will be excavated with a pan excavator. The pan excavator will stockpile the sand, which will be loaded onto dump trucks that will transport the fill material up and down the beach. Bulldozers will then be used to spread the fill material once it is placed on the beach. All heavy equipment will access the beach from existing roads and established access points. No new temporary or permanent roads will be constructed to access the beach or to transport the fill material to renourishment areas. No in water work will be required for this portion of the project.

Beach Fill

Initial beach fill placement is expected in 2011. The beach fill will start approximately 1,500 feet north of the Wallops Island-Assawoman Island property boundary and extend north for 3.7 miles. The initial fill will be placed so that there will be a 6-foot-high berm extending a minimum 70 feet seaward of the existing seawall. The remainder of the fill will slope underwater for an additional distance seaward; the amount of that distance will vary along the length of the beach fill, but will extend for a maximum of about 170 feet so that the total distance of the fill profile from the seawall will be approximately 240 feet. The beach fill profile will also include a 14-foot-high dune at the seawall. The front sloping face of the dune will rest against the seawall. As noted above, in year 2 of the SRIPP, placement activities will be initiated to restore the underwater area in front of the seawall and the remainder of the initial fill volume will be placed in year 3. Sand for initial nourishment will be dredged, as noted above, from Unnamed Shoal A and placed on the beach as described above. For renourishment fill volumes, up to one half of the fill volume may be excavated from the north Wallops Island borrow site, with the remainder of the sand obtained from either Unnamed Shoal A or Unnamed Shoal B.

Implementation Schedule

The initial components of the SRIPP (seawall extension, beach nourishment) will be staged and completed over a three-year timespan. As noted above, year 1 will involve the construction and completion of the seawall; year 2, partial initial beach fill and dredging; year 3, completion of initial beach fill and dredging.

Using the total volume of fill placed over years 2 and 3 of the SRIPP (3,199,000 yd^3), initial beach fill will require approximately 1,000 to 1,100 dredge trips from the offshore borrow sites to the Wallops Island shoreline. Based on previous offshore dredging operations along the east coast, it is assumed that dredgers with a hopper capacity of approximately 4,000 cubic yards will be used; however, because this volume is a slurry and not all sand, the actual volume of sand that each dredge will transport during each trip will be approximately 3,000 cubic yards. Following the completion of the initial beach fill (i.e., after 3 years) each renourishment cycle will require approximately 240 to 270 dredge trips or approximately 50 days to remove 1,007,500 cubic yards of sand to be placed as renourishment along the Wallops Island shoreline. As noted above, two dredges will be used at the same time and will accomplish about three round trips per day. Assuming 10% downtime for the dredges due to weather, equipment failure, etc., the 1.2 million yd^3 volume of fill placed in Year 2 will result in approximately 410 dredge trips and will take approximately 81 days, or about 3 months. The remaining volume to be placed in Year 3, approximately 2 million yd^3, will result in approximately 690 dredge trips and will take approximately 135 days, or about 4 and one-half months. As noted above, subsequent renourishment activities (assuming all fill is taken from one of the proposed offshore shoals), which are proposed to occur approximately once every five years, will take approximately 50 days, or about 2 months. When in operations, dredging is expected to occur at any time of the year, with the dredging window based upon contractor availability.

Mitigation Measures
Throughout the proposed action, NASA will implement measures to minimize any potential effects of dredging to listed species of sea turtles and whales throughout the proposed project. Mitigation measures specific to sea turtles were incorporated within the BA and PEIS NMFS received on February 18, 2010. After further analysis of the potential effects of dredging on listed species of whales, specifically in regards to dredge noise, NASA and NMFS devised additional mitigation measures to be put in place throughout the proposed action. These additional mitigation measures were received by NMFS on June 28, 2010 and will be incorporated into the final BA and EIS. The following are the mitigation measures NASA will implement as part of the proposed action:

1. NASA will ensure that during April 1-November 30, hopper dredges are outfitted with state-of-the-art sea turtle deflectors on the drag head and operated in a manner that will reduce the risk of interactions with sea turtles that may be present in the action area.

2. A NMFS-approved observer will be present on board the vessel for any dredging occurring from April 1-Novemeber 30.

3. NASA will ensure that dredges are equipped and operated in a manner that provides endangered/threatened species observers with a reasonable opportunity for detecting interactions with listed species and that provides for handling, collection, and resuscitation of turtles injured during project activity.

4. NASA will ensure that all measures are taken to protect any turtles that survive

entrainment in the dredge.

5. As the NMFS approved observer will only be on board the dredge from April 1-November 30, a lookout/bridge watch will be present on the dredge at all times from December1-March 31 to alert the captain when a listed whale is spotted within 1 kilometer (km) (0.62 miles) of the dredge. The lookout will be knowledgeable in listed species identification. From April 1-November 30, the NMFS approved observer will assume this responsibility.

6. If a NMFS approved observer or the lookout/bridgewatch observes a whale within 1 km (0.62 miles) of the dredge, all pumps will be turned off (i.e., dredging will stop) until the whale leaves the area (i.e., is farther than 1 km (0.62 miles) from the dredge).

7. All dredge operators will monitor the right whale (*Eubalaena glacialis*) sighting reports (i.e., sighting advisory system (SAS), dynamic management areas (DMA's), seasonal management areas (SMA's)) to remain informed on the whereabouts of right whales within the vicinity of the action area.

8. All dredge operators will conform to the regulations prohibiting the approach of right whales closer than 500 yards (50 CFR 224.103 (c)). Any vessel finding itself within the 500 yard buffer zone created by a surfacing whale must depart the area immediately at a safe, slow speed.

9. For dredging operations at night, the work area will be lit well enough to ensure that the observer/lookout can perform his/her work safely and effectively and that the measures mentioned above can be performed to the extent practicable.

10. NMFS will be contacted before dredging commences and again upon completion of the dredging activity.

11. All whale sightings will be reported to NMFS' Protected Resources Division Section 7 Coordinator.

Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area for this consultation includes the Wallops Island offshore borrow sites, the waters between and immediately adjacent to these areas where project vessels will travel and dredged material will be transported (see Appendix A for an illustration of the action area) as well as an area extending 4000 feet in all directions from the area to be dredged to account for the sediment plume generated during dredging activities. The action area also includes the northern portion of Wallops Island and the portion of Wallops Island shoreline and nearshore waters that will be affected by the extended seawall and beach fill (i.e., 3.7 miles of shoreline) (see Appendix A for an illustration of the action area).
As dredging operations will also produce underwater noise levels that range between 120-160 dB the action area will also include the area around the dredge where effects of increased underwater

noise levels will be experienced. Based on the analysis of dredge noise and transmission loss calculations, effects of dredge noise will be experienced within 794 meters from the dredge during loading and pumping.

LISTED SPECIES IN THE ACTION AREA

Several species listed under NMFS' jurisdiction occur in the action area. Four species of listed sea turtles occur in the action area during the warmer months (approximately April 1 – November 30). Three species of listed whales may also occur seasonally in the action area. No critical habitat has been designated within the action area; as such, no critical habitat will be affected by this action.

STATUS OF AFFECTED SPECIES

NMFS has determined that the action being considered in this biological opinion may affect the following endangered or threatened species under NMFS' jurisdiction:

Sea Turtles	
Loggerhead sea turtle (*Caretta caretta*)	Threatened
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered
Kemp's ridley sea turtle (*Lepidochelys kempi*)	Endangered
Green sea turtle (*Chelonia mydas*)	Endangered/Threatened[2]
Cetaceans	
Right whale (*Eubalaena glacialis*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered

This section will focus on the status of the various species within the action area, summarizing information necessary to establish the environmental baseline and to assess the effects of the proposed action.

Status of Sea Turtles

Sea turtles continue to be affected by many factors occurring on the nesting beaches and in the water. Poaching, habitat loss, and nesting predation by introduced species affect hatchlings and nesting females while on land. Fishery interactions, vessel interactions, and (non-fishery) dredging operations, for example, affect sea turtles in the neritic zone (defined as the marine environment extending from mean low water down to 200m (660 foot) depths, generally corresponding to the continental shelf (Lalli and Parsons 1997; Encyclopedia Britannica 2008)). Fishery interactions also affect sea turtles when these species and the fisheries co-occur in the oceanic zone (defined as the open ocean environment where bottom depths are greater than 200m (Lalli and Parsons 1997)).[3]

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[2] Pursuant to NMFS regulations at 50 CFR 223.205, the prohibitions of Section 9 of the Endangered Species Act apply to all green turtles, whether endangered or threatened.

3 As described in Bolten (2003), oceanographic terms have frequently been used incorrectly to describe sea turtle life stages. In turtle literature the terms benthic and pelagic were used incorrectly to refer to the neritic and oceanic zones, respectively. The term benthic refers to occurring on the bottom of a body of water, whereas the term pelagic refers to in the water column. Turtles can be "benthic" or pelagic" in either the neritic or oceanic zones.

As a result, sea turtles still face many of the original threats that were the cause of their listing under the ESA.

Sea turtles are listed under the ESA at the species level rather than as subspecies or distinct population segments (DPS). Therefore, information on the range-wide status of each species is included to provide the reader with information on the status of each species, overall. Additional background information on the range-wide status of these species can be found in a number of published documents, including sea turtle status reviews and biological reports (NMFS and USFWS 1995; Hirth 1997; USFWS 1997; Marine Turtle Expert Working Group (TEWG) 1998; TEWG 2000; NMFS and USFWS 2007a; 2007b; 2007c; 2007d; Leatherback TEWG 2007), and recovery plans for the loggerhead sea turtle (NMFS and USFWS 1991a), leatherback sea turtle (NMFS and USFWS 1992; NMFS and USFWS 1998), Kemp's ridley sea turtle (USFWS and NMFS 1992), and green sea turtle (NMFS and USFWS 1991b).

Loggerhead sea turtle

Loggerhead sea turtles are found in temperate and subtropical waters and occupy a range of habitats including offshore waters, continental shelves, bays, estuaries, and lagoons. The loggerhead is the most abundant species of sea turtle in U.S. waters. Genetic differences exist between loggerhead sea turtles that nest and forage in the different ocean basins (Bowen 2003; Bowen and Karl 2007). Differences in the maternally inherited mitochondrial DNA also exist between loggerhead nesting groups that occur within the same ocean basin (TEWG 2000; Pearce 2001; Bowen 2003; Bowen *et al.* 2005; Shamblin 2007). Site fidelity of females to one or more nesting beaches in an area is believed to account for these genetic differences (TEWG 2000; Bowen 2003). However, loggerhead sea turtles are currently listed under the ESA at the species level rather than as subspecies or distinct population segments (DPS). The ESA requires NMFS to ultimately conclude whether the action under consultation, in light of the Status of the Species, Environmental Baseline, and Cumulative Effects, is likely to jeopardize the species as it is listed. Therefore, information on the range-wide status of the species is included as follows.

Pacific Ocean. In the Pacific Ocean, major loggerhead nesting grounds are generally located in temperate and subtropical regions with scattered nesting in the tropics. The abundance of loggerhead sea turtles at nesting colonies throughout the Pacific basin has declined dramatically over the past ten to twenty years. Loggerhead sea turtles in the Pacific Ocean are represented by a northwestern Pacific nesting group (located in Japan) and a smaller southwestern Pacific nesting group that occurs in eastern Australia and New Caledonia. Data from 1995 estimated the Japanese nesting group at 1,000 adult females (Bolten *et al.* 1996). More recent information suggests that nest numbers have increased gradually over the period of 1998-2004 (NMFS and USFWS 2007a). However, this time period is too short to make a determination of the overall trend in nesting (NMFS and USFWS 2007a). Genetic analyses of loggerhead females nesting in Japan indicate the presence of genetically distinct nesting colonies (Hatase *et al.* 2002).

In Australia, long-term census data have been collected at some rookeries since the late 1960s and early 1970s, and nearly all the data show marked declines in nesting since the mid-1980s. The nesting group in Queensland, Australia is now less than 500 adult females, which represents an 86% reduction in the size of the annual nesting population in 23 years (Limpus and Limpus 2003).

Pacific loggerhead sea turtles are captured, injured, or killed in numerous Pacific fisheries including gillnet, longline, pound net, and trawl fisheries in the western and/or eastern Pacific Ocean (NMFS and USFWS 2007a). In Australia, where sea turtles are taken in bottom trawl and longline fisheries, efforts have been made to reduce fishery bycatch (NMFS and USFWS 2007a). Loggerheads in the Pacific are also impacted by a reduction in nesting habitat from erosion and extensive beach use, predation (by humans and animals), boat strikes, and marine pollution.

Indian Ocean. Loggerhead sea turtles are distributed throughout the Indian Ocean, along most mainland coasts and island groups (Baldwin *et al.* 2003). Throughout the Indian Ocean, loggerhead sea turtles face many of the same threats as in other parts of the world including loss of nesting beach habitat, fishery interactions, and predation and/or egg harvesting.

In the southwestern Indian Ocean, loggerhead nesting has shown signs of recovery in South Africa where protection measures have been in place for decades. However, in other southwestern areas (*e.g.*, Madagascar and Mozambique) loggerhead nesting groups are still affected by subsistence hunting of adults and eggs (Baldwin *et al.* 2003). The largest known nesting group of loggerheads in the world occurs in Oman in the northern Indian Ocean. An estimated 20,000-40,000 females nest at Masirah, the largest nesting site within Oman, each year (Baldwin *et al.* 2003). In the eastern Indian Ocean, all known nesting sites are found in Western Australia (Dodd 1988). Nesting numbers are disproportionate within the area with the majority of nesting occurring at a single location; Dirk Hartog Island hosts approximately 70%-75% of the nesting loggerheads in the southeastern Indian Ocean (Baldwin *et al.* 2003). The depletion of nesting at other Western Australia sites may, however, be the result of longstanding red fox predation on eggs (Baldwin *et al.* 2003).

Mediterranean Sea. Nesting in the Mediterranean Sea is confined almost exclusively to the eastern basin (Margaritoulis *et al.* 2003). The greatest numbers of nests in the Mediterranean are found in Greece with an average of 3,050 nests per year (Margaritoulis *et al.* 2003; NMFS and USFWS 2007a). Turkey has the second largest number of nests with 2,000 nests per year (NMFS and USFWS 2007a). There is a long history of exploitation of loggerheads in the Mediterranean (Margaritoulis *et al.* 2003). Although much of this is now prohibited, some directed captures still occur (Margaritoulis *et al.* 2003). Loggerheads in the Mediterranean also face the threat of habitat degradation, incidental fishery interactions, vessel strikes, and marine pollution (Margaritoulis *et al.* 2003). Longline fisheries, in particular, are believed to catch thousands of juvenile loggerheads each year (NMFS and USFWS 2007a), although genetic analyses indicate that only a portion of the loggerheads captured originate from loggerhead nesting groups in the Mediterranean (Laurent *et al.* 1998).

Atlantic Ocean. Ehrhart *et al.* (2003) provided a summary of the literature identifying known nesting habitats and foraging areas for loggerheads within the Atlantic Ocean. Detailed information is also provided in the 5-year status review for loggerheads (NMFS and USFWS 2007a) and the final revised recovery plan for loggerheads in the Northwest Atlantic Ocean (NMFS and USFWS 2008), which is a second revision to the original recovery plan that was approved in 1984 and subsequently revised in 1991.

Briefly, nesting occurs on island and mainland beaches on both sides of the Atlantic and both north and south of the Equator (Ehrhart *et al.* 2003). By far, the majority of Atlantic nesting occurs on beaches of the southeastern U.S. (NMFS and USFWS 2007a). Annual nest counts for loggerhead sea turtles on beaches from other countries are in the hundreds with the exception of Brazil, where a total of 4,837 nests were reported for the 2003-2004 nesting season (Marcovaldi and Chaloupka 2007; NMFS and USFWS 2007a), and Mexico, where several thousand nests are estimated to be laid each year. For example, the Yucatán nesting population had a range of 903-2,331 nests per year from 1987-2001 (Zurita *et al.* 2003; NMFS and USFWS 2008). In both the eastern and western Atlantic, waters as far north as 41°N to 42°N latitude are used for foraging by juveniles as well as adults (Shoop 1987; Shoop and Kenney 1992; Ehrhart *et al.* 2003; Mitchell *et al.* 2003).

In U.S. Atlantic waters, loggerheads commonly occur throughout the inner continental shelf from Florida to Cape Cod, Massachusetts and in the Gulf of Mexico from Florida to Texas, although their presence varies with the seasons due to changes in water temperature (Shoop and Kenney 1992; Epperly *et al.* 1995a, 1995b; Braun and Epperly 1996; Epperly and Braun-McNeill 2002; Mitchell *et al.* 2003). Loggerheads have been observed in waters with surface temperatures of 7° to 30°C, but water temperatures ≥11°C are most favorable (Shoop and Kenney 1992; Epperly *et al.* 1995b). The presence of loggerhead sea turtles in U.S. Atlantic waters is also influenced by water depth. Aerial surveys of continental shelf waters north of Cape Hatteras, North Carolina indicated that loggerhead sea turtles were most commonly sighted in waters with bottom depths ranging from 22 to 49 m deep (Shoop and Kenney 1992). However, more recent survey and satellite tracking data support that they occur in waters from the beach to beyond the continental shelf (Mitchell *et al.* 2003; Braun-McNeill and Epperly 2004; Blumenthal *et al.* 2006; Hawkes *et al.* 2006; McClellan and Read 2007).

Loggerhead sea turtles occur year round in ocean waters off North Carolina, South Carolina, Georgia, and Florida. In these areas of the South Atlantic Bight, water temperature is influenced by the proximity of the Gulf Stream. As coastal water temperatures warm in the spring, loggerheads begin to migrate to inshore waters of the southeast U.S. (*e.g.*, Pamlico and Core Sounds) and also move up the U.S. Atlantic coast (Epperly *et al.* 1995a, 1995b, 1995c; Braun-McNeill and Epperly 2004), occurring in Virginia foraging areas as early as April/May and on the most northern foraging grounds in the Gulf of Maine in June (Shoop and Kenney 1992). The trend is reversed in the fall as water temperatures cool. The large majority leave the Gulf of Maine by mid-September but some turtles may remain in Mid-Atlantic and Northeast areas until late fall. By December, loggerheads have migrated from inshore and more northern coastal waters to waters offshore of North Carolina, particularly off of Cape Hatteras, and waters further south where the influence of the Gulf Stream provides temperatures favorable to sea turtles (Shoop and Kenney 1992; Epperly *et al.* 1995b; Epperly and Braun-McNeill 2002).

In the southeastern U.S., loggerheads mate from late March to early June, and eggs are laid throughout the summer, with a mean clutch size of 100-126 eggs (Dodd 1988). Individual females nest multiple times during a nesting season, with a mean of 4.1 nests per individual (Murphy and Hopkins 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2 to 3 years, but can vary from 1 to 7 years (Dodd 1988; NMFS and USFWS 2008). Age at sexual maturity for loggerheads has been estimated at 32 to 35 years (NMFS and USFWS 2008).

For the past decade or so, the scientific literature has recognized five distinct nesting groups, or subpopulations, of loggerhead sea turtles in the Northwest Atlantic, divided geographically as follows: (1) a northern group of nesting females that nest from North Carolina to northeast Florida at about 29°N latitude; (2) a south Florida group of nesting females that nest from 29°N latitude on the east coast to Sarasota on the west coast; (3) a Florida Panhandle group of nesting females that nest around Eglin Air Force Base and the beaches near Panama City, Florida; (4) a Yucatán group of nesting females that nest on beaches of the eastern Yucatán Peninsula, Mexico (Márquez 1990; TEWG 2000); and (5) a Dry Tortugas group that nests on beaches of the islands of the Dry Tortugas, near Key West, Florida (NMFS SEFSC 2001). Genetic analyses of mitochondrial DNA, which a sea turtle inherits from its mother, indicate that there are genetic differences between loggerheads that nest at and originate from the beaches used by each of the five identified nesting groups of females (TEWG 2000). However, analyses of microsatellite loci from nuclear DNA, which represents the genetic contribution from both parents, indicates little to no genetic differences between loggerheads originating from nesting beaches of the five Northwest Atlantic nesting groups (Pearce and Bowen 2001; Bowen 2003; Bowen *et al.* 2005; Shamblin 2007). These results suggest that female loggerheads have site fidelity to nesting beaches within a particular area, while males provide an avenue of gene flow between nesting groups by mating with females that originate from different nesting groups (Bowen 2003; Bowen *et al.* 2005). The extent of such gene flow, however, is unclear (Shamblin 2007).

The lack of genetic structure makes it difficult to designate specific boundaries for the nesting subpopulations based on genetic differences alone. Therefore, the Loggerhead Recovery Team recently used a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to reassess the designation of these subpopulations to identify recovery units in the 2008 recovery plan.

In the 2008 recovery plan, the Loggerhead Recovery Team designated five recovery units for the Northwest Atlantic population of loggerhead sea turtles based on the aforementioned nesting groups and inclusive of a few other nesting areas not mentioned above. The first four of these recovery units represent nesting assemblages located in the southeast U.S. The fifth recovery unit is composed of all other nesting assemblages of loggerheads within the Greater Caribbean, outside the U.S., but which occur within U.S. waters during some portion of their lives. The five recovery units representing nesting assemblages are: (1) the Northern Recovery Unit (NRU: Florida/Georgia border through southern Virginia), (2) the Peninsular Florida Recovery Unit (PFRU: Florida/Georgia border through Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (DTRU: islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (NGMRU: Franklin County, Florida through Texas), and (5) the Greater Caribbean Recovery Unit (GCRU: Mexico through French Guiana, Bahamas, Lesser Antilles, and Greater Antilles).

The Recovery Team evaluated the status and trends of the Northwest Atlantic loggerhead population for each of the five recovery units, using nesting data available as of October 2008 (NMFS and USFWS 2008). The level and consistency of nesting coverage varies among recovery units, with coverage in Florida generally being the most consistent and thorough over time. Since 1989, nest count surveys in Florida have occurred in the form of statewide surveys (a near complete census of entire Florida nesting) and index beach surveys (Witherington *et al.* 2009). Index beaches were established to standardize data collection methods and maintain a constant level of effort on key nesting beaches over time.

From the beginning of standardized index surveys in 1989 until 1998, the PFRU, the largest nesting assemblage in the Northwest Atlantic by an order of magnitude, had a significant increase in the number of nests. However, from 1998 through 2008, there was a 41% decrease in annual nest counts from index beaches, which represent an average of 70% of the statewide nesting activity (NMFS and USFWS 2008). From 1989-2008, the PFRU had an overall declining nesting trend of 26% (95% CI: -42% to -5%; NMFS and USFWS 2008). In 2008, an increase in nest counts from the previous four years was reported, but this did not alter the declining trend. The Loggerhead Recovery Team acknowledged that this dramatic change in status for the PFRU is a serious concern and requires immediate attention to determine the cause(s) of this change and the actions needed to reverse it. The NRU, the second largest nesting assemblage of loggerheads in the U.S., has been declining at a rate of 1.3% annually since 1983 (NMFS and USFWS 2008). The NRU dataset included 11 beaches with an uninterrupted time series of coverage of at least 20 years; these beaches represent approximately 27% of NRU nesting (in 2008). Overall, there is strong statistical data to suggest the NRU has experienced a long-term decline. Evaluation of long-term nesting trends for the NGMRU is difficult because of changed and expanded beach coverage. However, the NGMRU has shown a significant declining trend of 4.7% annually since index nesting beach surveys were initiated in 1997 (NMFS and USFWS 2008). No statistical trends in nesting abundance can be determined for the DTRU because of the lack of long-term data. Similarly, statistically valid analyses of long-term nesting trends for the entire GCRU are not available because there are few long-term standardized nesting surveys representative of the region. Additionally, changing survey effort at monitored beaches and scattered and low-level nesting by loggerheads at many locations currently precludes comprehensive analyses (NMFS and USFWS 2008).

Sea turtle census nesting surveys are important in that they provide information on the relative abundance of nesting each year, and the contribution of each nesting group to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually. The 2008 recovery plan compiled the most recent information on mean number of loggerhead nests and the approximated counts of nesting females per year for four of the five identified recovery units (i.e., nesting groups). They are: (1) for the NRU, a mean of 5,215 loggerhead nests per year (from 1989-2008) with approximately 1,272 females nesting per year; (2) for the PFRU, a mean of 64,513 nests per year (from 1989-2007) with approximately 15,735 females nesting per year; (3) for the DTRU, a mean of 246 nests per year (from 1995-2004, excluding 2002) with approximately 60 females nesting per year; and (4) for the NGMRU, a mean of 906 nests per year (from 1995-2007) with approximately 221 females nesting per year. For the GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatán, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatán since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit. Note that the above values for average nesting females per year were based upon 4.1 nests per female per Murphy and Hopkins (1984).

Unlike nesting surveys, in-water studies of sea turtles typically sample both sexes and multiple age classes. In-water studies have been conducted in some areas of the Northwest Atlantic and provide data by which to assess the relative abundance of loggerhead sea turtles and changes in abundance over time (Maier *et al.* 2004; Morreale *et al.* 2005; Mansfield 2006; Ehrhart *et al.* 2007; Epperly *et al.* 2007). The 2008 loggerhead recovery plan includes a full discussion of in-water population studies for which trend data have been reported, and a brief summary will be provided here. Maier *et al.* (2004) used fishery-independent trawl data to establish a regional index of loggerhead abundance for the southeast coast of the U.S. (Winyah Bay, South Carolina to St. Augustine, Florida) during the period 2000-2003. A comparison of loggerhead catch data from this study with historical values suggested that in-water populations of loggerhead sea turtles along the southeast U.S. coast appear to be larger, possibly an order of magnitude higher than they were 25 years ago, but the authors caution a direct comparison between the two studies given differences in sampling methodology (Maier *et al.* 2004). A comparison of catch rates for sea turtles in pound net gear fished in the Pamlico-Albemarle Estuarine Complex of North Carolina between the years 1995-1997 and 2001-2003 found a significant increase in catch rates for loggerhead sea turtles for the latter period (Epperly *et al.* 2007). A long-term, on-going study of loggerhead abundance in the Indian River Lagoon System of Florida found a significant increase in the relative abundance of loggerheads over the last 4 years of the study (Ehrhart *et al.* 2007). However, there was no discernible trend in loggerhead abundance during the 24-year time period of the study (1982-2006) (Ehrhart *et al.* 2007). At St. Lucie Power Plant, data collected from 1977-2004 show an increasing trend of loggerheads at the power plant intake structures (FPL and Quantum Resources 2005).

In contrast to these studies, Morreale *et al.* (2005) observed a decline in the percentage and relative numbers of loggerhead sea turtles incidentally captured in pound net gear fished around Long Island, New York during the period 2002-2004 in comparison to the period 1987-1992, with only two loggerheads (of a total 54 turtles) observed captured in pound net gear during the period 2002-2004. This is in contrast to the previous decade's study where numbers of individual loggerheads ranged from 11 to 28 per year (Morreale *et al.* 2005). No additional loggerheads were reported captured in pound net gear through 2007, although 2 were found cold-stunned on Long Island bay beaches in the fall of 2007 (Memo to the File, L. Lankshear, December 2007). Potential explanations for this decline include major shifts in loggerhead foraging areas and/or increased mortality in pelagic or early benthic stage/age classes (Morreale *et al.* 2005). Using aerial surveys, Mansfield (2006) also found a decline in the densities of loggerhead sea turtles in Chesapeake Bay over the period 2001-2004 compared to aerial survey data collected in the 1980s. Significantly fewer loggerheads ($p<0.05$) were observed in both the spring (May-June) and the summer (July-August) of 2001-2004 compared to those observed during aerial surveys in the 1980s (Mansfield 2006). A comparison of median densities from the 1980s to the 2000s suggested that there had been a 63.2% reduction in densities during the spring residency period and a 74.9% reduction in densities during the summer residency period (Mansfield 2006). The decline in observed loggerhead populations in Chesapeake Bay may be related to a significant decline in prey, namely horseshoe crabs and blue crabs, with loggerheads redistributing outside of Bay waters (NMFS and USFWS 2008).

The diversity of a sea turtle's life history leaves them susceptible to many natural and human impacts, including impacts while they are on land, in the neritic environment, and in the oceanic environment. Recent studies have established that the loggerhead's life history is more complex than previously believed. Rather than making discrete developmental shifts from oceanic to neritic environments, research is showing that both adults and (presumed) neritic stage juveniles continue to use the oceanic environment and will move back and forth between the two habitats (Witzell 2002; Blumenthal *et al.* 2006; Hawkes *et al.* 2006; McClellan and Read 2007). One of the studies tracked the movements of adult post-nesting females and found that differences in habitat use were related to body size with larger adults staying in coastal waters and smaller adults traveling to oceanic waters (Hawkes *et al.* 2006). A tracking study of large juveniles found that the habitat preferences of this life stage were also diverse with some remaining in neritic waters and others moving off into oceanic waters (McClellan and Read 2007). However, unlike the Hawkes *et al.* (2006) study, there was no significant difference in the body size of turtles that remained in neritic waters versus oceanic waters (McClellan and Read 2007). In either case, the research demonstrates that threats to loggerheads in both the neritic and oceanic environments are likely impacting multiple life stages of this species.

The 5-year status review and 2008 recovery plan provide a summary of natural as well as anthropogenic threats to loggerhead sea turtles (NMFS and USFWS 2007a, 2008). Amongst those of natural origin, hurricanes are known to be destructive to sea turtle nests. Sand accretion, rainfall, and wave action that result from these storms can appreciably reduce hatchling success. Other sources of natural mortality include cold stunning, biotoxin exposure, and native species predation.

Anthropogenic factors that impact hatchlings and adult females on land, or the success of nesting and hatching include: beach erosion, beach armoring, and nourishment; artificial lighting; beach cleaning; beach pollution; increased human presence; recreational beach equipment; vehicular and pedestrian traffic; coastal development/construction; exotic dune and beach vegetation; removal of native vegetation; and poaching. An increased human presence at some nesting beaches or close to nesting beaches has led to secondary threats such as the introduction of exotic fire ants, feral hogs, dogs, and an increased presence of native species (*e.g.*, raccoons, armadillos, and opossums) which raid nests and feed on turtle eggs (NMFS and USFWS 2007a, 2008). Although sea turtle nesting beaches are protected along large expanses of the Northwest Atlantic coast (in areas like Merritt Island, Archie Carr, and Hobe Sound National Wildlife Refuges), other areas along these coasts have limited or no protection. Sea turtle nesting and hatching success on unprotected high density east Florida nesting beaches from Indian River to Broward County are affected by all of the above threats.

Loggerheads are affected by a completely different set of anthropogenic threats in the marine environment. These include underwater explosions; hopper dredging; offshore artificial lighting; power plant entrainment and/or impingement; entanglement in debris; ingestion of marine debris; marina and dock construction and operation; boat collisions; poaching; fishery interactions; oil and gas exploration, coastal development, and transportation; and marine pollution. For instance, on April 20, 2010 the Deepwater Horizon oil spill occurred in the Gulf of Mexico off the coast of Louisiana. As loggerhead sea turtles are known to migrate through, and nest and forage along the coastal waters of the Gulf of Mexico, the oil spill is likely to affect the loggerhead population; however, because all the information on sea turtle stranding, deaths, and recoveries has not yet been documented, the effects of the oil spill on the loggerhead population cannot be determined at this time.

A 1990 National Research Council (NRC) report concluded that for juveniles, subadults, and breeders in coastal waters, the most important source of human caused mortality in U.S. Atlantic waters was fishery interactions. Of the many fisheries known to adversely affect loggerheads, the U.S. south Atlantic and Gulf of Mexico shrimp fisheries were considered to pose the greatest threat of mortality to neritic juvenile and adult age classes of loggerheads, accounting for an estimated 5,000 to 50,000 loggerhead deaths each year (National Resource Council (NRC) 1990). Significant changes to the south Atlantic and Gulf of Mexico shrimp fisheries have occurred since 1990, and the effects of these shrimp fisheries on ESA-listed species, including loggerhead sea turtles, have been assessed several times through section 7 consultation. There is also a lengthy regulatory history with regard to the use of Turtle Excluder Devices (TEDs) in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries (Epperly and Teas 2002; NMFS 2002; Lewison *et al.* 2003). Section 7 consultation on shrimp trawling in the southeastern U.S. was reinitiated in 2002, in part, to consider the effect of a new rulemaking that would require increasing the size of TED escape openings to allow larger loggerheads (as well as green and leatherback sea turtles) to escape from shrimp trawl gear. The resulting Opinion was completed in December 2002 and concluded that, as a result of the new rule, annual loggerhead mortality from capture in shrimp trawls would decline from an estimated 62,294 to 3,948 turtles assuming that all TEDs were installed properly and that compliance was 100% (Epperly *et al.* 2002; NMFS 2002). The total annual level of take for loggerhead sea turtles as a result of the U.S. south Atlantic and Gulf of Mexico shrimp fisheries was estimated to be 163,160 loggerhead interactions (the total number of turtles that enter a shrimp trawl, which may then escape through the TED or fail to escape and be captured) with 3,948 of those takes being lethal (NMFS 2002). On February 21, 2003, NMFS issued the final rule in the *Federal Register* to require the use of the larger opening TEDs (68 FR 8456). The rule also provided the measures to disallow several previously approved TED designs that did not function properly under normal fishing conditions, and to require modifications to the trynet and bait shrimp exemptions to the TED requirements to decrease mortality of sea turtles.

In addition to improvements in TED designs and TED enforcement, interactions between loggerheads and the shrimp fishery have also been declining because of reductions in fishing effort unrelated to fisheries management actions. The 2002 Opinion take estimates are based in part on fishery effort levels. In recent years, low shrimp prices, rising fuel costs, competition with imported products, and the impacts of recent hurricanes in the Gulf of Mexico have all impacted the shrimp fleets; in some cases reducing fishing effort by as much as 50% for offshore waters of the Gulf of Mexico (GMFMC 2007). As a result, loggerhead interactions and mortalities in the Gulf of Mexico have been substantially less than projected in the 2002 Opinion. Currently, the estimated annual number of interactions between loggerheads and shrimp trawls in the Gulf of Mexico shrimp fishery is 23,336, with 647 (2.8%) of those interactions resulting in mortality (Memo from Dr. B. Ponwith, Southeast Fisheries Science Center [SEFSC] to Dr. R. Crabtree, Southeast Region [SERO], PRD, December 2008).

Loggerhead sea turtles are also known to interact with non-shrimp trawl, gillnet, longline, dredge, pound net, pot/trap, and hook and line fisheries. The NRC (1990) report stated that other U.S. Atlantic fisheries collectively accounted for 500 to 5,000 loggerhead deaths each year, but recognized that there was considerable uncertainty in the estimate. The first estimate of loggerhead sea turtle bycatch in U.S. Mid-Atlantic bottom otter trawl gear was completed in September 2006 and later updated in November 2008 (Murray 2006, 2008). Observers reported 66 loggerhead sea turtle interactions with bottom otter trawl gear from 1994-2004 of which 38 were reported as alive and uninjured and 28 were reported as dead, injured, resuscitated, or of unknown condition (Murray 2006, 2008). Seventy-seven percent of observed sea turtle interactions occurred on vessels fishing for summer flounder (50%) and Atlantic croaker (27%). The remaining 23% of observed interactions occurred on vessels targeting weakfish (11%), long-finned squid (8%), groundfish (3%), and short-finned squid (1%). Based on observed interactions and fishing effort as reported on VTRs, the average annual loggerhead bycatch in these bottom otter trawl fisheries combined was estimated to be 616 sea turtles per year for the period 1996-2004 (Murray 2006, 2008).

The 2008 update also reported loggerhead bycatch from 2000-2004 by main species (fish or invertebrate) group caught, which is a proxy for FMP group (which is not well reported in the observer data). The average annual bycatch estimate of loggerhead sea turtles from 2000-2004 (based on the rate from 1994-2004) over FMP groups identified by NERO was 411 turtles, with an additional 77 estimated bycatch events unassigned. An estimated 192 (47%) of assigned takes occurred annually in the summer flounder/scup/black sea bass group, 62 (15%) in the Atlantic mackerel/squid/butterfish group, 43 (10%) in the Northeast multispecies group, and 41 (10%) in the Atlantic croaker group. A total of 20 loggerheads (4.8%) were estimated as having been taken annually in bottom otter trawl gear catching sea scallops, which is in addition to the estimated 81-191 loggerheads reported by Murray (2007) as being caught annually in trawl gear designed specifically to harvest scallops based on data from 2004-2005 (Murray 2008).

There have been several published estimates of the number of loggerheads taken annually as a result of the dredge fishery for Atlantic sea scallops, ranging from a low of zero in 2005 (Murray 2007) to a high of 749 in 2003 (Murray 2004). An estimate of the number of loggerheads taken annually in U.S. Mid-Atlantic gillnet fisheries has recently been published in Murray (2009a). From 1995-2006, the average annual bycatch of loggerheads in U.S. Mid-Atlantic gillnet gear was estimated to be around 350 turtles (95% CI: 234 to 504). Bycatch rates were correlated with latitude, sea surface temperature, and mesh size. The highest predicted bycatch rates occurred in warm waters of the southern Mid-Atlantic in large-mesh gillnets (Murray 2009b).

The U.S. tuna and swordfish longline fisheries that are managed under the Highly Migratory Species (HMS) FMP are estimated to capture 1,905 loggerheads (no more than 339 mortalities) for each 3-year period starting in 2007 (NMFS 2004). NMFS has mandated gear changes for the HMS fishery to reduce sea turtle bycatch and the likelihood of death from those incidental takes that would still occur (Garrison *et al.* 2009). In 2008, there were 82 observed interactions between loggerhead sea turtles and longline gear used in the HMS fishery. All of the loggerheads were released alive, but the vast majority with injuries (Garrison *et al.* 2009). Most of the injured loggerheads had been hooked in the mouth or beak or swallowed the hook (Garrison *et al.* 2009). Based on the observed take, an estimated 771.6 (95% CI: 481.4-1236.6) loggerhead sea turtles are estimated to have been taken in the longline fisheries managed under the HMS FMP in 2008 (Garrison *et al.* 2009). The 2008 estimate is higher than that in 2007 and is consistent with historical averages since 2001 (Garrison *et al.* 2009). This fishery represents just one of several longline fisheries operating in the Atlantic Ocean. Lewison *et al.* (2004) estimated that 150,000-200,000 loggerheads were taken in all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries as well as others).

Summary of Status for Loggerhead Sea Turtles
Loggerheads are a long-lived species and reach sexual maturity relatively late at around 32-35 years in the Northwest Atlantic (NMFS and USFWS 2008). The species continues to be affected by many factors occurring on nesting beaches and in the water. These include poaching, habitat loss, and nesting predation that affects eggs, hatchlings, and nesting females on land, as well as fishery interactions, vessel interactions, marine pollution, and non-fishery (e.g., dredging) operations affecting all sexes and age classes in the water (NRC 1990; NMFS and USFWS 2007a). As a result, loggerheads still face many of the original threats that were the cause of their listing under the ESA.

As mentioned previously, a final revised recovery plan for loggerhead sea turtles in the Northwest Atlantic was published by NMFS and FWS in December 2008. The revised recovery plan is significant in that it identifies five unique recovery units, which comprise the population of loggerheads in the Northwest Atlantic, and describes specific recovery criteria for each recovery unit. Based on the most recent information, a decline in annual nest counts has been measured or suggested for three of the five recovery units for loggerheads in the Northwest Atlantic. This includes the PFRU, which is the largest (in terms of number of nests laid) in the Atlantic Ocean. The nesting trends for the other two recovery units could not be determined due to an absence of long term data.

NMFS convened a new Loggerhead Turtle Expert Working Group (TEWG) to review all available information on Atlantic loggerheads in order to evaluate the status of this species in the Atlantic. A final report from the Loggerhead TEWG was published in July 2009. In this report, the TEWG indicated that it could not determine whether or not the decreasing annual numbers of nests among the Northwest Atlantic loggerhead subpopulations were due to stochastic processes resulting in fewer nests, a decreasing average reproductive output of adult females, decreasing numbers of adult females, or a combination of these factors. Many factors are responsible for past or present loggerhead mortality that could impact current nest numbers; however, no single mortality factor stands out as a likely primary factor. It is likely that several factors compound to create the current decline, including incidental capture (in fisheries, power plant intakes, and dredging operations), lower adult female survival rates, increases in the proportion of first-time nesters, continued directed harvest, and increases in mortality due to disease. Regardless, the TEWG stated that the current levels of hatchling output will no doubt result in depressed recruitment to subsequent life stages over the coming decades (TEWG 2009).

Currently, there are no population estimates for loggerhead sea turtles in any of the ocean basins in which they occur. However, a recent loggerhead assessment prepared by NMFS states that the loggerhead adult female population in the western North Atlantic ranges from 20,000 to 40,000 or more, with a large range of uncertainty in total population size (NMFS SEFSC 2009).

In 2007, based on their 5-year status review of the species, NMFS and FWS determined that loggerhead sea turtles should not be delisted or reclassified as endangered. However, it was also determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified for the loggerhead (NMFS and USFWS 2007a). In 2008, NMFS and FWS established a Loggerhead Biological Review Team (BRT) to assess the global loggerhead population structure to determine whether DPSs exist and, if so, the status of each DPS. The BRT report was recently completed in August 2009 (Conant *et al.* 2009). In this report, the BRT identified the following nine loggerhead DPSs distributed globally: (1) North Pacific Ocean, (2) South Pacific Ocean, (3) North Indian Ocean, (4) Southeast Indo-Pacific Ocean, (5) Southwest Indian Ocean, (6) Northwest Atlantic Ocean, (7) Northeast Atlantic Ocean, (8) Mediterranean Sea, and (9) South Atlantic Ocean. According to an analysis using expert opinion in a matrix model framework used in the BRT report, all loggerhead DPSs have the potential to decline in the future. Although some DPSs are indicating increasing trends at nesting beaches (Southwest Indian Ocean and South Atlantic Ocean), available information about anthropogenic threats to juveniles and adults in neritic and oceanic environments indicate possible unsustainable additional mortalities. According to the threat matrix analysis in the BRT report, the potential for future decline is greatest for the North Indian Ocean, Northwest Atlantic Ocean, Northeast Atlantic Ocean, Mediterranean Sea, and South Atlantic Ocean DPSs (Conant *et al.* 2009).

On March 16, 2010, NMFS and USFWS published a proposed rule in the Federal Register to divide the worldwide population of loggerhead sea turtles into nine DPSs, as described in the 2009 Status Review. Two of the DPSs are proposed to be listed as threatened and seven of the DPSs, including the Northwest Atlantic Ocean DPS, are proposed to be listed as endangered (75 FR 12597, March 16, 2010). NMFS and the USFWS are accepting comments on the proposed rule through September 13, 2010 (75 FR 30769, June 2, 2010). Loggerhead sea turtles in the action area for this consultation would be in the Northwest Atlantic Ocean DPS described in the proposed rule.

Kemp's ridley sea turtle

The Kemp's ridley is one of the least abundant of the world's sea turtle species. In contrast to loggerhead, leatherback, and green sea turtles, which are found in multiple oceans of the world, Kemp's ridleys typically occur only in the Gulf of Mexico and the northwestern Atlantic Ocean (USFWS and NMFS 1992).

The majority of Kemp's ridleys nest along a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; USFWS and NMFS 1992; NMFS and USFWS 2007b). There is a limited amount of scattered nesting to the north and south of the primary nesting beach (NMFS and USFWS 2007b). The number of nesting adult females reached an estimated low of fewer than 250 in 1985 (USFWS and NMFS 1992; TEWG 2000; NMFS and USFWS 2007b). Conservation efforts by Mexican and U.S. agencies have aided this species by eliminating egg harvest, protecting eggs and hatchlings, and reducing at-sea mortality through fishing regulations (TEWG 2000). From 1985 to 1999, the number of nests observed at Rancho Nuevo and nearby beaches increased at a mean rate of 11.3% (95% C.I. slope = 0.096-0.130) per year (TEWG 2000). An estimated 5,500 females nested in the State of Tamaulipas over a 3-day period in May 2007 and over 4,000 of those nested at Rancho Nuevo (NMFS and USFWS 2007b). There is limited nesting in the U.S., most of which is located in south Texas. In 2006, approximately 100 nests were laid in Texas (NMFS and USFWS 2007b).

Kemp's ridleys mature at 10-17 years (Caillouet *et al.* 1995; Schmid and Witzell 1997; Snover *et al.* 2007; NMFS and USFWS 2007b). Nesting occurs from April through July each year with hatchlings emerging after 45-58 days (USFWS and NMFS 1992). Once they leave the nesting beach, neonates presumably enter the Gulf of Mexico where they feed on available S*argassum* and associated infauna or other epipelagic species (USFWS and NMFS 1992). The presence of juvenile turtles along both the U.S. Atlantic and Gulf of Mexico coasts, where they are recruited to the coastal benthic environment, indicates that post-hatchlings are distributed in both the Gulf of Mexico and Atlantic Ocean (TEWG 2000).

The location and size classes of dead turtles recovered by the STSSN suggest that benthic immature developmental areas occur in many areas along the U.S. coast and that these areas may change given resource quality and quantity (TEWG 2000). Developmental habitats are defined by several characteristics, including coastal areas sheltered from high winds and waves such as embayments and estuaries, and nearshore temperate waters shallower than 50 m (NMFS and USFWS 2007b). The suitability of these habitats depends on resource availability, with optimal environments providing rich sources of crabs and other invertebrates. Kemp's ridleys consume a variety of crab species, including *Callinectes* sp., *Ovalipes* sp., *Libinia* sp., and *Cancer* sp. Mollusks, shrimp, and fish are consumed less frequently (Bjorndal 1997). A wide variety of substrates have been documented to provide good foraging habitat, including seagrass beds, oyster reefs, sandy and mud bottoms, and rock outcroppings (NMFS and USFWS 2007b).

Foraging areas documented along the U.S. Atlantic coast include Charleston Harbor, Pamlico Sound (Epperly *et al.* 1995c), Chesapeake Bay (Musick and Limpus 1997), Delaware Bay, and Long Island Sound (Morreale and Standora 1993). For instance, in the Chesapeake Bay, where the seasonal juvenile population of Kemp's ridley sea turtles is estimated to be 211-1,083 individuals, Kemp's ridleys frequently forage in submerged aquatic grass beds for crabs (Musick and Limpus 1997). Upon leaving Chesapeake Bay in autumn, juvenile Kemp's ridleys migrate down the coast, passing Cape Hatteras in December and January (Musick and Limpus 1997). These larger juveniles are joined there by juveniles of the same size from North Carolina sounds and smaller juveniles from New York and New England to form one of the densest concentrations of Kemp's ridleys outside of the Gulf of Mexico (Epperly *et al.* 1995a, 1995b; Musick and Limpus 1997).

Adult Kemp's ridleys are found in the coastal regions of the Gulf of Mexico and southeastern U.S., but are typically rare in the northeastern U.S. waters of the Atlantic (TEWG 2000). Adults are primarily found in near-shore waters of 37 meters or less that are rich in crabs and have a sandy or muddy bottom (NMFS and USFWS 2007b).

Kemp's ridleys face many of the same natural threats as loggerheads, including destruction of nesting habitat from storm events, natural predators, and oceanic events such as cold-stunning. Although cold-stunning can occur throughout the range of the species, it may be a greater risk for sea turtles that utilize the more northern habitats of Cape Cod Bay and Long Island Sound. For example, as reported in the national STSSN database, in the winter of 1999/2000, there was a major cold-stunning event where 218 Kemp's ridleys, 54 loggerheads, and 5 green sea turtles were found on Cape Cod beaches. Annual cold stun events do not always occur at this magnitude; the extent of episodic major cold stun events may be associated with numbers of turtles utilizing Northeast U.S. waters in a given year, oceanographic conditions, and the occurrence of storm events in the late fall. Although many cold-stunned turtles can survive if found early enough, cold-stunning events can represent a significant cause of natural mortality.

Like other sea turtle species, the severe decline in the Kemp's ridley population appears to have been heavily influenced by a combination of exploitation of eggs and impacts from fishery interactions. From the 1940s through the early 1960s, nests from Ranch Nuevo were heavily exploited, but beach protection in 1966 helped to curtail this activity (USFWS and NMFS 1992). Following World War II, there was a substantial increase in the number of trawl vessels, particularly shrimp trawlers, in the Gulf of Mexico where adult Kemp's ridley sea turtles occur. Information from fishermen helped to demonstrate the high number of turtles taken in these shrimp trawls (USFWS and NMFS 1992). Subsequently, NMFS has worked with the industry to reduce sea turtle takes in shrimp trawls and other trawl fisheries, including the development and use of TEDs. As described, above, there is lengthy regulatory history with regard to the use of TEDs in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries (Epperly and Teas 2002; NMFS 2002; Lewison *et al.* 2003). The Biological Opinion on shrimp trawling in the southeastern U.S. completed in 2002 concluded that 155,503 Kemp's ridley sea turtles would be taken annually in the fishery with 4,208 of the takes resulting in mortality (NMFS 2002).

Although modifications to shrimp trawls have helped to reduce mortality of Kemp's ridleys, this species is also affected by other sources of anthropogenic impacts (fishery and non-fishery related) similar to those discussed above. For example, in the spring of 2000, a total of five Kemp's ridley carcasses were recovered from the same North Carolina beaches where 275 loggerhead carcasses were found. The cause of death for most of the turtles recovered was unknown, but the mass mortality event was suspected by NMFS to have been from a large-mesh gillnet fishery for monkfish and dogfish operating offshore in the preceding weeks (67 FR 71895). The five Kemp's ridley carcasses that were found are likely to have been only a minimum count of the number of Kemp's ridleys that were killed or seriously injured as a result of the fishery interaction, since it is unlikely that all of the carcasses washed ashore.

Summary of Status for Kemp's ridley Sea Turtles
The majority of Kemp's ridleys nest along a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; USFWS and NMFS 1992; NMFS and USFWS 2007b). The number of nesting females in the Kemp's ridley population declined dramatically from the late 1940s through the mid 1980s, with an estimated 40,000 nesting females in a single *arribada* in 1947 and fewer than 250 nesting females in the entire 1985 nesting season (USFWS and NMFS 1992; TEWG 2000). However, the total annual number of nests at Rancho Nuevo gradually began to increase in the 1990s (NMFS and USFWS 2007b). Based on the number of nests laid in 2006 and the remigration interval for Kemp's ridley sea turtles (1.8-2 years), there were an estimated 7,000-8,000 adult female Kemp's ridley sea turtles in 2006 (NMFS and USFWS 2007b). The number of adult males in the population is unknown, but sex ratios of hatchlings and immature Kemp's ridleys suggest that the population is female biased, suggesting that the number of adult males is less than the number of adult females (NMFS and USFWS 2007b).

As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution (e.g., oil spills), and habitat destruction account for an unknown level of other mortality. For instance, on April 20, 2010 the Deepwater Horizon oil spill occurred in the Gulf of Mexico off the coast of Louisiana. As Kemp's ridley sea turtles are known to migrate through, and nest and forage along the coastal waters of the Gulf of Mexico, the oil spill is likely to affect the Kemp's ridley population; however, because all the information on sea turtle stranding, deaths, and recoveries has not yet been documented, the effects of the oil spill on the Kemp's ridley population cannot be determined at this time.

Based on their 5-year status review of the species, NMFS and USFWS (2007b) determined that Kemp's ridley sea turtles should not be reclassified as threatened under the ESA.

Leatherback sea turtle

Leatherback sea turtles are widely distributed throughout the oceans of the world, including the Atlantic, Pacific, and Indian Oceans, and the Mediterranean Sea (Ernst and Barbour 1972). Leatherbacks are the largest living turtles and range farther than any other sea turtle species. Their large size and tolerance of relatively low water temperatures allows them to occur in northern boreal waters such as those off Labrador and in the Barents Sea (NMFS and USFWS 1995).

In 1980, the leatherback population was estimated at approximately 115,000 adult females globally (Pritchard 1982). By 1995, this global population of adult females was estimated to have declined to 34,500 (Spotila *et al.* 1996). However, the most recent population size estimate for the North Atlantic alone is a range of 34,000-94,000 adult leatherbacks (TEWG 2007). Thus, there is substantial uncertainty with respect to global population estimates of leatherback sea turtles.

Pacific Ocean. Leatherback nesting has been declining at all major Pacific basin nesting beaches for the last two decades (Spotila *et al.* 1996, 2000; NMFS and USFWS 1998, 2007d; Sarti *et al.* 2000). In the western Pacific, major nesting beaches occur in Papua New Guinea, Papua, Indonesia, Solomon Islands, and Vanuatu, with an approximate 2,700-4,500 total breeding females, estimated from nest counts (Dutton *et al.* 2007). However, leatherbacks appear to be approaching extinction in Malaysia (Spotila *et al.* 2000). For example, the nesting group on Terengganu, which was once one of the most significant nesting sites in the western Pacific, declined from an estimated 3,103 females in 1968 to 2 females in 1994 (Chan and Liew 1996). Nesting groups of leatherback sea turtles along the coasts of the Solomon Islands, which historically supported important nesting groups, are also reported to be declining (D. Broderick, pers. comm., *in* Dutton *et al.* 1999). In Fiji, Thailand, Australia, and Papua New Guinea (East Papua), leatherbacks have only been known to nest in low densities and scattered colonies.

The largest, extant leatherback nesting group in the Indo-Pacific lies on the north Vogelkop coast of Irian Jaya (West Papua), Indonesia, with 3,000-5,000 nests reported annually in the 1990s (Suárez *et al.* 2000). However, in 1999, local Indonesian villagers started reporting dramatic declines in sea turtles near their villages (Suárez 1999). Declines in nesting groups have been reported throughout the western Pacific region where observers report that nesting groups are well below abundance levels that were observed several decades ago (*e.g.*, Suárez 1999).

Leatherback sea turtles in the western Pacific are threatened by poaching of eggs, killing of nesting females, human encroachment on nesting beaches, incidental capture in fishing gear, beach erosion, and egg predation by animals.

In the eastern Pacific Ocean, major leatherback nesting beaches are located in Mexico and Costa Rica, where nest numbers have been declining. According to reports from the late 1970s and early 1980s, beaches located on the Mexican Pacific coasts of Michoacán, Guerrero, and Oaxaca sustained a large portion, perhaps fully one half, of all global nesting by leatherbacks (Sarti *et al.* 1996). A dramatic decline has been seen on nesting beaches in Pacific Mexico, where aerial survey data was used to estimate that tens of thousands of leatherback nests were laid on the beaches in the 1980s (Pritchard 1982), but a total of only 120 nests on the four primary index beaches (combined) were counted in the 2003-2004 season (Sarti Martinez *et al.* 2007). Since the early 1980s, the Mexican Pacific population of adult female leatherback turtles has declined to slightly more than 200 during 1998-1999 and 1999-2000 (Sarti *et al.* 2000). Spotila *et al.* (2000) reported the decline of the leatherback nesting at Playa Grande, Costa Rica, which had been the fourth largest nesting group in the world and the most important nesting beach in the Pacific. Between 1988 and 1999, the nesting group declined from 1,367 to 117 female leatherback sea turtles. Based on their models, Spotila *et al.* (2000) estimated that the group could fall to less than 50 females by 2003-2004. An analysis of the Costa Rican nesting beaches indicates a decline in nesting during 15 years of monitoring (1989-2004) with approximately 1,504 females nesting in 1988-1989 to an average of 188 females nesting in 2000-2001 and 2003-2004 (NMFS and USFWS 2007d).

Leatherbacks in the eastern Pacific face a number of threats to their survival. For example, commercial and artisanal swordfish fisheries off Chile, Colombia, Ecuador, and Peru; purse seine fisheries for tuna in the eastern tropical Pacific Ocean; and California/Oregon drift gillnet fisheries are known to capture, injure, or kill leatherbacks in the eastern Pacific Ocean. Given the declines in leatherback nesting in the Pacific, some researchers have concluded that the leatherback is on the verge of extinction in the Pacific Ocean (*e.g.,* Spotila *et al.* 1996, 2000).

Indian Ocean. Leatherbacks nest in several areas around the Indian Ocean. These sites include Tongaland, South Africa (Pritchard 2002) and the Andaman and Nicobar Islands (Andrews *et al.* 2002). Intensive survey and tagging work in 2001 provided new information on the level of nesting in the Andaman and Nicobar Islands (Andrews *et al.* 2002). Based on the survey and tagging work, it was estimated that 400-500 female leatherbacks nest annually on Great Nicobar Island (Andrews *et al.* 2002). The number of nesting females using the Andaman and Nicobar Islands combined was estimated around 1,000 (Andrews and Shanker 2002). Some nesting also occurs along the coast of Sri Lanka, although in much smaller numbers than in the past (Pritchard 2002). Spotila *et al.* (2000) indicated that leatherback sea turtles have been virtually extinct in Sri Lanka since 1994 and disappeared from India before 1930.

Mediterranean Sea. Casale *et al.* (2003) reviewed the distribution of leatherback sea turtles in the Mediterranean. Among the 411 individual records of leatherback sightings in the Mediterranean, there were no nesting records. Nesting in the Mediterranean is not known or is believed to be extremely rare. Leatherbacks found in Mediterranean waters originate from the Atlantic Ocean (P.

Dutton, NMFS, unpublished data).

Atlantic Ocean. Evidence from tag returns and strandings in the western Atlantic suggests that adult leatherback sea turtles engage in routine migrations between boreal, temperate, and tropical waters (NMFS and USFWS 1992). Leatherbacks are frequently thought of as a pelagic species that feed on jellyfish (*e.g.*, *Stomolophus, Chryaora*, and *Aurelia* spp.) and tunicates (*e.g.*, salps, pyrosomas) in oceanic habitats (Rebel 1974; Davenport and Balazs 1991). However, leatherbacks are also known to use coastal waters of the U.S. continental shelf (James *et al.* 2005a; Eckert *et al.* 2006; Murphy *et al.* 2006) as well as the European continental shelf on a seasonal basis (Witt *et al.* 2007). The waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands have been designated as critical habitat for the leatherback sea turtle.

The CETAP aerial survey of the outer continental shelf from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia conducted between 1978 and 1982 showed leatherbacks to be present throughout the area with the most numerous sightings made from the Gulf of Maine south to Long Island. Leatherbacks were sighted in water depths ranging from 1 to 4,151 m, but 84.4% of sightings were in waters less than 180 m (Shoop and Kenney 1992). Leatherbacks were sighted in waters within a sea surface temperature range similar to that observed for loggerheads, from 7°-27.2°C (Shoop and Kenney 1992). However, leatherbacks appear to have a greater tolerance for colder waters in comparison to loggerhead sea turtles since more leatherbacks were found at the lower temperatures (Shoop and Kenney 1992). This aerial survey estimated the summer leatherback population for the northeastern U.S. at approximately 300-600 animals (from near Nova Scotia, Canada to Cape Hatteras, North Carolina). However, the estimate was based on turtles visible at the surface and does not include those that were below the surface out of view. Therefore, it likely underestimated the leatherback population for the northeastern U.S. at the time of the survey. Estimates of leatherback abundance of 1,052 turtles (C.V. = 0.38) and 1,174 turtles (C.V. = 0.52) were obtained from surveys conducted from Virginia to the Gulf of St. Lawrence in 1995 and 1998, respectively (Palka 2000). However, since these estimates were also based on sightings of leatherbacks at the surface, the author considered the estimates to be negatively biased and the true abundance of leatherbacks may be 4.27 times the estimates (Palka 2000). Studies of satellite tagged leatherbacks suggest that they spend 10%-41% of their time at the surface, depending on the phase of their migratory cycle (James *et al.* 2005b). The greatest amount of surface time (up to 41%) was recorded when leatherbacks occurred in continental shelf and slope waters north of 38°N (James *et al.* 2005b).

Leatherbacks are a long lived species (>30 years). They were originally believed to mature at a younger age than loggerhead sea turtles, with a previous estimated age at sexual maturity of about 13-14 years for females with 9 years reported as a likely minimum (Zug and Parham 1996) and 19 years as a likely maximum (NMFS SEFSC 2001). However, new sophisticated analyses suggest that leatherbacks in the Northwest Atlantic may reach maturity at 24.5-29 years of age (Avens *et al.* 2009). In the U.S. and Caribbean, female leatherbacks nest from March through July. They nest frequently (up to 7 nests per year) during a nesting season and nest about every 2-3 years. During each nesting, they produce 100 eggs or more in each clutch and can produce 700 eggs or more per nesting season (Schultz 1975). However, a significant portion (up to approximately 30%) of the eggs can be infertile. Therefore, the actual proportion of eggs that can result in hatchlings is less than the total number of eggs produced per season. As is the case with other sea turtle species, leatherback hatchlings enter the water soon after hatching. Based on a review of all sightings of leatherback sea turtles of <145 centimeters (cm) curved carapace length (CCL), Eckert (1999) found that leatherback juveniles remain in waters warmer than 26°C until they exceed 100 cm CCL.

As described above, sea turtle nesting survey data is important in that it provides information on the relative abundance of nesting, and the contribution of each population/ subpopulation to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually, and as an indicator of the trend in the number of nesting females in the nesting group. The 5-year review for leatherback sea turtles (NMFS and USFWS 2007d) compiled the most recent information on mean number of leatherback nests per year for each of the seven leatherback populations or groups of populations that were identified by the Leatherback TEWG as occurring within the Atlantic. These are: Florida, North Caribbean, Western Caribbean, Southern Caribbean, West Africa, South Africa, and Brazil (TEWG 2007). In the U.S., the Florida Statewide Nesting Beach Survey program has documented an increase in leatherback nesting numbers from 98 nests in 1988 to between 800 and 900 nests in the early 2000s (NMFS and USFWS 2007d). An analysis of Florida's index nesting beach sites from 1989-2006 shows a substantial increase in leatherback nesting in Florida during this time, with an annual growth rate of approximately 1.17 (TEWG 2007). The TEWG reports an increasing or stable trend for all of the seven populations or groups of populations with the exception of the Western Caribbean and West Africa. However, caution is also warranted even for those that were identified as stable or increasing. In St. Croix, for example, researchers have noted a declining presence of neophytes (first-time nesters) since 2002 (Garner and Garner 2007). In addition, the leatherback rookery along the northern coast of South America in French Guiana and Suriname supports the majority of leatherback nesting in the western Atlantic (TEWG 2007), and represents more than half of total nesting by leatherback sea turtles worldwide (Hilterman and Goverse 2004). Nest numbers in Suriname have shown an increase and the long-term trend for the Suriname and French Guiana nesting group seems to show an increase (Hilterman and Goverse 2004). In 2001, the number of nests for Suriname and French Guiana combined was 60,000, one of the highest numbers observed for this region in 35 years (Hilterman and Goverse 2004). The TEWG (2007) report indicates that using nest numbers from 1967-2005, a positive population growth rate was found over the 39-year period for French Guinea and Suriname, with a 95% probability that the population was growing. Nevertheless, given the magnitude of leatherback nesting in this area compared to other nest sites, impacts to this area that negatively affect leatherback sea turtles could have profound impacts on the species, overall.

Tagging and satellite telemetry data indicate that leatherbacks from the western North Atlantic nesting beaches use the entire North Atlantic Ocean (TEWG 2007). For example, leatherbacks tagged at nesting beaches in Costa Rica have been found in Texas, Florida, South Carolina, Delaware, and New York (STSSN database). Leatherback sea turtles tagged in Puerto Rico, Trinidad, and the Virgin Islands have also been subsequently found on U.S. beaches of southern, Mid-Atlantic, and northern states (STSSN database). Animals from the South Atlantic nesting assemblages have not been re-sighted in the western North Atlantic (TEWG 2007).

The 5-year status review (NMFS and USFWS 2007d) and TEWG (2007) report provide summaries of natural as well as anthropogenic threats to leatherback sea turtles. Of the Atlantic sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, trap/pot gear in particular. This susceptibility may be the result of their body type (large size, long pectoral flippers, and lack of a hard shell), and their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, and perhaps to the light sticks used to attract target species in longline fisheries. Leatherbacks entangled in fishing gear generally have a reduced ability to feed, dive, surface to breathe, or perform any other behavior essential to survival (Balazs 1985). In addition to drowning from forced submergence, they may be more susceptible to boat strikes if forced to remain at the surface, and entangling lines can constrict blood flow resulting in tissue necrosis.

Leatherbacks have been documented interacting with longline, trap/pot, trawl, and gillnet fishing gear. For instance, according to observer records, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992-1999, of which 88 were released dead (NMFS SEFSC 2001). Currently, the U.S. tuna and swordfish longline fisheries managed under the HMS FMP are estimated to capture 1,764 leatherbacks (no more than 252 mortalities) for each 3-year period starting in 2007 (NMFS 2004). In 2008, there were 90 observed interactions between leatherback sea turtles and longline gear used in the HMS fishery. Four of the leatherbacks were dead upon release and one was in unknown condition. The vast majority of leatherbacks that were released alive had injuries due to external hooking (Garrison *et al.* 2009). Based on the observed take, an estimated 381.3 (95% CI: 288.7-503.7) leatherback sea turtles are estimated to have been taken in the longline fisheries managed under the HMS FMP in 2008 (Garrison *et al.* 2009). The 2008 estimate is consistent with the annual numbers since 2005 and remains well below the average prior to implementation of gear regulations (Garrison *et al.* 2009). Since the U.S. fleet accounts for only 5%-8% of the longline hooks fished in the Atlantic Ocean, adding up the under-represented observed takes of the other 23 countries actively fishing in the area would likely result in annual take estimates of thousands of leatherbacks over different life stages (NMFS SEFSC 2001). Lewison *et al.* (2004) estimated that 30,000-60,000 leatherbacks were taken in all Atlantic longline fisheries in 2000 (including the U.S. Atlantic tuna and swordfish longline fisheries as well as others).

Leatherbacks are susceptible to entanglement in the lines associated with trap/pot gear used in several fisheries. From 1990-2000, 92 entangled leatherbacks were reported from New York through Maine (Dwyer *et al.* 2002). Additional leatherbacks stranded wrapped in line of unknown origin or with evidence of a past entanglement (Dwyer *et al.* 2002). More recently, from 2002 to 2007, NMFS received 144 reports of entangled sea turtles in vertical lines from Maine to Virginia, with 96 events confirmed (verified by photo documentation or response by a trained responder; NMFS 2008b). Of the 96 confirmed events during this period, 87 events involved leatherbacks. NMFS identified the gear type and fishery for 42 of the 96 confirmed events, which included lobster, whelk, sea bass, crab, and research pot gear. A review of leatherback mortality documented by the STSSN in Massachusetts suggests that vessel strikes and entanglement in fixed gear (primarily lobster pots and whelk pots) are the principal sources of this mortality (Dwyer *et al.* 2002). Fixed gear fisheries in the Mid-Atlantic have also contributed to leatherback entanglements. For example, in North Carolina, two leatherback sea turtles were reported entangled in a crab pot buoy line inside Hatteras Inlet (NMFS SEFSC 2001). A third leatherback was reported entangled in a crab pot buoy line in Pamlico Sound off of Ocracoke. This turtle was disentangled and released alive; however, lacerations on the front flippers from the lines were evident (NMFS SEFSC 2001). In the southeast U.S., leatherbacks are vulnerable to entanglement in Florida's lobster pot and stone crab fisheries as documented on stranding forms. In the U.S. Virgin Islands, where one of five leatherback strandings from 1982 to 1997 were due to entanglement (Boulon 2000), leatherbacks have been observed with their flippers wrapped in the line of West Indian fish traps (R. Boulon, pers. comm. to Joanne Braun-McNeill, NMFS SEFSC 2001).

Leatherback interactions with the U.S. south Atlantic and Gulf of Mexico shrimp fisheries are also known to occur (NMFS 2002b). Leatherbacks are likely to encounter shrimp trawls working in the coastal waters off the U.S. Atlantic coast (from Cape Canaveral, Florida through North Carolina) as they make their annual spring migration north. For many years, TEDs that were required for use in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries were less effective for leatherbacks as compared to the smaller, hard-shelled turtle species, because the TED openings were too small to allow leatherbacks to escape. To address this problem, NMFS issued a final rule on February 21, 2003 to amend the TED regulations (68 FR 8456). Modifications to the design of TEDs are now required in order to exclude leatherbacks as well as large benthic immature and sexually mature loggerhead and green sea turtles (see section 3.1.1 above for further information on the shrimp trawl fishery).

Other trawl fisheries are also known to interact with leatherback sea turtles although on a much smaller scale. In October 2001, for example, a fisheries observer documented the take of a leatherback in a bottom otter trawl fishing for *Loligo* squid off of Delaware. TEDs are not currently required in this fishery. In November 2007, fisheries observers reported the capture of a leatherback sea turtle in bottom otter trawl gear fishing for summer flounder.

Gillnet fisheries operating in the waters of the Mid-Atlantic states are also known to capture, injure, and/or kill leatherbacks when these fisheries and leatherbacks co-occur. Data collected by the NEFSC Fisheries Observer Program from 1994-1998 (excluding 1997) indicate that a total of 37 leatherbacks were incidentally captured (16 lethally) in drift gillnets set in offshore waters from Maine to Florida during this period. Observer coverage for this period ranged from 54%-92%. In North Carolina, six additional leatherbacks were reported captured in gillnet sets in the spring (NMFS SEFSC 2001). In addition to these, in September 1995, two dead leatherbacks were removed from an 11-inch (28.2 cm) monofilament shark gillnet set in the nearshore waters off of Cape Hatteras (STSSN unpublished data reported in NMFS SEFSC 2001).

Fishing gear interactions are problems for leatherbacks throughout their range. Entanglements are common in Canadian waters where Goff and Lien (1988) reported that 14 of 20 leatherbacks encountered off the coast of Newfoundland/Labrador were entangled in fishing gear including salmon net, herring net, gillnet, trawl line, and crab pot line. Leatherbacks are known to drown in fish nets set in coastal waters of Sao Tome, West Africa (Castroviejo *et al.* 1994; Graff 1995). Gillnets are one of the suspected causes for the decline in the leatherback sea turtle population in French Guiana (Chevalier *et al.* 1999), and gillnets targeting green and hawksbill sea turtles in the waters of coastal Nicaragua also incidentally catch leatherback sea turtles (Lagueux 1998).

Observers on shrimp trawlers operating in the northeastern region of Venezuela documented the capture of six leatherbacks from 13,600 trawls (Marcano and Alio-M. 2000). An estimated 1,000 mature female leatherback sea turtles are caught annually in fishing nets off of Trinidad and Tobago with mortality estimated to be between 50%-95% (Eckert and Lien 1999). However, many of the sea turtles do not die as a result of drowning, but rather because the fishermen cut them out of their nets (NMFS SEFSC 2001).

Leatherbacks may be more susceptible to marine debris ingestion than other sea turtle species due to the tendency of floating debris to concentrate in convergence zones that juveniles and adults use for feeding areas (Shoop and Kenney 1992; Lutcavage *et al.* 1997). Investigations of the stomach contents of leatherback sea turtles revealed that a substantial percentage (44% of the 16 cases examined) contained plastic (Mrosovsky 1981). Along the coast of Peru, intestinal contents of 19 of 140 (13%) leatherback carcasses were found to contain plastic bags and film (Fritts 1982). The presence of plastic debris in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items (e.g., jellyfish) and plastic debris (Mrosovsky 1981). Balazs (1985) speculated that plastic objects may resemble food items by their shape, color, size, or even movements as they drift about, and induce a feeding response in leatherbacks.

Summary of Status for Leatherback Sea Turtles
In the Pacific Ocean, the abundance of leatherback sea turtles on nesting beaches has declined dramatically over the past 10 to 20 years. Nesting groups throughout the eastern and western Pacific Ocean have been reduced to a fraction of their former abundance by the combined effects of human activities that have reduced the number of nesting females and reduced the reproductive success of females that manage to nest (for example, egg poaching) (NMFS and USFWS 2007d). No reliable long term trend data for the Indian Ocean populations are currently available. While leatherbacks are known to occur in the Mediterranean Sea, nesting in this region is not known to occur (NMFS and USFWS 2007d).

Nest counts in many areas of the Atlantic Ocean show increasing trends, including for beaches in Suriname and French Guiana which support the majority of leatherback nesting (NMFS and USFWS 2007d). The species as a whole continues to face numerous threats at nesting and marine habitats. As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like pollution (e.g., oils spills) and habitat destruction account for an unknown level of other mortality. For instance, on April 20, 2010 the Deepwater Horizon oil spill occurred in the Gulf of Mexico off the coast of Louisiana. As leatherback sea turtles are known to migrate through and along the coastal waters of the Gulf of Mexico, the oil spill is likely to affect the leatherback population; however, because all the information on sea turtle stranding, deaths, and recoveries has not yet been documented, the effects of the oil spill on the leatherback population cannot be determined at this time. The long term recovery potential of this species may be further threatened by observed low genetic diversity, even in the largest nesting groups like French Guiana and Suriname (NMFS and USFWS 2007d).

Based on its 5-year status review of the species, NMFS and USFWS (2007d) determined that endangered leatherback sea turtles should not be delisted or reclassified. However, it was also determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified for the leatherback (NMFS and USFWS 2007d).

Green sea turtle

Green sea turtles are distributed circumglobally, and can be found in the Pacific, Indian, and Atlantic Oceans as well as the Mediterranean Sea (NMFS and USFWS 1991; Seminoff 2004; NMFS and USFWS 2007c). In 1978, the Atlantic population of the green sea turtle was listed as threatened under the ESA, except for the breeding populations in Florida and on the Pacific coast of Mexico, which were listed as endangered. As it is difficult to differentiate between breeding populations away from the nesting beaches, in water all green sea turtles are considered endangered.

Pacific Ocean. Green sea turtles occur in the western, central, and eastern Pacific. Foraging areas are also found throughout the Pacific and along the southwestern U.S. coast (NMFS and USFWS 1991b). In the western Pacific, major nesting rookeries at four sites including Heron Island (Australia), Raine Island (Australia), Guam, and Japan were evaluated and determined to be increasing in abundance, with the exception of Guam which appears stable (NMFS and USFWS 2007c). In the central Pacific, nesting occurs on French Frigate Shoals, Hawaii, which has also been reported as increasing with a mean of 400 nesting females from 2002-2006 (NMFS and USFWS 2007c). The main nesting sites for the green sea turtle in the eastern Pacific are located in Michoacan, Mexico and in the Galapagos Islands, Ecuador (NMFS and USFWS 2007c). The number of nesting females per year exceeds 1,000 females at each site (NMFS and USFWS 2007c). However, historically, greater than 20,000 females per year are believed to have nested in Michoacan alone (Cliffton *et al.* 1982; NMFS and USFWS 2007c). Thus the current number of nesting females is still far below what has historically occurred. Again, the Pacific Mexico green turtle nesting population (also called the black turtle) is considered endangered.

Historically, green sea turtles were used in many areas of the Pacific for food. They were also commercially exploited and this, coupled with habitat degradation, led to their decline in the Pacific (NMFS and USFWS 1991b). Green sea turtles in the Pacific continue to be affected by poaching, habitat loss or degradation, fishing gear interactions, and fibropapilloma (NMFS and USFWS 1991b; NMFS 2004).

Indian Ocean. There are numerous nesting sites for green sea turtles in the Indian Ocean. One of the largest nesting sites for green sea turtles worldwide occurs on the beaches of Oman where an estimated 20,000 green sea turtles nest annually (Hirth 1997; Ferreira *et al.* 2003). Based on a review of the 32 Index Sites used to monitor green sea turtle nesting worldwide, Seminoff (2004) concluded that declines in green sea turtle nesting were evident for many of the Indian Ocean Index Sites. While several of these had not demonstrated further declines in the more recent past, only the Comoros Island Index Site in the Western Indian Ocean showed evidence of increased nesting (Seminoff 2004).

Mediterranean Sea. There are four nesting concentrations of green sea turtles in the Mediterranean from which data are available, including those in Turkey, Cyprus, Israel, and Syria. Currently, approximately 300-400 females nest each year—about two-thirds of which nest in Turkey and one-third in Cyprus. Although this population is depleted from historic levels (Kasparek *et al.* 2001), nesting data gathered since the early 1990s in Turkey, Cyprus, and Israel show no apparent trend in any direction. However, a declining trend is apparent along the coast of Palestine/Israel, where 300-350 nests were deposited each year in the 1950s (Sella 1982) compared to a mean of 6 nests per year from 1993-2004 (Kuller 1999; Y. Levy, Israeli Sea Turtle Rescue Center, unpublished data). A recent discovery of green sea turtle nesting in Syria adds roughly 100 nests per year to green sea turtle nesting activity in the Mediterranean (Rees *et al.* 2005). That such a major nesting concentration could have gone unnoticed until recently (the Syria coast was surveyed in 1991, but nesting activity was attributed to loggerheads) bodes well for the ongoing speculation that the unsurveyed coast of Libya may also host substantial nesting.

Atlantic Ocean. As has occurred in other oceans of its range, green sea turtles were once the target of directed fisheries in the U.S. and throughout the Caribbean. In 1890, over one million pounds of green sea turtles were taken in the Gulf of Mexico green sea turtle fishery (Doughty 1984). However, declines in the turtle fishery throughout the Gulf of Mexico were evident by 1902 (Doughty 1984).

In the western Atlantic, green sea turtles range from Massachusetts to Argentina, including the Gulf of Mexico and Caribbean (Wynne and Schwartz 1999). Green sea turtles occur seasonally in Mid-Atlantic and Northeast waters such as Chesapeake Bay and Long Island Sound (Musick and Limpus 1997; Morreale and Standora 1998; Morreale *et al.* 2005), which serve as foraging and developmental habitats.

Some of the principal feeding pastures in the western Atlantic Ocean include the upper west coast of Florida, the Florida Keys, and the northwestern coast of the Yucatán Peninsula. Additional important foraging areas in the western Atlantic include the Mosquito and Indian River Lagoon systems and nearshore wormrock reefs between Sebastian and Ft. Pierce Inlets in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, and scattered areas along Colombia and Brazil (Hirth 1971). The waters surrounding the island of Culebra, Puerto Rico, and its outlying keys are considered critical habitat for the green sea turtle.

Age at maturity for green sea turtles is estimated to be 20-50 years (Balazs 1982; Frazer and Ehrhart 1985; Seminoff 2004). As is the case with the other sea turtle species described above, adult females may nest multiple times in a season (average 3 nests/season with approximately 100 eggs/nest) and typically do not nest in successive years (NMFS and USFWS 1991b; Hirth 1997).

As is also the case for the other sea turtle species described above, nest count information for green sea turtles provides information on the relative abundance of nesting, and the contribution of each nesting group to total nesting of the species. Nest counts can also be used to estimate the number of reproductively mature females nesting annually. The 5-year status review for the species identified eight geographic areas considered to be primary sites for threatened green sea turtle nesting in the Atlantic/Caribbean, and reviewed the trend in nest count data for each (NMFS and USFWS 2007c). These include: (1) Yucatán Peninsula, Mexico, (2) Tortuguero, Costa Rica, (3) Aves Island, Venezuela, (4) Galibi Reserve, Suriname, (5) Isla Trindade, Brazil, (6) Ascension Island, United Kingdom, (7) Bioko Island, Equatorial Guinea, and (8) Bijagos Archipelago, Guinea-Bissau (NMFS and USFWS 2007c). Nesting at all of these sites was considered to be stable or increasing with the exception of Bioko Island, which may be declining, and the Bijagos Archipelago, which may be stable; however, the lack of sufficient data precluded a meaningful trend assessment for either site (NMFS and USFWS 2007c).

Seminoff (2004) likewise reviewed green sea turtle nesting data for eight sites in the western, eastern, and central Atlantic, including all of the above threatened nesting sites with the exception that nesting in Florida was reviewed in place of Isla Trindade, Brazil. Seminoff (2004) concluded that all sites in the central and western Atlantic showed increased nesting with the exception of nesting at Aves Island, Venezuela, while both sites in the eastern Atlantic demonstrated decreased nesting. These sites are not inclusive of all green sea turtle nesting in the Atlantic Ocean. However, other sites are not believed to support nesting levels high enough that would change the overall status of the species in the Atlantic (NMFS and USFWS 2007c).

By far, the most important nesting concentration for green sea turtles in the western Atlantic is in Tortuguero, Costa Rica (NMFS and USFWS 2007c). Nesting in the area has increased considerably since the 1970s and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS 2007c). The number of females nesting per year on beaches in the Yucatán, at Aves Island, Galibi Reserve, and Isla Trindade number in the hundreds to low thousands, depending on the site (NMFS and USFWS 2007c).

The status of the endangered Florida breeding population was also evaluated in the 5-year review (NMFS and USFWS 2007c). The pattern of green sea turtle nesting shows biennial peaks in abundance, with a generally positive trend since establishment of the Florida index beach surveys in 1989 to 2006. This is perhaps due to increased protective legislation throughout the Caribbean (Meylan *et al.* 1995), as well as protections in Florida and throughout the U.S. (NMFS and USFWS 2007c).

The statewide Florida surveys (2000-2006) have shown that a mean of approximately 5,600 nests are laid annually in Florida, with a low of 581 in 2001 to a high of 9,644 in 2005 (NMFS and USFWS 2007c). Most nesting occurs along the east coast of Florida, but occasional nesting has been documented along the Gulf coast of Florida, at southwest Florida beaches, as well as the beaches in the Florida Panhandle (Meylan *et al.* 1995). More recently, green sea turtle nesting occurred on Bald Head Island, North Carolina (just east of the mouth of the Cape Fear River), on Onslow Island, and at Cape Hatteras National Seashore.

Green sea turtles face many of the same natural threats as loggerhead and Kemp's ridley sea turtles. In addition, green sea turtles appear to be susceptible to fibropapillomatosis, an epizootic disease producing lobe-shaped tumors on the soft portion of a turtle's body. Juveniles appear to be most affected in that they have the highest incidence of disease and the most extensive lesions, whereas lesions in nesting adults are rare. Also, green sea turtles frequenting nearshore waters, areas adjacent to large human populations, and areas with low water turnover, such as lagoons, have a higher incidence of the disease than individuals in deeper, more remote waters. The occurrence of fibropapilloma tumors may result in impaired foraging, breathing, or swimming ability, leading potentially to death (George 1997).

As with the other sea turtle species, incidental fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches. Sea sampling coverage in the pelagic driftnet, pelagic longline, southeast shrimp trawl, and summer flounder bottom trawl fisheries has recorded takes of green sea turtles. Other activities like dredging, pollution (e.g., oil spills), and habitat destruction account for an unknown level of other mortality (i.e., stranding reports indicate that between 200-400 green sea turtles strand annually along the eastern U.S. coast from a variety of causes most of which are unknown (STSSN database)). For instance, on April 20, 2010 the Deepwater Horizon oil spill occurred in the Gulf of Mexico off the coast of Louisiana. As green sea turtles are known to migrate through, and nest and forage along the coastal waters of the Gulf of Mexico, the oil spill is likely to affect the green sea turtle population; however, because all the information on sea turtle stranding, deaths, and recoveries has not yet been documented, the effects of the oil spill on the green sea turtle population cannot be determined at this time.

Summary of Status of Green Sea Turtles

A review of 32 Index Sites[4] distributed globally revealed a 48%-67% decline in the number of mature females nesting annually over the last three generations[5] (Seminoff 2004). An evaluation of green sea turtle nesting sites was also conducted as part of the 5-year status review of the species (NMFS and USFWS 2007c). Of the 23 threatened nesting groups assessed in that report for which nesting abundance trends could be determined, 10 were considered to be increasing, 9 were considered stable, and 4 were considered to be decreasing (NMFS and USFWS 2007c). Nesting groups were considered to be doing relatively well (the number of sites with increasing nesting were greater than the number of sites with decreasing nesting) in the Pacific, western Atlantic, and central Atlantic (NMFS and USFWS 2007c). However, nesting populations were determined to be doing relatively poorly in Southeast Asia, Eastern Indian Ocean, and perhaps the Mediterranean. Overall, based on mean annual reproductive effort, the report estimated that 108,761 to 150,521 females nest each year among the 46 threatened and endangered nesting sites included in the evaluation (NMFS and USFWS 2007c). However, given the late age to maturity for green sea turtles, caution is urged regarding the status for any of the nesting groups since no area has a dataset spanning a full green sea turtle generation (NMFS and USFWS 2007c).

There is cautious optimism that green sea turtle abundance is increasing in the Atlantic Ocean. Seminoff (2004) and NMFS and USFWS (2007c) made comparable conclusions with regard to nesting for four nesting sites in the western Atlantic. Each also concluded that nesting at Tortuguero, Costa Rica represented the most important nesting area for green sea turtles in the western Atlantic and that nesting had increased markedly since the 1970s (Seminoff 2004; NMFS and USFWS 2007c). However, the 5-year review also noted that the Tortuguero nesting stock continued to be affected by ongoing directed take at their primary foraging area in Nicaragua (NMFS and USFWS 2007c). The endangered breeding population in Florida appears to be increasing based upon index nesting data from 1989-2006 (NMFS and USFWS 2007c).

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4 The 32 Index Sites include all of the major known nesting areas as well as many of the lesser nesting areas for which quantitative data are available.

5 Generation times ranged from 35.5 years to 49.5 years for the assessment depending on the Index Beach site.

As with the other sea turtle species, fishery mortality accounts for a large proportion of annual human-caused mortality outside the nesting beaches, while other activities like dredging, pollution, and habitat destruction account for an unknown level of other mortality.

Based on its 5-year status review of the species, NMFS and USFWS (2007c) determined that the listing classification for green sea turtles should not be changed. However, it was also determined that an analysis and review of the species should be conducted in the future to determine whether DPSs should be identified (NMFS and USFWS 2007c).

North Atlantic Right whales

Historically, right whales have occurred in all the world's oceans from temperate to subarctic latitudes (Perry *et al.* 1999). In both hemispheres, they are observed at low latitudes and in nearshore waters where calving takes place in the winter months, and in higher latitude foraging grounds in the summer (Clapham *et al.* 1999; Perry *et al.* 1999).

Right whales have been listed as endangered under the Endangered Species Act (ESA) since 1973. They were originally listed as the "northern right whale" as endangered under the Endangered Species Conservation Act, the precursor to the ESA in June 1970. NMFS interpreted this listing to have included two species: *Eubalaena glacialis* and *Eubalaena australis.* The species is also designated as depleted under the Marine Mammal Protection Act (MMPA).

In December 2006, NMFS completed a comprehensive review of the status of right whales in the North Atlantic and North Pacific Oceans. Based on the findings from the status review, NMFS concluded that right whales in the northern hemisphere exist as two species: North Atlantic right whale (*Eubalaena glacialis*) and the North Pacific right whale (*Eubalaena japonica*). NMFS determined that each of the species is in danger of extinction throughout its range. In 2008, based on the status review, NMFS listed right whales in the northern hemisphere as two separate endangered species: the North Atlantic right whale (*E. glacialis*) and North Pacific right whale (*E. japonica*) (73 FR 12024).

The International Whaling Commission (IWC) recognizes two right whale populations in the North Atlantic: a western and eastern population (IWC, 1986). It is thought that the eastern population migrated along the coast from northern Europe to northwest Africa. The current distribution and migration patterns of the eastern North Atlantic right whale population, if extant, are unknown. Sighting surveys from the eastern Atlantic Ocean suggest that right whales present in this region are rare (Best *et al.*, 2001) and it is unclear whether a viable population in the eastern North Atlantic still exists (Brown 1986, NMFS 1991b). Photo-identification work has shown that some of the whales observed in the eastern Atlantic were previously identified as western Atlantic right whales (Kenney 2002). This Opinion will focus on the western North Atlantic subpopulation of right whales which occurs in the action area.

Habitat and Distribution

Western North Atlantic right whales generally occur from the southeast U.S. to Canada (*e.g.*, Bay of Fundy and Scotian Shelf) (Kenney 2002; Waring *et al.* 2007). Like other right whale species, they follow an annual pattern of migration between low latitude winter calving grounds and high latitude summer foraging grounds (Perry *et al.* 1999; Kenney 2002). Right whale movements and habitat have been described as follows:

> The distribution of right whales seems linked to the distribution of their principal zooplankton prey, calanoid copepods (Winn et al. 1986; NMFS 2005; Baumgartner and Mate 2005; Waring *et al.* 2007). Right whales are most abundant in Cape Cod Bay between February and April (Hamilton and Mayo 1990; Schevill *et al.* 1986; Watkins and Schevill 1982) and in the Great South Channel in May and June (Kenney *et al.* 1986; Payne *et al.* 1990; Kenney *et al.* 1995; Kenney 2001) where they have been observed feeding predominantly on copepods of the genera *Calanus* and *Pseudocalanus* (Baumgartner and Mate 2005; Waring *et al.* 2007). Right whales also frequent Stellwagen Bank and Jeffrey's Ledge, as well as Canadian waters including the Bay of Fundy and Browns and Baccaro Banks in the summer through fall (Mitchell *et al.* 1986; Winn *et al.* 1986; Stone *et al.* 1990). Calving occurs in the winter months in coastal waters off of Georgia and Florida (Kraus *et al.* 1988). In the North Atlantic it appears that not all reproductively active females return to the calving grounds each year (Kraus *et al.*, 1986; Payne, 1986). The location of the majority of the population during the winter months remains unknown (NMFS 2005).

While right whales are known to congregate in the aforementioned areas, much is still not understood and movements within and between these areas are extensive (Waring *et al.* 2009). In the winter, only a portion of the known right whale population is seen on the calving grounds. The winter distribution of the remaining right whales remains uncertain (NMFS 2005, Waring *et al.* 2007). Results from winter surveys and passive acoustic studies suggest that animals may be dispersed in several areas including Cape Cod Bay (Brown *et al.* 2002) and offshore waters of the southeastern U.S. (Waring *et al.* 2007). Telemetry data have shown lengthy and somewhat distant excursions into deep water off of the continental shelf (Mate *et al.* 1997) as well as extensive movements over the continental shelf during the summer foraging period (Mate *et al.* 1992; Mate *et al.* 1997; Bowman 2003; Baumgartner and Mate 2005). Knowlton *et al.* (1992) reported several long-distance movements as far north as Newfoundland, the Labrador Basin, and southeast of Greenland; in addition, resightings of photographically identified individuals have been made off Iceland, arctic Norway, and in the old Cape Farewell whaling ground east of Greenland. The Norwegian sighting (September 1999) represents one of only two sightings this century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range matches indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described. Similarly, records from the Gulf of Mexico (Moore and Clark, 1963; Schmidly *et al.*, 1972) represent either geographic anomalies or a more extensive historic range beyond the sole known calving and wintering ground in the waters of the southeastern United States. The frequency with which right whales occur in offshore waters in the southeastern U.S. remains unclear (Waring *et al.*, 2009a).

Abundance estimates and trends

Although an estimate of the pre-exploitation population size for the North Atlantic right whale is not available, it is well known and documented that there are relatively few right whales remaining in the western North Atlantic. As is the case with most wild animals, an exact count cannot be obtained. However, abundance can be reasonably estimated as a result of the extensive study of this subpopulation. IWC participants from a 1999 workshop agreed to a minimum direct-count estimate of 263 right whales alive in 1996 and noted that the true population was unlikely to be greater than this estimate (Best *et al.* 2001). Based on a census of individual whales using photo-identification techniques and an assumption of mortality for those whales not seen in seven years, a total 299 right whales was estimated in 1998 (Kraus *et al.* 2001), and a review of the photo-ID recapture database on October 10, 2008, indicated that 345 individually recognized whales were known to be alive during 2005 (Waring *et al.* 2009). Because this 2008 review was a nearly complete census, it is assumed this estimate represents a minimum population size. The minimum number alive population index for the years 1990-2004 suggests a positive trend in numbers. These data reveal a significant increase in the number of catalogued whales alive during this period, but with significant variation due to apparent losses exceeding gains during 1998-1999. Mean growth rate for the period was 1.8% (Waring *et al.* 2009).

A total of 235 right whale calves have been born from 1993-2007 (Waring *et al.* 2009). The mean calf production for the 15-year period from 1993-2007 is estimated to be 15.6/year (Waring *et al.* 2009). Calving numbers have been sporadic, with large differences among years, including a record calving season in 2000/2001 with 31 right whale births (Waring *et al.* 2007). The three calving years (97/98; 98/99; 99/00) prior to this record year provided low recruitment levels with only 11 calves born. The last seven calving seasons (2000-2007) have been remarkably better with 31, 21, 19, 17, 28, 19, and 23 births, respectively (Waring *et al.* 2009). A preliminary calf count for the 2008/2009 season indicates a new record calving season of 39 calves (Zoodsma, pers. comm.). However, the subpopulation has also continued to experience losses of calves, juveniles and adults. As of August 1, 2008, there were 528 individually identified right whales in the photo-identification catalog of which 25 were known to be dead, 135 were presumed to be dead as they had not been sighted in the past six years, and 368 were presumed to be alive (Hamilton *et al.* 2008). Although the population has seen some growth over the past 8 years, the level of growth is significantly lower than healthy populations of large whales (Pace *et al.* 2008).

As is the case with other mammalian species, there is an interest in monitoring the number of females in this right whale subpopulation since their numbers will affect the subpopulation trend (whether declining, increasing or stable). As of 2005, 92 reproductively-active females had been identified (Kraus *et al.* 2007). From 1983-2005, the number of new mothers recruited to the population (with an estimated age of 10 for the age of first calving), varied from 0-11 each year with no significant increase or decline over the period (Kraus *et al.* 2007). By 2005, 16 right whales had produced at least 6 calves each, and 4 cows had at least seven calves. Two of these cows were at an age which indicated a reproductive life span of at least 31 years (Kraus *et al.* 2007). As described above, the 2000/2001 - 2006/2007 calving seasons have had relatively high calf production and have included additional first time mothers (*e.g.*, eight new mothers in 2000/2001). These potential "gains" have been offset, however, by continued losses to the subpopulation including the death of mature females as a result of anthropogenic mortality (like that described in Glass *et al.* 2009, below). Of the 15 serious injuries and mortalities between 2003-2007, at least 9 were adult females, three of which were carrying near-term fetuses and 4 of which were just starting to bear calves (Waring *et al.* 2009). Since the average lifetime calf production is 5.25 calves (Fujiwara and Caswell 2001), the deaths of these 9 females represent a loss of reproductive potential of as many as 47 animals. However, it is important to note that not all right whale mothers are equal with regards to calf production. Right whale #1158 had only one calf over a 25-year period (Kraus *et al.* 2007). In contrast, one of the largest right whales on record was a female nicknamed "Stumpy," who was killed in February 2004 of an apparent ship strike (NMFS 2006). She was first sighted in 1975 and known to be a prolific breeder, successfully rearing calves in 1980, 1987, 1990, 1993, and 1996 (Moore *et. al* 2007). At the time of her death, she was estimated to be 30 years of age and carrying her sixth calf; the near-term fetus also died (NMFS 2006).

Abundance estimates are an important part of assessing the status of the species. However, for Section 7 purposes, the population trend (*i.e.,* whether increasing or declining) provides better information for assessing the effects of a proposed action on the species. As described in previous Opinions, data collected in the 1990s suggested that right whales were experiencing a slow but steady recovery (Knowlton *et al.* 1994). However, Caswell *et al.* (1999) used photo-identification data and modeling to estimate survival and concluded that right whale survival decreased from 1980 to 1994. Modified versions of the Caswell *et al.* (1999) model as well as several other models were reviewed at the 1999 IWC workshop (Best *et al.* 2001). Despite differences in approach, all of the models indicated a decline in right whale survival in the 1990s relative to the 1980s with female survival, in particular, apparently affected (Best *et al.* 2001, Waring *et al.* 2007). In 2002, NMFS' NEFSC hosted a workshop to review right whale population models to examine: (1) potential bias in the models and (2) changes in the subpopulation trend based on new information collected in the late 1990s (Clapham *et al.* 2002). Three different models were used to explore right whale survivability and to address potential sources of bias. Although biases were identified that could negatively affect the results, all three modeling techniques resulted in the same conclusion; survival has continued to decline and seems to be focused on females (Clapham *et al.* 2002). Mortalities, including those in the first half of 2005, suggest an increase in the annual mortality rate (Kraus *et al.* 2005). Calculations indicate that this increased mortality rate would reduce population growth by approximately 10% per year (Kraus *et al.* 2005).

Reproductive Fitness

Healthy reproduction is critical for the recovery of the North Atlantic right whale (Kraus *et al.* 2007). While modeling work suggests a decline in right whale abundance as a result of reduced survival, particularly for females, some researchers have also suggested that the subpopulation is being affected by a decreased reproductive rate (Best *et al.* 2001; Kraus *et al.* 2001). Kraus *et al.* (2007) reviewed reproductive parameters for the period 1983-2005, and estimated calving intervals to have changed from 3.5 years in 1990 to over five years between 1998-2003, and then suddenly decreased to just over 3 years in 2004 and 2005.

Factors that have been suggested as affecting the right whale reproductive rate include reduced genetic diversity (and/or inbreeding), contaminants, biotoxins, disease, nutritional stress, and loss of habitat (e.g., breeding and foraging grounds). Although it is believed that a combination of these factors is likely causing an effect on right whales (Kraus *et al.* 2007), there is currently no evidence available to determine their potential effect, if any. The dramatic reduction in the North Atlantic right whale population believed to have occurred due to commercial whaling may have resulted in a loss of genetic diversity which could affect the ability of the current population to successfully reproduce (*i.e.*, decreased conceptions, increased abortions, and increased neonate mortality). The current hypothesis is that the low level of genetic variability in this species produces a high rate of mate incompatibility and unsuccessful pregnancies (Frasier *et al.* 2007). Analyses are currently under way to assess this relationship further as well as the influence of genetic characteristics on the potential for species recovery (Frasier *et al.* 2007). Studies by Schaeff *et al.* (1997) and Malik *et al.* (2000) indicate that western North Atlantic right whales are less genetically diverse than southern right whales. However, several apparently healthy populations of cetaceans, such as sperm whales and pilot whales, have even lower genetic diversity than observed for western North Atlantic right whales (IWC 2001a). Similarly, while contaminant studies have confirmed that right whales are exposed to and accumulate contaminants, researchers could not conclude that these contaminant loads were negatively affecting right whale reproductive success since concentrations were lower than those found in marine mammals proven to be affected by PCBs and DDT (Weisbrod *et al.* 2000). Another suite of contaminants (i.e. antifouling agents and flame retardants) that have been proven to disrupt reproductive patterns and have been found in other marine animals, have raised new concerns (Kraus *et al.* 2007). Recent data also support a hypothesis that chromium, an industrial pollutant, may be a concern for the health of the North Atlantic right whales and that inhalation may be an important exposure route (Wise *et al.* 2008). A number of diseases could be also affecting reproduction, however tools for assessing disease factors in free-swimming large whales currently do not exist (Kraus *et al.* 2007). Once developed, such methods may allow for the evaluation of disease effects on right whales. Impacts of biotoxins on marine mammals are also poorly understood, yet data is showing that marine algal toxins may play significant roles in mass mortalities of these animals (Rolland *et al.* 2007). Although there are no published data concerning the effects of biotoxins on right whales, researchers are now certain that right whales are being exposed to measurable quantities of paralytic shellfish poisoning (PSP) toxins and domoic acid via trophic transfer through the copepods upon which they feed (Durbin *et al.* 2002, Rolland *et al.* 2007).

Data indicating right whales are food-limited are difficult to evaluate (Kraus *et al.* 2007). Although North Atlantic right whales seem to have thinner blubber than right whales from the South Atlantic (Kenney 2000), there is no evidence at present to demonstrate that the decline in birth rate and increase in calving interval is related to a food shortage. Nevertheless, a connection among right whale reproduction and environmental factors may yet be found. Modeling work by Caswell *et al.* (1999) and Fujiwara and Caswell (2001) suggests that the North Atlantic Oscillation (NAO), a naturally occurring climatic event, does affect the survival of mothers and the reproductive rate of mature females, and it also seems to affect calf survival (Clapham *et al.* 2002). Greene *et al.* (2003) described the potential oceanographic processes linking climate variability to the reproduction of North Atlantic right whales. Climate-driven changes in ocean circulation have had a significant impact on the plankton ecology of the Gulf of Maine, including effects on *Calanus finmarchicus*, a primary prey resource for right whales. Researchers found that during the 1980's, when the NAO index was predominately positive, *C. finmarchicus* abundance was also high; when a record drop occurred in the NAO index in 1996, *C. finamarchicus* abundance levels also decreased significantly. Right whale calving rates since the early 1980's seem to follow a similar pattern, where stable calving rates were noted from 1982-1992, but then two major, multi-year declines occurred from 1993-2001, consistent with the drops in copepod abundance. It has been hypothesized that right whale calving rates are thus a function of food availability as well as the number of females available to reproduce (Greene *et al.* 2003, Greene and Pershing 2004). Such findings suggest that future climate change may emerge as a significant factor influencing the recovery of right whales. Some believe the effects of increased climate variability on right whale calving rates should be incorporated into future modeling studies so that it may be possible to determine how sensitive right whale population numbers are to variable climate forcing (Greene and Pershing 2004).

Anthropogenic Mortality

There is general agreement that right whale recovery is negatively affected by anthropogenic mortality. From 2004-2008, right whales had the highest proportion of entanglement and ship strike events relative to the number of reports for a species (Glass *et al.* 2010). Given the small population size and low annual reproductive rate of right whales, human sources of mortality may have a greater effect to relative population growth rate than for other large whale species (Waring *et al.* 2009). For the period 2004-2008, the annual human-caused mortality and serious injury rate for the North Atlantic right whale averaged 2.8 per year (2.2 in U.S. waters; 0.6 in Canadian waters) (Glass *et al.* 2010). Twenty-one confirmed right whale mortalities were reported along the U.S. east coast and adjacent Canadian Maritimes from 2004-2008 (Glass *et al.* 2010). These numbers represent the minimum values for serious injury and mortality for this period. Given the range and distribution of right whales in the North Atlantic, and the fact that positively buoyant species like right whales may become negatively buoyant if injury prohibits effective feeding for prolonged periods, it is highly unlikely that all carcasses will be observed (Moore *et. al.* 2004, Glass *et al.* 2009). Moreover, carcasses floating at sea often cannot be examined sufficiently and may generate false negatives (i.e., not a right whale, but a different species of whale) if they are not towed to shore for further necropsy (Glass *et al.* 2009). Decomposed and/or unexamined animals represent lost data, some of which may relate to human impacts (Waring *et al.* 2009).

Considerable effort has been made to examine right whale carcasses for the cause of death (Moore *et al.* 2004). Because they live in an ocean environment, examining right whale carcasses is often very difficult. Some carcasses are discovered floating at sea and cannot be retrieved. Others are in such an advanced stage of decomposition when discovered that a complete examination is not possible. Wave action and post-mortem predation by sharks can also damage carcasses, and preclude a thorough examination of all body parts. It should also be noted that mortality and serious injury event judgments are based upon the best available data and additional information may result in revisions (Glass *et al.* 2010). Of the 21 total, confirmed right whale mortalities (2004-2008) described in Glass *et al.* (2010), 3 were confirmed to be entanglement mortalities (1 adult female, 1 female calf, 1 male calf) and 8 were confirmed to be ship strike mortalities (5 adult females, 1 female of unknown age, 1 male calf, and 1 yearling male). Serious injury involving right whales was documented for 1 entanglement event (adult male) and 2 ship strike events (1 adult female and 1 yearling male).

Although disentanglement is either unsuccessful or not possible for the majority of cases, during the period of 2003-2007, there were at least 4 documented cases of entanglements for which the intervention of disentanglement teams averted a likely serious injury determination (Waring *et al.* 2009). Even when entanglement or vessel collision does not cause direct mortality, it may weaken or otherwise affect individuals so that further injury or death is likely (Waring *et. al* 2007). Some right whales that have been entangled were subsequently involved in ship strikes (Hamilton *et al.*

1998) suggesting that the animal may have become debilitated by the entanglement to such an extent that it was less able to avoid a ship. Similarly, skeletal fractures and/or broken jaws sustained during a vessel collision may heal, but then compromise a whale's ability to efficiently filter feed (Moore *et al.* 2007). A necropsy of right whale #2143 ("Lucky) found dead in January 2005 suggested the animal (and her near-term fetus) died after healed propeller wounds from a previous ship strike re-opened and became infected as a result of pregnancy (Moore *et al.* 2007, Glass *et al.* 2008). Sometimes, even with a successful disentanglement, an animal may die of injuries sustained by fishing gear (e.g. RW #3107) (Waring *et al.* 2009).

Entanglement records from 1990-2007 maintained by NMFS include 46 confirmed right whale entanglement events (Waring *et al.* 2009). Because whales often free themselves of gear following an entanglement event, scarification analysis of living animals may provide better indications of fisheries interactions rather than entanglement records (Waring et al. 2009). Data presented in Knowlton *et al.* 2008 indicate the annual rate of entanglement interaction remains at high levels. Four hundred and ninety-three individual, catalogued right whales were reviewed and 625 separate entanglement interactions were documented between 1980 and 2004. Approximately 358 out of 493 animals (72.6% of the population) were entangled at least once; 185 animals bore scars from a single entanglement, however one animal showed scars from 6 different entanglement events. The number of male and female right whales bearing entanglement scars was nearly equivalent (142/202 females, 71.8%; 182/224 males, 81.3%), indicating that right whales of both sexes are equally vulnerable to entanglement. However, juveniles appear to become entangled at a higher rate than expected if all age groups were equally vulnerable. For all years but one (1998), the proportion of juvenile, entangled right whales exceeded their proportion within the population. Based on photographs of catalogued animals from 1935 through 1995, Hamilton *et al.* (1998) estimated that 6.4 percent of the North Atlantic right whale population exhibit signs of injury from vessel strikes. Reports received from 2003-2007 indicate that right whales had the greatest number of ship strike mortalities (n=9) and serious injuries (n=2) (Glass *et al.* 2009). In 2006 alone, four reported mortalities and one serious injury resulted from right whale ship strikes (Glass *et al.* 2009).

Summary of Right Whale Status

In March 2008, NMFS listed the North Atlantic right whale as a separate, endangered species (*Eubalaena glacialis*) under the ESA. This decision was based on an analysis of the best scientific and commercial data available. The decision took into consideration current population trends and abundance, demographic risk factors affecting the continued survival of the species, and ongoing conservation efforts. NMFS determined that the North Atlantic right whale is in danger of extinction throughout its range because of: (1) overutilization for commercial, recreational, scientific or educational purposes; (2) the inadequacy of existing regulatory mechanisms; and (3) other natural and manmade factors affecting its continued existence.

Previous models estimated that the right whale population in the Atlantic numbered 300 (+/- 10%) (Best *et al.* 2001). However, a review of the photo-ID database on October 10, 2008 indicated that 345 individually recognized right whales were known to be alive in 2005 (Waring et al. 2009). The 2000/2001 - 2007/2008 calving seasons have had relatively high calf production (31, 21, 19, 17, 28, 19, and 23 calves, respectively) and have included additional first time mothers (*e.g.*, eight new mothers in 2000/2001) (Waring *et al.* 2009). There are some indications that climate-driven ocean changes impacting the plankton ecology of the Gulf of Maine, may, in some manner, be affecting right whale fitness and reproduction. However, there is also general agreement that right whale recovery is negatively affected by human sources of mortality, which may have a greater impact on population growth rate given the small population size and low annual reproductive rate of right whales (Waring et al. 2009). Of particular concern is the death of mature females. Of the recent mortalities, including those in the first half of 2005, six were adult females, three of which were carrying near-term fetuses and four of which were just starting to bear calves (Glass *et al.* 2009).

Over the five-year period 2004-2008, right whales had the highest proportion of entanglements and ship strikes relative to the number of reports for a species: of 64 reports involving right whales, 24 were confirmed entanglements and 17 were confirmed ship strikes. There were 21 verified right whale mortalities, three due to entanglements, and eight due to ship strikes (Glass *et al.* 2010). This represents an absolute minimum number of the right whale mortalities for this period. Given the range and distribution of right whales in the North Atlantic, it is highly unlikely that all carcasses will be observed. Scarification analysis indicates that some whales do survive encounters with ships and fishing gear. However, the long-term consequences of these interactions are unknown.

A variety of modeling exercises and analyses indicate that survival probability declined in the 1990s (Best *et al.* 2001), and recent mortalities, including a number of adult females, also suggest an increase in the annual mortality rate (Kraus *et al.* 2005). Nonetheless, a census of the minimum number of right whales alive based on the photo-ID catalog as it existed on October 10, 2008, indicates a positive trend in numbers for the years 1990-2004 (Waring et al. 2009). In addition, calving intervals appear to have declined to 3 years in recent years (Kraus *et al.* 2007), and calf production has been relatively high over the past several seasons. Based on the information currently available, for the purposes of this Opinion, NMFS believes that the minimum estimate for the western North Atlantic right whale subpopulation is 345 individuals and that the population is increasing.

Humpback Whales

Humpback whales inhabit all major ocean basins from the equator to subpolar latitudes. They generally follow a predictable migratory pattern in both hemispheres, feeding during the summer in the higher near-polar latitudes and migrating to lower latitudes in the winter where calving and breeding takes place (Perry *et al.* 1999). Humpbacks are listed under the ESA at the species level. Therefore, information is presented below regarding the status of humpback whales throughout their range.

North Pacific, Northern Indian Ocean and Southern Hemisphere

Humpback whales in the North Pacific feed in coastal waters from California to Russia and in the Bering Sea. They migrate south to wintering destinations off Mexico, Central America, Hawaii, southern Japan, and the Philippines (Carretta *et al.* 2009). Although the IWC only considered one stock (Donovan 1991) there is evidence to indicate multiple populations migrating between their respective summer/fall feeding areas to winter/spring calving and mating areas within the North Pacific Basin (Angliss and Outlaw 2007, Carretta *et al.* 2007). NMFS recognizes three management units within the U.S. EEZ for the purposes of managing this species under the MMPA. These are: the eastern North Pacific stock (feeding areas off the US west coast), the central North Pacific stock (feeding areas from Southeast Alaska to the Alaska Peninsula) and the western North Pacific stock (feeding areas from the Aleutian Islands, the Bering Sea, and Russia) (Carretta *et al.* 2009). Because fidelity appears to be greater in feeding areas than in breeding areas, the stock structure of humpback whales is defined based on feeding areas (Carretta et al. 2009). Recent research efforts via the Structure of Populations, Levels of Abundance, and Status of Humpback Whales (SPLASH) Project estimate the abundance of humpback whales to be just under 20,000 whales for the entire North Pacific, a number which doubles previous population predictions (Calambokidis *et al.* 2008). There are indications that the eastern North Pacific stock was growing in the 1980's and early 1990's with a best estimate of 8% growth per year (Carretta *et al.* 2009). The best available estimate for the eastern North Pacific stock is 1,391 whales (Carretta et al. 2009). The central North Pacific stock is estimated at 4,005 (Angliss and Allen 2009), and various studies report that it appears to have increased in abundance at rates between 6.6%-10% per year (Angliss and Allen 2009). Although there is no reliable population trend data for the western North Pacific stock, as surveys of the known feeding areas are incomplete and many feeding areas remain unknown, minimum population size is currently estimated at 367 whales (Angliss and Allen 2009).

Little or no research has been conducted on humpbacks in the Northern Indian Ocean so information on their current abundance does not exist (Perry *et al.* 1999). Since these humpback whales do not occur in U.S. waters, there is no recovery plan or stock assessment report for the northern Indian Ocean humpback whales. Likewise, there is no recovery plan or stock assessment report for southern hemisphere humpback whales, and there is also no current estimate of abundance for humpback whales in the southern hemisphere although there are estimates for some of the six southern hemisphere humpback whale stocks recognized by the IWC (Perry *et al.* 1999). Like other whales, southern hemisphere humpback whales were heavily exploited for commercial whaling. Although they were given protection by the IWC in 1963, Soviet whaling data made available in the 1990's revealed that 48,477 southern hemisphere humpback whales were taken from 1947-1980, contrary to the original reports to the IWC which accounted for the take of only 2,710 humpbacks (Zemsky *et al.* 1995, IWC 1995, Perry *et al.* 1999).

Gulf of Maine (North Atlantic)

Humpback whales from most Atlantic feeding areas calve and mate in the West Indies and migrate to feeding areas in the northwestern Atlantic during the summer months. Most of the humpbacks that forage in the Gulf of Maine visit Stellwagen Bank and the waters of Massachusetts and Cape Cod Bays. Previously, the North Atlantic humpback whale population was treated as a single stock for management purposes, however due to the strong fidelity to the region displayed by many whales, the Gulf of Maine stock was reclassified as a separate feeding stock (Waring *et al.* 2009). Sightings are most frequent from mid-March through November between 41□N and 43□N, from the Great South Channel north along the outside of Cape Cod to Stellwagen Bank and Jeffrey's Ledge (CeTAP 1982) and peak in May and August. Small numbers of individuals may be present in this area year-round, including the waters of Stellwagen Bank. They feed on a number of species of small schooling fishes, particularly sand lance and Atlantic herring, targeting fish schools and filtering large amounts of water for their associated prey. It is hypothesized humpback whales may also feed on euphausiids (krill) as well as capelin (Waring *et al.* 2009, Stevick *et al.* 2006).

In winter, whales from waters off New England, Canada, Greenland, Iceland, and Norway, migrate to mate and calve primarily in the West Indies where spatial and genetic mixing among these groups does occur (Waring *et al.* 2009). Various papers (Clapham and Mayo 1990; Clapham 1992; Barlow and Clapham 1997; Clapham *et al.* 1999) summarize information gathered from a catalogue of photographs of 643 individuals from the western North Atlantic population of humpback whales. These photographs identified reproductively mature western North Atlantic humpbacks wintering in tropical breeding grounds in the Antilles, primarily on Silver and Navidad Banks, north of the Dominican Republic. The primary winter range also includes the Virgin Islands and Puerto Rico (NMFS 1991a).

Humpback whales use the Mid-Atlantic as a migratory pathway to and from the calving/mating grounds, but it may also be an important winter feeding area for juveniles. Since 1989, observations of juvenile humpbacks in the Mid-Atlantic have been increasing during the winter months, peaking January through March (Swingle *et al.* 1993). Biologists theorize that non-reproductive animals may be establishing a winter feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. Swingle *et al.* (1993) identified a shift in distribution of juvenile humpback whales in the nearshore waters of Virginia, primarily in winter months. Identified whales using the Mid-Atlantic area were found to be residents of the Gulf of Maine and Atlantic Canada (Gulf of St. Lawrence and Newfoundland) feeding groups, suggesting a mixing of different feeding populations in the Mid-Atlantic region. Strandings of humpback whales have increased between New Jersey and Florida since 1985 consistent with the increase in Mid-Atlantic whale sightings. Strandings were most frequent during September through April in North Carolina and Virginia waters, and were composed primarily of juvenile humpback whales of no more than 11 meters in length (Wiley *et al.* 1995).

Photographic mark-recapture analyses from the Years of the North Atlantic Humpback (YONAH) project gave an ocean-basin-wide estimate of 11,570 animals during 1992/1993 and an additional genotype-based analysis yielded a similar by less precise estimate of 10,400 whales (95% c.i. = 8,000 - 13,600) (Waring *et al.* 2009). For management purposes under the MMPA, the estimate of 11,570 individuals is regarded as the best available estimate for the North Atlantic population (Waring *et al.* 2007). The best, recent estimate for the Gulf of Maine stock is 847 whales, derived from the 2006 aerial survey (Waring *et al.* 2009).

As is the case with other large whales, the major known sources of anthropogenic mortality and injury of humpback whales occur from fishing gear entanglements and ship strikes. For the period 2003 through 2007, the minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine humpback whale stock averaged 4.4 animals per year (U.S. waters, 4.0; Canadian waters, 0.4) (Glass *et al.* 2009, Waring *et al.* 2009). Between 2003 and 2007 humpback whales were involved in 76 confirmed entanglement events and 11 confirmed ship strike events (Glass *et al.* 2009). Over the five-year period, humpback whales were the most commonly observed entangled whale species; entanglements accounted for 4 mortalities and 10 serious injuries (Glass *et al.* 2009). Although ship strikes were relatively uncommon, 8 of the 11 confirmed events were fatal (Glass *et al.* 2009). It was assumed that all of these events involved members of the Gulf of Maine stock of humpback whales unless a whale was confirmed to be from another stock; in reports prior to 2007, only events involving whales confirmed to be members of the Gulf of Maine stock were included. As of May 2009, all of the available information indicated that the events described here involved animals from the Gulf of Maine stock (Glass *et al.* 2009). There were also many carcasses that washed ashore or were spotted floating at sea for which the cause of death could not be determined. Given the number of decomposed and incompletely or unexamined animals in the records, there needs to be greater emphasis on the timely recovery of carcasses and complete necropsies; decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or no necropsy performed) represent 'lost data' some of which may relate to human impacts (Glass *et al.* 2009, Waring *et al.* 2009).

Based on photographs taken between 2000-2002 of the caudal peduncle and fluke of humpback whales, Robbins and Mattila (2004) estimated that at least half (48-57%) of the sample (187 individuals) was coded as having a high likelihood of prior entanglement. Evidence suggests that entanglements have occurred at minimum rate of 8-10% per year. Scars acquired by Gulf of Maine stock humpback whales between 2000 and 2002 suggest a minimum of 49 interactions with gear took place. Based on composite scar patterns, it was believed that male humpback whales were more vulnerable to entanglement than females. Males may be subject to other sources of injury that could affect scar pattern interpretation. Images were obtained from a humpback whale breeding ground; 24% exhibited raw injuries, presumable a result from agonistic interactions. However, current evidence suggests that breeding ground interactions alone cannot explain the higher frequency of healed scar patterns among Gulf of Maine stock male humpback whales (Robbins and Matilla 2004).

Humpback whales, like other baleen whales, may also be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources due to trophic effects resulting from a variety of activities including fisheries operations, vessel traffic, and coastal development. Currently, there is no evidence that these types of activities are affecting humpback whales. However, Geraci *et al.* (1989) provide strong evidence that a mass mortality of humpback whales from 1987-1988 resulted from the consumption of mackerel whose livers contained high levels of saxitoxin, a naturally occurring red tide toxin, the origin of which remains unknown. It has been suggested that the occurrence of a red tide event is related to an increase in freshwater runoff from coastal development, leading some observers to suggest that such events may become more common among marine mammals as coastal development continues (Clapham *et al.* 1999). Since that mass mortality event, there have been three additional known cases of a mass mortality involving large whale species along the east coast: 2003, 2005, and 2006. In the most recent event, 21 dead humpback whales were found between July 10 and December 31, 2006, triggering NMFS to declare an unusual mortality event (UME) for humpback whales in the Northeast United States. The UME was officially closed on December 31, 2007 after a review of 2007 humpback whale strandings and mortality showed that the elevated numbers were no longer being observed. The cause of the UME has not been determined to date, although investigations are ongoing.

Changes in humpback distribution in the Gulf of Maine have been found to be associated with changes in herring, mackerel, and sand lance abundance associated with local fishing pressures (Stevick *et al.* 2006, Waring *et al.* 2007). Shifts in relative finfish species abundance correspond to changes in observed humpback whale movements (Stevick *et al.* 2006). However, there is no evidence that humpback whales were adversely affected by these trophic changes.

Summary of Humpback Whales Status

The best available population estimate for humpback whales in the North Atlantic Ocean is estimated as 11,570 animals, and the best, recent estimate for the Gulf of Maine stock is 847 whales (Waring *et al.* 2009). Anthropogenic mortality associated with fishing gear entanglements and ship strikes remains significant. In the winter, mating and calving occurs in areas located outside of the United States where the species is afforded less protection. Despite all of these factors, current data suggest that the Gulf of Maine humpback stock is steadily increasing in size (Waring *et al.* 2009). Population modeling, using data obtained from photographic mark-recapture studies, estimates the growth rate of the Gulf of Maine stock to be at 6.5% for the period 1979-1991 (Barlow and Clapham 1997). More recent analysis for the period 1992-2000 revealed lower growth rates ranging from 0% to 4.0%, depending on calf survival rate (Clapham *et al.* 2003 in Waring *et al.* 2009). However, it is unclear whether the decline is an artifact resulting from a shift in distribution documented for the period 1992-1995, or whether it is a real decline related to high mortality of young-of-the-year whales in US mid-Atlantic waters (Waring *et al.* 2009). Regardless, calf survival appears to have increased since 1996, presumably accompanied by an increase in population growth (Waring *et al.* 2009). Stevick *et al.* (2003) calculated an average population growth rate of 3.1% in the North Atlantic population overall for the period 1979-1993 (Waring *et al.* 2009). With respect to the species overall, there are also indications of increasing abundance for the eastern and central North Pacific stocks. Trend and abundance data is lacking for the western North Pacific stock, the Southern Hemisphere humpback whales, and the Southern Indian Ocean humpbacks. However, changes in status of the North Atlantic humpback population are likely to affect the overall survival and recovery of the species. Therefore, given the best available information, for the purposes of this biological opinion, NMFS believes the humpback whale population is increasing.

Fin Whale

Fin whales inhabit a wide range of latitudes between 20-75° N and 20-75° S (Perry *et al.* 1999). The fin whale is ubiquitous in the North Atlantic and occurs from the Gulf of Mexico and Mediterranean Sea northward to the edges of the arctic ice pack (NMFS 1998a). The overall pattern of fin whale movement is complex, consisting of a less obvious north-south pattern of migration than that of right and humpback whales. Based on acoustic recordings from hydrophone arrays Clark (1995) reported a general southward flow pattern of fin whales in the fall from the Labrador/Newfoundland region, south past Bermuda, and into the West Indies. The overall distribution may be based on prey availability as this species preys opportunistically on both invertebrates and fish (Watkins et al. 1984). Fin whales feed by filtering large volumes of water for the associated prey. Fin whales are larger and faster than humpback and right whales and are less concentrated in nearshore environments.

Pacific Ocean

Within US waters of the Pacific, fin whales are found seasonally off of the coast of North America and Hawaii and in the Bering Sea during the summer (Angliss and Allen 2009). Although stock structure in the Pacific is not fully understood, NMFS recognizes three fin whale stocks in the US Pacific waters for the purposes of managing this species under the MMPA. These are: Alaska (Northeast Pacific), California/Washington/Oregon, and Hawaii (Carretta *et al.* 2009). Reliable estimates of current abundance for the entire Northeast Pacific fin whale stock are not available

(Angliss and Allen 2009). A provisional population estimate of 5,700 was calculated for the Alaska stock west of the Kenai Peninsula by adding estimates from multiple surveys (Angliss and Allen 2009). This can be considered a minimum estimate for the entire stock because it was estimated from surveys that covered only a portion of the range of the species (Angliss and Allen 2009). An annual population increase of 4.8% between 1987-2003 was estimated for fin whales in coastal waters south of the Alaska Peninsula (Angliss and Allen 2009). This is the first estimate of population trend for North Pacific fin whales; however, it must be interpreted cautiously due to the uncertainty in the initial population estimate and the population structure (Angliss and Allen 2009). The best available estimate for the California/Washington/Oregon stock is 2,636, which is likely an underestimate (Carretta *et al.* 2009). The best available estimate for the Hawaii stock is 174, based on a 2002 line-transect survey (Carretta *et al.* 2009).

Stock structure for fin whales in the southern hemisphere is unknown. Prior to commercial exploitation, the abundance of southern hemisphere fin whales is estimated to have been at 400,000 (IWC 1979, Perry *et al.* 1999). There are no current estimates of abundance for southern hemisphere fin whales. Since these fin whales do not occur in US waters, there is no recovery plan or stock assessment report for the southern hemisphere fin whales.

North Atlantic

NMFS has designated one population of fin whale in US waters of the North Atlantic (Waring *et al.* 2008). This species is commonly found from Cape Hatteras northward. A number of researchers have suggested the existence of fin whale subpopulations in the North Atlantic based on local depletions resulting from commercial overharvesting (Mizroch and York 1984) or genetics data (Bérubé *et al.* 1998). Photoidentification studies in western North Atlantic feeding areas, particularly in Massachusetts Bay, have shown a high rate of annual return by fin whales, both within years and between years (Seipt *et al.* 1990) suggesting some level of site fidelity. In 1976, the IWC's Scientific Committee proposed seven stocks (or populations) for North Atlantic fin whales. These are: (1) North Norway, (2) West Norway-Faroe Islands, (3) British Isles-Spain and Portugal, (4) East Greenland-Iceland, (5) West Greenland, (6) Newfoundland-Labrador, and (7) Nova Scotia (Perry *et al.* 1999). However, it is uncertain whether these boundaries define biologically isolated units (Waring *et al.* 2008).

During 1978-1982 aerial surveys, fin whales accounted for 24% of all cetaceans and 46% of all large cetaceans sighted over the continental shelf between Cape Hatteras and Nova Scotia (Waring *et al.*2009). Underwater listening systems have also demonstrated that the fin whale is the most acoustically common whale species heard in the North Atlantic (Clark 1995). The single most important area for this species appeared to be from the Great South Channel, along the 50m isobath past Cape Cod, over Stellwagen Bank, and past Cape Ann to Jeffrey's Ledge (Hain *et al.*1992).

Like right and humpback whales, fin whales are believed to use North Atlantic waters primarily for feeding, and more southern waters for calving. However, evidence regarding where the majority of fin whales winter, calve, and mate is still scarce. Clark (1995) reported a general pattern of fin whale movements in the fall from the Labrador/Newfoundland region, south past Bermuda and into the West Indies, but neonate strandings along the US Mid-Atlantic coast from October through January suggest the possibility of an offshore calving area (Hain *et al.* 1992).

Fin whales achieve sexual maturity at 5-15 years of age (Perry *et al.* 1999), although physical maturity may not be reached until 20-30 years (Aguilar and Lockyer 1987). Conception is believed to occur during the winter with birth of a single calf after a 12 month gestation (Mizroch and York 1984). The calf is weaned 6-11 months after birth (Perry *et al.* 1999). The mean calving interval is 2.7 years (Agler *et al.* 1993).

The predominant prey of fin whales varies greatly in different geographical areas depending on what is locally available (IWC 1992). In the western North Atlantic, fin whales feed on a variety of small schooling fish (*i.e.*, herring, capelin, sand lance) as well as squid and planktonic crustaceans (Wynne and Schwartz 1999). Fin whales feed by filtering large volumes of water for their prey through their baleen plates.

Threats to fin whale recovery
The major known sources of anthropogenic mortality and injury of fin whales include entanglement in commercial fishing gear and ship strikes. The mean annual rate of confirmed human-caused serious injury and mortality to North Atlantic fin whales from 2003-2007 was 2.8 (Glass *et al.* 2009). During this five year period, there were 13 confirmed entanglements (3 fatal; 3 serious injuries) and 11 ship strikes (8 fatal) (Glass *et al.* 2009). Fin whales are believed to be the cetacean most commonly struck by large vessels (Laist *et al.* 2001). In addition, hunting of fin whales continued well into the 20th century. Fin whales were given total protection in the North Atlantic in 1987 with the exception of a subsistence whaling hunt for Greenland (Gambell 1993, Caulfield 1993). However, Iceland reported a catch of 136 whales in the 1988/89 and 1989/90 seasons, and has since ceased reporting fin whale kills to the IWC (Perry *et al.* 1999). In total, there have been 239 reported kills of fin whales from the North Atlantic from 1988 to 1995. Fin whales may also be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources due to trophic effects resulting from a variety of activities.

Population Trends and Status
Various estimates have been provided to describe the current status of fin whales in western North Atlantic waters. One method used the catch history and trends in Catch Per Unit Effort to obtain an estimate of 3,590 to 6,300 fin whales for the entire western North Atlantic (Perry *et al.* 1999). Hain *et al.* (1992) estimated that about 5,000 fin whales inhabit the Northeastern US continental shelf waters. The Draft 2009 Stock Assessment Report (SAR) gives a best estimate of abundance for fin whales of 2,269 (CV = 0.37). However, this estimate must be considered extremely conservative in view of the incomplete coverage of the known habitat of the stock and the uncertainties regarding population structure and whale movements between surveyed and unsurveyed areas (Waring *et al.* 2009). The minimum population estimate for the western North Atlantic fin whale is 1,678 (Waring *et al.* 2009). However, there are insufficient data at this time to determine population trends for the fin whale (Waring *et al.* 2009).

Summary of Fin Whale Status

Information on the abundance and population structure of fin whales worldwide is limited. NMFS recognizes three fin whale stocks in the Pacific for the purposes of managing this species under the MMPA. Reliable estimates of current abundance for the entire Northeast Pacific fin whale stock are not available (Angliss *et al.* 2001). Stock structure for fin whales in the southern hemisphere is unknown and there are no current estimates of abundance for southern hemisphere fin whales. As noted above, the best population estimate for the western North Atlantic fin whale is 2,269 which is believed to be an underestimate. The minimum population estimate for the western North Atlantic fin whale is 1,678. The Draft 2009 SAR indicates that there are insufficient data at this time to determine population trends for the fin whale. Fishing gear appears to pose less of a threat to fin whales in the North Atlantic Ocean than to North Atlantic right or humpback whales. However, fin whales continue to be struck by large vessels and some level of whaling for fin whales in the North Atlantic may still occur. As this species continues to be subject to natural and anthropogenic mortality, for the purposes of this Opinion, NMFS considers this population to be at best stable and at worst declining.

ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species in the action area. The activities that shape the environmental baseline in the action area of this consultation generally include: dredging operations, vessel and fishery operations, water quality/pollution, and recovery activities associated with reducing those impacts.

Federal Actions that have Undergone Formal or Early Section 7 Consultation

NMFS has undertaken several ESA section 7 consultations to address the effects of vessel operations and gear associated with federally-permitted fisheries on threatened and endangered species in the action area. Each of those consultations sought to develop ways of reducing the probability of adverse impacts of the action on listed species. Additionally, NMFS has consulted on dredging and construction projects authorized by the USACE. Formal consultations completed in the action area are summarized below.

Assateague Island Short Term Restoration (STRP) Project and Assateague Island Long Term Sand Management (LTSMP) Project, Maryland-Dredging

In 1998, a consultation was completed between the USACE and NMFS on the effects of the USACE's authorization and completion of several beach restoration and renourishment projects in Maryland. The projects under consideration were the STRP, the LTSMP, and the Atlantic Coast of Maryland Shoreline Protection Project (see below). The Opinion considered the effects of the STRP, which was a one-time remedial action that involved the dredging of an offshore borrow site, Great Gull Bank, for the purposes of short term restoration of the northern end of Assateague Island, and the renourishment cycles to occur annually (or biannually) over the 25 year life of the LTSMP on sea turtles. Both the STRP and LTSMP involved the use of a self propelled hopper dredge. In the 1998 Opinion, NMFS concluded that both the STRP and the LTSMP were likely to adversely affect, but were not likely to jeopardize the continued existence of the loggerhead, Kemp's ridley, and green sea turtles, and were not likely to adversely affect leatherback sea turtles and listed species of marine mammals. The Incidental Take Statement (ITS) issued with 1998 Opinion exempted the lethal take (due to entrainment in the hopper dredge) of one Kemp's ridley, one green sea turtle, and five loggerhead sea turtles for the STRP, while the ITS for the LTSMP exempted the lethal take of one Kemp's ridley, two green sea turtles, and ten loggerhead sea turtles for the 25-year life of the proposed action. To date no takes have been recorded.

Atlantic Coast of Maryland Shoreline Protection Project (ACMSPP) -Dredging
In 2006 the ACMSPP consultation was reinitiated as a result of proposed modifications to the proposed action (i.e., revised borrow area locations). In a November 30, 2006 Opinion NMFS concluded that the proposed action may adversely affect, but is not likely to jeopardize the continued existence of the loggerhead and Kemp's ridley sea turtles and is not likely to adversely affect leatherback or green sea turtles or right, humpback, and fin whales. The ITS exempted the incidental taking of sea turtles as follows:

- For dredge cycles involving the removal of up to and including 500,000 cy of material, the take of 1 sea turtle is exempted;
- For dredge cycles involving the removal of more than 500,000 cy up to and including 1 million cy of material, the take of 2 sea turtles is exempted;
- For dredge cycles involving the removal of more than 1 million up to and including 1.5 million cy of material, the take of 3 sea turtles is exempted; and,
- For dredge cycles involving the removal of more than 1.5 million cy up to 1.6 million cy of material, the take of 4 sea turtles in exempted.

All exempted take was lethal take due to entrainment in a hopper dredge. Over the life of the project (i.e., through 2044), NMFS anticipated that up to 24 sea turtles were likely to be entrained and killed, with up to two of these being Kemp's ridleys and the remainder being loggerheads. To date no dredging associated with this action has been undertaken.

Assateague Island Emergency Response Action (ERA), Maryland-Dredging
During the fall of 1998, the USACE constructed the ERA, which repaired a storm damaged area on North Assateague Island with sand borrowed from Great Gull Bank. NMFS issued a Biological Opinion on the ERA in August 1998, which concluded that the ERA would adversely affect, but was not likely to jeopardize the continued existence of protected sea turtles. The ITS issued with the 1998 Opinion exempted the lethal take (due to entrainment in the hopper dredge) of one Kemp's ridley, one green sea turtle, and five loggerhead sea turtles. The action was completed and no takes were recorded.

Assateague State Park Beach Nourishment Project (ASPBN), Maryland
On December 20, 2000 NMFS issued an Opinion that considered the effects of the USACE's proposed one time borrowing of material from Great Gull bank, via a self propelled hopper dredge, for the purposes of beach nourishment along the Assateague State Park's oceanfront shoreline. NMFS concluded that the ASPBN may adversely affect, but would not likely jeopardize the continued existence of listed species of sea turtles. The 2000 Opinion included an ITS which exempted the lethal take (due to entrainment in the hopper dredge) of one Kemp's ridley, one green sea turtle, and two loggerhead sea turtles during the one time conduction of this project.

Vessel Operations

Potential adverse effects from federal vessel operations in the action area of this consultation include operations of the US Navy (USN) and the US Coast Guard (USCG), which maintain the largest federal vessel fleets, the EPA, the National Oceanic and Atmospheric Administration (NOAA), and the USACE. NMFS has conducted formal consultations with the USCG, the USN, EPA and NOAA on their vessel operations. In addition to operation of USACE vessels, NMFS has consulted with the USACE to provide recommended permit restrictions for operations of contract or private vessels around whales. Through the section 7 process, where applicable, NMFS has and will continue to establish conservation measures for all these agency vessel operations to avoid adverse effects to listed species. Refer to the biological opinions for the USCG (September 15, 1995; July 22, 1996; and June 8, 1998) and the USN (May 15, 1997) for details on the scope of vessel operations for these agencies and conservation measures being implemented as standard operating procedures.

Federal Fishery Operations

Several commercial fisheries operating in the action area use gear which is known to interact with listed species. Efforts to reduce the adverse effects of commercial fisheries are addressed through both the MMPA take reduction planning process and the ESA section 7 process. Federally regulated gillnet, longline, trawl, seine, dredge, and pot fisheries have all been documented as interacting with either whales or sea turtles or both. Other gear types may impact whales and sea turtles as well. For all fisheries for which there is a federal fishery management plan (FMP) or for which any federal action is taken to manage that fishery, impacts have been evaluated through the section 7 process.

Formal ESA section 7 consultation has been conducted on the following fisheries which occur in the action area: Multispecies, Monkfish, Summer Flounder/Scup/Black Sea Bass, Atlantic Bluefish, Highly Migratory Species, Tilefish, Skate, and Spiny Dogfish fisheries. These consultations are summarized below. These fisheries overlap with the action area in the ocean to varying degrees.

The ***Multispecies sink gillnet fishery*** occurs in the action area and is known to entangle whales and sea turtles. This fishery has historically occurred along the northern portion of the Northeast Shelf Ecosystem from the periphery of the Gulf of Maine to Rhode Island in water depths to 60 fathoms. In recent years, more of the effort in this fishery has occurred in offshore waters and into the Mid-Atlantic. The fishery operates throughout the year with peaks in the spring and from October through February. Formal consultation on the multispecies fishery has been on-going since June 12, 1986. The most recent consultation was completed on June 14, 2001 and concluded that the continued operation of the multispecies fishery, including measures previously implemented as part of the Atlantic Large Whale Take Reduction Plan (ALWTRP.), was likely to jeopardize the continued existence of right whales. The Seasonal Area Management (SAM) program and the Dynamic Area Management (DAM) program components of the RPA were implemented as part of the revised ALWTRP. The June 14, 2001 Opinion also concluded that continued operation of the fishery may adversely affect ESA-listed sea turtles. An Incidental Take Statement (ITS) was provided in the Opinion that exempted the lethal or non-lethal take of one loggerhead, and one green, leatherback, or Kemp's ridley sea turtle annually.

In 2006, the Northeast Fisheries Science Center (NEFSC) reported on the annual estimated taking of loggerhead sea turtles in bottom-otter trawl gear fished in Mid-Atlantic waters during the period of 1996-2004 (Murray 2006). The bycatch rate identified in Murray 2006 was used to estimate the take of loggerhead sea turtles in all fisheries (by FMP group) using bottom otter trawl gear fished in Mid-Atlantic waters during the period of 2000-2004 (Murray 2008). Based on the approach described in Murray (2008), the average annual take of loggerhead sea turtles in bottom otter trawl gear for the period of 2000-2004 was estimated to be 43 for trawl gear used in the Northeast multispecies fishery. In addition, on October 5, 2007, NMFS published a final rule in the *Federal Register* (72 FR 57104; October 5, 2007) that made many changes to the ALWTRP, including elimination of the DAM program as of April 7, 2008, and elimination of the SAM program as of October 6, 2008[6]. The newly estimated levels of take for loggerhead sea turtles and the changes to the ALWTRP (72 FR 57104; October 5, 2007) resulted in NMFS reinitiating formal consultation on the multispecies fishery on April 2, 2008 to reconsider the effects of the continued operation of the multispecies fishery on ESA-listed cetaceans and sea turtles. Consultation is currently ongoing and to date, a revised Opinion has not yet been issued.

The ***Atlantic Bluefish fishery*** may pose a risk to protected marine mammals, but is most likely to interact with sea turtles (primarily Kemp's ridleys and loggerheads) given the time and locations where the fishery occurs. Gillnets are the primary gear used to commercially land bluefish. Whales and turtles can become entangled in the buoy lines of the gillnets or in the net panels. Formal consultation on this fishery was completed on July 2, 1999, with NMFS concluding that operation of the fishery under the FMP and Amendment 1 was not likely to jeopardize the continued existence of listed species. The ITS exempted the annual take 6 loggerheads (no more than 3 lethal), 6 Kemp's ridleys (lethal or non-lethal) and 1 shortnose sturgeon (lethal or non-lethal). However, as a result of new information on large whale interactions with, and sea turtle bycatch in net gear used to target Atlantic bluefish (*Pomatomus saltatrix*), NMFS reinitiated section 7 consultation on this FMP in December 2007 to consider the effects of the fisheries on ESA-listed whales and sea turtles that were previously considered in the 1999 Opinion. Consultation is currently ongoing and to date, a revised Opinion has not yet been issued.

The federal ***Monkfish fishery*** occurs in all waters under federal jurisdiction from Maine to the North Carolina/South Carolina border. The monkfish fishery uses several gear types that may entangle protected species. In 1999, observers documented that turtles were taken in excess of the ITS as a result of entanglements in monkfish gillnet gear. NMFS reinitiated consultation on the Monkfish FMP on May 4, 2000 to reevaluate the affect of the monkfish gillnet fishery on sea turtles. The Opinion also considered new information on the status of the North Atlantic right whale and new ALWTRP measures, and the ability of the reasonable and prudent alternatives (RPAs) to avoid the likelihood of jeopardy to right whales. The Opinion concluded that continued implementation of the Monkfish FMP was likely to jeopardize the existence of the North Atlantic

[6] Effective October 5, 2008, NMFS reinstituted the DAM program under the ALWTRP pursuant to a preliminary injunction issued in the case The Humane Society of the United States, et al. v. Gutierrez, et al. (Civil Action No. 08-cv-1593 (ESH)). The DAM program was effective through 2400 hrs April 4, 2009, and expired at this time when the broad-based sinking groundline requirement for Atlantic trap/pot fisheries became effective on April 5, 2009.

right whale. A new RPA was provided that was expected to remove the threat of jeopardy to right whales. In addition, a new ITS was provided for the take of sea turtles in the fishery.

On February 12, 2003, consultation was reinitiated on the Monkfish FMP to consider the effects of Framework Adjustment 2 on ESA-listed species. This consultation was completed on April 14, 2003 and concluded that the proposed action may adversely affect, but was not likely to jeopardize the continued existence of any ESA-listed species under NMFS jurisdiction. The ITS issued under the 2003 Opinion anticipated the take of 3 loggerheads and 1 non-loggerhead species (green, leatherback, or Kemp's ridley) in monkfish gillnet gear, and 1 sea turtle (loggerhead, green, leatherback, or Kemp's ridley) in monkfish trawl gear. Due to changes in the ALWTRP (72 FR 57104; October 5, 2007), as well as new information on the effects of the monkfish fishery on sea turtle takes (i.e., the average annual take of loggerhead sea turtles in bottom otter trawl gear for the period of 2000-2004 was estimated to be 2 for trawl gear used in the monkfish fishery (Murray 2006, 2008)), formal consultation was reinitiated on April 2, 2008 to reconsider the effects of the continued operation of the monkfish fishery on ESA-listed cetaceans and sea turtles. Consultation is currently ongoing and to date, a revised Opinion has not yet been issued.

The ***Skate fishery***, which ranges from Maine to Cape Hatteras, North Carolina, is primarily a bottom trawl (i.e., otter trawls) fishery with 65%-85% of skate landings attributed to this gear type. Gillnet gear is the next most common gear type, accounting for 30% of skate landings. The Northeast skate complex is comprised of seven skate species which are distributed along the coast of the northeast US from the tide line to depths exceeding 700m (383 fathoms). Section 7 consultation on the new Skate FMP was completed July 24, 2003, and concluded that implementation of the Skate FMP may adversely affect ESA-listed sea turtles as a result of interactions with (capture in) gillnet and trawl gear. The ITS anticipated the take of one sea turtle annually of any species of sea turtle.

In August 2007, NMFS received an estimate of loggerhead sea turtle bycatch in bottom otter trawl gear used in the skate fishery (Memo from K. Murray, Northeast Fisheries Science Center [NEFSC] to L. Lankshear, NERO, Protected Resources Division [PRD]). This information has since been published in a 2008 NEFSC Reference Document (Murray 2008). Using Vessel Trip Report (VTR) data from 2000-2004, and the average annual bycatch of sea turtles as described in Murray (2006), the average annual bycatch of loggerhead sea turtles in bottom otter trawl gear used in the skate fishery was estimated to be 24 per year (Memo from K. Murray, NEFSC to L. Lankshear, NERO, PRD; Murray 2008). NMFS also received an estimate of loggerhead sea turtle bycatch in gillnet gear used in the skate fishery from the NEFSC in November 2009 (Murray 2009a). In that report, the average annual bycatch of loggerhead sea turtles in gillnet gear used in the skate fishery, based on VTR data from 2002-2006, was estimated to be 9 per year (Murray 2009a). Both of these bycatch estimates represent new information on the effects of the skate fishery on sea turtles and as such, formal consultation was reinitiated on April 2, 2008 to reconsider the effects of the skate fishery on ESA-listed sea turtles, including loggerhead, leatherback, Kemp's ridley, and green sea turtles. Consultation is currently ongoing and to date, a revised Opinion has not yet been issued.

The primary gear types for the ***Spiny dogfish fishery*** are sink gillnets, otter trawls, bottom longline, and driftnet gear. Sea turtles can be incidentally captured in all gear sectors of this fishery. After the entanglement and death of a Northern right whale in spiny dogfish gillnet gear in 1999 and the exceedance of the 1999 Opinion's incidental take level of sea turtles in 2000, NMFS reinitiated consultation on the Spiny Dogfish FMP on May 4, 2000, in order to reevaluate the ability of the RPA to avoid the likelihood of jeopardy to right whales, and the effect of the spiny dogfish gillnet fishery on sea turtles. The Opinion, signed on June 14, 2001, concluded that continued implementation of the Spiny Dogfish FMP is likely to jeopardize the existence of the North Atlantic right whale. A new RPA was provided that was expected to remove the threat of jeopardy to right whales as a result of the gillnet sector of the spiny dogfish fishery. In addition, the ITS anticipated the annual take of 3 loggerheads (no more than 2 lethal), 1 green (lethal or non-lethal), 1 leatherback (lethal or non-lethal), and 1 Kemp's ridley (lethal or non-lethal). Due to changes in the ALWTRP (72 FR 57104; October 5, 2007), as well as new information on the effects of the fishery on sea turtle takes (Murray 2006, 2008), formal consultation was reinitiated on April 2, 2008 to reconsider the effects of the continued operation of the spiny dogfish fishery on ESA-listed cetaceans and sea turtles. Consultation is currently ongoing and to date, a revised Opinion has not yet been issued.

The ***Summer Flounder, Scup and Black Sea Bass fisheries*** are known to interact with sea turtles. Significant measures have been developed to reduce the injury and mortality associated with takes of sea turtles in the summer flounder trawls, and trawls that meet the definition of a summer flounder trawl, by requiring the use of turtle excluder devices (TEDs) throughout the year for trawl nets fished from the North Carolina/South Carolina border to Oregon Inlet, NC, and seasonally (March 16-January 14) for trawl vessels fishing between Oregon Inlet, NC and Cape Charles, VA. Takes may still occur with this gear type in other areas however. Based on the occurrence of gillnet entanglements in other fisheries, the gillnet portion of this fishery could entangle endangered whales. The pot gear and staked trap sectors could also entangle whales and sea turtles. The most recent (December 16, 2001) formal consultation on this fishery concluded that the operation of the fishery may adversely affect but is not likely to jeopardize the continued existence of listed species. The ITS anticipated that 19 loggerhead or Kemp's ridley takes (up to 5 lethal) and 2 green turtle takes (lethal or non-lethal) may occur annually. However, as a result of new information not considered in previous consultations, NMFS has reinitiated section 7 consultation on this FMP to consider the effects of the fisheries on ESA-listed whales and sea turtles. Consultation is currently ongoing and to date, a revised Opinion has not yet been issued.

The ***Squid/Mackerel/Butterfish (MSB) fishery*** is known to take sea turtles and may occasionally interact with whales and shortnose sturgeon. Several types of gillnet gear may be used in this fishery. Other gear types that may be used in this fishery include midwater and bottom trawl gear, pelagic longline/hook-and-line/handline, pot/trap, dredge, poundnet, and bandit gear. Entanglements or entrapments of whales, sea turtles, and sturgeon have been recorded in one or more of these gear types. An Opinion issued on April 28, 1999 anticipates the take of 6 loggerheads (up to 3 lethal), 2 Kemp's ridleys (lethal or non-lethal), 2 green (lethal or non-lethal), 1 leatherback (lethal or non-lethal) and 3 shortnose sturgeon (1 lethal).

In August 2007, NMFS received an estimate of loggerhead sea turtle bycatch in bottom otter trawl gear used in the MSB fishery (Memo from K. Murray, Northeast Fisheries Science Center [NEFSC] to L. Lankshear, NERO, Protected Resources Division [PRD]). This information has since been published in a 2008 NEFSC Reference Document (Murray 2008). Using Vessel Trip Report (VTR) data from 2000-2004 and the average annual bycatch of sea turtles as described in Murray (2006), the average annual bycatch of loggerhead sea turtles in bottom otter trawl gear used in the MSB fishery was estimated to be 62 loggerhead sea turtles per year. Given that information on a listed species (Loggerhead sea turtle) may be affected in a manner or to an extent not previously considered NMFS reinitiated formal consultation on March 6, 2008. Consultation is currently ongoing and to date, a revised Opinion has not yet been issued.

Fishing Vessel Operations
Other than entanglement in fishing gear, effects of fishing vessels on listed species may involve disturbance or injury/mortality due to collisions or entanglement in anchor lines. Generally speaking, listed species or critical habitat may also be affected by fuel oil spills resulting from fishing vessel accidents. No collisions between commercial fishing vessels and listed species or adverse effects resulting from disturbance have been documented within the action area. Fishing vessels operate at relatively slow speeds, particularly when towing or hauling gear. Thus, large cetaceans and sea turtles in the path of a fishing vessel would be more likely to have time to move away before being struck. Although entanglement in fishing vessel anchor lines has been documented historically, no information is available on the prevalence of such events. Fuel oil spills could affect animals directly or indirectly through the food chain. Fuel spills involving fishing vessels are common events. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species. Larger spills may result from accidents, although these events would be rare and involve small areas. No direct adverse effects on listed species or critical habitat resulting from fishing vessel fuel spills have been documented within the action area. There is no critical habitat in the action area for this consultation. Given the current lack of information on prevalence or impacts of vessel related interactions with listed species in the action area, the effects of such activities on the environmental baseline are unknown at this time.

Non-Federally Regulated Actions
Private and Commercial Vessel Operations
Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with listed species. Ship strikes have been identified as a significant source of mortality to the North Atlantic right whale population (Kraus 1990) and are also known to impact all other endangered whales. The Sea Turtle Stranding and Salvage Network (STSSN) also reports regular incidents of likely vessel interactions (e.g., propeller-type injuries) with sea turtles. Interactions with these types of vessels and sea turtles could occur in the action area and it is possible that these collisions would result in mortality; however, it is important to note that minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so it is more likely to become vulnerable to effects such as entanglements.

Listed species may also be affected by fuel oil spills resulting from vessel accidents. Fuel oil spills could affect animals directly or indirectly through the food chain. Fuel spills involving fishing vessels are common events. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species. Larger oil spills may result from accidents, although these events would be rare and involve small areas. No direct adverse effects on listed sea turtles resulting from fishing vessel fuel spills have been documented.

An unknown number of private recreational boaters frequent coastal waters; some of these are engaged in whale watching or sport fishing activities. These activities have the potential to result in lethal (through entanglement or boat strike) or non-lethal (through harassment) takes of listed species. Effects of harassment or disturbance which may be caused by such vessel activities are currently unknown; however, no conclusive detrimental effects have been demonstrated. Recent federal efforts regarding mitigating impacts of the whale watch and shipping industries on endangered whales are discussed below.

Non-Federally Regulated Fishery Operations
Very little is known about the level of interactions with listed species in fisheries that operate strictly in state waters. However, depending on the fishery in question, many state permit holders also hold federal licenses; therefore, section 7 consultations on federal actions in those fisheries address some state-water activity. Impacts on sea turtles from state fisheries may be greater than those from federal activities in certain areas due to the distribution of these species. Nearshore entanglements of turtles have been documented; however, information is not currently available on whether the vessels involved were permitted by the state or by NMFS. Impacts of state fisheries on endangered whales are addressed as appropriate through the MMPA take reduction planning process. NMFS is actively participating in a cooperative effort with the Atlantic States Marine Fisheries Commission (ASMFC) and member states to standardize and/or implement programs to collect information on level of effort and bycatch of protected species in state fisheries. When this information becomes available, it can be used to refine take reduction plan measures in state waters.

With regard to whale entanglements, vessel identification is occasionally recovered from gear removed from entangled animals. With this information, it is possible to determine whether the gear was deployed by a federal or state permit holder and whether the vessel was fishing in federal or state waters (e.g., in 1998, 3 entanglements of humpback whales in state-water fisheries were documented).

Global Climate Change
There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities - frequently referred to in layman's terms as "global warming." Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. The Environmental Protection Agency's climate change webpage provides basic background information on these and other measured or anticipated effects (see www. epa.gov/climatechange/index.html). Activities in the action area that may have contributed to global warming include the combustion of fossil fuels by vessels.

Sea Turtles
The effects of global climate change on sea turtles is typically viewed as being detrimental to the species (NMFS and USFWS 2007a; 2007b; 2007c; 2007d). It is believed that increases in sea level, approximately 4.2 mm per year until 2080, have the potential to remove available nesting beaches, particularly on narrow low lying coastal and inland beaches and on beaches where coastal development has occurred (Church *et al.* 2001; IPCC 2007; Nicholls 1998; Fish *et al.* 2005; Baker *et al.* 2006; Jones *et al.* 2007; Mazaris *et al.* 2009). Additionally, global climate change may affect

the severity of extreme weather (e.g., hurricanes), with more intense storms expected, which may result in the loss/erosion of or damage to shorelines, and therefore, the loss of potential sea turtle nests and/or nesting sites (Goldenburg *et al.* 2001; Webster *et al.* 2005; IPCC 2007). The cyclical loss of nesting beaches resulting from extreme storm events may then result in a decrease in hatching success and hatchling emergence (Martin 1996; Ross 2005; Pike and Stiner 2007; Prusty *et al.* 2007; Van Houton and Bass 2007). However, there is evidence that, depending on the species, sea turtles species with lower nest site fidelity (i.e., leatherbacks) would be less vulnerable to storm related threats than those with a higher site fidelity (i.e., loggerheads). In fact, it has been reported that sea turtles in Guiana are able to maintain successful nesting despite the fact that between nesting years some beaches they once nested on have disappeared, suggesting that sea turtle species may be able to behavioral adapt to such changes (Pike and Stiner 2007; Witt *et al.* 2008; Plaziat and Augustinius 2004; Girondot and Fretey 1996; Rivalan *et al.* 2005; Kelle *et al.* 2007).

Changes in water temperature are also expected as a result of global climate change. Changes in water temperature are expected affect water circulation patterns perhaps even to the extent that the Gulf Stream is disrupted, which would have profound effects on every aspect of sea turtle life history from hatching success, oceanic migrations at all life stages, foraging, and nesting. (Gagosian 2003; NMFS and USFWS 2007a; 2007b; 2007c; 2007d; Rahmstorf 1997, 1999; Stocker and Schmittner 1997). Thermocline circulation patterns are expected to change in intensity and direction with changes in temperature and freshwater input at the poles (Rahmstorf 1997; Stocker and Schmittner 1997), which will potentially affect not only hatchlings, which rely on passive transport in surface currents for migration and dispersal but also pelagic adults (i.e., leatherbacks) and juveniles, which depend on current patterns and major frontal zones in obtaining suitable prey, such as jellyfish (Hamann *et al.* 2007; Hawkes *et al.* 2009).

Changes in water temperature may also affect prey availability for species of sea turtles. Herbivorous species, such as the green sea turtle, depend primarily on seagrasses as their forage base. Seagrasses could ultimately be negatively affected by increased temperatures, salinities, and acidification of coastal waters (Short and Neckles 1999; Bjork 2008), as well as increased runoff due the expected increase in extreme storm events as a result of global climate change. These alterations of the marine environment due to global climate change could ultimately affect the distribution, physiology, and growth rates of seagrasses, potentially eliminating them from particular areas. However, the magnitude of these effects on seagrass beds, and therefore green sea turtles, are difficult to predict, although some populations of green sea turtles appear to specialize in the consumption of algae (Bjorndal 1997) and mangroves (Limpus and Limpus 2000) and as such, green sea turtles may be able to adapt their foraging behavior to the changing availability of seagrasses in the future. Omnivorous species, such as Kemp's ridley and loggerhead sea turtles, may face changes to benthic communities as a result of changes to water temperature; however, these species are probably less likely to suffer shortages of prey than species with more specific diets (i.e., green sea turtles) (Hawkes *et al.* 2009).

Several studies have also investigated the effects of changes in sea surface temperature and air temperatures on turtle reproductive behavior. For loggerhead sea turtles, warmer sea surface temperatures in the spring have been correlated to an earlier onset of nesting (Weishampel *et al.* 2004; Hawkes *et al.* 2007), shorter internesting intervals (Hays *et al.* 2002), and a decrease in the length of the nesting season (Pike *et al.* 2006). Green sea turtles also exhibited shorter internesting intervals in response to warming water temperatures (Hays *et al.* 2002).

Air temperatures also play a role in sea turtle reproduction. In marine turtles, sex is determined by temperature in the middle third of incubation with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25-35° C (Ackerman 1997). Based on modeling done of loggerhead sea turtles, a 2° C increase in air temperature is expected to result in a sex ratio of over 80% female offspring for loggerhead nesting beaches in the vicinity of Southport, NC. Farther to the south at Cape Canaveral, Florida, a 2°C increase in air temperature would likely result in production of 100% females while a 3°C increase in air temperature would likely exceed the thermal threshold of turtle clutches (i.e., greater than 35° C) resulting in death (Hawkes *et al.* 2007). Glen et al. (2003) also reported that, for green sea turtles, incubation temperatures also appeared to affect hatchling size with smaller turtles produced at higher incubation temperatures; however, it is unknown whether this effect is species specific and what impact it has on the survival of the offspring. Thus changes in air temperature as a result of global climate change may alter sex ratios and may reduce hatchling production in the most southern nesting areas of the U.S. (Hawkes et al. 2007; Hamann *et al.* 2007). Given that the south Florida nesting group is the largest loggerhead nesting group in the Atlantic (in terms of nests laid), a decline in the success of nesting as a result of global climate change could have profound effects on the abundance and distribution of the loggerhead species in the Atlantic, including the action area; however; variation of sex ratios to incubation temperature between individuals and populations is not fully understood and as such, it is unclear whether sea turtles will (or can) adapt behaviorally to alter incubation conditions to counter potential feminization or death of clutches associated with water temperatures (e.g., choosing nest sites that are located in cooler areas, such as shaded areas of vegetation or higher latitudes; nesting earlier or later during cooler periods of the year) (Hawkes *et al.* 2009).

Although potential effects of climate change on sea turtle species are currently being addressed, fully understanding the effects of climate change on listed species of sea turtles will require development of conceptual and predictive models of the effects of climate change on sea turtles, which to date are still being developed and will depend greatly on the continued acquisition and maintenance of long-term data sets on sea turtle life history and responses to environmental changes. Until such time, the type and extent of effects to sea turtles as a result of global climate change are will continue to be speculative and as such, the effects of these changes on sea turtles cannot, for the most part, be accurately predicted at this time.

Whales

The impact of climate change on cetaceans is likely to be related to changes in sea temperatures, potential freshening of sea water due to melting ice and increased rainfall, sea level rise, the loss of polar habitats and potential shifts in the distribution and abundance of prey species. Of the main factors affecting distribution of cetaceans, water temperature appears to be the main influence on geographic ranges of cetacean species (Macleod 2009). Humpback and fin whales are distributed in all water temperature zones, therefore, it is unlikely that their range will be directly affected by an increase in water temperature.

The North Atlantic right whale currently has a range of sub-polar to sub-tropical waters. An increase in water temperature would likely result in a northward shift of range, with both the northern and southern limits moving poleward. The northern limit, which may be determined by feeding habitat and the distribution of preferred prey, may shift to a greater extent than the southern limit, which requires ideal temperature and water depth for calving. This may result in an unfavorable affect on the North Atlantic right whale due to an increase in the length of migrations (Macleod 2009) or a favorable effect by allowing them to expand their range.

Cetaceans are unlikely to be directly affected by sea level rise, although important coastal bays for humpback breeding could be affected (IWC 1997). Some indirect effects to marine mammals that may be associated with sea level rise include the construction of sea-wall defenses and protective measures for coastal habitats, which may impact coastal marine species and may interfere with migration (Learmonth *et al.* 2006). The effect of sea level rise to cetaceans is likely negligible.

The direct effects of increased CO_2 concentrations, and associated decrease in pH (ocean acidification), on marine mammals are unknown (Learmonth *et al.* 2006). Marine plankton is a vital food source for many marine species. Studies have demonstrated adverse impacts from ocean acidification on the ability of marine algae and free-swimming zooplankton to maintain protective shells as well as a reduction in the survival of larval marine species. A decline in the marine plankton could have serious consequences for the marine food web.

There are many direct and indirect effects that global climate change may have on marine mammal prey species. For example, Greene *et al.* (2003) described the potential oceanographic processes linking climate variability to the reproduction of North Atlantic right whales. Climate-driven changes in ocean circulation have had a significant impact on the plankton ecology of the Gulf of Maine, including effects on *Calanus finmarchicus*, a primary prey resource for right whales. More information is needed in order to determine the potential impacts global climate change will have on the timing and extent of population movements, abundance, recruitment, distribution and species composition of prey (Learmonth *et al.* 2006). Changes in climate patterns, ocean currents, storm frequency, rainfall, salinity, melting ice, and an increase in river inputs/runoff (nutrients and pollutants) will all directly affect the distribution, abundance and migration of prey species (Waluda *et al.* 2001; Tynan & DeMaster 1997; Learmonth *et al.* 2006). These changes will likely have several indirect effects on marine mammals, which may include changes in distribution including displacement from ideal habitats, decline in fitness of individuals, population size due to the potential loss of foraging opportunities, abundance, migration, community structure, susceptibility to disease and contaminants, and reproductive success (Macleod 2009). Global climate change may also result in changes to the range and abundance of competitors and predators which will also indirectly affect marine mammals (Learmonth *et al.* 2006). A decline in the reproductive fitness as a result of global climate change could have profound effects on the abundance and distribution of large whales in the Atlantic. However, fully understanding the effects of climate change on listed species of marine mammals will require development of conceptual and predictive models of the effects of climate change on marine mammals, which to date are still being developed and will depend greatly on the continued aquistion and maintenance of long-term data sets on marine mammal life history and responses to environmental changes. Until such time, the type and extent of effects to marine mammals as a result of global climate change are will continue to be speculative and as such, the effects of these changes on marine mammals cannot, for the most part, be accurately predicted at this time.

Other Potential Sources of Impacts in the Action Area

Sources of human-induced mortality, injury, and/or harassment of turtles in the action area that are reasonably certain to occur in the future include incidental takes in state-regulated fishing activities, vessel collisions, ingestion of plastic debris, and pollution. While the combination of these activities may affect populations of endangered and threatened sea turtles, preventing or slowing a species' recovery, the magnitude of these effects is currently unknown. A number of anthropogenic activities have likely directly or indirectly affected listed species in the action area of this consultation. These potential sources of impacts include previous dredging projects, pollution, water quality/pollution. However, the impacts from these activities are difficult to measure. Where possible, conservation actions are being implemented to monitor or study impacts from these sources.

Pollution and Water Quality

Excessive turbidity due to coastal development and/or construction sites could influence sea turtle foraging ability. Whales and turtles are not very easily affected by changes in water quality or increased suspended sediments, but if these alterations make habitat less suitable for listed species and hinder their capability to forage and/or for their foraging items to exist, eventually they will tend to leave or avoid these less desirable areas (Ruben and Morreale 1999).

Marine debris (*e.g.*, discarded fishing line or lines from boats) can entangle turtles and whales causing serious injuries or mortalities to these species. Turtles commonly ingest plastic or mistake debris for food (Magnuson et al. 1990). Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, industrial development, and debris and materials from launch activities occurring at WFF (i.e., spent rockets, payloads, and rocket-boosted projectiles, as well as non-hazardous expended material such as steel, aluminum, rubber, vinyl, glass, and plastics). Chemical contaminants may also have an effect on sea turtle reproduction and survival and may be linked to the fibropapilloma virus that kills many turtles each year (NMFS 1997). If pollution is not the causal agent, it may make sea turtles more susceptible to disease by weakening their immune systems. Excessive turbidity due to coastal development and/or construction sites could influence sea turtle and whale foraging ability; however, as mentioned previously, turtles and whales are not very easily affected by changes in water quality or increased suspended sediments, but if these alterations make habitat less suitable for prey species of turtles and/or whales, foraging capabilities may be hindered resulting in whales and/or sea turtles eventually leaving or avoiding these less desirable areas (Ruben and Morreale 1999). Noise pollution has primarily been raised as a concern for marine mammals but may be a concern for other marine organisms, including sea turtles. As described above, global warming is likely to negatively affect sea turtles and whales (e.g., affecting when female sea turtles lay eggs and the sex ratios of sea turtle offspring; affecting whale distribution as well abundance of foraging items). To the extent that air pollution, for example from the combustion of fossil fuels by vessels, contributes to global warming, then it is also expected to negatively affect sea turtles.

NMFS and the US Navy have been working cooperatively to establish a policy for monitoring and managing acoustic impacts from anthropogenic sound sources in the marine environment. Acoustic impacts can include temporary or permanent injury, habitat exclusion, habituation, and disruption of other normal behavior patterns. It is expected that the policy on managing anthropogenic sound in the oceans will provide guidance for programs such as the use of acoustic deterrent devices in reducing marine mammal-fishery interactions and review of federal activities and permits for research involving acoustic activities.

As noted above, private and commercial vessels operate within the action area. Listed species may be affected by fuel oil spills resulting from vessel accidents. Fuel oil spills could affect animals directly or indirectly through the food chain. Fuel spills involving fishing vessels are common events. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species.

Larger oil spills may also occur as a result of accidents. A prime example of this is the Deepwater Horizon oil spill that occurred on April 20, 2010. As the effects of this disaster are still ongoing, and information on the number of strandings, deaths, and recoveries of listed species are still being recorded, the effects of the oil spill on listed species will remain unknown at this time.

Conservation and Recovery Actions Reducing Threats to Listed Species

A number of activities are in progress that may ameliorate some of the threat that activities summarized in the *Environmental Baseline* pose to threatened and endangered species in the action area of this consultation. These include education/outreach activities; specific measures to reduce the adverse effects of entanglement in fishing gear, including gear modifications, fishing gear time-area closures, and whale disentanglement; and, measures to reduce ship and other vessel impacts to protected species. Many of these measures have been implemented to reduce risk to critically endangered right whales. Despite the focus on right whales, other cetaceans and some sea turtles will likely benefit from the measures as well.

Reducing threats of vessel collision on listed whales

In addition to the ESA measures for federal activities mentioned in the previous section, numerous recovery activities are being implemented to decrease the adverse effects of private and commercial vessel operations on the species in the action area and during the time period of this consultation. These include implementation of NOAA's Right Whale Ship Strike Reduction Strategy, extensive education and outreach activities, the Sighting Advisory System (SAS), other activities recommended by the Northeast Implementation Team for the recovery of the North Atlantic right whale (NEIT) and Southeast Implementation Team for the Right Whale Recovery Plan (SEIT), and NMFS regulations.

Northeast Implementation Team (NEIT)

The Northeast Large Whale Recovery Plan Implementation Team (NEIT) was founded in 1994 to help implement the right and humpback whale recovery plans developed under the ESA. The NEIT provided advice and expertise on the issues affecting right and humpback whale recovery and was comprised of representatives from federal and state regulatory agencies and private organizations, and was advised by a panel of scientists with expertise in right and humpback whale biology. The

Ship Strike Committee (SSC) was one of the most active committees of the NEIT, and NMFS came to recognize that vessel collisions with right whales was the recovery issue needing the most attention. As such, the NEIT was restructured in May 2004 to focus exclusively on right whale ship strike reduction research and issues and providing support to the NMFS Right Whale Ship Strike Working Group.

The Ship Strike Committee (SSC) of the former NEIT undertook multiple projects to reduce ship collisions with North Atlantic right whales. These included production of a video entitled: *Right Whales and the Prudent Mariner* and most recently, a CD entitled: *A Prudent Mariner's Guide to Right Whale Protection*, both of which provide information to mariners on the plight of right whales and on distribution and behavior of right whales in relation to vessel traffic. Additionally, SSC has also developed a merchant mariner education module that can be used by instructors in mariner certification or licensing safety courses to educate ship's captains about the potential for ship strikes of right whales. NMFS and the NEIT also funded a project to develop recommended measures to reduce right whale ship strikes. The recommended measures project included looking at all possible options such as routing, seasonal and dynamic management areas, and vessel speed. It became evident in the process of meeting with the industry that a comprehensive strategy would have to be developed for the entire East coast. Development of NOAA's Ship Strike Reduction Strategy has been ongoing over the last number of years. The strategy is currently focused on protecting the North Atlantic right whale, but the operational measures are expected to reduce the incidence of ship strike on other large whales to some degree. The strategy consists of five basic elements and includes both regulatory and non-regulatory components: 1) operational measures for the shipping industry, including speed restrictions and routing measures, 2) section 7 consultations with Federal agencies that maintain vessel fleets, 3) education and outreach programs, 4) a bilateral conservation agreement with Canada, and 5) continuation of ongoing measures to reduce ship strikes of right whales (e.g., SAS, MSR, ongoing research into the factors that contribute to ship strikes, and research to identify new technologies that can help mariners and whales avoid each other). Progress made under these elements will be discussed further below.

Regulatory Actions to Reduce Vessel Strikes
In one recovery action aimed at reducing vessel-related impacts, including disturbance, NMFS published a proposed rule in August 1996 restricting vessel approach to right whales (61 FR 41116) to a distance of 500 yards. The Recovery Plan for the North Atlantic Right Whale identified anthropogenic disturbance as one of many factors which had some potential to impede right whale recovery (NMFS 2005a). Following public comment, NMFS published an interim final rule in February 1997 codifying the regulations. With certain exceptions, the rule prohibits both boats and aircraft from approaching any right whale closer than 500 yards. Exceptions for closer approach are provided for the following situations, when: (a) compliance would create an imminent and serious threat to a person, vessel, or aircraft; (b) a vessel is restricted in its ability to maneuver around the 500-yard perimeter of a whale; (c) a vessel is investigating or involved in the rescue of an entangled or injured right whale; or (d) the vessel is participating in a permitted activity, such as a research project. If a vessel operator finds that he or she has unknowingly approached closer than 500 yards, the rule requires that a course be steered away from the whale at slow, safe speed. In addition, all aircraft, except those involved in whale watching activities, are excepted from these approach

regulations. This rule is expected to reduce the potential for vessel collisions and other adverse vessel-related effects in the environmental baseline.

In April 1998, the USCG submitted, on behalf of the U.S., a proposal to the International Maritime Organization (IMO) requesting approval of a mandatory ship reporting system (MSR) in two areas off the east coast of the U.S., one which includes the right whale feeding grounds in the northeast, and one which includes the right whale calving grounds in the southeast. The USCG worked closely with NMFS and other agencies on technical aspects of the proposal. The package was submitted to the IMO's Subcommittee on Safety and Navigation for consideration and submission to the Marine Safety Committee at IMO and approved in December 1998. The USCG and NOAA play important roles in helping to operate the MSR system, which was implemented on July 1, 1999. Ships entering the northeast and southeast MSR boundaries are required to report the vessel identity, date, time, course, speed, destination, and other relevant information. In return, the vessel receives an automated reply with the most recent right whale sightings in the area and information on precautionary measures to take while in the vicinity of right whales.

A key component of NOAA's right whale ship strike reduction program is the implementation of speed restrictions for vessels transiting the US Atlantic in areas and seasons where right whales predictably occur in high concentrations. The NEIT-funded "Recommended Measures to Reduce Ship Strikes of North Atlantic Right Whales" found that seasonal speed and routing measures could be an effective means of reducing the risk of ship strike along the US East coast. Based on these recommendations, NMFS published an Advance Notice of Proposed Rulemaking (ANPR) in June 2004 (69 FR 30857; June 1, 2004), and subsequently published a proposed rule on June 26, 2006 (71 FR 36299; June 26, 2006). NMFS published regulations on October 10, 2008 to implement a 10-knot speed restriction for all vessels 65 feet or longer in Seasonal Management Areas (SMAs) along the East coast of the U.S. Atlantic seaboard at certain times of the year (73 FR 60173; October 10, 2008). In view of uncertainties these restrictions will have on large whales and the burdens imposed on vessel operators, the rule will expire five years from the date of effectiveness. During the five-years the rule is in effect, NOAA will analyze data on ship-whale interactions and review the economic consequences to determine further steps regarding the rule.

Right Whale Sighting Advisory System
The right whale Sighting Advisory System (SAS) was initiated in early 1997 as a partnership among several federal and state agencies and other organizations to conduct aerial and ship board surveys to locate right whales and to alert mariners to right whale sighting locations in a near real time manner. The SAS surveys and opportunistic sightings reports document the presence of right whales and are provided to mariners via fax, email, NAVTEX, Broadcast Notice to Mariners, NOAA Weather Radio, several web sites, and the Traffic Controllers at the Cape Cod Canal. Fishermen and other vessel operators can obtain SAS sighting reports, and make necessary adjustments in operations to decrease the potential for interactions with right whales. The SAS has also served as the only form of active entanglement monitoring in the Cape Cod Bay and Great South Channel critical habitats. Some of these sighting efforts have resulted in successful disentanglement of right whales. SAS flights have also contributed sightings of dead floating animals that can occasionally be retrieved to increase our knowledge of the biology of the species and effects of human impacts. The USCG has also played a vital role in this effort, providing air

and sea support as well as a commitment of resources to NMFS operations. The Commonwealth of Massachusetts has been a key collaborator to the SAS effort and has continued the partnership. Other sources of opportunistic right whale sightings include whale watch vessels, commercial and recreational mariners, fishermen, the U.S. Navy, NMFS research vessels, and NEFSC cetacean abundance aerial survey data.

In 2009, with the implementation of the new ship strike regulations and the Dynamic Management Area (DMA) program (described below), the SAS alerts were modified to provide current Seasonal Management Area (SMA) and DMA information to mariners on a weekly basis in an effort to maximize compliance with all active right whale protection zones.

Dynamic Management Area (DMA) Program
The DMA program was initiated in December 2008 as a supplement to the ship speed regulations discussed above. The program implements dynamic vessel traffic management zones in order to provide protection for unpredictable aggregations of right whales that occur outside of SMAs. When NOAA aerial surveys or other reliable sources report aggregations of 3 or more right whales in a density that indicates the whales are likely to persist in the area, NOAA calculates a buffer zone around the aggregation and announces the boundaries of the zone to mariners via various mariner communication outlets, including NOAA Weather Radio, USCG Broadcast Notice to Mariners, MSR return messages, email distribution lists, and the Right Whale Sighting Advisory System (SAS). NOAA requests mariners to route around these zones or transit through them at 10 knots or less. Compliance with these zones is voluntary.

Education and Outreach Activities
NMFS, primarily through the NEIT and SEIT, is engaged in a number of education and outreach activities aimed specifically at increasing mariner awareness of the threat of ship strike to right whales. The NEIT and SEIT have developed a comprehensive matrix of mariner education and outreach tasks ranked by priority for all segments of the maritime industry, including both commercial and recreational vessels, and are in the process of implementing high priority tasks as funding allows. In anticipation of the 2006/2007 calving season, the SEIT is nearing completion of two new outreach tools—a multimedia CD to educate commercial mariners about right whale ship strike issues, and a public service announcement (PSA) targeted towards private recreational vessel operators to be distributed to media outlets in the southeast.

NMFS also distributes informational packets on right whale ship strike avoidance to vessels entering ports in the northeast. The informational packets contain various outreach materials developed by NMFS, including the video "Right Whales and the Prudent Mariner," and more recently, the CD "A Prudent Mariner's Guide to Right Whale Protection," a placard on the MSR system, extracts from the US Coast Pilots about whale avoidance measures and seasonal right whale distribution, and a placard on applicable right whale protective regulations and recommended vessel operating measures.

NMFS has also worked with the International Fund for Animal Welfare (IFAW) to develop educational placards for recreational vessels. These placards provide vessel operators with information on right whale identification, behavior, and distribution, as well as information about the threat of ship strike and ways to avoid collisions with whales.

The NEIT has contracted the development of a comprehensive merchant mariner education module for use and distribution to maritime academies along the east coast. The purpose of this program is to inform both new captains and those being re-certified about right whales and operational guidelines for minimizing the risk of collision. Development of the module is now complete and is in the process of being distributed and implemented in various maritime academies.

Miscellaneous Activities

Through deliberations of the NEIT and its Ship Strike Committee, NMFS and the National Ocean Service (NOS) revised the whale watch guidelines for the Northeast in 1999, including the Studds-Stellwagen Bank National Marine Sanctuary (SBNMS). The whale watch guidelines provide operating measures to reduce repeated harassment of whales from close approaches of whale watch vessels. These measures include vessel speed guidelines at specific approach distances, and are therefore expected to reduce the risk of ship strike as well as harassment.

NMFS has established memoranda of agreements (MOA) with several Federal agencies, including the USCG, the Navy, and the USACE, to provide funding and support for NOAA's aerial surveys conducted for the SAS and the Early Warning System in the southeast. Through these MOAs, the USCG also broadcasts right whale sighting information over USCG outlets such as Notices to Mariners, NAVTEX, and the MSR system, provides enforcement support for regulations that protect right whales, and assists NMFS with distribution of outreach materials aimed at commercial mariners.

In addition, NMFS continues to research technological solutions that have the potential to minimize the threat of vessel collisions with right whales, including technologies that improve our ability to detect the presence and location of right whales and transmit that information to mariners on a real-time basis.

Although many of the above-mentioned activities are focused specifically on right whales, other cetaceans and some sea turtles will likely benefit from the measures as well.

Reducing the Threat of Entanglement on Whales

Atlantic Large Whale Take Reduction Plan

Several efforts are ongoing to reduce the risk and impact of entanglement on listed whales, including both regulatory and non-regulatory measures. Most of these activities are captured under the Atlantic Large Whale Take Reduction Plan (ALWTRP). The ALWTRP is a multi-faceted plan that includes both regulatory and non-regulatory actions that reduce the risk of serious injury to and/or mortality of large whales due to incidental entanglement in U.S. commercial fishing gear. The ALWTRP focuses on the critically endangered North Atlantic right whale, but is also intended to reduce entanglement of endangered humpback and fin whales and to benefit non-endangered minke whales. The plan is required by the Marine Mammal Protection Act (MMPA) and has been developed by NOAA's National Marine Fisheries Service (NMFS). The ALWTRP covers the U.S. Atlantic Exclusive Economic Zone (EEZ) from Maine through Florida (26°46.5'N lat.). The requirements are year-round in the Northeast, and seasonal in the Mid and South Atlantic.

The plan has been developing in collaboration with the Atlantic Large Whale Take Reduction Team (ALWTRT), which consists of fishing industry representatives, environmentalists, state and federal officials, and other interested parties. The ALWTRP is an evolving plan that changes as NMFS and the ALWTRT learn more about why whales become entangled and how fishing practices might be modified to reduce the risk of entanglement. Regulatory actions are directed at reducing serious entanglement injuries and mortality of right, humpback and fin whales from fixed gear fisheries (*i.e.*, trap and gillnet fisheries). The non-regulatory component of the ALWTRP is composed of four principal parts: (1) gear research and development, (2) disentanglement, (3) the Sighting Advisory System (SAS), and (4) education/outreach. These components will be discussed in more detail below. The first ALWTRP went into effect in 1997.

Regulatory Measures to Reduce the Threat of Entanglement on Whales
The regulatory component of the ALWTRP includes a combination of broad fishing gear modifications and time-area restrictions supplemented by progressive gear research to reduce the chance that entanglements will occur, or that whales will be seriously injured or die as a result of an entanglement. The long-term goal, established by the 1994 Amendments to the MMPA, was to reduce entanglement related serious injuries and mortality of right, humpback and fin whales to insignificant levels approaching zero within five years of its implementation. Despite these measures, entanglements, some of which resulted in serious injuries or mortalities, continued to occur. The ALWTRP is an evolving plan, and revisions are made to the regulations as new information and technology becomes available. Because serious injury and mortality of right, humpback and fin whales have continued to occur due to gear entanglements, new and revised regulatory measures have been issued since the original plan was developed. These changes are made with the input of the Atlantic Large Whale Take Reduction Team (ALWTRT), which is comprised of representatives from federal and state government, the fishing industry, scientists and conservation organizations.

Gear Research and Development
Gear research and development is a critical component of the ALWTRP, with the aim of finding new ways of reducing the number and severity of protected species-gear interactions while still allowing for fishing activities. At the outset, the gear research and development program followed two approaches: (a) reducing the number of lines in the water while still allowing fishing, and (b) devising lines that are weak enough to allow whales to break free and at the same time strong enough to allow continued fishing. Development of gear modifications are ongoing and are primarily used to minimize risk of large whale entanglement. The ALWTRT has now moved into the next phase with the focus and priority being research to reduce risk associated with vertical lines. This aspect of the ALWTRP is important, in that it incorporates the knowledge and encourages the participation of industry in the development and testing of modified and experimental gear. Currently, NMFS is developing a co-occurrence risk model that will allow us to examine the density of whale and density of vertical lines in time and space to identify those areas and times that appear to pose the greatest vertical line risk and prioritize those areas for management. The current schedule would result in a proposed rule for additional vertical line risk reduction to be published in 2013.

The NMFS, in consultation with the ALWTRT, is currently developing a monitoring plan for the ALWTRP. While the number of serious injuries and mortalities caused by entanglements is higher than our goals, it is still a relatively small number which makes monitoring difficult. Specifically, we want to know if the most recent management measures, which became fully effective April 2009, have resulted in a reduction in entanglement related serious injuries and mortalities of right, humpback and fin whales. Because these are relatively rare events and the data obtained from each event is sparse, this is a difficult question to answer. The NEFSC has identified proposed metrics that will be used to monitor progress and they project that five years of data would be required before a change may be able to be detected. Therefore, data from 2010-2014 may be required and the analysis of that data would not be able to occur until 2016.

Large Whale Disentanglement Program
Entanglement of marine mammals in fishing gear and/or marine debris is a significant problem throughout the world's oceans. NMFS created and manages a Whale Disentanglement Network, purchasing equipment caches to be located at strategic spots along the Atlantic coastline, supporting training for fishers and biologists, purchasing telemetry equipment, etc. This has resulted in an expanded capacity for disentanglement along the Atlantic seaboard including offshore areas. Along the eastern seaboard of the United States, large whale entanglement reports have been received of humpback whales and North Atlantic right whales and to a lesser extent minke whales, fin whales, sei whales and blue whales. In 1984 the Provincetown Center for Coastal Studies (PCCS), in partnership with NMFS, developed a technique for disentangling free-swimming large whales from life threatening entanglements. Over the next decade PCCS and NMFS continued working on the development of the technique to safely disentangle both anchored and free swimming large whales. In 1995 NOAA Fisheries Service issued a contract to disentangle large whales with PCCS. Based on successful disentanglement efforts by many researchers and partners NOAA Fisheries Service and Provincetown Center for Coastal Studies established the large whale disentanglement program, also referred to as the Atlantic Large Whale Disentanglement Network (ALWDN).

Memorandums of Agreement were also issued between NMFS and other Federal Government agencies to increase the resources available to respond to reports of entangled large whales anywhere along the eastern seaboard of the United States. For instance, a Memorandum of Understandings developed with the USCG ensured their participation and assistance in the disentanglement effort. Hundreds of Coast Guard and Marine Patrol workers have received training to assist in disentanglements. In addition, NMFS has also established agreements with many coastal states to collaboratively monitor and respond to entangled whales. As a result of the success of the disentanglement network, NMFS believes whales that may otherwise have succumbed to complications from entangling gear have been freed and survived. Over the past several years the disentanglement network has been involved in many successes and has assisted many whales shed gear or freed them by disentangling gear from 42 humpback and 18 right whales (PCCS web site).

Sighting Advisory System
Although the Sighting Advisory System (SAS) was developed primarily as a method of locating right whales and alerting mariners to right whale sighting locations in a real time manner, the SAS also addresses entanglement threats. Fishermen can obtain SAS sighting reports and make necessary adjustments in operations to decrease the potential for interactions with right whales.

Some of these sighting efforts have resulted in successful disentanglement of right whales.

Educational Outreach
Education and outreach activities are considered one of the primary tools to reduce the threats to all protected species from human activities, including fishing activities. Outreach efforts for fishermen under the ALWTRP are fostering a more cooperative relationship between all parties interested in the conservation of threatened and endangered species. NMFS has also been active in public outreach to educate fishermen regarding sea turtle handling and resuscitation techniques. NMFS has conducted workshops with longline fishermen to discuss bycatch issues related to protected species and to educate them regarding handling and release guidelines. NMFS intends to continue these outreach efforts in an attempt to increase the survival of protected species through education on proper release techniques.

Reducing Threats to Listed Sea Turtles
Strategy for Sea Turtle Conservation and Recovery in Relation to Atlantic Ocean and Gulf of Mexico Fisheries
The Strategy for Sea Turtle Conservation and Recovery in Relation to Atlantic and Gulf of Mexico Fisheries (Sea Turtle Strategy) is a program to reduce sea turtle bycatch by evaluating and addressing priority gear types on a comprehensive per-gear basis throughout the Atlantic and Gulf of Mexico, rather than fishery by fishery. Certain types of gear are more prone to the incidental capture of sea turtles than others, depending on the design of the gear, the way the gear is fished, and the time and area in which the gear is fished. The Strategy will address sea turtle bycatch across jurisdictional boundaries and fisheries for gear types that have the greatest impact on sea turtle populations. The major components of the strategy are: characterizing fisheries in state and federal waters of the Atlantic and the Gulf of Mexico; developing a geographical information system that depicts sea turtle distribution, bycatch, fisheries effort, regulated areas, and oceanographic information; soliciting constituent input on the Strategy framework, prioritization of gears, and management alternatives; and, developing and implementing management measures, where necessary, to reduce sea turtle bycatch.

NMFS has announced that it is considering, through the Sea Turtle Strategy, amendments to the regulatory requirements in trawl fisheries to help conserve and recover sea turtles (72 FR 7382; 15 February 2007). On May 8, 2009, NMFS announced its intent to prepare an Environmental Impact Statement to assess potential impacts resulting from the proposed implementation of new sea turtle regulations in the Atlantic and Gulf of Mexico trawl fisheries (74 FR 21627).

Turtle Excluder Devices (TEDs)
TEDs are devices comprised of a grid of bars with an escape opening, usually covered by a webbing flap that allows sea turtles to escape from trawl nets. As TEDs have proven an effective method to minimize adverse effects related to sea turtle bycatch in the shrimp fishery, and where applicable, the summer flounder fishery, NMFS sea turtle conservation regulations (50 CFR 223.206(d)) require most shrimp and summer flounder trawlers operating in the Southeast United States (Atlantic area and Gulf area) to have a NMFS approved TED installed in each net that is rigged for fishing.

As noted on page 54, the summer flounder fishery influences the environmental baseline of this Opinion. Since 1992, all vessels using bottom trawls to fish for summer flounder within an area off Virginia and North Carolina have been required to use NMFS approved TEDs in their nets (57 FR 57358, December 4, 1992; 50 CFR 223.206(d)(2)(iii)). This area is considered the Summer Flounder Fishery-Sea Turtle Protection Area and is bounded on the north by a line extending off from Cape Charles, Virginia, on the south by a line extending from the South Carolina-North Carolina boundary, and seaward of the Exclusive Economic Zone boundary. Vessels are exempted from the TED requirement north of Oregon Inlet, North Carolina, from January 15-March 15 when take of sea turtles by the fishery is not expected.

Recently, based on documented takes of sea turtles from 1994-2004 in the summer flounder and other Mid-Atlantic bottom otter trawl fisheries in areas and times when TEDS are not required (Murray 2006), NMFS is considering moving the northern boundary of the Summer Flounder Fishery-Sea Turtle Protection Area farther north to reduce sea turtle bycatch. Additionally, NMFS is considering expanding the TED requirements to other trawl fisheries in the Mid-Atlantic which currently do not have any TED requirements within this geographic area.

NMFS is also considering an option to modify TED regulations in the summer flounder trawl fishery to require a larger escape opening. Currently, the escape opening requirements for the summer flounder TEDs are ≤35 inches (≤89 cm) in width and ≤12 inches (≤30 cm) in height (50 CFR 223.207(b)(1)). The proposed larger openings would have a 142-inch circumference with a corresponding 71-inch straight line stretched measurement. This larger escape opening is expected to decrease escape times for all turtles and allow for the release of leatherback and all large loggerhead and green sea turtles. The larger opening would be consistent with sea turtle conservation measures currently in place in the shrimp trawl fishery (69 FR 8456, February 2003).

Large-Mesh Gillnet Restrictions

In December 2002, NMFS issued regulations for the use of gillnets with larger than 8 inch stretched mesh in federal waters off of North Carolina and Virginia (67 FR 71895, Dec. 3, 2002). Gillnets with larger than 8 inch stretched mesh were not allowed in federal waters (3-200 nautical miles) north of the North Carolina/South Carolina border at the coast to Oregon Inlet at all times; north of Oregon Inlet to Currituck Beach Light, NC from March 16 through January 14; north of Currituck Beach Light, NC to Wachapreague Inlet, VA from April 1 through January 14; and, north of Wachapreague Inlet, VA to Chincoteague, VA from April 16 through January 14. On April 26, 2006, NMFS published a final rule (71 FR 24776) that included modifications to the large-mesh gillnet restrictions. Specifically, the new final rule revises the gillnet restrictions to apply to stretched mesh that is 7 inches or greater and extends the prohibition on the use of such gear to North Carolina and Virginia state waters. Federal and state waters north of Chincoteague, VA remain unaffected by the large-mesh gillnet restrictions. These measures are in addition to the Harbor Porpoise Take Reduction Plan measures that prohibit the use of large-mesh gillnets in southern mid-Atlantic waters (territorial and federal waters from Delaware through North Carolina out to 72° 30'W longitude) from February 15 – March 15, annually.

Pelagic Longline Restrictions

In July 2004, NMFS issued new sea turtle bycatch and bycatch mortality mitigation measures for all Atlantic vessels that have pelagic longline gear onboard and that have been issued, or are required to have, Federal HMS limited access permits, consistent with the requirements of the ESA, the MSFCMA, and other domestic laws. These measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality. This final rule also allows vessels with pelagic longline gear onboard that have been issued, or are required to have, Federal HMS limited access permits to fish in the Northeast Distant Closed Area, if they possess and/or use certain circle hooks and baits, sea turtle release equipment, and comply with specified sea turtle handling and release protocols (69 FR 40733, July 6, 2004).

Sea Turtle Stranding and Salvage Network (STSSN)
There is an extensive network of STSSN participants along the Atlantic and Gulf of Mexico coasts which not only collects data on dead sea turtles, but also rescues and rehabilitates live stranded turtles. Data collected by the STSSN are used to monitor stranding levels and identify areas where unusual or elevated mortality is occurring. These data are also used to monitor incidence of disease, study toxicology and contaminants, and conduct genetic studies to determine population structure. All of the states that participate in the STSSN tag live turtles when encountered (either via the stranding network through incidental takes or in-water studies). Tagging studies help provide an understanding of sea turtle movements, longevity, and reproductive patterns, all of which contribute to our ability to reach recovery goals for the species.

Sea Turtle Disentanglement Network
NMFS Northeast Region established the Northeast Atlantic Coast Sea Turtle Disentanglement Network (STDN) in 2002. This program was established in response to the high number of leatherback sea turtles found entangled in vertical lines or fixed gear along the U.S. Northeast Atlantic coast. The STDN is considered a component of the larger STSSN program. The NMFS Northeast Regional Office oversees the STDN program.

Sea Turtle Handling and Resuscitation Techniques
NMFS also developed and published as a final rule in the *Federal Register* (66 FR 67495, December 31, 2001) sea turtle handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the final rule. These measures help to prevent mortality of hard-shelled turtles caught in fishing or scientific research gear.

Sea Turtle Entanglements and Rehabilitation
A final rule (70 FR 42508) published on July 25, 2005, allows any agent or employee of NMFS, the FWS, the U.S. Coast Guard, or any other Federal land or water management agency, or any agent or employee of a state agency responsible for fish and wildlife, when acting in the course of his or her official duties, to take endangered sea turtles encountered in the marine environment if such taking is necessary to aid a sick, injured, or entangled endangered sea turtle, or dispose of a dead endangered sea turtle, or salvage a dead endangered sea turtle that may be useful for scientific or educational purposes. NMFS already affords the same protection to sea turtles listed as threatened under the ESA (50 CFR 223.206(b)).

Education and Outreach Activities

Education and outreach activities are considered one of the primary tools to reduce the threats to all protected species. NMFS has been active in public outreach to educate fishermen regarding sea turtle handling and resuscitation techniques. For example, NMFS has conducted workshops with longline fishermen to discuss bycatch issues including protected species, and to educate them regarding handling and release guidelines. NMFS intends to continue these outreach efforts in an attempt to increase the survival of protected species through education on proper release techniques.

Summary and synthesis of the Status of Species and Environmental Baseline

The Status of the Species and Environmental Baseline taken together, along with the Cumlative Effects, establish a "baseline" to which the effects of the proposed action are added in order to determine whether the action-NASA's proposed seawall extension, dredging of offshore borrow sites for the purposes of beach renourishment along the Wallops Island Shoreline, and renourishment cycles over the 50 year life of the SRIPP-is likely to jeopardize the continued existence of listed species. This section synthesizes the Status of the Species and the Environmental Baseline sections as best as possible given that some information on sea turtles and whales is quantified, yet much remains qualitative or unknown.

North Atlantic right whales, humpback whales, fin whales, leatherback and Kemp's ridley sea turtles are endangered species, meaning that they are in danger of extinction throughout all or a significant portion of their ranges. The loggerhead sea turtle is a threatened species, meaning that it is likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range. Green sea turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. For purposes of this Opinion, NMFS considers the numbers to be increasing for North Atlantic right whales and humpback whales. These trends are the result of past, present, and likely future human activities and natural events, some effects of which are positive, some negative, and some unknown, as discussed previously in the Status of the Species and Environmental Baseline Sections taken together and are, for the purposes of this Opinion, assumed to continue throughout the 50-year life of the proposed project. Additional information is provided below.

North Atlantic Right Whales. North Atlantic right whales are listed as a single species classified as endangered under the ESA. The International Whaling Commission (IWC) recognizes two right whale populations in the North Atlantic: a western and eastern population (IWC 1986). However, sighting surveys from the eastern Atlantic Ocean suggest that right whales present in this region are rare (Best *et al.* 2001) and it is unclear whether a viable population in the eastern North Atlantic still exists (Brown 1986; NMFS 2005a). In the western Atlantic, North Atlantic right whales generally occur from the Southeast U.S. (waters off of Georgia, Florida) to Canada (*e.g.*, Bay of Fundy and Scotian Shelf) (Kenney 2002; Waring *et al.* 2009). Research results suggest the existence of six major habitats or congregation areas for western North Atlantic right whales. Results from telemetry studies and photo-id studies have shown extensive right whale movements: (a) over the continental shelf during the summer foraging period (Mate *et al.* 1992; Mate *et al.* 1997; Baumgartner and Mate 2005), (b) between calving/nursery areas and foraging areas in the winter (Brown and Marx 2000; Waring *et al.* 2009), and (c) into deep water off of the continental shelf (Mate *et al.* 1997).

As of August 1, 2008, there were 368 individually identified right whales in the photo-identification catalog that were presumed to be alive (Hamilton *et al.* 2008). An additional 135 were presumed to be dead as they had not been sighted in the past six years (Hamilton *et al.* 2008). Examination of the minimum number of right whales alive as calculated from the sightings database indicate a significant increase in the number of catalogued whales (Waring *et al.* 2009). Based on counts of animals alive from the sightings database as of 10 October 2008, for the years 1990-2004, the mean growth rate for the period was 1.9% (Waring *et al.* 2009). However, there was significant variation in the annual growth rate due to apparent losses exceeding gains during 1998-1999 and the number of photo-identified and catalogued female North Atlantic right whales numbers less than 200 whales (Waring *et al.* 2007). The current estimate of breeding females is 97 (Schick *et al.* 2009).

There is general agreement that right whale recovery is negatively affected by anthropogenic mortality. Fifty-four right whale mortalities were reported from Florida to the Canadian Maritimes during the period 1970-2002 (Moore *et al.* 2004). For the more recent period of 2003-2007, 20 right whale mortalities were confirmed, three due to entanglements, nine due to ship strikes (Glass *et al.* 2009). Serious injury was documented for an additional three right whales during that timeframe. These numbers represent the minimum values for human-caused mortality for this period since it is unlikely that all carcasses will be observed (Moore *et. al.* 2004; Glass *et al.* 2009). Given the small population size and low annual reproductive rate of right whales, human sources of mortality may have a greater effect to relative population growth rate than for other large whale species (Waring *et al.* 2009). Other negative effects to the species may include changes to the environment as a result of global climate change, contaminants, and loss of genetic diversity.

In light of the above, for purposes of this Opinion, NMFS considers the numbers for North Atlantic right whales to be increasing at a low rate. Although the right whale population is believed to be increasing, caution is exercised in considering the overall effect to the species given the many on-going negative impacts to the species across all areas of its range and to all age classes, and information to support that there are fewer than 200 female right whales total (of all age classes) in the population. New measures recently implemented into the ALWTRP and ship strike reduction program are expected to reduce the risk of anthropogenic serious injury and mortality to right whales. The programs are evolving plans and will continue to undergo changes based on available information to reduce the serious injury and mortality risk to large whales. For the purposes of this Opinion, the increase of North Atlantic right whales will be assumed to continue throughout the 50-year life of the action.

Humpback Whales. Humpback whales are listed as a single species classified as "endangered" under the ESA. Humpback whales range widely across the North Pacific during the summer months (Johnson and Wolman 1984; Perry *et al.* 1999). Although the IWC only considered one stock (Donovan 1991) there is evidence to indicate multiple populations migrating between their respective summer/fall feeding areas to winter/spring calving and mating areas within the North Pacific Basin (Anglis and Outlaw 2007; Carretta *et al.* 2007). Recent research efforts via the Structure of Populations, Levels of Abundance, and Status of Humpback Whales (SPLASH) Project estimate the abundance of humpback whales to be just under 20,000 whales for the entire North Pacific, a number which doubles previous population predictions obtained for 1991-1993 in a previous study (Calambokidis *et al.* 2008). There are indications that some stocks of North Pacific humpback whales increased in abundance between the 1980's -1990's (Anglis and Outlaw 2007; Carretta *et al.* 2009). Little or no research has been conducted on humpbacks in the northern Indian Ocean so information on their current abundance does not exist (Perry *et al.* 1999). Likewise, there is also no current estimate of abundance for humpback whales in the southern hemisphere although there are estimates for some of the six southern hemisphere humpback whale stocks recognized by the IWC (Perry *et al.* 1999). Although they were given protection by the IWC in 1963, Soviet whaling data made available in the 1990's revealed that southern hemisphere humpbacks continued to be hunted through 1980 (Zemsky *et al.* 1995; IWC 1995; Perry *et al.* 1999).

Photographic mark-recapture analyses from the Years of the North Atlantic Humpback (YONAH) project gave an ocean-basin-wide estimate of 11,570 animals during 1992/1993 and an additional genotype-based analysis yielded a similar but less precise estimate of 10,400 whales (95% c.i. = 8,000 - 13,600) (Waring *et al.* 2009). For management purposes under the MMPA, the estimate of 11,500 individuals is regarded as the best available estimate for the North Atlantic population (Waring *et al.* 2007). Previously, the North Atlantic humpback whale population was treated as a single stock for management purposes, however due to the strong fidelity to the region displayed by many whales, the Gulf of Maine stock was reclassified as a separate feeding stock (Waring *et al.* 2009). The best, recent estimate for the Gulf of Maine stock is 847 whales, derived from the 2006 aerial survey (Waring *et al.* 2009). Population modeling estimates the growth rate of the Gulf of Maine stock to be at 6.5% (Barlow and Clapham 1997). Current productivity rates for the North Atlantic population overall are unknown, although Stevick *et al.* (2003) calculated an average population growth rate of 3.1% for the period 1979-1993 (Waring *et al.* 2009).

As is the case with other large whales, the major known sources of anthropogenic mortality and injury of humpback whales occur from fishing gear entanglements and ship strikes. There were 76 confirmed entanglement events and 11 confirmed ship strike events for humpback whales in the Atlantic between 2003-2007, resulting in a total of 12 confirmed mortalities and 10 serious injury determinations (Glass *et al.* 2009). These numbers are expected to be a minimum account of what actually occurred given the range and distribution of humpbacks in the Atlantic. In addition to their potential for being negatively affected by other human related effects such as global climate change and contaminants, humpbacks may be susceptible to consumption of lethal levels of toxic dinoflagellates that can become concentrated in humpback prey such as mackerel. In addition, humpback prey in the Atlantic includes fish species targeted in commercial fishing operations (*i.e.*, herring and mackerel). There is no evidence as yet that current levels of fishing for these fish species has an effect on humpback survival. However, changes in humpback distribution in the Gulf of Maine have been found to be associated with changes in herring, mackerel, and sand lance abundance associated with local fishing pressures (Stevick *et al.* 2003, Waring *et al.* 2009).

In light of the above, for purposes of this Opinion, NMFS considers the numbers for humpback whales as a species to be increasing. However, NMFS also recognizes that there are many on-going negative impacts to the species across all areas of its range and to all age classes. Therefore, caution should also be exercised in considering the overall effect to the species given the available information and its classification as an "endangered" species under the ESA. For the purposes of this Opinion, the increase of humpback whales will be assumed to continue throughout the 50-year life of the action.

Fin Whales. Fin whales are listed as a single species classified as "endangered" under the ESA. NMFS recognizes three fin whale stocks in the Pacific for the purposes of managing this species under the MMPA. These are: Alaska (Northeast Pacific), Hawaii, and California/Washington/Oregon (Angliss *et al.* 2001). Reliable estimates of current abundance for the entire Northeast Pacific fin whale stock are not available (Angliss *et al.* 2001). Stock structure for fin whales in the southern hemisphere is unknown. Prior to commercial exploitation, the abundance of southern hemisphere fin whales is estimated to have been at 400,000 (IWC 1979; Perry *et al.* 1999). There are no current estimates of abundance for southern hemisphere fin whales.

NMFS recognizes fin whales off the eastern United States, Nova Scotia and the southeastern coast of Newfoundland as a single stock in the Atlantic for the purposes of managing this species under the MMPA (Waring *et al.* 2009). Various estimates have been provided to describe the current status of fin whales in western North Atlantic waters. One method used the catch history and trends in Catch Per Unit Effort to obtain an estimate of 3,590 to 6,300 fin whales for the entire western North Atlantic (Perry *et al.* 1999). Hain *et al.* (1992) estimated that about 5,000 fin whales inhabit the northeastern United States continental shelf waters. Previous abundance estimates of fin whales in the western North Atlantic were 2,200 (Palka 1995), 2,814 (Palka 2000), 2,933 (Palka 2006), and 1,925 (Palka 2006) in 1995, 1999, 2002, and 2004 respectively. The 2009 Stock Assessment Report (SAR) gives a best estimate of abundance for the western North Atlantic stock of fin whales as 2,269 (C.V. = 0.37), derived from an aerial survey in 2006 (Waring *et al.* 2009). This estimate is considered extremely conservative in view of the incomplete coverage of the known habitat of the stock and the uncertainties regarding population structure and whale movements between surveyed and unsurveyed areas (Waring *et al.* 2009). There are insufficient data to determine population trends for this species. Current and maximum net productivity rates are unknown for this stock (Waring *et al.* 2009).

Like right whales and humpback whales, anthropogenic mortality and injury of fin whales include entanglement in commercial fishing gear and ship strikes. From 1999-2003, fin whales had a low proportion of entanglements; of 40 reported events,[7] only 7 were of entanglements (all confirmed), two of which were fatal (Cole *et al.* 2005). Ten ship strikes were reported, five of which were confirmed and proved fatal. Of 61 fin whale events recorded between 2003 and 2007, eight mortalities were associated with vessel interactions, and three mortalities were attributed to entanglements (Glass *et al.* 2009). In addition to their potential for being negatively affected by other human related effects, global climate change and contaminants may also adversely affect fin whales.

Loggerhead Sea Turtles. Loggerhead sea turtles are listed as a single species classified as "threatened" under the ESA. Loggerhead nesting occurs on beaches of the Pacific, Indian, and Atlantic oceans, and Mediterranean Sea. Genetic analyses of maternally inherited mitochondrial DNA demonstrate the existence of separate, genetically distinct nesting groups between as well as within the ocean basins (TEWG 2000; Bowen and Karl 2007).

7 A large whale event includes entanglements, ship strikes, and mortalities.

It takes decades for loggerhead sea turtles to reach maturity. Once they have reached maturity, females typically lay multiple clutches of eggs within a season, but do not typically lay eggs every season (NMFS and USFWS 1991a). There are many natural and anthropogenic factors affecting survival of turtles prior to their reaching maturity as well as for those adults who have reached maturity. As described above, negative impacts causing death of various age classes occur both on land and in the water. In addition, given the distances traveled by loggerheads in the course of their development, actions to address these negative impacts require the work of multiple countries at both the national and international level (NMFS and USFWS 2007a). Many actions have been taken to address known negative impacts to loggerhead sea turtles; however, many remain unaddressed, have not been sufficiently addressed, or have been addressed in some manner but whose success cannot be quantified.

There are no population estimates for loggerhead sea turtles. Sea turtle nesting data, in terms of the number of nests laid each year, is collected for loggerhead sea turtles for at least some nesting beaches within each of the ocean basins and the Mediterranean Sea. From this, the number of reproductively mature females utilizing those nesting beaches can be estimated based on the presumed remigration interval and the average number of nests laid by a female loggerhead sea turtle per season. These estimates provide a minimum count of the number of loggerhead sea turtles in any particular nesting group. The estimates do not account for adult females who nest on beaches with no or little survey coverage, and do not account for adult males or juveniles of either sex. The proportion of adult males to females from each nesting group, and the age structure of each loggerhead nesting group is currently unknown. For these reasons, nest counts cannot be used to estimate the total population size of a nesting group and, similarly, trends in the number of nests laid cannot be used as an indicator of the population trend (whether decreasing, increasing or stable) (Meylan 1982; Ross 1996; Zurita *et al.* 2003; Hawkes *et al.* 2005; Loggerhead TEWG 2009). Nevertheless, nest count data are a valuable source of information for each loggerhead nesting group and for loggerheads as a species since the number of nests laid reflect the reproductive output of the nesting group each year, and also provide insight on the contribution of each nesting group to the species. Based on a comparison of the available nesting data, the world's largest known loggerhead nesting group (in terms of estimated number of nesting females) occurs in Oman in the northern Indian Ocean where an estimated 20,000-40,000 females nest each year (Baldwin *et al.* 2003). The world's second largest known loggerhead nesting group occurs along the east coast of the United States where approximately 15,966 females nest per year on south Florida beaches (based on a mean of 65,460 nests laid per year from 1989-2006; NMFS and USFWS 2007a). The world's third largest loggerhead nesting group also occurs in the United States, from approximately northern Florida through North Carolina; however, the mean nest count for this nesting group is 5,151 nests laid per year (NMFS and USFWS 2007a), which is less than 1/10th the mean number of nests laid by the south Florida nesting group. Thus, while loggerhead nesting occurs at multiple sites within multiple ocean basins and the Mediterranean Sea, the extent of nesting is disproportionate amongst the various sites and only two geographic areas, Oman and south Florida, U.S., account for the majority of nesting for the species worldwide.

Declines in loggerhead nesting have been noted at nesting beaches throughout the range of the species. These include nesting for the south Florida nesting group -the second largest loggerhead nesting group in the world and the largest of all of the loggerhead nesting groups in the Atlantic (Dodd 2003; Meylan *et al.* 2006; Letter to NMFS from the Director, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, October 25, 2006; Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission web posting November 2007; NMFS and USFWS 2007a, 75 FR 12597, March 16, 2010).

Leatherback turtles. Leatherback sea turtles are listed as a single species classified as "endangered" under the ESA. Leatherbacks are widely distributed throughout the oceans of the world, and are found in waters of the Atlantic, Pacific, and Indian Oceans, the Caribbean Sea, Mediterranean Sea, and the Gulf of Mexico (Ernst and Barbour 1972). Leatherback nesting occurs on beaches of the Atlantic, Pacific and Indian Oceans as well as in the Caribbean (NMFS and USFWS 2007d).

Like loggerheads, sexually mature female leatherbacks typically nest in non-successive years and lay multiple clutches in each of the years that nesting occurs. Leatherbacks face a multitude of threats that can cause death prior to and after reaching maturity. Some activities resulting in leatherback mortality have been addressed; however, many others remain to be addressed. Given their range and distribution, international efforts are needed to address all known threats to leatherback sea turtle survival (NMFS and USFWS 2007d).

There are some population estimates for leatherback sea turtles although there appears to be considerable uncertainty in the numbers. In 1980, the global population of adult leatherback females was estimated to be approximately 115,000 (Pritchard 1982). By 1995, this global population of adult females was estimated to be 34,500 (Spotila *et al.* 1996); however, the most recent population size estimate for the North Atlantic alone is 34,000-94,000 adult leatherbacks (Leatherback TEWG 2007; NMFS and USFWS 2007d).

Leatherback nesting in the eastern Atlantic *(i.e.,* off Africa) and in the Caribbean appears to be stable, but there is conflicting information for some sites and it is certain that some nesting groups *(e.g.,* St. John and St. Thomas, U.S. Virgin Islands) have been extirpated (NMFS and USFWS 1995). Data collected for some nesting beaches in the western Atlantic, including leatherback nesting beaches in the U.S., clearly indicate increasing numbers of nests (NMFS SEFSC 2001; NMFS and USFWS 2007d); however, declines in nesting have been noted for beaches in the western Caribbean (NMFS and USFWS 2007d). The largest leatherback rookery in the western Atlantic remains along the northern coast of South America in French Guiana and Suriname. More than half the present world leatherback population is estimated to be nesting on the beaches in and close to the Marowijne River Estuary in Suriname and French Guiana (Hilterman and Goverse 2004). The long-term trend for the Suriname and French Guiana nesting group seems to show an increase (Hilterman and Goverse 2004). In 2001, the number of nests for Suriname and French Guiana combined was 60,000, one of the highest numbers observed for this region in 35 years (Hilterman and Goverse 2004). Studies by Girondot *et al.* (2007) also suggest that the trend for the Suriname -French Guiana nesting population over the last 36 years is stable or slightly increasing.

Increased nesting by leatherbacks in the Atlantic is not expected to affect leatherback abundance in the Pacific where the abundance of leatherback turtles on nesting beaches has declined dramatically over the past 10 to 20 years (NMFS and USFWS 2007d). Although genetic analyses suggest little difference between Atlantic and Pacific leatherbacks (Bowen and Karl 2007), it is generally recognized that there is little to no genetic exchange between these turtles.

Kemp's Ridley Sea Turtles. Kemp's ridley sea turtles are listed as a single species classified as "endangered" under the ESA. Kemp's ridleys occur in the Atlantic Ocean and Gulf of Mexico. The only major nesting site for ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963; USFWS and NMFS 1992; NMFS and USFWS 2007b). Approximately 60% of its nesting occurs here with a limited amount of scattered nesting to the north and south of the primary nesting beach (NMFS and USFWS 2007b). Age to maturity for Kemp's ridley sea turtles occurs earlier than for either loggerhead or leatherback sea turtles; however, maturation may still take 10-17 years (NMFS and USFWS 2007b). As is the case with the other turtle species, adult, female Kemp's ridleys typically lay multiple nests in a nesting season but do not typically nest every nesting season (TEWG 2000; NMFS and USFWS 2007b). Although actions have been taken to protect the nesting beach habitat, and to address activities known to be negatively impacting Kemp's ridley sea turtles, Kemp's ridleys continue to be impacted by anthropogenic activities.

Nest count data provides the best available information on the number of adult females nesting each year. As is the case with the other sea turtles species discussed above, nest count data must be interpreted with caution given that these estimates provide a minimum count of the number of nesting Kemp's ridley sea turtles. In addition, the estimates do not account for adult males or juveniles of either sex. Without information on the proportion of adult males to females, and the age structure of the Kemp's ridley population, nest counts cannot be used to estimate the total population size and, similarly, trends in the number of nests laid cannot be used as an indicator of the population trend (whether decreasing, increasing or stable) (Meylan 1982; Ross 1996; Zurita *et al.* 2003; Hawkes *et al.* 2005; Loggerhead TEWG 2009). Nevertheless, the nesting data does provide valuable information on the extent of Kemp's ridley nesting and the trend in the number of nests laid. Estimates of the adult female nesting population reached a low of approximately 250-300 in 1985 (USFWS and NMFS 1992; TEWG 2000). From 1985 to 1999, the number of nests observed at Rancho Nuevo, and nearby beaches increased at a mean rate of 11.3% per year (TEWG 2000). Current estimates suggest an adult female population of 7,000-8,000 Kemp's ridleys (NMFS and USFWS 2007b).

The most recent review of the Kemp's ridley as a species suggests that it is in the early stages of recovery (NMFS and USFWS 2007b). The nest count data indicates increased nesting and an increased number of nesting females in the population. In light of this information, for purposes of this Opinion, NMFS considers the numbers for Kemp's ridley sea turtles to be stable. This determination that the numbers for Kemp's ridleys as a species is stable provides benefit of the doubt to the species given the species classification of "endangered" under the ESA, the caveats associated with using nesting data as indicators of population size and population trends, that the estimated number of nesting females in the current population is still far below historical numbers (Stephens and Alvarado-Bremer 2003; NMFS and USFWS 2007b), the many on-going negative impacts to the species, and given that the majority of nesting for the species occurs in one area. For the purposes of this Opinion, the number of Kemp's ridleys will be assumed to remain stable throughout the 50-year life of the action.

Green Sea Turtles. Green sea turtles are listed as both threatened and endangered under the ESA. Breeding colony populations in Florida and on the Pacific cost of Mexico are considered endangered while all others are considered threatened. Due to the inability to distinguish between these populations away from the nesting beach, for this Opinion, green turtles are considered endangered wherever they occur in U.S. waters. Green turtles are distributed circumglobally, and can be found in the Pacific, Indian and Atlantic Oceans as well as the Mediterranean Sea (NMFS and USFWS 1991b; Seminoff 2004; NMFS and USFWS 2007c).

Green sea turtles appear to have the latest age to maturity of all of the sea turtles with age at maturity occurring after 2-5 decades (NMFS and USFWS 2007c). As is the case with all of the other turtle species mentioned here, mature green sea turtles typically nest more than once in a nesting season but do not nest every nesting season. As is also the case with the other turtle species, green sea turtles face numerous threats on land and in the water that affect the survival of all age classes.

A review of 32 Index Sites distributed globally revealed a 48% to 67% decline in the number of mature females nesting annually over the last 3-generations (Seminoff 2004). For example, in the eastern Pacific, the main nesting sites for the green sea turtle are located in Michoacan, Mexico, and in the Galapagos Islands, Ecuador where the number of nesting females exceed 1,000 females per year at each site (NMFS and USFWS 2007c). Historically, however, greater than 20,000 females per year are believed to have nested in Michoacan, alone (Cliffton *et at.* 1982; NMFS and USFWS 2007c). However, the decline is not consistent across all green sea turtle nesting areas. Increases in the number of nests counted and, presumably, the number of mature females laying nests, were recorded for several areas (Seminoff 2004; NMFS and USFWS 2007c). Of the 32 index sites reviewed by Seminoff (2004), the trend in nesting was described as: increasing for 10 sites, decreasing for 19 sites, and stable (no change) for 3 sites. Of the 46 green sea turtle nesting sites reviewed for the 5-year status review, the trend in nesting was described as increasing for 12 sites, decreasing for 4 sites, stable for 10 sites, and unknown for 20 sites (NMFS and USFWS 2007c). The greatest abundance of green sea turtle nesting in the western Atlantic occurs on beaches in Tortuguero, Costa Rica (NMFS and USFWS 2007c). Nesting in the area has increased considerably since the 1970's and nest count data from 1999-2003 suggest nesting by 17,402-37,290 females per year (NMFS and USFWS 2007c). One of the largest nesting sites for green sea turtles worldwide is still believed to be on the beaches of Oman in the Indian Ocean (Hirth 1997; Ferreira *et al.* 2003; NMFS and USFWS 2007c); however, nesting data for this area has not been published since the 1980's and updated nest numbers are needed (NMFS and USFWS 2007c).

The results of genetic analyses show that green sea turtles in the Atlantic do not contribute to green sea turtle nesting elsewhere in the species range (Bowen and Karl 2007). Therefore, increased nesting by green sea turtles in the Atlantic is not expected to affect green sea turtle abundance in other ocean basins in which the species occurs. However, the ESA-listing of green sea turtles as a species across ocean basins means that the effects of a proposed action must, ultimately, be considered at the species level for section 7 consultations.

EFFECTS OF THE ACTION

This section of an Opinion assesses the direct and indirect effects of the proposed action on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent (50 CFR 402.02). Indirect effects are those that are caused later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This Opinion examines the likely effects (direct and indirect) of the proposed action on whales and sea turtles in the action area and their habitat within the context of the species current status, the environmental baseline and cumulative effects. As explained in the Description of the Action, the proposed action under consideration in this Opinion includes the extension and construction of a seawall during Year One of the SRIPP; the initial dredging cycle needed to renourish the 3.7 mile stretch of shoreline/beach along the Goddard Space Flight Center's WFF, which will be conducted within the second and third year of the SRIPP; the subsequent nine renourishment cycles required to maintain beach nourishment, which are expected to occur every 5 years; and, the transport of material to and from the borrow areas throughout the 50 year life of the SRIPP.

Effects of Seawall Construction and Extension

The construction and extension of the seawall will occur on the beach parallel to the shoreline in the approximate location of the geotextile tubes. The new seawall will be constructed landward of the existing shoreline and will be comprised of 5-7 ton rock that will placed on the beach, with the top of the seawall approximately 14-feet above the normal high tide water level. As this portion of the project will occur on land where listed species under NMFS jurisdiction will not be present, no direct or indirect effects are expected to be incurred on sea turtles or whales during this phase of the SRIPP.

Effects of Dredging Operations

As explained in the Description of the Action section above, over the 50 year life of the SRIPP, a hopper dredge will be used for both initial and renourishment cycles of dredging. Below, the effects of hopper dredging on threatened and endangered species will be considered. Effects of the proposed dredging include (1) entrainment and impingement; (2) alteration of sea turtle prey and foraging behavior due to dredging; (3) suspended sediment associated with dredging operations; (4) underwater noise generated during dredging operations; and (5) the potential for interactions between project vessels and individual whales or sea turtles.

As noted above, sea turtles are likely to occur in the action area from April-November of any year. The primary concern for loggerhead, Kemp's ridley, and green sea turtles is entrainment and the potential for effects to foraging, while the primary concern for leatherbacks is vessel collision. Right whales are likely to be present from November-May; humpbacks from September-April; and fin whales from October-January; however, individual transient right whales could be present in the action area outside of these time frame as this area is used by whales migrating between calving/mating grounds and foraging grounds. The primary concern for listed species of whales is the potential for vessel collisions.

Alteration of foraging habitat

As discussed above, listed species of whales may be present within the action area year round as this area is used by whales migrating between calving/mating grounds and forgaing grounds. Listed species of whales forage upon pelagic prey items (e.g., krill, copepods, sand lance) and as such, dredging and its impacts on the benthic environment will not have any direct or indirect effects on whale prey/foraging items. As such, the remainder of this section will discuss the effects of dredging and the alteration of sea turtle foraging habitat.

As outlined above, sea turtles are likely to occur in the action area from April through November 30 each year with the largest numbers present from June through October of any year (Stetzar 2002). One of the main factors influencing sea turtle presence in northern waters is seasonal temperature patterns (Ruben and Morreale 1999). Temperature is correlated with the time of year, with the warmer waters in the late spring, summer, and early fall being the most suitable for cold-blooded sea turtles. Sea turtles are most likely to occur in the action area between April and November when water temperatures are above 11°C. Sea turtles have been documented in the action area by the CETAP aerial and boat surveys as well as by surveys conducted by NMFS Northeast Science Center and fisheries observers. Additionally, satellite tracked sea turtles have been documented in the action area (seaturtle.org tracking database). The majority of sea turtle observations have been of loggerhead sea turtles, although all four species of sea turtles have been recorded in the area.

As sea turtles are likely to be feeding on or near the bottom of the water column during the warmer months, to some extent, water depth also dictates the number of sea turtles occurring in a particular area. Water depths in and around the borrow sites range from approximately 25-50 feet. Satellite tracking studies of sea turtles in the Northeast found that foraging turtles mainly occurred in areas where the water depth was between approximately 16 and 49 feet (Ruben and Morreale 1999). This depth was interpreted not to be as much an upper physiological depth limit for turtles, as a natural limiting depth where light and food are most suitable for foraging turtles (Morreale and Standora 1990). The areas to be dredged and the depths preferred by sea turtles do overlap, suggesting that if suitable foraging items were present, loggerheads and Kemp's ridleys may be foraging in the offshore shoals where dredging will occur. As there are no SAV beds in any of the borrow areas where dredging will occur, green sea turtles are not likely to use the areas to be dredged for foraging[8].

The offshore borrow sites are not known to be an area where sea turtles concentrate to forage and develop. Instead, the action area is used primarily as a coastal corridor through which sea turtles migrate; however, based on surveys conducted at the borrow sites, potential sea turtle foraging items appear to be present, including jellyfish, comb jellies, crabs (portly spider (*Libinia emarginata*) and Atlantic rock crabs (*Cancer irroratus*)), moon shell, and whelks. Since dredging involves removing the bottom material down to a specific depth, the benthic environment will be impacted by dredging operations as the proposed dredging is likely to entrain and kill some of these forage items. As noted above, no seagrass beds occur in the areas to be dredged.

Of the listed species found in the action area, loggerhead and Kemp's ridley sea turtles are the most

8 According to the 2008 SAV online mapper prepared by the Virginia Institute of Marine Science (VIMS), the nearest mapped SAV bed to the SRIPP project area is in New Virginia Cove, approximately 11 km (7 miles) from the northern most point of the proposed beach fill on Wallops Island shoreline.

likely to utilize these areas for feeding, foraging mainly on benthic species, such as crabs and mollusks (Morreale and Standora 1992; Bjorndal 1997). As no seagrass beds exist at the borrow areas, green sea turtles will not use the borrow sites as foraging areas and as such, dredging activities are not likely to disrupt normal feeding behaviors of green sea turtles. Additionally, jellyfish, the primary foraging item of leatherback sea turtles, are not likely to be affected by dredging activities as jellyfish occur within the upper portions of the water column and away from the sediment surface where dredging will occur. As jellyfish are not likely to be entrained during dredging, there is not likely to be any reduction in available forage for leatherback sea turtles due to the dredging operations. However, as suitable loggerhead and Kemp's ridley sea turtle foraging items occur on the benthos of the borrow areas and depths within the borrow areas are suitable for use by these species of sea turtles, some loggerhead and Kemp's ridley sea turtle foraging likely occurs at these sites and therefore, may be affected by dredging activities within this portion of the action area.

Dredging can cause indirect effects on sea turtles by reducing prey species through the alteration of the existing biotic assemblages. Some of the prey species targeted by turtles, including species of crabs, are mobile; therefore, some individuals are likely to avoid the dredge. While some offshore areas may be more desirable to certain turtles due to prey availability, there is no information to indicate that the borrow areas proposed for dredging have more abundant turtle prey or better foraging habitat than other surrounding areas. The assumption can be made that sea turtles are not likely to be more attracted to the borrow areas than to other foraging areas and should be able to find sufficient prey in alternate areas. Depending on the species, recolonization of a dredged area can begin in as short as a month (Guerra-Garcia and Garcia-Gomez 2006). The dredged area is expected to be completely recolonized by benthic organisms within approximately 12 months. These conclusions are supported by a benthic habitat study which examined an area of Thimble Shoals following dredging, which concluded that recolonization of the dredged area was rapid, with macrobenthic organisms abundant on the first sampling date following cessation of dredging activities (less than a month later). As such, recolonization of the borrow areas should be complete within 3 years after the initial dredge cycle. It also should be noted that only a small percentage of the available sand at each borrow area (e.g., if Unnamed Shoal A is used for the initial dredge cycle and all renourishment cycles, SRIPP will remove approximately 33% of the total volume of available sand on Unnamed Shoal A (40 million yd^3) through 2050) is proposed to be removed and suitable foraging items should continue to be available at each borrow area at all times.

In total, there is nearly 2,560,000 acres of seafloor offshore of Maryland and Virginia. Cumulatively, the reasonably foreseeable, future dredging projects offshore will affect less than 0.4% of the nearshore seafloor in the region (NASA Draft PEIS 2010). NMFS anticipates that while the dredging activities may temporarily disrupt normal feeding behaviors for sea turtles by causing them to move to alternate areas, the action is not likely to remove critical amounts of prey resources from the action area and any disruption to normal foraging is likely to be insignificant. In addition, the dredging activities are not likely to alter the habitat in any way that prevents sea turtles or whales from using the action area as a migratory pathway to other near-by areas that may be more suitable for foraging.

Entrainment
As noted above, sea turtles are likely to be feeding on or near the bottom of the water column during the warmer months, with loggerhead and Kemp's ridley sea turtles being the most common species in these waters. Although not expected to be as numerous as loggerheads and Kemp's ridleys, green and leatherback sea turtles are also likely to occur in the action area; however, leatherbacks are more subject to vessel collisions than dredge entrainment due to their size and behavioral characteristics. Similarly, humpback, fin, and right whales are not vulnerable to entrainment in dredge gear due to their large size. Therefore, this section of the Opinion will only consider the effects of entrainment on loggerhead, Kemp's ridley and green sea turtles.

The National Research Council's Committee on Sea Turtle Conservation (1990) estimated that dredging mortalities, along with boat strikes, were second only to fishery interactions as a source of probable mortality of sea turtles. Experience has shown that injuries sustained by sea turtles entrained in hopper dredge dragheads are usually fatal. Mortality in hopper dredging operations most often occurs when turtles are entrained in the dredge draghead, pumped through the intake pipe and then killed as they cycle through the centrifugal pump and into the hopper. Because entrainment is believed to occur primarily as the dredge is being placed or removed from the bottom, creating suction in the draghead, or when the dredge is operating on an uneven or rocky substrate causing the draghead to rise off the bottom, it is likely that only those species feeding or resting on or near the bottom would be vulnerable to entrainment. Recent information from the USACE suggests that the risk of entrainment is highest when the bottom terrain is uneven or when the dredge is conducting "clean up" operations at the end of a dredge cycle when the bottom is trenched and the dredge is working to level out the bottom. In these instances, it is difficult for the dredge operator to keep the draghead buried in the sand and sea turtles near the bottom may be more vulnerable to entrainment. However, it is possible to operate the dredge in a manner that minimizes potential for such incidents as noted in the Monitoring Specifications for Hopper Dredges (Appendix B).

Sea turtles have been killed in hopper dredge operations along the East and Gulf coasts of the US. Documented turtle mortalities during dredging operations in the USACE South Atlantic Division (SAD; i.e., south of the Virginia/North Carolina border) are more common than in the USACE North Atlantic Division (NAD; Virginia-Maine) probably due to the greater abundance of turtles in these waters and the greater frequency of hopper dredge operations. For example, in the USACE SAD, over 467 sea turtles have been entrained in hopper dredges since 1980 and in the Gulf Region over 186 sea turtles have been killed since 1995. Records of sea turtle entrainment in the USACE NAD began in 1994. Since this time, at least 72 sea turtles deaths (see Table 1) related to hopper dredge activities have been recorded in waters north of the North Carolina/Virginia border (USACE Sea Turtle Database[9]).

9 The USACE Sea Turtle Data Warehouse is maintained by the USACE's Environmental Laboratory and contains information on USACE dredging projects conducted since 1980 with a focus on information on interactions with sea turtles.

Table 1. Sea Turtle Takes in USACE NAD Dredging Operations

Project Location	**Year of Operation**	**Cubic Yardage Removed**	**Observed Takes**
Thimble Shoal Channel	2009	NA	3 Loggerheads
York Spit	2007	608,000	1 Kemp's Ridley
Cape Henry	2006	NA	3 Loggerheads
Thimble Shoal Channel	2006	300,000	1 loggerhead
Delaware Bay	2005	50,000	2 Loggerheads
Thimble Shoal Channel	2003	1,828,312	7 Loggerheads 1 Kemp's ridley 1 unknown
Cape Henry	2002	1,407,814	6 Loggerheads 1 Kemp's ridley 1 green
VA Beach Hurricane Protection Project (Cape Henry)	2002	NA	1 Loggerhead
York Spit Channel	2002	911,406	8 Loggerheads 1 Kemp's ridley
Cape Henry	2001	1,641,140	2 loggerheads 1 Kemp's ridley
VA Beach Hurricane Protection Project (Thimble Shoals)	2001	NA	5 loggerheads 1 unknown
Thimble Shoal Channel	2000	831,761	2 loggerheads 1 unknown
York River Entrance Channel	1998	672,536	6 loggerheads
Atlantic Coast of NJ	1997	1,000,000	1 Loggerhead
Thimble Shoal Channel	1996	529,301	1 loggerhead
Delaware Bay	1995	218,151	1 Loggerhead
Cape Henry	1994	552,671	4 loggerheads 1 unknown
York Spit Channel	1994	61,299	4 loggerheads
Delaware Bay	1994	NA	1 Loggerhead
Cape May NJ	1993	NA	1 Loggerhead
Off Ocean City MD	1992	1,592,262	3 Loggerheads
			TOTAL = 72 Turtles

Official records of sea turtle mortality in dredging activities in the USACE NAD begin in the early 1990s. Before this time, endangered species observers were not required on board hopper dredges and dredge baskets were not inspected for sea turtles or sea turtle parts. The majority of sea turtle takes in the NAD have occurred in the Norfolk district. This is largely a function of the large number of loggerhead and Kemp's ridley sea turtles that occur in the Chesapeake Bay each summer and the intense dredging operations that are conducted to maintain the Chesapeake Bay entrance channels and for beach nourishment projects at Virginia Beach. Since 1992, the take of 10 sea turtles (all loggerheads) has been recorded during hopper dredge operations in the Philadelphia, Baltimore and New York Districts. Hopper dredging is relatively rare in New England waters where sea turtles are known to occur, with most hopper dredge operations being completed by the specialized Government owned dredge Currituck which operates at low suction and has been demonstrated to have a very low likelihood of entraining or impinging sea turtles. To date, no hopper dredge operations (other than the Currituck) have occurred in the New England District in areas or at times when sea turtles are likely to be present.

Of the 10 sea turtle mortalities attributed to hopper dredge operations outside of the Norfolk District, 6 have occurred in the Philadelphia District, 3 in the Baltimore District and 1 in the New York District. As explained in the USACE BA, the Philadelphia District Endangered Species Monitoring Program began in 1992. For four hopper dredging projects conducted in 1992 -1994, observers were present to provide approximately 25% coverage (6 hours on, 6 hours off on a biweekly basis). No sea turtles were observed during the 8/25-10/13/92 dredging at Bethany Bay, DE or the 10/24-11114/92 dredging at Cape May, NJ. The dredge McFarland worked in the Delaware River entrance channel from 6/23 -7/23/93 with no sea turtle observations. The dredge continued at Cape May from 7/24-8/2 and 8/10-8/19/93. Fresh sea turtle parts were observed in the inflow screening on two separate dates three days apart at Cape May. Additionally, three live sea turtles were observed from the bridge during dredging operations. Dredging with the McFarland continued in the Delaware Bay entrance channel from 6/13-8/1 0/94. During this dredging cycle, relocation trawling was conducted in an attempt to capture sea turtles in the area where dredging was occurring and move them away from the dredge. Eight loggerhead sea turtles were captured alive with the trawl and relocated away from the dredging site. One loggerhead was taken by the dredge on June 22, 1994. Since this event in 1994, dredge observer coverage was increased to 50%. On November 3, 1995, one loggerhead was taken by a hopper dredge operating in the entrance channel. In 1999, dredging occurred in July at the entrance channel. Three decomposed loggerheads were observed at Brandywine Shoal and Reedy Island by the dredge observer while the dredge was transiting to the disposal site. There is no evidence to suggest that these turtles were killed during dredging operations. On July 27, 2005 fresh loggerhead parts were observed in two different dredge loads while dredging was being conducted in the Miah Maul Range of the channel in Delaware Bay. It is currently unknown whether these were parts of the same turtle or two different turtles.

In addition to sea turtles observed as entrained, one loggerhead was killed during dredging operations off Sea Girt, New Jersey during an USACE New York District beach renourishment project on August 23, 1997. This turtle was closed up in the hinge between the draghead and the dragarm as the dragarm lifted off the bottom.

Most of the available information on the effects of hopper dredging on sea turtles in the USACE NAD has come from operations in Virginia waters, particularly in the entrance channels to the Chesapeake Bay. Since 1994, 63 sea turtles mortalities have been observed on hopper dredges operating in Virginia waters. In Thimble Shoals Channel, maintenance dredging took several turtles during the warmer months of 1996 (1 loggerhead) and 2000 (2 loggerheads, 1 unknown). A total of 6 turtles (5 loggerhead, 1 unknown) were taken in association with dredging in Thimble Shoal Channel during 2001, and one turtle was taken in May 2002 (1 loggerhead). Nine sea turtle takes were reported during dredging conducted in September and October 2003 (7 loggerhead, 1 Kemp's ridley, 1 unknown) and one sea turtle take (1 loggerhead) was reported in the summer of 2006. Most recently, Thimble Shoals Channel was dredged in the spring of 2009, with 3 loggerheads killed during this operation.

Incidental takes have occurred in the Cape Henry and York Spit Channels as well. In May and June 1994, parts of at least five sea turtles were observed (at least 4 loggerheads and 1 unknown) during dredging at Cape Henry. In September and October 2001, 3 turtle takes were observed (1 Kemp's ridley and 2 loggerheads). Eight turtle takes were observed during dredging at Cape Henry in April, May, June and October 2002 (1 green, 1 Kemp's and 6 loggerhead). Three loggerheads were killed during the dredging of the Cape Henry Channel in the summer of 2006. At York Spit, four loggerheads were taken in dredging operations occurring during one week in June 1994. Nine turtles were taken in dredging operations at York Spit in 2002 (8 loggerheads, 1 Kemp's ridley). York Spit was last dredged in the summer of 2007, with the take of 1 Kemp's ridley reported. In 1998, dredging in the York River Entrance Channel took 5 loggerheads. No turtles had been observed in dredging operations in Rappahannock Shoal Channels or the Sandbridge Shoals borrow area.

It should be noted that the observed takes may not be representative of all the turtles killed during dredge operations. Typically, endangered species observers are required to observe a total of 50% of the dredge activity (i.e., 6 hours on watch, 6 hours off watch). As such, if the observer was off watch or the cage was emptied and not inspected or the dredge company either did not report or was unable to identify the turtle incident, there is the possibility that a turtle could be taken by the dredge and go unnoticed. Additionally, in older Opinions (i.e., prior to 1995), NMFS frequently only required 25% observer coverage and monitoring of the overflows which has since been determined to not be as effective as monitoring of the intakes. These conditions may have led to sea turtle takes going undetected.

NMFS raised this issue to the USACE during the 2002 season, after several turtles were taken in the Cape Henry and York Spit Channels, and expressed the need for 100% observer coverage. On September 30, 2002, the USACE informed the dredge contractor that when the observer was not present, the cage should not be opened unless it is clogged. This modification was to ensure that any sea turtles that were taken and on the intake screen (or in the cage area) would remain there until the observer evaluated the load. The USACE's letter further stated "Crew members will only go into the cage and remove wood, rocks, and man-made debris; any aquatic biological material is left in the cage for the observer to document and clear out when they return on duty. In addition, the observer is the only one allowed to clean off the overflow screen. This practice provides us with

100% observation coverage and shall continue." Theoretically, all sea turtle parts were observed under this scheme, but the frequency of clogging in the cage is unknown at this time. Obviously, the most effective way to ensure that 100% observer coverage is attained is to have a NMFS-approved endangered species observer monitoring all loads at all times. This level of observer coverage would document all turtle interactions and better quantify the impact of dredging on turtle populations. More recently issued Opinions have required 100% observer coverage which increases the likelihood of takes being detected and reported.

Sea turtles have been found resting in deeper waters, which could increase the likelihood of interactions from dredging activities. In 1981, observers documented the take of 71 loggerheads by a hopper dredge at the Port Canaveral Ship Channel, Florida (Slay and Richardson 1988). This channel is a deep, low productivity environment in the Southeast Atlantic where sea turtles are known to rest on the bottom, making them extremely vulnerable to entrainment. The large number of turtle mortalities at the Port Canaveral Ship Channel in the early 1980s resulted in part from turtles being buried in the soft bottom mud, a behavior known as brumation. Since 1981, 77 loggerhead sea turtles have been taken by hopper dredge operations in the Port Canaveral Ship Channel, Florida. Chelonid turtles have been found to make use of deeper, less productive channels as resting areas that afford protection from predators because of the low energy, deep water conditions. While sea turtle brumation has not been documented in mid-Atlantic or New England waters, it is possible that this phenomenon occurs in these waters.

It is likely that not all sea turtles killed by dredges are observed onboard the hopper dredge. Several sea turtles stranded on Virginia shores with crushing type injuries from May 25 to October 15, 2002. The Virginia Marine Science Museum (VMSM) found 10 loggerheads, 2 Kemp's ridleys, and 1 leatherback exhibiting injuries and structural damage consistent with what they have seen in animals that were known dredge takes. While it cannot be conclusively determined that these strandings were the result of dredge interactions, the link is possible given the location of the strandings (e.g., in the southern Chesapeake Bay near ongoing dredging activity), the time of the documented strandings in relation to dredge operations, the lack of other ongoing activities which may have caused such damage, and the nature of the injuries (e.g., crushed or shattered carapaces and/or flipper bones, black mud in mouth). Additionally, in 1992, three dead sea turtles were found on an Ocean City, Maryland beach while dredging operations were ongoing at a borrow area located 3 miles offshore. Necropsy results indicate that the deaths of all three turtles were dredge related. It is unknown if turtles observed on the beach with these types of injuries were crushed by the dredge and subsequently stranded on shore or whether they were entrained in the dredge, entered the hopper and then were discharged onto the beach with the dredge spoils.

A dredge could crush an animal as it was setting the draghead on the bottom, or if the draghead was lifting on and off the bottom due to uneven terrain, but the actual cause of these crushing injuries cannot be determined at this time. Further analyses need to be conducted to better understand the link between crushed strandings and dredging activities, and if those strandings need to be factored into an incidental take level. More research also needs to be conducted to determine if sea turtles are in fact undergoing brumation in mid-Atlantic or New England waters. Regardless, it is possible that dredges are taking animals that are not observed on the dredge which may result in strandings on nearby beaches.

Due to the nature of interactions between listed species and dredge operations, it is difficult to predict the number of interactions that are likely to occur from a particular dredging operation. Projects that occur in an identical location with the same equipment year after year may result in interactions in some years and none in other years as noted in the examples of sea turtle takes above. Dredging operations may go on for months, with sea turtle takes occurring intermittently throughout the duration of the action. For example, dredging occurred at Cape Henry over 160 days in 2002 with 8 sea turtle takes occurring over 3 separate weeks while dredging at York Spit in 1994 resulted in 4 sea turtle takes in one week. In Delaware Bay, dredge cycles have been conducted during the May-November period with no observed entrainment and as many as two sea turtles have been entrained in as little as three weeks. Even in locations where thousands of sea turtles are known to be present (e.g., Chesapeake Bay) and where dredges are operating in areas with preferred sea turtle depths and forage items (as evidenced by entrainment of these species in the dredge), the numbers of sea turtles entrained is an extremely small percentage of the likely number of sea turtles in the action area. This is likely due to the distribution of individuals throughout the action area, the relatively small area which is affected at any given moment and the ability of some sea turtles to avoid the dredge even if they are in the immediate area.

The number of interactions between dredge equipment and sea turtles seems to be best associated with the volume of material removed, which is closely correlated to the length of time dredging takes, with a greater number of interactions associated with a greater volume of material removed and a longer duration of dredging. The number of interactions is also heavily influenced by the time of year dredging occurs (with more interactions correlated to times of year when more sea turtles are present in the action area) and the type of dredge plant used (sea turtles are apparently capable of avoiding pipeline and mechanical dredges as no takes of sea turtles have been reported with these types of dredges). The number of interactions may also be influenced by the terrain in the area being dredged, with interactions more likely when the draghead is moving up and off the bottom frequently. Interactions are also more likely at times and in areas when sea turtle forage items are concentrated in the area being dredged, as sea turtles are more likely to be spending time on the bottom while foraging.

Few interactions with listed sea turtles have been recorded during dredging at offshore borrow areas. This is likely due to the transitory nature of most sea turtles occurring in offshore borrow areas as well as the widely distributed nature of sea turtles in offshore waters. This lack of information is also largely due to the infrequency of dredging in offshore borrow areas in the USACE NAD, which makes it even more difficult to predict the likely number of interactions between this action and listed sea turtles. However, as sea turtles have been documented in the action area and suitable habitat and forage items are present, it is likely that sea turtles will be present in the action area when dredging takes place. As sea turtles are likely to be less concentrated in the action area than they are while foraging in Virginia waters such as the entrance channels to the Chesapeake Bay, the level of interactions during this project are likely to be fewer than those recorded during dredging in the Chesapeake Bay area (i.e., the Thimble Shoals and Cape Henry projects noted above).

In the USACE Sea Turtle Database, records for 34 projects occurring during "sea turtle season" (i.e., April 1 – November 30) are available that report the cubic yardage removed during a project (see Table 2). As noted above, the most complete information is available for the Norfolk district.

Records for 19 projects occurring in the April – November time frame that report cubic yards removed are available for channels in the Chesapeake Bay (see Table 3). NMFS has made calculations from that data which indicate that, in the Norfolk District, an average of 1 sea turtle is killed for approximately every 290,000 cubic yards (cy) removed. This calculation has been based on a number of assumptions including the following: that sea turtles are evenly distributed throughout all channels and borrow areas for which takes have occurred, that all dredges will take an identical number of sea turtles, and that sea turtles are equally likely to be encountered throughout the April to November time frame.

Table 2. Dredging projects in USACE NAD with recorded cubic yardage

Project Location	**Year of Operation**	**Cubic Yards Removed**	**Observed Takes**
York Spit Channel	2009	372,533	0
Dewey and Bethany Beach (DE)	2009	397,956	0
York Spit	2007	608,000	1 Kemp's Ridley
Atlantic Ocean Channel	2006	1,118,749	0
Thimble Shoal Channel	2006	300,000	1 loggerhead
Dewey Beach/Cape Henlopen (DE Bay)	2005	1,134,329	0
Delaware Bay	2005	50,000	2 Loggerheads
Cape May	2004	2,425,268	0
Thimble Shoal Channel	2004	139,200	0
Thimble Shoal Channel	2003	1,828,312	7 Loggerheads 1 Kemp's ridley 1 unknown
York River Entrance Channel	2003	343,092	0
Off Ocean City MD	2002	744,827	0
Cape Henry	2002	1,407,814	6 Loggerheads 1 Kemp's ridley 1 green
York Spit Channel	2002	911,406	8 Loggerheads 1 Kemp's ridley
Chincoteague Inlet	2002	84,479	0
Cape Henry	2001	1,641,140	2 loggerheads 1 Kemp's ridley
Cape Henry	2001	1,641,140	0
Thimble Shoal Channel	2000	831,761	2 loggerheads 1 unknown
Cape Henry	2000	759,986	0
York River Entrance Channel	1998	672,536	6 loggerheads
Off Ocean City MD	1998	1,289,817	0
York Spit Channel	1998	296,140	0
Atlantic Coast of NJ	1997	1,000,000	1 Loggerhead
Thimble Shoal Channel	1996	529,301	1 loggerhead
Delaware Bay	1995	218,151	1 Loggerhead
Cape Henry Channel	1995	485,885	0
Bethany Beach (DE Bay)	1994	184,451	0
York Spit Channel	1994	61,299	4 loggerheads
Cape Henry	1994	552,671	4 loggerheads 1 unknown
Dewey Beach (DE Bay)	1994	907,740	0
Off Ocean City MD	1994	1,245,125	0
Off Ocean City MD	1992	1,592,262	3 Loggerheads
Off Ocean City MD	1991	1,622,776	0
Off Ocean City MD	1990	2,198,987	0
	TOTAL	***29,597,133 cy***	***57 Turtles***

Table 3. Projects in USACE NAD with recorded cubic yardage – Chesapeake Bay Only

Project Location	Year of Operation	Cubic Yards Removed	Observed Takes
York Spit Channel	2009	372,533	0
York Spit	2007	608,000	1 Kemp's Ridley
Atlantic Ocean Channel	2006	1,118,749	0
Thimble Shoal Channel	2006	300,000	1 loggerhead
Thimble Shoal Channel	2004	139,200	0
Thimble Shoal Channel	2003	1,828,312	7 Loggerheads 1 Kemp's ridley 1 unknown
York River Entrance Channel	2003	343,092	0
Cape Henry	2002	1,407,814	6 Loggerheads 1 Kemp's ridley 1 green
York Spit Channel	2002	911,406	8 Loggerheads 1 Kemp's ridley
Cape Henry	2001	1,641,140	2 loggerheads 1 Kemp's ridley
Cape Henry	2001	1,641,140	0
Thimble Shoal Channel	2000	831,761	2 loggerheads 1 unknown
Cape Henry	2000	759,986	0
York River Entrance Channel	1998	672,536	6 loggerheads
York Spit Channel	1998	296,140	0
Thimble Shoal Channel	1996	529,301	1 loggerhead
Cape Henry Channel	1995	485,885	0
York Spit Channel	1994	61,299	4 loggerheads
Cape Henry	1994	552,671	4 loggerheads 1 unknown
	TOTAL	***14,500,965 cy***	***50 turtles***

As noted above, sea turtles are likely to be less concentrated in the action area for this consultation than they are in the Chesapeake Bay area. Based on this information, NMFS believes that hopper dredges operating in the offshore borrow areas are less likely to interact with sea turtles than hopper dredges operating in the Chesapeake Bay area. Based on habitat characteristics and geographic area, the level of interactions during this project may be more comparable to the level of interactions recorded for dredging projects in Delaware Bay or offshore New York and New Jersey (i.e., Cape May, Sea Girt, lower Delaware Bay).

Records for 15 projects occurring during "sea turtle season" (i.e., April 1 – November 30) in the

Baltimore, Philadelphia and New York District (all offshore) are available that report the cubic yardage removed during a project; however an important caveat is that observer coverage at these projects has ranged from 0 to 50% (see Table 4).

As explained above, for projects prior to 1995, observers were only present on the dredge for every other week of dredging. For projects in 1995 to the present, observers were present on board the dredge full time and worked a 6-hour on, 6-hour off shift. The only time that cages (where sea turtle parts are typically observed) were cleaned by anyone other than the observer was when there was a clog. If a turtle or turtle part was observed in such an instance, crew were instructed to inform the observer, even if off-duty. As such, it is reasonable to expect that even though there was only 50% observer coverage, an extremely small amount of biological material went unobserved. To make the data from the 1993 and 1994 dredge events when observers were only on board every other week, comparable to the 1995-2006 data when observers were on board full time, NMFS has assumed that an equal number of turtles were entrained when observers were not present. This calculation is reflected in Table 4 as "adjusted entrainment number."

Table 4. Projects in USACE NAD with recorded cubic yardage (with Chesapeake Bay projects removed)

Project Location	**Year of Operation**	**Cubic Yards Removed**	**Observed Entrainment**	**Adjusted Entrainment Number**
Dewey and Bethany Beach (DE)	2009	397,956	0	0
Dewey Beach/Cape Henlopen (DE Bay)	2005	1,134,329	0	0
Delaware Bay	2005	50,000	2 Loggerhead	2 Loggerhead
Cape May	2004	2,425,268	0	0
Off Ocean City MD	2002	744,827	0	0
Chincoteague Inlet	2002	84,479	0	0
Offshore New Jersey	1997	1,000,000	1 Loggerhead	1 Loggerhead
Off Ocean City MD	1998	1,289,817	0	0
Delaware Bay	1995	218,151	1 Loggerhead	1 Loggerhead
Bethany Beach (DE Bay)	1994	184,451	0	0
Dewey Beach (DE Bay)	1994	907,740	0	0
Off Ocean City MD	1994	1,245,125	0	0
Off Ocean City MD	1992	1,592,262	3 Loggerheads	6 Loggerheads
Off Ocean City MD	1991	1,622,776	0	0
Off Ocean City MD	1990	2,198,987	0	0
	TOTAL	***15,096,168***	***7 Loggerheads***	***10 Loggerheads***

As information available (number of days dredged, cubic yards removed) on projects outside of the Norfolk District is incomplete and observer coverage has been relatively low, it is difficult to estimate the number of sea turtles likely to be taken in these areas. The most reasonable approach is to calculate the number of sea turtles taken during projects where cubic yardage is available, not just for projects where take has occurred (which would overestimate the likelihood of interactions). Using this method, and based on the adjusted entrainment number in Table 4, an estimate of 1 sea turtle per 1.5 million cubic yards is calculated. As noted above, it is likely that including the Norfolk District data would overestimate the number of interactions in offshore borrow areas likely due to the concentration of sea turtles in the Chesapeake Bay and differences in habitat between the Norfolk District's Chesapeake Bay entrance channels and the offshore locations dredged in the other districts. Therefore, the best available information indicates that for dredging in offshore borrow areas outside of the Chesapeake Bay, 1 sea turtle is likely to be entrained for every 1.5 million cubic yards of material removed by a hopper dredge. This calculation has been based on a number of assumptions including the following: that sea turtles are evenly distributed throughout all borrow areas, that all dredges will take an identical number of sea turtles, and that sea turtles are equally likely to be encountered throughout the April to November time frame.

With the exception of one green turtle in a Virginia dredge, all other sea turtles entrained in dredges operating in the USACE NAD have been loggerheads and Kemp's ridley. Of these 72 sea turtles, 62 have been loggerhead, 5 have been Kemp's ridleys, 1 green and 4 unknown. Overall, of those identified to species, approximately 90% of the sea turtles taken in dredges operating in the USACE North Atlantic Division have been loggerheads. No Kemp's ridleys or greens have been taken in dredge operations outside of the Chesapeake Bay area. The high percentage of loggerheads is likely due to several factors including their tendency to forage on the bottom where the dredge is operating and the fact that this species is the most numerous of the sea turtle species in Northeast and Mid-Atlantic waters. It is likely that the documentation of only one green sea turtle take in Virginia dredging operations is a reflection of the low numbers of green sea turtles that occur in waters north of North Carolina. The low number of green sea turtles in the action area makes an interaction with a green sea turtle extremely unlikely to occur.

Based on the above information, NMFS believes that it is reasonable to expect that 1 sea turtle is likely to be injured or killed for approximately every 1.5 million cy of material removed from the proposed borrow area and that at least 90% will be loggerheads. Based on the information outlined above, NMFS anticipates that no more than 3 sea turtles are likely to be entrained in the initial dredge cycle when 3,998,750 cy of material is removed. Maintenance dredging operations are expected to remove up to 1,007,500 cy of sand every 5 years. Over the 50 year life of the SRIPP 9 maintenance cycles will occur removing approximately 9,067,500 cubic yards of material from the shoals, preferably Shoal A, resulting in the death of no more than 6 sea turtles are likely to be killed. Due to the nature of the injuries expected to result from entrainment, all of the turtles are expected to die.

NMFS expects that nearly all of the sea turtles will be loggerheads and that the entrainment of a Kemp's ridley during a particular dredge cycle will be rare; however, as Kemp's ridleys have been documented in the action area and have been entrained in hopper dredges, it is likely that this species will interact with the dredge over the course of the project life. As explained above, approximately 90% of the sea turtles taken in dredges operating in the USACE North Atlantic Division have been loggerheads. Based on that ratio, NMFS anticipates that over the life of the project, for every 10 sea turtle interactions only 1 of them is likely to be with a Kemp's ridley. As noted above, no interactions with green sea turtles are likely. The USACE has indicated that over the life of the project, approximately 13,066,250 cy of material will be removed from the borrow area. As such, over the life of the project (i.e., through 2061), NMFS anticipates that up to 9 sea turtles could be killed, with no more than 1 being a Kemp's ridley.

As explained in the Status of the Species section, loggerheads in the action area are most likely to come from the northern nesting subpopulation and the south Florida nesting subpopulation with a smaller portion from the Yucatan subpopulation. Based on the best available information on sea turtles in the action area, NMFS anticipates that a loggerhead entrained at the Wallops Island borrow site is likely to be either a benthic immature or sexually mature turtle. There is no information to suggest that either sex is disproportionately taken in hopper dredges. Therefore, either a male or female loggerhead may be entrained in the dredge.

Interactions with the Sediment Plume

Dredging operations cause sediment to be suspended in the water column. This results in a sediment plume in the water, typically present from the dredge site and decreasing in concentration as sediment falls out of the water column as distance increases from the dredge site. The nature, degree, and extent of sediment suspension around a dredging operation are controlled by many factors including: the particle size distribution, solids concentration, and composition of the dredged material; the dredge type and size, discharge/cutter configuration, discharge rate, and solids concentration of the slurry; operational procedures used; and the characteristics of the hydraulic regime in the vicinity of the operation, including water composition, temperature and hydrodynamic forces (i.e., waves, currents, etc.) causing vertical and horizontal mixing (USACE 1983).

Resuspension of fine-grained dredged material during hopper dredging operations is caused by the dragheads as they are pulled through the sediment, turbulence generated by the vessel and its prop wash, and overflow of turbid water during hopper filling operations. During the filling operation, dredged material slurry is often pumped into the hoppers after they have been filled with slurry in order to maximize the amount of solid material in the hopper. The lower density turbid water at the surface of the filled hoppers overflows and is usually discharged through ports located near the waterline of the dredge. In the vicinity of hopper dredge operations, a near-bottom turbidity plume of resuspended bottom material may extend 2,300 to 2,400 ft down current from the dredge. In the immediate vicinity of the dredge, a well-defined upper plume is generated by the overflow process. Approximately 1,000 ft behind the dredge, the two plumes merge into a single plume. Suspended solid concentrations may be as high as several tens of parts per thousand (ppt; grams per liter) near the discharge port and as high as a few parts per thousand near the draghead. In a study done by Anchor Environmental (2003), nearfield concentrations ranged from 80.0-475.0 mg/l. Turbidity levels in the near-surface plume appear to decrease exponentially with increasing distance from the dredge due to settling and dispersion, quickly reaching concentrations less than 1 ppt. By a distance of 4000 feet from the dredge, plume concentrations are expected to return to background levels. Studies also indicate that in almost all cases, the vast majority of resuspended sediments resettle close to the dredge within one hour, and only a small fraction takes longer to resettle (Anchor Environmental 2003).

No information is available on the effects of total suspended solids (TSS) on juvenile and adult sea turtles or whales. Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). TSS is most likely to affect sea turtles or whales if a plume causes a barrier to normal behaviors or if sediment settles on the bottom affecting sea turtle prey. As sea turtles and whales are highly mobile they are likely to be able to avoid any sediment plume and any effect on sea turtle or whale movements is likely to be insignificant. Additionally, the TSS levels expected are below those shown to have an adverse effect on fish (580.0 mg/L for the most sensitive species, with 1,000.0 mg/L more typical (Breitburg 1988 in Burton 1993; Summerfelt and Moiser 1976 and Combs 1979 in Burton 1993)) and benthic communities (390.0 mg/L (EPA 1986)).

While the increase in suspended sediments may cause sea turtles or whales to alter their normal movements, any change in behavior is likely to be insignificant as it will only involve movement to alter course out of the sediment plume. Based on this information, any increase in suspended sediment is not likely to affect the movement of sea turtles or whales between foraging areas or while migrating or otherwise negatively affect listed species in the action area. Based on this information, it is likely that the effect of the suspension of sediment resulting from dredging operations will be insignificant.

Collisions with dredges

There have not been any reports of dredge vessels colliding with listed species, but contact injuries resulting from dredge movements could occur at or near the water surface and could therefore involve any of the listed species present in the action area. Because the dredge is unlikely to be moving at speeds greater than three knots during dredging operations, blunt trauma injuries resulting from contact with the hull are unlikely during dredging operations. It is more likely that contact injuries during actual dredging would involve the propeller of the vessel and are more likely to occur when the dredge is moving from the dredging area to port or between dredge locations. While the distance between these areas is relatively short, the dredge in transit would be moving at faster speeds (i.e., 10 knots) than during dredging operations (i.e., 3 knots), particularly when empty and returning to the borrow area. The speed of the dredge while empty is not expected to exceed 10 knots.

The dredge vessel may collide with marine mammals and sea turtles when they are at the surface. These species have been documented with injuries consistent with vessel interactions and it is reasonable to believe that the dredge vessels considered in this Opinion could inflict such injuries on marine mammals and sea turtles, should they collide. As mentioned, sea turtles are found distributed throughout the action area in the warmer months, generally from April through November, while right whales are likely to be present from November-May; humpbacks from September-April; and fin whales from October-January; however, individual transient right whales could be present in the action area outside of these time frame as the this area serves as a migration corridor for whales migrating between calving/mating grounds and foraging grounds.

Effects of Vessel Collisions on Sea Turtles

Interactions between vessels and sea turtles occur and can take many forms, from the most severe (death or bisection of an animal or penetration to the viscera), to severed limbs or cracks to the carapace which can also lead to mortality directly or indirectly. Sea turtle stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993, about 9% of living and dead stranded sea turtles had propeller or other boat strike injuries (Lutcavage *et al.* 1997). According to STSSN stranding data from 2001-2008, at least 520 sea turtles (loggerhead, green, Kemp's ridley and leatherbacks) that stranded on beaches within the NMFS Northeast Region (Maine through Virginia) showed evidence of propeller wounds and were, therefore, probable vessel strikes. In the vast majority of cases, it is unknown whether these injuries occurred pre or post mortem; however, in 18 cases there was evidence that the turtle was alive at the time of the strike.

Information is lacking on the type or speed of vessels involved in turtle vessel strikes. However, there does appear to be a correlation between the number of vessel struck turtles and the level of recreational boat traffic (NRC 1990). Although little is known about a sea turtle's reaction to vessel traffic, it is generally assumed that turtles are more likely to avoid injury from slower-moving vessels since the turtle has more time to maneuver and avoid the vessel. The speed of the dredge is not expected to exceed 3 knots while dredging or transiting to the pump site with a full load and is expected to operate at a maximum speed of 10 knots while empty. As such, the 10 knot or less speed of the dredge vessel is likely to reduce the chances of collision with a sea turtle. In addition, the risk of ship strike will be influenced by the amount of time the animal remains near the surface of the water. For the proposed action, the greatest risk of vessel collision will occur during transit between shore and the offshore Wallops Island borrow sites to be dredged. Sea turtles present in these shallow nearshore waters are most likely to be foraging along the bottom. The presence of an experienced endangered species observer who can advise the vessel operator to slow the vessel or maneuver safely when sea turtles are spotted will further reduce to a discountable level the potential for interaction with vessels.

Effects of Vessel Collisions on Whales
Large whales, particularly right whales, are vulnerable to injury and mortality from ship strikes. Ship strike injuries to whales take two forms: (1) propeller wounds characterized by external gashes or severed tail stocks; and (2) blunt trauma injuries indicated by fractured skulls, jaws, and vertebrae, and massive bruises that sometimes lack external expression (Laist *et al.* 2001). Collisions with smaller vessels may result in propeller wounds or no apparent injury, depending on the severity of the incident. Laist et al. (2001) reports that of 41 ship strike accounts that reported vessel speed, no lethal or severe injuries occurred at speeds below ten knots, and no collisions have been reported for vessels traveling less than six knots. A majority of whale ship strikes seem to occur over or near the continental shelf, probably reflecting the concentration of vessel traffic and whales in these areas (Laist *et al.* 2001). As discussed in the Status of the Species section, all whales are potentially subject to collisions with ships. However, due to their critical population status, slow speed, and behavioral characteristics that cause them to remain at the surface, vessel collisions pose the greatest threat to right whales. From 2003-2007, NMFS confirmed that 7 female right whales have been killed by ship collisions, one of which was carrying a near-term fetus. Because females are more critical to a population's ability to replace its numbers and grow, the premature loss of even one reproductively mature female could hinder the species' likelihood of recovering.

On October 10, 2008 a final rule for the Ship Strike Reduction Strategy was issued (50 CFR 224.105). The final rule mandates all vessels, 65 feet or greater, to travel at speeds of 10 knots or less within seasonal management units (designated for right whales) located along the East Coast of the United States. These measures outlined in the NMFS Ship Strike Reduction Strategy are the best available means of reducing ship strikes of right whales. Most ship strikes have occurred at vessel speeds of 13-15 knots or greater (Jensen and Silber 2003; Laist et al. 2001). An analysis by Vanderlaan and Taggart (2006) showed that at speeds greater than 15 knots, the probability of a ship strike resulting in death increases asymptotically to 100%. At speeds below 11.8 knots, the probability decreases to less than 50%, and at ten knots or less, the probability is further reduced to approximately 30%. Although these measures have been developed specifically with right whales in mind, the speed reduction is likely to provide protection for other large whales as well, as these species are generally faster swimmers and are more likely to be able to avoid oncoming vessels. As noted above, under the proposed action, the speed of the dredge is not expected to exceed 3 knots while dredging or while transiting to the pump out site with a full load, and it is expected to operate at a maximum speed of 10 knots while empty. As such, compliance with 50 CFR 224.105 is expected throughout the life of the SRIPP. In addition, all vessels operators and observers will receive training on prudent vessel operating procedures to avoid vessel strikes with all protected species, which will further reduce to a discountable level the potential for interaction with vessels.

Synthesis of the Effects of Vessel Collisions on Listed Species

Although the threat of vessel collision exists anywhere listed species and vessel activity overlap, ship strike is more likely to occur in areas where high vessel traffic coincides with high species density. In addition, ship strikes are more likely to occur and more likely to result in serious injury or mortality when vessels are traveling at speeds greater than ten knots. As noted above, compliance with 50 CFR 224.105 is expected throughout the life of the SRIPP. As such, with dredge vessels moving at speeds of 10 knots or less, dredge vessels in the action area are not likely to pose a vessel strike risk to listed species of whales and sea turtles. In addition, the onboard observer will be able to watch for whales and sea turtles while the vessel is in transit and provide information to both dredges operating in the action area about the location of sea turtles and whales nearby, thereby allowing vessels to reduce their speeds further and/or alter their course accordingly. Based on the best available information on sea turtle and whale interactions with vessels, and the fact that vessel strike avoidance measures will be in place, NMFS concludes that the likelihood of dredge related vessel traffic resulting in the collision with a whale or sea turtle is discountable.

Dredge Noise

When anthropogenic disturbances elicit responses from sea turtles and marine mammals, it is not always clear whether they are responding to visual stimuli, the physical presence of humans or manmade structures, acoustic stimuli, or any combination of these. However, because sound travels well underwater it is reasonable to assume that, in many conditions, marine organisms would be able to detect sounds from anthropogenic activities before receiving visual stimuli. As such, exploring the acoustic effects of the proposed dredging operations provides a reasonable and conservative estimate of the magnitude of disturbance caused by the general presence of a hopper dredge in the marine environment, as well as the specific effects of sound on marine mammal and sea turtle behavior.

Marine organisms rely on sound to communicate with conspecifics and derive information about their environment. There is growing concern about the effect of increasing ocean noise levels due to anthropogenic sources on marine taxa, particularly marine mammals. Effects of noise exposure on these taxa can be characterized by the following range of behavioral and physical responses (Richardson *et al.* 1995):

1. Behavioral reactions – Range from brief startle responses, to changes or interruptions in feeding, diving, or respiratory patterns, to cessation of vocalizations, to temporary or permanent displacement from habitat.
2. Masking – Reduction in ability to detect communication or other relevant sound signals due to elevated levels of background noise.
3. Temporary threshold shift (TTS) – Temporary, fully recoverable reduction in hearing sensitivity caused by exposure to sound. TTS may occur within specified frequency range or across all frequency ranges.
4. Permanent threshold shift (PTS) – Permanent, irreversible reduction in hearing sensitivity due to damage or injury to ear structures caused by prolonged exposure to sound or temporary exposure to very intense sound. PTS may occur within a specified frequency range or across

all frequency ranges.

5. Non-auditory physiological effects – Effects of sound exposure on tissues in non-auditory systems either through direct exposure or as a consequence of changes in behavior (e.g., resonance of respiratory cavities or growth of gas bubbles in body fluids).

Under the proposed action, dredging will produce sound that may affect listed species of sea turtles and whales. NMFS is in the process of developing a comprehensive acoustic policy that will provide guidance on assessing the impacts of anthropogenically produced sound on marine mammals. In the interim, NMFS' current thresholds for determining impacts to marine mammals typically center around root-mean-square (RMS) received levels of 180 dB re 1μPa for potential injury, 160 dB re 1μPa for behavioral disturbance/harassment from an impulsive noise source (e.g., seismic survey), and 120 dB re 1μPa for behavioral disturbance/harassment from a continuous noise source (e.g., dredging). These thresholds are based on a limited number of experimental studies on captive odontocetes and pinnipeds, a limited number of controlled field studies on wild marine mammals, observations of marine mammal behavior in the wild, and inferences from studies of hearing in terrestrial mammals. In addition, marine mammal responses to sound can be highly variable, depending on the individual hearing sensitivity of the animal, the behavioral or motivational state at the time of exposure, past exposure to the noise which may have caused habituation or sensitization, demographic factors, habitat characteristics, environmental factors that affect sound transmission, and non-acoustic characteristics of the sound source, such as whether it is stationary or moving (NRC 2003). Nonetheless, the threshold levels referred to above are considered conservative and are based on the best available scientific information and will be used as guidance in the analysis of effects for this BO.

Noise generated by dredges are considered continuous and low in frequency (i.e., no rapid rise times and below 1000 Hertz (Hz)) (MALSF 2009; 74FR 46090, September 8, 2009) and as such, are within the audible range of listed species of whales and sea turtles likely to occur in the action area (e.g., auditory bandwidth for right, humpback, and fin whales are 7 Hz-22kHz (Southall *et al.* 2007); hearing thresholds for sea turtles are 100-1000 Hz (Ketten and Bartol 2005)). Low frequency noise tends to carry long distances in water, but due to spreading loss, is attenuated as the distance from the source increases. Under the proposed action, underwater noise will be generated through the use of a hopper dredge. The primary noise produced from a hopper dredge is associated with the suction pipes and pumps used to remove the fill from the seabed; however, these noise levels fluctuate with the operational status of the dredge, with the highest levels occurring during loading operations (i.e., during the removal of the substrate) (Greene 1985a, 1987). Greene (1987) measured hopper dredge noise during the removal of gravel in the Beaufort Sea and reported received levels of 142 dB re 1μPa at 0.93 kilometers (km) (0.58 miles) for loading operations at a depth of 20 meters, 127 dB re 1μPa at 2.4 km (1.5 miles) while underway, and 117 dB re 1μPa at 13.3 km (8.3 miles) while pumping at a depth of 13 meters. Based on this information, NASA calculated a worst case estimate of underwater noise levels to the 120dB threshold (i.e., the threshold for continuous noise sources); however, based on the review of the paper by Greene (1987) and a document by the USACE (Clarke *et al.* 2003), which dealt with the removal of sand substrate via a hopper dredge, NMFS has determined that the most appropriate document to use in the analysis of dredge noise, for the purposes of this proposed action, is the information presented by Clarke *et al.* (2003), as it deals with the removal of similar substrate and the recorded levels of underwater noise are in accordance with thresholds established by NMFS (i.e., RMS values) for marine mammals. Additionally, in the analysis of dredge noise and propagation undertaken by NMFS, a transmission loss of 15 log R was used over 10 log R as the latter is more appropriate to use for dredging operations occurring in extremely shallow waters (e.g., less than 25 feet). Based on this information, NMFS has calculated that within 794 meters from the dredge, noise levels could reach 120 dB_{RMS} re 1μPa, with source levels of 164 dB_{RMS} re 1μPa being produced approximately 1 meter from the dredge. It should be noted that to date, equations that take into account other factors affecting perceived underwater noise levels and the propagation of noise (e.g., water depth, frequency, absorptive bottom substrate, ambient noise levels, level of activity in the area, etc.) have not been developed and as such, the estimated distances by NASA and NMFS are most likely overestimates of where increased underwater noise levels will be experienced. Based on the best available information, listed species of whales and sea turtles may be exposed to increased underwater noise levels within the action area; however, the audibility and behavioral response of listed species of whales and sea turtles is dependent on many factors, such as the physical environment (e.g., depth), existing ambient noise, acoustic characteristics of the sound (e.g., frequency), hearing ability of the animal, as well as behavioral context of the animal (e.g., feeding, migrating, resting) (Southall *et al.* 2007).

Exposure Analysis: Right, Humpback, and Fin Whale Hearing
In order for right, humpback, and fin whales to be adversely affected by dredge noise, they must be able to perceive the noises produced by the activities. If a species cannot hear a sound, or hears it poorly, then the sound is unlikely to have a significant effect (Ketten 1998). Baleen whale hearing has not been studied directly, and there are no specific data on sensitivity, frequency or intensity discrimination, or localization (Richardson et al. 1995) for these whales. Thus, predictions about probable impact on baleen whales are based on assumptions about their hearing rather than actual studies of their hearing (Richardson *et al.* 1995; Ketten 1998). Ketten (1998) summarized that the vocalizations of most animals are tightly linked to their peak hearing sensitivity. Hence, it is generally assumed that baleen whales hear in the same range as their typical vocalizations, even though there are no direct data from hearing tests on any baleen whale. Most baleen whale sounds are concentrated at frequencies less than 1 kHz (Richardson *et al.* 1995), although humpback whales can produce songs up to 8 kHz (Payne and Payne 1985). Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies below 1 kHz but can hear sounds up to a considerably higher but unknown frequency. Most of the man made sounds that elicited reactions by baleen whales were at frequencies below 1 kHz (Richardson *et al.* 1995). Some or all baleen whales may hear infrasounds, sounds at frequencies well below those detectable by humans. Functional models indicate that the functional hearing of baleen whales extends to 20 Hz, with an upper range of 30 Hz. Even if the range of sensitive hearing does not extend below 20-50 Hz, whales may hear strong infrasounds at considerably lower frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hz, strong infrasounds at 5 Hz might be detected (Richardson et al. 1995). Fin whales are predicted to hear at frequencies as low as 10-15 Hz. The right whale uses tonal signals in the frequency range from roughly 20 to 1000 Hz, with broadband source levels ranging from 137 to 162 dB (RMS) re 1 μPa at 1 m (Parks & Tyack 2005). One of the more common sounds made by right whales is the "up call," a frequency-modulated upsweep in the 50–200 Hz range (Mellinger 2004). The following table summarizes the range of sounds produced by right, humpback, and fin whales (from Au *et al.* 2000):

Table 5. Summary of known right, humpback, and fin whale vocalizations

Species	Signal type	Frequency Limits (Hz)	Dominant Frequencies (Hz)	Source Level (dB re 1μPa RMS)	References
Northern right	Moans	< 400	--	--	Watkins and Schevill (1972)
	Tonal	20-1000	100-2500	137-162	Parks and Tyack (2005)
	Gunshots		50-2000	174-192	Parks et al. (2005)
Humpback	Grunts	25-1900	25-1900	--	Thompson, Cummings, and Ha (1986)
	Pulses	25-89	25-80	176	Thompson, Cummings, and Ha (1986)
	Songs	30-8000	120-4000	144-174	Payne and Payne (1985)
Fin	FM moans	14-118	20	160-186	Watkins (1981), Edds (1988), Cummings and Thompson (1994)
	Tonal	34-150	34-150		Edds (1988)
	Songs	17-25	17-25	186	Watkins (1981)

Most species also have the ability to hear beyond their region of best sensitivity. This broader range of hearing probably is related to their need to detect other important environmental phenomena, such as the locations of predators or prey. Considerable variation exists among marine mammals in hearing sensitivity and absolute hearing range (Richardson *et al.* 1995; Ketten 1998); however, from what is known of right, humpback, and fin whale hearing and the source levels and dominant frequencies of the dredge noise, it is evident that right, humpback, and fin whales are capable of perceiving dredge noises, and have hearing ranges that are likely to have peak sensitivities in low frequency ranges that overlap the dominant frequencies of noise produced by dredging operations.

Exposure Analysis: Sea Turtle Hearing

The hearing capabilities of sea turtles are poorly known. Few experimental data exist, and since sea turtles do not vocalize, inferences cannot be made from their vocalizations as is the case with baleen whales. Direct hearing measurements have been made in only a few species. An early experiment measured cochlear potential in three Pacific green turtles and suggested a best hearing sensitivity in air of 300–500 Hz and an effective hearing range of 60–1,000 Hz (Ridgway *et al.* 1969). Sea turtle underwater hearing is believed to be about 10 dB less sensitive than their in-air hearing (Lenhardt 1994). Lenhardt *et al.* (1996) used a behavioral "acoustic startle response" to measure the underwater hearing sensitivity of a juvenile Kemp's ridley and a juvenile loggerhead turtle to a 430-Hz tone. Their results suggest that those species have a hearing sensitivity at a frequency similar to those of the green turtles studied by Ridgway et al. (1969). Lenhardt (1994) was also able to induce startle responses in loggerhead turtles to low frequency (20–80 Hz) sounds projected into their tank. He suggested that sea turtles have a range of best hearing from 100–800 Hz, an upper limit of about 2,000 Hz, and serviceable hearing abilities below 80 Hz. More recently, the hearing abilities of loggerhead sea turtles were measured using auditory evoked potentials in 35 juvenile animals caught in tributaries of Chesapeake Bay (Bartol *et al.* 1999). Those experiments suggest that the effective hearing range of the loggerhead sea turtle is 250–750 Hz and that its most sensitive hearing is at 250 Hz. In general, however, these experiments indicate that sea turtles generally hear best at low frequencies and that the upper frequency limit of their hearing is likely about 1 kHz. As such, sea turtles are capable of hearing in low frequency ranges that overlap with the dominant frequencies of dredge noise, and are therefore likely to be exposed to construction-related noise.

Exposure to Injurious Levels of Sound

As described above, NMFS considers 180 dB to be the onset of potential for injury for cetaceans; however, based on the scientific literature, injury likely occurs at some level well above this level. Therefore, this level is considered conservative. Regardless, hopper dredging under the proposed action will not generate source levels in excess of 180 dB re 1μPa and thus is not likely to cause injury to whales or sea turtles. The predominant noise source associated with hopper dredging is caused by the noise generated by suction pipes and pumps. Although source levels of some dredging operations have been reported to reach source levels of 180 dB re 1μPa within 10 meters or less of the dredge, it is extremely unlikely that whales or sea turtles would be exposed to such injurious sound levels as the dredges are moving at very slow speeds (i.e., 10 knots or less), minimizing the likelihood that a sea turtle or whale would be unable to move away from an approaching vessel before the received level reaches a potentially injurious threshold. Based on this information, and the fact that the source levels of dredge noise under the proposed action will not exceed 164 dB_{RMS}, sea turtles and whales are not likely to be exposed to levels of dredge related noise that will result injury.

Exposure to Disturbing Levels of Sound

Injury from dredging noise is not expected; however, there is potential for whales to be exposed to behaviorally disturbing levels of sound produced by these activities. Potentially disturbing levels of construction-related noise (120-160 dB) are expected to propagate over distances ranging from 1.0-794 meters from the source. As dredging operations are proposed to occur year round and humpbacks are likely to occur in the action area from September-April; right whales from November-May; and Fin whales from October-January; and, individual transient whales could be present in the action area outside of these time frame as the this area is used by whales migrating between calving/mating grounds and foraging grounds, there is a potential for listed species to be exposed to increased underwater noise levels at anytime throughout the year.

There is very little information about sea turtle behavioral reactions to levels of sound below the thresholds suspected to cause injury or TTS. However, some studies have demonstrated that sea turtles have fairly limited capacity to detect sound, although all results are based on a limited number of individuals and must be interpreted cautiously. Ridgway et al. (1969) found that one green turtle with a region of best sensitivity around 400 Hz had a hearing threshold of about 126 dB in water. Streeter (in press) found similar results in a captive green sea turtle, which demonstrated a hearing threshold of approximately 125 dB at 400 Hz, but better sensitivity at 200 Hz (110-115 dB threshold). McCauley (2000) noted that dB levels of 166 dB re 1μPa were required before any behavioral reaction was observed. As underwater noise levels produced by dredging operations throughout the 50 year life of the SRIPP will not exceed 166 dB re 1μPa (i.e., maximum underwater noise levels will be 164 dB_{RMS} re 1μPa within 1 meter of the dredge) under water noise levels are not likely to reach levels that will disturb sea turtles. As such, NMFS concludes that dredge noise is not likely to adversely affect sea turtles, and the remainder of the acoustics portion of the analysis will focus on the effects of dredge noise on listed species of whales.

Effects of Dredge Noise

Characterizing the effects of noise on whales and sea turtles involves assessing the species' sensitivity to the particular frequency range of the sound; the intensity, duration, and frequency of the exposure; the potential physiological effects caused by the animals response to the increase in underwater noise; and, the potential behavioral responses that could lead to impairment of feeding, breeding, nursing, breathing, sheltering, migration, or other biologically important functions. To date, few studies have been done that analyze and assess the effects of dredge noise and operations on marine mammals. Much of any analysis involving the effects of anthropogenic sounds on listed species relates to how an animal may change behavior upon exposure to vessel noise and operations (e.g., drillships and seismic vessels) and as such, will be used as the best available information in referencing potential effects of dredge noise on listed species of whales.

The most commonly observed marine mammal behavioral responses to vessel noise and activities include increased swim speed (Watkins 1981), horizontal and vertical (diving) avoidance (Baker et al 1983; Richardson *et al.* 1985), changes in respiration or dive rate (Baker *et al.* 1982; Bauer and Herman 1985; Richardson *et al.* 1985; Baker and Herman 1989; Jahoda *et al.* 2003), and interruptions or changes in feeding or social behaviors (Richardson *et al.* 1985; Baker *et al.* 1982; Jahoda *et al.* 2003). However, Watkins *et al.* (1981) noted that the passage of a tanker within 800 m did not disrupt feeding humpback whales and Brewer *et al.* (1993) and Hall *et al.* (1994) reported numerous sightings of marine mammals, including bowhead whales, in the vicinity of offshore drilling operations in the Beaufort Sea, with one whale sighted 400 m of the drilling vessel. Additionally, based on the review of a number of papers describing the response of marine mammals to non-pulsed sound, Southall *et al.* (2007) reported that in general, behavioral responses of marine mammals did not occur until sounds were higher than 120 dB and that many animals had no observable response at all when exposed to anthropogenic sound at levels of 120 dB or even higher.

Although the above studies demonstrate that a high degree of variability exists in the intensity of responses of marine mammals to vessel noise and activities, it is still unclear whether these responses are due solely to the increase in underwater noise levels, the physical presence of a nearby vessel, or a combination of both. Often, specific acoustic features of the sound and contextual variables (i.e., proximity, durations, or recurrence of the sound or the current behavior that the marine mammal is engaged in or its prior experience), as well as entirely separate factors such as the physical presence of a nearby vessel, may be more relevant to the animal's response than the received level alone (75 FR Register 20482, April 19, 2010). For instance, Baker *et al.* (1982) found that abrupt changes in engine speed and aggressive maneuvers such as circling the whale or crossing directly behind or in front of the whale or its projected path elicited much stronger responses than unobtrusive maneuvering (tracking in parallel to the whale and changing vessel speed only when necessary to maintain a safe distance from the whale). Reactions were even less intense during a simple straight line passby, which most closely represents the type of vessel transit that will take place as a result of the construction activities (i.e., not targeted toward viewing whales).

Richardson *et al.* (1985) observed strong reactions in bowhead whales to approaching boats and subtler reactions to drillship playbacks, but also found that bowhead whales often occurred in areas where low frequency underwater noise from drillships, dredges, or seismic vessels was readily detectable, suggesting that bowheads may react to transient or recently begun industrial activities, but may tolerate noise from operations that continue with little change for extended periods of time (hours or days).

Watkins (1986) compiled and summarized whale responses to human activities in Cape Cod Bay over 25 years, and found that the types of reactions had shifted over the course of time, generally from predominantly negative responses to an increasing number of uninterested or positive responses, although trends varied by species and only emerged over relatively long spans of time (i.e., individual variability from one experience to the next remains high). Watkins also noted that whales generally appeared to habituate rapidly to stimuli that were relatively non-disturbing.

One playback experiment on right whales recorded behavioral reactions on summer foraging grounds to different stimuli, including an alert signal, vessel noise, other whale social sounds, and a silent control (Nowacek *et al.* 2004). No significant response was observed in any case except the alert signal broadcast ranging from 500-4500 Hz. In response to the alert signal, which had measured received levels between 130 and 150 dB, whales abandoned current foraging dives, began a high power ascent, remained at or near the surface for the duration of the exposure, and spent more time at subsurface depths (1–10 m) (Nowacek *et al.* 2004). The only whale that did not respond to this signal was the sixth and final whale tested, which had potentially already been exposed to the sound five times. The lack of response to a vessel noise stimulus from a container ship and from passing vessels indicated that whales are unlikely to respond to the sounds of approaching vessels even when they can hear them (Nowacek *et al.* 2004). This non-avoidance behavior could be an indication that right whales have become habituated to the vessel noise in the ocean and therefore do not feel the need to respond to the noise or may not perceive it as a threat. In another study, scientists played a recording of a tanker using an underwater sound source and observed no response from a tagged whale 600 meters away (Johnson and Tyack 2003). These studies may suggest that if right whales are startled or disturbed by novel construction sounds, they may temporarily abandon feeding activities, but may habituate to those sounds over time, particularly if the sounds are not associated with any aversive conditions.

The evidence presented above indicates that animals do respond and modify behavioral patterns in the presence of vessel noise and activity, although adequate data does not yet exist to quantitatively assess or predict the significance of minor alterations in behavior to the health and viability of marine mammal and sea turtle populations. Based on this information it is reasonable to assume that the potential exists that dredge noise and operations under the proposed action may similarly cause behavioral changes to listed species of whales in the action area. However, in previous studies the areas of research were known to be sites where whales concentrated and as such had a higher probability of being exposed to elevated underwater noise levels that resulted in behavioral alterations. The action area is not known as an area where listed species of whales congregate for the purposes of foraging, resting, or reproduction. Instead, the action area is primarily used for migration to and from foraging and calving grounds throughout the year. As such, the behavioral responses observed in previous studies due to vessel noise and operations are extremely unlikely to occur under the proposed action as it is extremely unlikely that whales will be found in high concentrations in the action area, resulting in an extremely low probability that a whale will be within 794 meters of the dredge at any one time and therefore, exposed to levels of underwater noise levels that could adversely affect and/or cause behavioral changes to the animal in a manner that disrupts essential behaviors (e.g., feeding, resting, migrating, reproducing). In addition, in the unlikely event that a whale approaches the area where the dredge is in operation, the mitigation measures NASA has established as part of the proposed action (e.g., NMFS approved sea turtle/marine mammal observer on board all dredge vessels from April-November and a designated lookout/bridge watch on board all dredge vessels from December 1- March 31; shut down of dredge pumps when a whale is observed within 1 km of the dredge; 500 yard restriction on vessel approach to right whales; compliance with SAS operations), will ensure that whales will not be exposed to underwater noise levels greater than or equal to 120 dB. Based on the best available information, NMFS concludes that the effects of dredge noise on listed species of whales will be insignificant and discountable.

In addition, it should be noted that when assessing the potential effects of anthropogenic noise on marine mammals, it is important to consider that there are "zones of audibility" and "zones of responsiveness" that will affect marine mammal responses to anthropogenic noise. The most extensive zone is the zone of audibility, the area within which the mammal might hear noise (Richardson *et al.* 1995). The zone of responsiveness is the region within which the animal reacts behaviorally (i.e., stop feeding) or physiologically (i.e., increase in respiratory rates) (Richardson *et al.* 1995). Marine mammals usually do not respond overtly to audible, but weak man made sounds and therefore, the zone of responsiveness is usually much smaller than the zone of audibility (Richardson *et al.* 1995). It has believed that marine mammals will not remain in areas where received levels of continuous underwater noise are 140 + dB at frequencies to which the animals are most sensitive (Richardson *et al.* 1995). As such, although underwater noise levels of 120 dB may be audible to listed species of whales within 794 meters of the dredge, the behavioral response to elevated noise levels most likely will occur within 40 meters or less from the dredge where underwater noise levels will be greater than or equal to 140 dB. As noted above, it is extremely unlikely for whales to be within 1 km of the dredge and therefore, extremely unlikely for a whale to be within 40 meters or less of the dredge where responses to underwater noise levels are believed to occur. In addition, with the mitigation measures in place, listed species of whales will not be exposed to levels greater than or equal 120 dB as all pumps will be turned off upon a whale observed within 1 km of the dredge. As such, based on the best available information, NMFS concludes that the effects of dredge noise on listed species of whales is discountable.

Fuel Oil Spills

Fuel oil spills could occur from the dredge plant or tender vessel. A fuel oil spill would be an unintended, unpredictable event. Marine animals, including whales and sea turtles, are known to be negatively impacted by exposure to oil and other petroleum products. Without an estimate of the amount of fuel oil released it is difficult to predict the likely effects on listed species. No accidental spills of diesel fuel are expected during dredging operations; however, if such an incident does occur, implementation of the USCG-approved safety response plans or procedures outlined in the WFF Integrated Contingency Plan (ICP) to prevent and minimize any impacts associated with a spill will be implemented by all personnel to ensure a rapid response to any spill. As the effects of a possible spill are likely to be localized and temporary, sea turtles and whales are not likely to be exposed to oil and any effects would be discountable. Additionally, should a response be required by the United States Environmental Protection Agency or the USCG, there would be an opportunity for NMFS to conduct a consultation with the lead Federal agency on the oil spill response.

Effects of Sand Placement/Beach Renourishment

As noted in the Description of the Action, 3.7 miles of the Wallops Island shoreline will receive beach fill and renourishment over the 50 year life of the SRIPP. Initial nourishment will require the placement of 3.2 million cy of sand along the shoreline, with 806,000 cy of fill placed every 5 years for renourishment. The initial fill will be placed so that there will be a 6-foot high berm extending a minimum of 70-feet seaward of the existing seawall. The remainder of the fill will slope underwater for an additional distance seaward. The amount will vary along the length of the beach fill, but will extend a maximum of about 170-feet so that the total distance of the fill profile from the seawall will be up to approximately 240-feet. The primary effects under consideration are: (1) reduction in sea turtle prey and alteration of foraging behavior; and (2) suspended sediment associated with beach fill operations.

Interactions with the Sediment Plume

The placement of sand along the 3.7 mile area along the Wallops Island shoreline will cause an increase in localized turbidity associated with the beach nourishment operations in the nearshore environment and from the anchoring of the dredge and pump-out stations. Nearshore turbidity impacts from fill placement are directly related to the quantity of fines (silt and clay) in the nourishment material. As the material from the offshore borrow sites is comprised of medium sized grains of sand, and consists of beach quality sand of similar grain size and composition as indigenous beach sands, short suspension time and containment of sediment during and after placement activities is expected. As such, turbidity impacts are expected to be short-term (i.e., within several hours of the cessation of operations (Greene 2002)) and spatially limited to the vicinity of the dredge outfall pipe, the pump-out station, and dredge anchor points.

The Atlantic States Marine Fisheries Commission (Greene 2002) review of the biological and physical impacts of beach nourishment cites several studies that report that the turbidity plume and elevated total suspended sediment (TSS) levels drop off rapidly seaward of the sand placement operations. Wilber *et al.* (2006) reported that turbidity approximately 100 meters directly offshore from an active fill site was similar to turbidity along other areas of a beach in New Jersey, while other studies have reported that the turbidity plume and elevated TSS levels produced from beach nourishment operations are limited to a narrow area of the swash zone (defined as the area of the nearshore that is intermittently covered and uncovered by waves) up to 500 meters down current from the discharge pipe (Schubel *et al.* 1978; Burlas *et al.* 2001; Wilber *et al.* 2006). Previous studies have estimated maximum turbidity levels of several hundred Nephelometric Turbidity Units (NTUs) within the swash zone of an active sand placement site, below 100 NTUs (approximately 13 mg/l) in the surf zone, and below 50 NTUs (approximately 6.5 mg/l) in the nearshore area offshore of the placement site (Greene 2002; Wilber *et al.* 2006). As such, based on the best available information, turbidity levels created by the beach fill operations along Wallops Island shoreline are expected to be between 6.5-13 mg/l; limited to an area approximately 500 meters down current from the discharge pipe, with dissipation occurring within several hundred meters along the shore; and, are expected to be short term, only lasting several hours.

As noted above, no information is available on the effects of total suspended solids (TSS) on juvenile and adult sea turtles. Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). TSS is most likely to affect sea turtles if a plume causes a barrier to normal behaviors or if sediment settles on the bottom affecting sea turtle prey. As sea turtles are highly mobile they are likely to be able to avoid any sediment plume and any effect on sea turtle movements is likely to be insignificant. Additionally, the TSS levels expected are below those shown to have an adverse effect on fish (580.0 mg/L for the most sensitive species, with 1,000.0 mg/L more typical (Breitburg 1988 in Burton 1993; Summerfelt and Moiser 1976 and Combs 1979 in Burton 1993)) and benthic communities (390.0 mg/L (EPA 1986)).

While the increase in suspended sediments may cause sea turtles to alter their normal movements, any change in behavior is likely to be insignificant as it will only involve movements to alter course out of the sediment plume. Based on this information, any increase in suspended sediment is not likely to affect the movement of sea turtles between foraging areas or while migrating. Based on this information, it is likely that the effect of the suspension of sediment resulting from beach fill operations will be insignificant.

Alteration of foraging habitat

Of the listed species found in the action area, loggerhead and Kemp's ridley sea turtles are the most likely to utilize the nearshore area for feeding, foraging mainly on benthic species, namely crabs and mollusks (Morreale and Standora 1992, Bjorndal 1997). As no seagrass beds exist along the nearshore area of Wallops Island, green sea turtles will not use the nearshore area as foraging areas and as such, sand placement and beach nourishment are not likely to disrupt normal feeding behaviors of green sea turtles. Additionally, leatherback sea turtles are primarily pelagic, feeding on jellyfish and may come into shallow water if there is an abundance of jellyfish nearshore. However, as the nearshore area along Wallops Island is not known to be an area where jellyfish concentrate, leatherback sea turtles are unlikely to be found foraging in the nearshore area where disposal activities will occur. As such, beach nourishment activities are not likely to disrupt leatherback foraging behavior. However, as suitable loggerhead and Kemps ridley foraging items occur on the benthos of the nearshore area and depths within this portion of the action area are suitable for use by sea turtles, some loggerhead and Kemp ridley sea turtle foraging likely occurs at these sites.

Beach nourishment can affect sea turtles by reducing prey species through the alteration of the existing biotic assemblages. The placement of dredged sand along the Wallops shoreline will bury existing subtidal benthic organisms (i.e., crabs, clams, mussels) along the 14,000 feet of seawall as well as the area extending seaward, approximately 250-feet from the seawall. In total, approximately 1.2 acres of hard bottom, intertidal habitat will be permanently buried. In addition, approximately 225 acres of the sub-tidal benthic community along the existing seawall will be buried during initial fill placement.

Some of the prey species targeted by turtles, including species of crabs, are mobile; therefore, some individuals are likely to avoid the disturbance by migrating out of the area where sand placement is occurring. While some nearshore areas may be more desirable to certain turtles due to prey availability, there is no information to indicate that the nearshore areas proposed for beach nourishment have more abundant turtle prey or better foraging habitat than other surrounding areas. The assumption can be made that sea turtles are not likely to be more attracted to the nearshore waters along the Wallops Island shoreline than to other foraging areas and should be able to find sufficient prey in alternate areas. Depending on the species, recolonization of a newly renourished beach are can begin in as short as 2-6 months (Burlas *et al.* 2001) when there is a good match between the fill material and the natural beach sediment. As the sand being placed along the Wallops shoreline is similar in grain size as the indigenous beach sand, it is expected that recolonization of the nearshore benthos will occur within 2-6 months after initial beach fill or renourishment cycles are complete. As such, no long term impacts on the numbers of species or community composition of the beach infauna is expected (USACE 1994; Burlas *et al.* 2001).

NMFS anticipates that while the beach nourishment activities may temporarily disrupt normal feeding behaviors for sea turtles by causing them to move to alternate areas, the beach nourishment activities are not likely to alter the habitat in any way that prevents sea turtles from using the action area as a migratory pathway to other near-by areas that may be more suitable for foraging. In addition, the placement of sand seaward of the existing seawall, where previously no beach area existed, will have beneficial effects on benthic organisms by restoring and creating new beach habitat and therefore, providing additional sources of prey along the Wallops Island shoreline that previously were not present. As such, based on the best available information, the placement of sand is not likely to remove critical amounts of prey resources from the action area and any disruption to normal foraging is likely to be insignificant.

Fuel Oil Spills

Throughout the proposed project, construction vehicles will be present on the existing roads and also during the use of heavy machinery on the beach or at the north end of Wallops Island throughout different phases of the SRIPP. The nearshore marine environment may be affected if a spill or leak from construction vehicles or heavy machinery occurs. Construction-related impacts are expected to be temporary and will not likely be adverse because any accidental release of contaminants or liquid fuels will be addressed in accordance with the existing WFF ICP emergency response and clean-up measures. Additionally, implementation of Best Management Practices (BMPs) for equipment and vehicle fueling and maintenance and spill prevention and control measure will reduce the potential impacts on surface water during construction. As the effects of a possible spill are likely to be localized and temporary, sea turtles and whales are not likely to be exposed to oil and any effects would be discountable. Additionally, should a response be required by the United States Environmental Protection Agency or the USCG, there would be an opportunity for NMFS to conduct a consultation with the lead Federal agency on the oil spill response.

CUMULATIVE EFFECTS

Cumulative effects, as defined in the ESA, are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Sources of human-induced mortality or harassment of cetaceans or turtles in the action area include incidental takes in state-regulated fishing activities, vessel collisions, ingestion of plastic debris, and pollution. The combination of these activities potentially will affect populations of ESA-listed species, preventing or slowing a species' recovery.

Future commercial fishing activities in state waters may take several protected species. However, it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Environmental Baseline section. The Atlantic Coastal Cooperative Statistics Program (ACCSP) and the NMFS sea turtle/fishery strategy, when implemented, are expected to provide information on takes of protected species in state fisheries and systematically collected fishing effort data which will be useful in monitoring impacts of the fisheries. NMFS expects these state water fisheries to continue in the future, and as such, the potential for interactions with listed species will also continue.

Natural mortality of listed species, including disease (parasites) and predation, occurs in Mid-Atlantic waters. In addition to dredging activities, sources of anthropogenic mortality, injury, and/or harassment of listed species in the action area include incidental takes in state-regulated fishing activities, private vessel interactions, marine debris and/or contaminants.

As noted in the Environmental Baseline section, private vessel activities in the action area may adversely affect listed species in a number of ways, including entanglement, boat strike, or harassment. It is not possible to predict whether additional impacts from these private activities will occur in the future, but it appears likely that they will continue, especially if actions are not taken to minimize these impacts.

Excessive turbidity due to coastal development and/or construction sites could also influence sea turtle foraging ability. As mentioned previously, turtles are not very easily affected by changes in water quality or increased suspended sediments, but if these alterations make habitat less suitable for turtles and hinder their capability to forage, eventually they would tend to leave or avoid these less desirable areas (Ruben and Morreale 1999).

Marine debris (e.g., discarded fishing line, lines from boats, plastics) can entangle turtles in the water and drown them. Turtles commonly ingest plastic or mistake debris for food, as observed with the leatherback sea turtle. The leatherback's preferred diet includes jellyfish, but similar looking plastic bags are often found in the turtle's stomach contents (Magnuson et al. 1990). It is anticipated that marine debris will continue to impact listed species in the action area.

Sources of contamination in the action area include atmospheric loading of pollutants, stormwater runoff from coastal development, groundwater discharges, and industrial development. Chemical contamination may have an effect on listed species reproduction and survival. While the effects of contaminants on sea turtles are relatively unclear, pollution may also make sea turtles more susceptible to disease by weakening their immune systems. While dependent upon environmental stewardship and clean up efforts, impacts from marine pollution, excessive turbidity, and chemical contamination on marine resources and the Virginia coastal ecosystem are expected to continue in the future.

Increasing vessel traffic (e.g., commercial fishing operations) in the action area is possible and raises concerns about the potential effects of noise pollution on marine mammals and sea turtles. The effects of increased noise levels are not yet completely understood, although they can range from minor behavioral disturbance to injury and even death. Acoustic impacts can include auditory trauma, temporary or permanent loss of hearing sensitivity, habitat exclusion, habituation, and disruption of other normal behavior patterns such as feeding, migration, and communication. NMFS is working to develop policy guidelines for monitoring and managing acoustic impacts on marine mammals from anthropogenic sound sources in the marine environment.

INTEGRATION AND SYNTHESIS OF EFFECTS

In the effects analysis outlined above, NMFS considered potential effects from the following sources: (1) dredging, via hopper dredges, of offshore shoals; (2) placement of dredge material along the shoreline of Wallops Island for beach nourishment; (3) physical alteration of the action area including disruption of benthic communities and changes in turbidity levels in the action area; (4) dredge noise and resultant increases in underwater noise levels. In addition to these categories of effects, NMFS considered the potential for collisions between listed species and project vessels in the action area.

Green and Leatherback Sea Turtles

As noted in sections above, the dredging operations, beach nourishment, and associated physical disturbance of sediments is not likely to affect the foraging behavior of green or leatherback sea turtles as suitable foraging habitat (i.e., SAV) for green sea turtles is not known to occur at the borrow sites or along the nearshore area of Wallops Island and jellyfish, the primary food source of leatherbacks, are not known to be concentrated within the borrow sites or the nearshore area of the action area and are not known to be affected by dredging operations or increases in turbidity. Additionally, dredging operations and beach nourishment/fill operations within the action area are not likely to alter the habitat in any way that prevents leatherback or green sea turtles from using the action area as a migratory pathway to other areas that may be more suitable for foraging or resting. Also, as explained above, no green or leatherback sea turtles are likely to be entrained in any dredge operating within the offshore shoals and, while vessel strikes area possible, neither of these species is likely to be involved in any collision with a project vessel as all vessels will be traveling at low speeds (i.e., 10 knots or less). As all effects to green and leatherback sea turtles from the proposed project are likely to be insignificant or discountable, this action is not likely to adversely affect these species.

Kemp's ridley and Loggerhead Sea Turtles

In the "Effects of the Action" section above, NMFS determined that Kemp's ridleys and loggerhead sea turtles could be entrained in hopper dredge operations occurring over the 50 year life of the SRIPP. Based on a calculated entrainment rate of sea turtles for projects using hopper dredges in the action area, NMFS estimates that 1 sea turtle is likely to be entrained for every 1.5 million cy of material removed with a hopper dredge. Also, based on the ratio of loggerhead and Kemp's ridleys entrained in other hopper dredge operations in the USACE NAD, NMFS estimates that no more than 10% of the sea turtles entrained during project operations are likely to be Kemp's ridleys with the remainder being loggerheads. Based on this information, NMFS has determined that of the 9 sea turtles likely to be entrained during the 50 year life of the SRIPP, no more than 1 is likely to be a Kemp's ridley, with the remainder being loggerheads.

Kemp's ridley sea turtles
The lethal removal of up to one Kemp's ridley sea turtle over the 50 year time period, whether a male or female, immature or mature animal, would reduce the number of Kemp's ridley sea turtles as compared to the number of Kemp's ridleys that would have been present in the absence of the proposed action assuming all other variables remained the same; the loss of one Kemp's ridley over a 50 year time period represents a very small percentage of the species' population as a whole (less than 0.01%). The loss of up to 1 female Kemp's ridley sea turtle, over the 50 year life of the permit, would be expected to reduce the reproduction of Kemp's ridley sea turtles as compared to the reproductive output of Kemp's ridley sea turtles in the absence of the proposed action. As described in the "Status of the Species" section above, NMFS considers the trend for Kemp's ridley sea turtles to be stable. Nevertheless, the death of up to one Kemp's ridley sea turtles as a result of the proposed SRIPP will not appreciably reduce the likelihood of survival for the species for the following reasons. From 1985 to 1999, the number of Kemp's ridley nests observed at Rancho Nuevo and nearby beaches increased at a mean rate of 11.3 % per year. An estimated 4,047 females nested in 2006 and an estimated 5,500 females nested in Tamaulipas (the primary but not sole nesting site) over a 3-day period in May 2007 (NMFS and USFWS 2007b). Based on the number of nests laid in 2006 and the remigration interval for Kemp's ridley sea turtles, there were an estimated 7,000-8,000 adult female Kemp's ridleys in 2006 (NMFS and USFWS 2007b). The observed increase in nesting of Kemp's ridley sea turtles suggests that the combined impact to Kemp's ridley sea turtles from on-going activities as described in the *Environmental Baseline, Cumulative Effects,* and the *Status of the Species* (for those activities that occur outside of the action area of this Opinion) are less than what has occurred in the past. The result of which is that more female Kemp's ridley sea turtles are maturing and subsequently nesting, and/or are surviving to an older age and producing more nests across their lifetime, suggesting that in the future the population of Kemp's ridley sea turtles may increase.

As described in the *Status of the Species* and *Environmental Baseline,* action has been taken to reduce anthropogenic effects to Kemp's ridley sea turtles. These include regulatory measures implemented in 2002 to reduce the number and severity of Kemp's ridley sea turtle interactions in the U.S. South Atlantic and Gulf of Mexico shrimp fisheries --a leading known cause of Kemp's ridley sea turtle mortality. Since these regulatory measures are relatively recent, it is unlikely that current nesting trends reflect the benefit of these measures to Kemp's ridley sea turtles. Therefore, the current nesting trends for Kemp's ridley sea turtles are likely to improve as a result of regulatory action taken for the U.S. south Atlantic and Gulf of Mexico shrimp fisheries.

While generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range, or the species has extremely low levels of genetic diversity. This situation is not likely the case of Kemp's ridleys because: the species is widely distributed geographically, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population, and the number of Kemp's ridleys is likely to be increasing and at worst is stable. This action is also not likely to reduce the distribution of Kemp's ridleys because the action will not impede Kemp's ridleys from accessing other suitable foraging grounds or disrupt other migratory behaviors.

Based on the information provided above, the death of up to one Kemp's ridley sea turtle over a 50 year time period as a result of the proposed SRIPP will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for Kemp's ridley sea turtles given that: (1) the species' nesting trend is increasing; (2) the death of one Kemp's ridley represents an extremely small percentage of the species as a whole (less than 0.01%); (3) the loss of one Kemp's ridley will not change the status or trends of the species as a whole; (4) the loss of one Kemp's ridley is likely to have an undetectable effect on reproductive output of the species as a whole; (5) the action will have no effect on the distribution of Kemp's ridleys in the action area or throughout its range; and, (6) measures have been implemented to reduce the number of Kemp's ridley sea turtles injured and killed (which should result in increases to the numbers of Kemp's ridley sea turtles that would not have occurred in the absence of those regulatory measures).

Section 4(a)(1) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence. Recovery of a species occurs when listing it as an endangered or threatened species is no longer warranted. As explained above, the proposed action will not appreciably reduce the likelihood of survival of this species. Also, it is not expected to modify, curtail or destroy the range of the species since: (1) it will result in an extremely small reduction in the number of Kemp's ridley sea turtles in any geographic area and (2) it will not affect the overall distribution of Kemp's ridley sea turtles other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize Kemp's ridley sea turtles for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect any of these species of sea turtles, or affect their continued existence. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will cause the mortality of no more than one Kemp ridley, which represents an extremely small percentage of the total population of Kemp's ridleys and this mortality is not expected to result in the reduction of overall reproductive fitness for the species as a whole. Therefore, the proposed action will not appreciably reduce the likelihood that Kemp's ridley sea turtles can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, resulting in the mortality of no more than one Kemp's ridley over a 50 year time period, is not likely to appreciably reduce the survival and recovery of this species.

Loggerhead sea turtles
Loggerheads are threatened throughout their entire range. As noted above, currently, there are no population estimates for loggerhead sea turtles in any of the ocean basins in which they occur. However, a recent loggerhead assessment prepared by NMFS states that the loggerhead adult female population in the western North Atlantic ranges from 20,000 to 40,000 or more, with a large range of uncertainty in total population size (NMFS SEFSC 2009).

This species exists as five subpopulations in the western Atlantic, which were recognized as recovery units in the 2008 Recovery Plan for this species and showed limited evidence of interbreeding. Based on information provided in this Opinion, NMFS anticipates the entrainment and mortality of no more than 9 sea turtles over a period of 50 years, with no more than one being a Kemp's ridley. The lethal removal of potentially 9 loggerhead sea turtles from the action area would be expected to reduce the number of loggerhead sea turtles from the recovery unit of which they originated as compared to the number of loggerheads that would have been present in the absence of the proposed actions (assuming all other variables remained the same). However, this does not necessarily mean that these recovery units will experience reductions in reproduction, numbers, or distribution in response to these effects to the extent that survival and recovery would be appreciably reduced. The final revised recovery plan compiled the most recent information on mean number of loggerhead nests and the approximated counts of nesting females per year for four of the five identified recovery units (i.e., nesting groups). They are: (1) for the NRU, a mean of 5,215 loggerhead nests per year with approximately 1,272 females nesting per year; (2) for the PFRU, a mean of 64,513 nests per year with approximately 15,735 females nesting per year; (3) for the DTRU, a mean of 246 nests per year with approximately 60 females nesting per year; and (4) for the NGMRU, a mean of 906 nests per year with approximately 221 females nesting per year. For the GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatan, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatan since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit.

It is likely that the sea turtles entrained in hopper dredges operating in the waters off Virginia originate from several of the recovery units. Limited information is available on the genetic makeup of sea turtles in the mid-Atlantic. Cohorts from each of the five western Atlantic subpopulations are expected to occur in the action area. Genetic analysis of samples collected from immature loggerhead sea turtles captured in pound nets in the Pamlico-Albemarle Estuarine Complex in North Carolina from September-December of 1995-1997 indicated that cohorts from all five western Atlantic subpopulations were present (Bass *et al.* 2004). In a separate study, genetic analysis of samples collected from loggerhead sea turtles from Massachusetts to Florida found that all five western Atlantic loggerhead subpopulations were represented (Bowen *et al.* 2004). Bass et al. (2004) found that 80 percent of the juveniles and sub-adults utilizing the foraging habitat originated from the south Florida nesting population, 12 percent from the northern subpopulation, 6 percent from the Yucatan subpopulation, and 2 percent from other rookeries. The previously defined loggerhead subpopulations do not share the exact delineations of the recovery units identified in the 2008 recovery plan. However, the PFRU encompasses both the south Florida and Florida panhandle subpopulations, the NRU is roughly equivalent to the northern nesting group, the Dry Tortugas subpopulation is equivalent to the DTRU, and the Yucatan subpopulation is included in the GCRU.

Based on the genetic analysis presented in Bass *et al.* (2004), and the small number of loggerheads likely to occur in the action area from the DTRU or the NGMRU, it is extremely unlikely that any of the up to 9 loggerheads that are likely to be entrained during dredging operations are likely to have originated from either of these recovery units. The majority, at least 80% of the loggerheads entrained, are likely to have originated from the PFRU, with the remainder from the NRU and GCRU. As such, 7 of the sea turtles are expected to be from the PFRU and 2 from the NRU or the GCRU.

As noted above, the most recent population estimates indicate that there are approximately 15,735 females nesting annually in the PFRU and approximately 1,272 females nesting per year in the NRU. For the GCRU, the only estimate available for the number of loggerhead nests per year is from Quintana Roo, Yucatan, Mexico, where a range of 903-2,331 nests per year was estimated from 1987-2001 (NMFS and USFWS 2007a). There are no annual nest estimates available for the Yucatan since 2001 or for any other regions in the GCRU, nor are there any estimates of the number of nesting females per year for any nesting assemblage in this recovery unit; however, the 2008 recovery plan indicates that the Yucatan nesting aggregation has at least 1,000 nesting females annually. As the numbers outlined here are only for nesting females, the total number of loggerhead sea turtles in each recovery unit is likely significantly higher. The loss of 7 loggerheads over a 50 year time period represents an extremely small percentage of the number of sea turtles in the PFRU. Even if the total population was limited to 15,735 loggerheads, the loss of 7 individuals would represent approximately 0.04% of the population. Similarly, the loss of two loggerheads over a 50 year period from the NRU or GCRU represents an extremely small percentage from either recovery unit. Even if the total NRU population was limited to 1,272 loggerheads, the loss of two individuals would represent approximately 0.16% of the NRU population, while the loss of two loggerheads over a 50 year time period from the GCRU, which is expected to support at least 1,000 nesting females, represents less than 0.2 % of the population. The loss of such a small percentage of individuals from any of these recovery units represents an even smaller percentage of the species as a whole. As such, it is unlikely that the death of these individuals will have a detectable effect on the numbers and population trends of loggerheads in these recovery units or the number of loggerheads in the population as a whole. Additionally, this action is not likely to reduce the distribution of loggerheads as the action will not impede loggerheads from accessing suitable foraging grounds or disrupt other migratory behaviors.

In general, while the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species, this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of loggerhead sea turtles because: the species is widely distributed geographically, it is not known to have low levels of genetic diversity, and there are several thousand individuals in the population.

Based on the information provided above, the death of up to 9 loggerhead sea turtles over a 50 year time period as a result of the proposed deepening project will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) for loggerhead sea turtles given that: (1) the death of up to 9 loggerheads represents an extremely small percentage of the species as a whole; (2) the loss of these loggerheads will not change the status or trends of any nesting aggregation, recovery unit or the species as a whole; (3) the loss of these loggerheads is likely to have an undetectable effect on reproductive output of any nesting aggregation or the species as a whole; and, (4) the action will have no effect on the distribution of loggerheads in the action area or throughout its range.

Section 4(a)(l) of the ESA requires listing of a species if it is in danger of extinction throughout all or a significant portion of its range (i.e., "endangered"), or likely to become in danger of extinction throughout all or a significant portion of its range in the foreseeable future (i.e., "threatened") because of any of the following five listing factors: (1) The present or threatened destruction, modification, or curtailment of its habitat or range, (2) overutilization for commercial, recreational, scientific, or educational purposes, (3) disease or predation, (4) the inadequacy of existing regulatory mechanisms, (5) other natural or manmade factors affecting its continued existence. Recovery of a species occurs when listing it as an endangered or threatened species is no longer warranted. As explained above, the proposed action will not appreciably reduce the likelihood of survival of the loggerhead sea turtle species. Also, it is not expected to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of loggerheads in any geographic area and since it will not affect the overall distribution of loggerheads other than to cause minor temporary adjustments in movements in the action area. The proposed action will not utilize loggerheads for recreational, scientific or commercial purposes, affect the adequacy of existing regulatory mechanisms to protect any of these species of sea turtles, or affect their continued existence. The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction since the action will cause the mortality of only an extremely small percentage of the loggerheads in any nesting aggregation, recovery unit or the species as whole and these mortalities are not expected to result in the reduction of overall reproductive fitness for the species as a whole. Therefore, the proposed action will not appreciably reduce the likelihood that loggerhead sea turtles can be brought to the point at which they are no longer listed as endangered or threatened. Based on the analysis presented herein, the proposed action, resulting in the mortality of no more than 9 loggerheads over a 50 year time period, is not likely to appreciably reduce the survival and recovery of this species.

Right, Humpback and Fin Whales

Right, humpback, and fin whales may be affected by increased levels of underwater noise produced during dredging operations and by vessels transiting the action area during project operations or. Although there is potential for collisions with these large whales to occur within the action area, these collisions are considered unlikely as all vessels will be operating at speeds of 10 knots or less in accordance with 50 CFR 224.105 and the use of a bridge watch will further aid in reducing the possibility of these interactions as well. Additionally, although increased levels of underwater noise (i.e., 120-160 dB) will be produced during dredging operations, these elevated levels of underwater noise will be experienced within a 794 meter radius of the dredge (i.e., beyond 794 meters underwater noise levels will be less than 120 dB). As the action area is not known as an area where listed species of whales congregate for the purposes of foraging, resting, or reproduction, but instead is used primarily for migration, it is extremely unlikely that whales will be found in high concentrations in the action area, resulting in an extremely low probability that a whale will be within 794 meters of the dredge at any one time and therefore, exposed to levels of underwater noise levels that could adversely affect and/or cause behavioral changes to the animal in a manner that disrupts essential behaviors (e.g., feeding, resting, migrating, reproducing). In addition, in the unlikely event that a whale approaches the area where the dredge is in operation, the mitigation measures NASA has established (e.g., NMFS observer/designated bridge watch; shut down of dredge pumps if whale within 1 km of dredge) will ensure that whales will not be exposed to underwater noise levels greater than or equal to 120 dB. As all effects of the proposed action on right, humpback, and fin whales will be insignificant or discountable, the proposed action is not likely to adversely affect these species.

CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under NMFS jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is NMFS' biological opinion that the proposed action may adversely affect but is not likely to jeopardize the continued existence of the loggerhead and Kemp's ridley sea turtle and is not likely to adversely affect leatherback or green sea turtles or right, humpback or fin whales. Because no critical habitat is designated in the action area, none will be affected by the proposed action.

As explained in *the Status of Affected Species* section of this Opinion, on March 16, 2010, NMFS published a proposed rule to list two distinct population segments of loggerhead sea turtles as threatened and seven distinct population segments of loggerhead sea turtles as endangered. This rule, when finalized, would replace the existing listing for loggerhead sea turtles. Currently, the species is listed as threatened range-wide. Once a species is proposed for listing, the conference provisions of the ESA apply. As stated at 50 CFR 402.10, "Federal agencies are required to confer with NMFS on any action which is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat. The conference is designed to assist the Federal agency and any applicant in identifying and resolving potential conflicts at an early stage in the planning process."

As described in this Opinion, the proposed action is anticipated to result in the death of no more than 9 loggerhead sea turtles over a 50 year time period. In this Opinion, NMFS concludes that this level of take is not likely to reduce appreciably the likelihood of both the survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species and that, therefore, the action is not likely to jeopardize the continued existence of loggerhead sea turtles.

As explained in the Opinion, the majority, at least 80% of the loggerheads entrained, are likely to have originated from the Peninsular Florida Recovery Unit (PFRU: Florida/Georgia border through Pinellas County, Florida), with the remainder from the Northern Recovery Unit (NRU: Florida/Georgia border through southern Virginia), and the Greater Caribbean Recovery Unit (GCRU: Mexico through French Guiana, The Bahamas, Lesser Antilles, and Greater Antilles). All of these recovery units fall within the Northwest Atlantic DPS, one of the seven DPSs proposed to be listed as endangered in the March 16, 2010 proposed rule. In this Opinion, NMFS determined that the loss of these individuals would not be detectable at the recovery unit level or at the species as whole (i.e., range-wide) and that the death of up to 9 loggerhead sea turtles over a 50 year time period as a result of the proposed SRIPP project will not appreciably reduce the likelihood of survival (i.e., it will not increase the risk of extinction faced by this species) or recovery for loggerhead sea turtles. As explained in the Opinion, the individuals likely to be killed represent

0.04% (PFRU), 0.16 % (NRU), and 0.2 % (GCRU) of the individuals in each recovery unit. The proposed Northwest Atlantic DPS consists of these three recovery units as well as two others; the individuals likely to be killed represent no more than 0.1% of the sea turtles in the proposed Northwest Atlantic DPS. In this Opinion NMFS determines that the loss of these individuals from each of the three recovery units was likely to be undetectable; as such, and given that the proposed DPS is comprised of these three recovery units as well as two others, it is reasonable to expect that the conclusions reached for the current range-wide listing would be the same as for the proposed Northwest Atlantic DPS. Conference is only required when an action is likely to jeopardize the continued existence of any proposed species, and, based on the above information, it is unlikely that the effects of the proposed action would result in jeopardy for the proposed Northwest Atlantic DPS. Thus, conference is not required for this proposed action. Additionally, as ITS included with this Opinion contains all terms and conditions and reasonable and prudent measures necessary and appropriate to minimize and monitor take of loggerhead sea turtles, it is unlikely that a conference would identify or resolve additional conflicts or provide additional means to minimize or monitor take of loggerhead sea turtles.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken so that they become binding conditions for the exemption in section 7(o)(2) to apply. Failure to implement the terms and conditions through enforceable measures may result in a lapse of the protective coverage of section 7(o)(2).

Amount or Extent of Take

The proposed dredging project has the potential to directly affect loggerhead and Kemp's ridley sea turtles by entraining these species in the dredge. These interactions are likely to cause injury and/or mortality to the affected sea turtles. Based on the distribution of sea turtles in the action area and information available on historic interactions between sea turtles and dredging and relocation trawling operations, NMFS believes that it is reasonable to expect that no more than 1 sea turtle is likely to be injured or killed for approximately every 1.5 million cy of material removed from the borrow areas. NMFS has estimated that at least 90% of these turtles will be loggerheads. As such, over the course of the project life, NMFS expects that a total of 9 sea turtles will be killed, with no more than 1 being a Kemp's ridley and the remainder being loggerheads. Due to the nature of the injuries expected by entrainment, any entrained sea turtle is expected to die.

NMFS also expects that the maintenance dredging may collect an additional unquantifiable number of parts from previously dead sea turtles. While collecting decomposed animals or parts there of in federal operations is considered to be a take, based on the definition of "take" in Section 3 of the ESA and "wildlife" at 50CFR§222.102, NMFS recognizes that decomposed sea turtles may be taken in dredging operations that may not necessarily be related to the dredging activity itself. Theoretically, if dredging operations are conducted properly, no takes of sea turtles should occur as the turtle draghead defector should push the turtles to the side and the suction pumps should be turned off whenever the dredge draghead is away from the substrate. However, due to certain environmental conditions (e.g., rocky bottom, uneven substrate), the dredge draghead may periodically lift off the bottom and entrain previously dead sea turtle parts (as well as live turtles) that may be on the bottom through the high level of suction.

Thus, the aforementioned anticipated level of take refers to those turtles which NMFS confirms as freshly dead. While this definition is subject to some interpretation by the observer, a fresh dead animal may exhibit the following characteristics: little to no odor; fresh blood present; fresh (not necrotic, pink/healthy color) tissue, muscle, or skin; no bloating; color consistent with live animal; and live barnacles. A previously (non-fresh) dead animal may exhibit the following characteristics: foul odor; necrotic, dark or decaying tissues; sloughing of scutes; pooling of old blood; atypical coloration; and opaque eyes. NMFS recognizes that decomposed sea turtles may be taken in dredging operations that may not necessarily be related to the dredging activity itself. NMFS expects that the proposed dredging may take an additional unquantifiable number of previously dead sea turtle parts.

NMFS believes this level of incidental take is reasonable given the seasonal distribution and abundance of these species in the action area and the level of take historically during other dredging operations in the USACE NAD. In the accompanying Opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to loggerhead or Kemp's ridley sea turtles.

Measures have been undertaken by the USACE to reduce the takes of sea turtles in dredging activities. Measures that have been successful in minimizing take in other dredging operations have included reevaluating all dredging procedures to assure that the operation of the dragheads and turtle deflectors were in accordance with the project specifications; modifying dredging operations per the recommendation of Mr. Glynn Banks of the USACE Engineering Research and Development Center; training the dredge crew and all inspectors in proper operation of the dragpipe and turtle deflector systems; and, initiating sea turtle relocation trawling. Proper use of draghead deflectors prevent an unquantifiable yet substantial number of sea turtles from being entrained and killed in dredging operations. Tests conducted by the USACE's Jacksonville District using fake turtles and draghead deflectors showed convincingly that the sea turtle deflecting draghead is useful in reducing entrainments. As the use of draghead deflectors and other modifications to hopper dredge operations have been demonstrated to be effective at minimizing the number of sea turtles taken in dredging operations, NMFS has determined that the use of draghead deflectors and certain operating guidelines (as outlined below) are necessary and appropriate to minimize the take of sea turtles during the dredging of the two borrow areas.

In order to effectively monitor the effects of this action, it is necessary to examine the sea turtles entrained in the dredge. Monitoring provides information on the characteristics of the turtles encountered and may provide data which will help develop more effective measures to avoid future interactions with listed species. For example, measurement data may reveal that draghead deflectors or trawl gear is most effective for a particular size class of turtle. In addition, data from genetic sampling of dead sea turtles can definitively identify the species of turtle as well as the subpopulation from which it came (in the case of loggerheads). Reasonable and prudent measures and implementing terms and conditions requiring this monitoring are outlined below.

Reasonable and Prudent Measures

NMFS has determined that the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of sea turtles. It should be noted that this Opinion results from the reintiation of consultation that lead to the September 25, 2007 Opinion. The action agencies have incorporated the reasonable and prudent measures from the 2007 Opinion as well as all associated specifications and requirements for monitoring hopper dredge operations (Appendix B); sea turtle handling and resuscitation (Appendix C); protocols for collecting tissue from sea turtles for genetic analysis (Appendix D, E, F); endangered species observer forms (Appendix G); and incident report forms for sea turtle takes (Appendix H) as part of this consultations proposed action's mitigation measures (see pages 6-7).

1. NMFS must be contacted within 3 days prior to commencement of dredging and again within 3 days following completion of the dredging activity. Upon contacting NMFS, NASA shall report to NMFS whether:
    a. during April 1-November 30, when sea turtles are known to be present in the action area, hopper dredges are outfitted with state-of-the-art sea turtle deflectors on the draghead and operated in a manner that will reduce the risk of interactions with sea turtles which may be present in the action area;
    b. NMFS-approved observer is present on board the vessel for any dredging occurring in the April 1 – November 30 time frame;
    c. all dredges are equipped and operated in a manner that provides endangered/threatened species observers with a reasonable opportunity for detecting interactions with listed species and that provides for handling, collection, and resuscitation of turtles injured during project activity. Full cooperation with the endangered/threatened species observer program is essential for compliance with the ITS; and,
    d. measures are taken to protect any turtles that survive entrainment in the dredge.
2. All interactions with listed species must be properly documented and promptly reported to NMFS.

Terms and conditions

In order to be exempt from prohibitions of section 9 of the ESA, the NASA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. To implement RPM #1(a-d), the NASA must contact NMFS (section 7 coordinator: by phone (978)-281-9328 or mail: Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930)). This correspondence will serve both to alert NMFS of the commencement and cessation of dredging activities, to give NMFS an opportunity to provide NASA with any updated contact information or reporting forms, and to provide NMFS with information of any incidences with listed species.

2. To implement RPM #2, if a sea turtle or their parts are taken in dredging operations, the take must be documented on the form included as Appendix H and submitted to NMFS along with the final report.

3. To implement RPM #2, NASA must contact NMFS within 24 hours of any interactions with sea turtles, including non-lethal and lethal takes. NMFS will provide contact information annually when alerted of the start of dredging activity. Until alerted otherwise, the USACE should contact the Section 7 Coordinator by phone (978)281-9328 or fax 978-281-9394).

4. To implement RPM #2, NASA must ensure that any sea turtles observed during project operations are measured and photographed (including sea turtles or body parts observed at the disposed location or on board the dredge, hopper or scow and the corresponding form (Appendix H) must be completed and submitted to NMFS **within 24 hours** by fax (978-281-9394).

5. To implement RPM #2, in the event of any lethal takes of sea turtles, any dead specimens or body parts must be photographed, measured, and preserved (refrigerate or freeze) until disposal procedures are discussed with NMFS. The form included as Appendix H must be completed and submitted to NMFS as noted above.

6. To implement RPM #2, if a dead sea turtle or sea turtle part is taken in dredging operations, a genetic sample must be taken following the procedure outlined in Appendix D.

7. To implement RPM #2, if a decomposed turtle or turtle part is entrained during dredging operations, an incident report must be completed and the specimen must be photographed. Any turtle parts that are considered 'not fresh' (i.e., they were obviously dead prior to the dredge take and NASA anticipates that they will not be counted towards the ITS) must be frozen and transported to a nearby stranding or rehabilitation facility for review. NASA must submit an incident report for the decomposed turtle part, as well as photographs, to NMFS within 24 hours of the take (see Appendix H) and request concurrence that this take should not be attributed to the Incidental Take Statement. NMFS shall have the final say in determining if the take should count towards the Incidental Take Statement.

8. To implement RPM #2, any time take occurs NASA immediately contacts NMFS at (978) 281-9328 to review the situation. At that time, NASA must provide NMFS with information on the amount of material dredged thus far and the amount remaining to be dredged during that cycle. Also at that time, NASA and the USACE should discuss with

NMFS whether any new management measures could be implemented to prevent the total incidental take level from being exceeded.

9. To implement RPM #2, NASA must submit a final report summarizing the results of dredging and any takes of listed species to NMFS within 30 working days of the completion of each dredging contract (by mail to the attention of the Section 7 Coordinator, NMFS Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930). This report must be submitted at the close of each dredging contract.

10. To implement RPM#2, if the take estimate for any contract is exceeded, NASA and the USACE must work with NMFS to determine whether the additional take represents new information revealing effects of the action that may not have been previously considered.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize and monitor the impact of incidental take that might otherwise result from the proposed action. Specifically, these RPMs and Terms and Conditions will keep NMFS informed of when and where dredging activities are taking place and will require USACE to report any take in a reasonable amount of time, as well as implement measures to monitor for entrainment during dredging. The NASA has reviewed the RPMs and Terms and Conditions outlined above and has agreed to implement all of these measures as described herein and in the referenced Appendices. The discussion below explains why each of these RPMs and Terms and Conditions are necessary and appropriate to minimize or monitor the level of incidental take associated with the proposed action and how they represent only a minor change to the action as proposed by the NASA.

RPM #1 and Term and Condition #1 are necessary and appropriate because they will serve to ensure that NMFS is aware of the dates and locations of all dredging activities as well as any incidences of interactions of listed species. This will also allow NMFS to monitor the duration and seasonality of dredging activities as well as give NMFS an opportunity to provide NASA with any updated contact information for NMFS staff. This is only a minor change because it is not expected to result in any delay to the project and will merely involve an occasional telephone call or e-mail between NASA and NMFS staff.

RPM #2 and Terms and Conditions (#2-10) are necessary and appropriate to ensure the proper handling and documentation of any interactions with listed species as well as requiring that these interactions are reported to NMFS in a timely manner with all of the necessary information. This is essential for monitoring the level of incidental take associated with the proposed action. RPM #16 requires that NASA work with NMFS to determine if any takes above those estimated for each contract represent new information on the effects of the project that was not previously considered. In a situation where the estimated level of take for a particular contract is exceeded but the overall level of take exempted by the ITS is not exceeded, compliance with this condition will allow NASA and NMFS to determine if reinitiation of consultation is necessary at the time that the take occurs. These RPMs and Terms and Conditions represent only a minor change as compliance will not result in any increased cost, delay of the project or decrease in the efficiency of the dredging operations.

CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that proposed projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species." Conservation Recommendations are discretionary activities designed to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. When endangered species observers are required on hopper dredges (April 1 to November 30), 100% overflow screening is recommended. While monitoring 100% of the inflow screening is required as a term and condition of this project's Incidental Take Statement, observing 100% of the overflow screening would ensure that any takes of sea turtles are detected and reported.

2. To facilitate future management decisions on listed species occurring in the action area, NASA should maintain a database mapping system to: a) create a history of use of the geographic areas affected; and, b) document endangered/threatened species presence/interactions with project operations.

3. NASA should support ongoing and/or future research to determine the abundance and distribution of sea turtles in offshore Virginia waters.

4. NASA should work with the USACE to investigate, support, and/or develop additional technological solutions to further reduce the potential for sea turtle takes in hopper dredges. For instance, NMFS recommends that the USACE coordinate with other Southeast Districts, the Association of Dredge Contractors of America, and dredge operators regarding additional reasonable measures they may take to further reduce the likelihood of sea turtle takes. The diamond-shaped pre-deflector, or other potentially promising pre-deflector designs such as tickler chains, water jets, sound generators, etc., should be developed and tested and used where conditions permit as a means of alerting sea turtles and sturgeon of approaching equipment. New technology or operational measures that would minimize the amount of time the dredge is spent off the bottom in conditions of uneven terrain should be explored. Pre-deflector use should be noted on observer daily log sheets, and annual reports to NMFS should note what progress has been made on deflector or pre-deflector technology and the benefits of or problems associated with their usage. NMFS believes that development and use of effective pre-deflectors could reduce the need for sea turtle relocation trawling.

5. New approaches to sampling for turtle parts should be investigated. Project proponents should seek continuous improvements in detecting takes and should determine, through research and development, a better method for monitoring and estimating sea turtle takes by hopper dredges. Observation of overflow and inflow screening appears to be only partially effective and may provide only minimum estimates of total sea turtle mortality. NMFS believes that some listed species taken by hopper dredges may go undetected because body parts are forced through the sampling screens by the water pressure (as seen in 2002 Cape Henry dredging) and are buried in the dredged material, or animals are crushed or killed, but not entrained by the suction and so

the takes may go unnoticed (or may subsequently strand on nearby beaches). The only mortalities that are documented are those where body parts float, are large enough to be caught in the screens, or can be identified to species.

6. NMFS recommends that all sea turtles entrained in hopper dredge dragheads be sampled for genetic analysis by a NMFS laboratory. Any genetic samples from live sea turtles must be taken by trained and permitted personnel. Copies of NMFS genetic sampling protocols for live and dead turtles are attached as Appendix D.

7. NASA and the USACE should consider devising and implementing some method of significant economic incentives to hopper dredge operators such as financial reimbursement based on their satisfactory completion of dredging operations, or a certain number of cubic yards of material removed, or hours of dredging performed, *without taking turtles*. This may encourage dredging companies to research and develop "turtle friendly" dredging methods, more effective deflector dragheads, pre-deflectors, top-located water ports on dragarms, etc.

8. When whales are present in the action area, vessels transiting the area should post a bridge watch, avoid intentional approaches closer than 100 yards (or 500 yards in the case of right whales) when in transit, and reduce speeds to below 4 knots.

REINITIATION OF CONSULTATION

This concludes formal consultation on NASA's proposed Wallops Island Shoreline Restoration and Infrastructure Protection Program. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) a new species is listed or critical habitat designated that may be affected by the action; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered. If the amount or extent of incidental take is exceeded, NASA must immediately request reinitiation of formal consultation.

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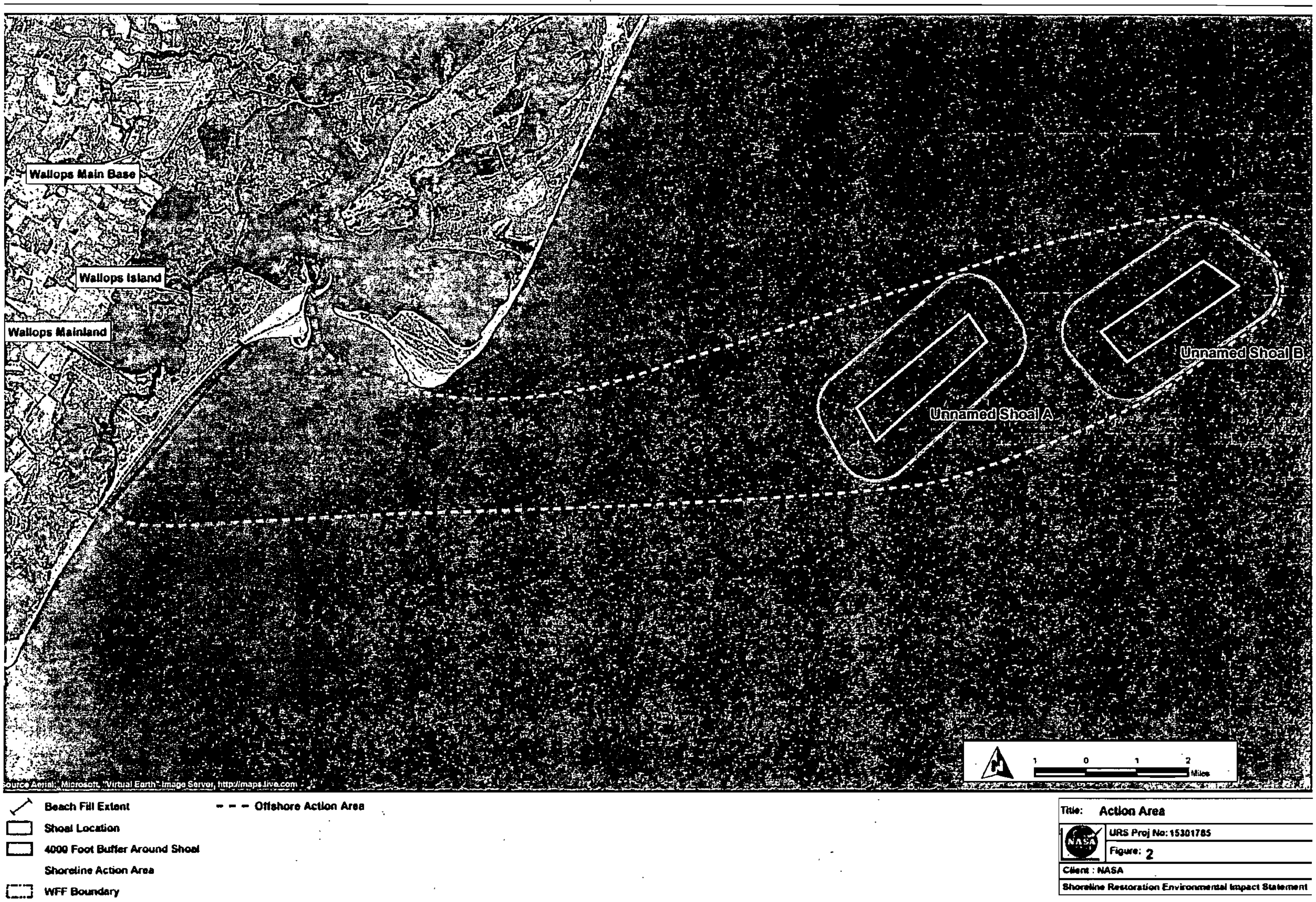
APPENDIX A
Map of Action Area



APPENDIX B.

MONITORING SPECIFICATIONS FOR HOPPER DREDGES

I. EQUIPMENT SPECIFICATIONS

A. Baskets or screening

Baskets or screening must be installed over the hopper inflows with openings no smaller than 4 inches by 4 inches to provide 100% coverage of all dredged material and shall remain in place during all dredging operations between April and November 30 of any calendar year. Baskets/screening will allow for better monitoring by observers of the dredged material intake for sea turtles and their remains. The baskets or screening must be safely accessible to the observer and designed for efficient cleaning.

B. Draghead

The draghead of the dredge shall remain on the bottom **at all times** during a pumping operation, except when:

1) the dredge is not in a pumping operation, and the suction pumps are turned completely off;
2) the dredge is being re-oriented to the next dredge line during borrow activities; and
3) the vessel's safety is at risk (i.e., the dragarm is trailing too far under the ship's hull).

At initiation of dredging, the draghead shall be placed on the bottom during priming of the suction pump. If the draghead and/or dragarm become clogged during dredging activity, the pump shall be shut down, the dragarms raised, whereby the draghead and/or dragarm can be flushed out by trailing the dragarm along side the ship. If plugging conditions persist, the draghead shall be placed on deck, whereby sufficient numbers of water ports can be opened on the draghead to prevent future plugging.

Upon completion of a dredge track line, the drag tender shall:

1) throttle back on the RPMs of the suction pump engine to an idling speed (e.g., generally less than 100 RPMs) **prior to** raising the draghead off the bottom, so that no flow of material is coming through the pipe into the dredge hopper. Before the draghead is raised, the vacuum gauge on the pipe should read zero, so that no suction exists both in the dragarm and draghead, and no suction force exists that can impinge a turtle on the draghead grate;
2) hold the draghead firmly on the bottom with no flow conditions for approximately 10 to 15 seconds before raising the draghead; then, raise the draghead quickly off the bottom and up to a mid-water column level, to further reduce the potential for any adverse interaction with nearby turtles;
3) re-orient the dredge quickly to the next dredge line; and
4) re-position the draghead firmly on the bottom prior to bringing the dredge pump to normal pumping speed, and re-starting dredging activity.

C. Floodlights

Floodlights must be installed to allow the NMFS-approved observer to safely observe and monitor the baskets or screens.

D. Intervals between dredging

Sufficient time must be allotted between each dredging cycle for the NMFS-approved observer to inspect and thoroughly clean the baskets and screens for sea turtles and/or turtle parts and document the findings. Between each dredging cycle, the NMFS-approved observer should also examine and clean the dragheads and document the findings.

II. OBSERVER PROTOCOL

A. Basic Requirement

A NMFS-approved observer with demonstrated ability to identify sea turtle species must be placed aboard the dredge(s) being used, starting immediately upon project commencement to monitor for the presence of listed species and/or parts being entrained or present in the vicinity of dredge operations.

B. Duty Cycle

Beginning April 1, NMFS-approved observers are to be onboard for every week of the dredging project until project completion or November 30, whichever comes first. While onboard, observers shall provide the required inspection coverage on a rotating basis so that combined monitoring periods represent 100% of total dredging through the project period.

C. Inspection of Dredge Spoils

During the required inspection coverage, the trained NMFS-approved observer shall inspect the galvanized screens and baskets at the completion of each loading cycle for evidence of sea turtles. The Endangered Species Observation Form shall be completed for each loading cycle, whether listed species are present or not (Appendix G). If any whole (alive or dead) or turtle parts are taken incidental to the project(s), the NMFS Section 7 Coordinator (978-281-9328) must be contacted within 24 hours of the take. An incident report for sea turtle take (Appendix H) shall also be completed by the observer and sent to Julie Crocker via FAX (978) 281-9394 within 24 hours of the take. Incident reports shall be completed for every take regardless of the state of decomposition. NMFS will determine if the take should be attributed to the incidental take level, after the incident report is received. Every incidental take (alive or dead, decomposed or fresh) should be photographed, and photographs shall be sent to NMFS either electronically (julie.crocker@noaa.gov) or through the mail. Weekly reports, including all completed load sheets, photographs, and relevant incident reports, as well as a final report, shall be submitted to NMFS NER, Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930-2298.

D. Information to be Collected

For each sighting of any endangered or threatened marine species (including whales as well as sea turtles), record the following information on the Endangered Species Observation Form (Appendix G):

1) Date, time, coordinates of vessel
2) Visibility, weather, sea state
3) Vector of sighting (distance, bearing)
4) Duration of sighting
5) Species and number of animals
6) Observed behaviors (feeding, diving, breaching, etc.)
7) Description of interaction with the operation

E. Disposition of Parts

If any whole turtles or shortnose sturgeon (alive or dead, decomposed or fresh) or turtle or shortnose sturgeon parts are taken incidental to the project(s), Julie Crocker (978) 282-8480 or Pat Scida (978) 281-9208 must be contacted within 24 hours of the take. All whole dead sea turtles or shortnose sturgeon, or turtle or shortnose sturgeon parts, must be photographed and described in detail on the Incident Report of Sea Turtle Mortality (Appendix H). The photographs and reports should be submitted to Julie Crocker, NMFS, Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930-2298. After NMFS is notified of the take, it may instruct the observer to save the animal for future analysis if there is freezer space. Regardless, any dead **Kemp's ridley** sea turtles shall be photographed, placed in plastic bags, labeled with location, load number, date, and time taken, and placed in cold storage. Dead turtles or turtle parts will be further labeled as recent or old kills based on evidence such as fresh blood, odor, and length of time in water since death. Disposition of dead sea turtles will be determined by NMFS at the time of the take notification. If the species is unidentifiable or if there are entrails that may have come from a turtle, the subject should be photographed, placed in plastic bags, labeled with location, load number, date and time taken, and placed in cold storage. Dead Kemp's ridley or unidentifiable species or parts will be collected by NMFS or NMFS-approved personnel (contact Julie Crocker at (978) 282-8480). Live turtles (both injured and uninjured) should be held onboard the dredge until transported as soon as possible to the appropriate stranding network personnel for rehabilitation (Appendix C). No live turtles should be released back into the water without first being checked by a qualified veterinarian or a rehabilitation facility. Virginia and Maryland stranding network members (for rehabilitating turtles) include Mark Swingle [(757)-385-0326 or (757)-437-6022] and/or Susan Barco [(757)-437-7765] at the Virginia Marine Science Museum [Hotline: (757)437-6159], and Dr. Brent Whitaker [(410-576-3852] and/or Jennifer Dittmar [(410)-986-2377] of the National Aquarium in Baltimore [Hotline: (410)373-0083]. Mark Swingle/Susan Barco, Brent Whitaker/Jennifer Dittmar, and the NMFS Stranding Hotline at (978)-281-9351 should also be contacted immediately for any marine mammal injuries or mortalities.

III. OBSERVER REQUIREMENTS

Submission of resumes of endangered species observer candidates to NMFS for final approval ensures that the observers placed onboard the dredges are qualified to document takes of endangered and threatened species, to confirm that incidental take levels are not exceeded, and to provide expert advice on ways to avoid impacting endangered and threatened species. NMFS does not offer certificates of approval for observers, but approves observers on a case-by-case basis.

A. Qualifications

Observers must be able to:

1) differentiate between leatherback (*Dermochelys coriacea*), loggerhead *Caretta caretta*), Kemp's ridley *(Lepidochelys kempii*), green (*Chelonia mydas*), and hawksbill *(Eretmochelys imbricata*) turtles and their parts, and shortnose (*Acipenser brevirostrum*) and Atlantic (*Acipenser oxyrinchus oxyrinchus*) sturgeon and their parts;
2) handle live sea turtles and sturgeon and resuscitate and release them according accepted procedures;
3) correctly measure the total length and width of live and whole dead sea turtle and sturgeon species;
4) observe and advise on the appropriate screening of the dredge's overflow, skimmer funnels, and dragheads; and
5) identify marine mammal species and behaviors.

B. Training

Ideally, the applicant will have educational background in marine biology, general experience aboard dredges, and hands-on field experience with the species of concern. For observer candidates who do not have sufficient experience or educational background to gain immediate approval as endangered species observers, the below observer training is necessary to be considered admissible by NMFS. We can assist the USACE by identifying groups or individuals capable of providing acceptable observer training. Therefore, at a minimum, observer training must include:

1) instruction on how to identify sea turtles and sturgeon and their parts;
2) instruction on appropriate screening on hopper dredges for the monitoring of sea turtles and sturgeon (whole or parts);
3) demonstration of the proper handling of live sea turtles and sturgeon incidentally captured during project operations. Observers may be required to resuscitate sea turtles according to accepted procedures prior to release;

4) instruction on standardized measurement methods for sea turtle and sturgeon lengths and widths; and
5) instruction on how to identify marine mammals; and
6) instruction on dredging operations and procedures, including safety precautions onboard a vessel.

APPENDIX C

Sea Turtle Handling and Resuscitation

It is unlikely that sea turtles will survive entrainment in a hopper dredge, as the turtles found in the dragheads are usually dead, dying, or dismantled. However, the procedures for handling live sea turtles follow in case the unlikely event should occur. These guidelines are adapted from 50 CFR § 223.206(d)(1).

Please photograph all turtles (alive or dead) and turtle parts found during dredging activities and complete the Incident Report of Sea Turtle Take (Appendix H).

Dead sea turtles
The procedures for handling dead sea turtles and parts are described in Appendix C-II-E.

Live sea turtles
When a sea turtle is found in the dredge gear, observe it for activity and potential injuries.

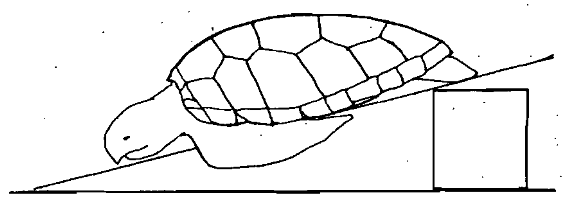
< **If the turtle is actively moving,** it should be retained onboard until evaluated for injuries by a permitted rehabilitation facility. Due to the potential for internal injuries associated with hopper entrainment, it is necessary to transport the live turtle to the nearest rehabilitation facility as soon as possible, following these steps:

1) Contact the nearest rehabilitation facility to inform them of the incident. If the rehabilitation personnel cannot be reached immediately, please contact Julie Crocker at (978) 281-9300 ext. 6530 or Pat Scida at (978) 281-9128.
2) Keep the turtle shaded and moist (e.g., with a water-soaked towel over the eyes, carapace, and flippers), and in a confined location free from potential injury.
3) Contact the crew boat to pick up the turtle as soon as possible from the dredge (within 12 to 24 hours maximum). The crew boat should be aware of the potential for such an incident to occur and should develop an appropriate protocol for transporting live sea turtles.
4) Transport the live turtle to the closest permitted rehabilitation facility able to handle such a case.

Do not assume that an inactive turtle is dead. The onset of rigor mortis and/or rotting flesh are often the only definite indications that a turtle is dead. Releasing a comatose turtle into any amount of water will drown it, and a turtle may recover once its lungs have had a chance to drain.

< **If a turtle appears to be comatose** (unconscious), contact the designated stranding/rehabilitation personnel immediately. Once the rehabilitation personnel has been informed of the incident, attempts should be made to revive the turtle at once. Sea turtles have been known to revive up to 24 hours after resuscitation procedures have been followed.

- Place the animal on its bottom shell (plastron) so that the turtle is right side up and elevate the hindquarters at least 6 inches for a period of 4 up to 24 hours. The degree of elevation depends on the size of the turtle; greater elevations are required for larger turtles.
- Periodically, rock the turtle gently left to right and right to left by holding the outer edge of the shell (carapace) and lifting one side about 3 inches then alternate to the other side.
- Periodically, <u>gently</u> touch the eye and pinch the tail (reflex test) to see if there is a response.
- Keep the turtle in a safe, contained place, shaded, and moist (e.g., with a water-soaked towel over the eyes, carapace, and flippers) and observe it for up to 24 hours.
- If the turtle begins actively moving, retain the turtle until the appropriate rehabilitation personnel can evaluate the animal. The rehabilitation facility should eventually release the animal in a manner that minimizes the chances of re-impingement and potential harm to the animal (i.e., from cold stunning).
- Turtles that fail to move within several hours (up to 24) must be handled in the manner described in Appendix C-II-E, or transported to a suitable facility for necropsy (if the condition of the sea turtle allows and the rehabilitation facility wants to necropsy the animal).



<u>Stranding/rehabilitation contacts</u>

Sea Turtles in Virginia

< Virginia Marine Science Museum (Hotline: (757)-437-6159)
Mark Swingle, Phone: (757)-385-0326 or (757)-437-6022
Susan Barco, Phone: (757)-437-7765

Marine Mammals

< Mark Swingle/Susan Barco (VA)
< Dr. Whitaker/Jennifer Dittmar (MD) [(410)-576-3852/ (410)-986-2377]
< NMFS Stranding Hotline at (978)-281-9351

APPENDIX D
Protocol for Collecting Tissue from Sea Turtles for Genetic Analysis

Materials for collecting genetic samples:

- surgical gloves
- alcohol swabs
- betadine swabs
- sterile disposable biopsy punches
- sterile disposable scalpels
- permanent marker to externally label the vials
- scotch tape to protect external labels on the vials
- pencil to write on internal waterproof label
- waterproof label, 1/4" x 4"
- screw-cap vial of saturated NaCl with 20% DMSO*, wrapped in parafilm
- piece of parafilm to wrap the cap of the vial after sample is taken
- vial storage box

* The 20% DMSO buffer within the vials is nontoxic and nonflammable. Handling the buffer without gloves may result in exposure to DMSO. This substance soaks into skin very rapidly and is commonly used to alleviate muscle aches. DMSO will produce a garlic/oyster taste in the mouth along with breath odor. The protocol requires that you wear gloves each time you collect a sample and handle the buffer vials. DO **NOT** store the buffer where it will experience extreme heat. The buffer must be stored at room temperature or cooler, such as in a refrigerator.

Please collect two small pieces of muscle tissue from ***all*** live or dead sea turtles. A muscle sample can be obtained no matter what stage of decomposition a carcass is in. Please utilize the equipment in these kits for genetic sampling of *turtles only* and contact Kate Sampson when you need additional supplies.

Sampling protocol for live turtles:

1. Stabilize the turtle on its plastron. When turtles are placed on their carapace they tend to flap their flippers aggressively and injuries can happen. Exercise caution around the head and jaws.

2. The biopsy location is the dorsal surface of the rear flipper, 5-10 cm from the posterior (trailing) edge and close to the body. Put on a pair of surgical gloves and wipe this area with a Betadine swab. **Insert photo**

3. Wipe the hard surface (plastic dive slate, biopsy vial cap or other available clean surface) that will be used under the flipper with an alcohol swab and place this surface underneath the Betadine treated flipper.

4. Using a new (sterile and disposable) plastic skin biopsy punch, gently press the biopsy punch into the flesh, as close to the posterior edge of the rear flipper as possible. Press down with moderate force and rotate the punch one or two complete turns to make a circular cut all the way through the flipper. The biopsy tool has a sharp cutting edge so exercise caution at all times.

5. Repeat the procedure on the other rear flipper (one sample per rear flipper) with the same biopsy punch so that you now have two samples from this animal.

6. Remove the tissue plugs by knocking them directly from the biopsy punch into a single vial containing 20% DMSO saturated with salt. It is important to ensure that the tissue samples do not come into contact with any other surface or materials during this transfer.

7. Wipe the biopsy area with another Betadine swab.

8. Dispose of the used biopsy punch in a sharps container. It is very important to use a new biopsy punch and gloves for each animal to avoid cross contamination.

Sampling protocol for dead turtles:

1. The best place to obtain the muscle sample is on the ventral side where the front flippers insert near the plastron. It is not necessary to cut very deeply to get muscle tissue.

2. Using a new (sterile and disposable) scalpel cut out two pieces of muscle of a size that will fit in the vial.

3. Transfer both samples directly from the scalpel to a single vial of 20% DMSO saturated with salt.

4. Dispose of the used scalpel in a sharps container. It is very important to use a new scalpel and gloves for each animal to avoid cross contamination.

Labeling of sample vials:

1. Use a pencil to write stranding ID, date, species and SCL on a waterproof label and place it in the vial with the samples.

2. Use a permanent marker to label stranding ID, date, species and SCL on the outside of the vial.

3. Apply a piece of clear scotch tape over the label on the outside of the vial to protect it from being erased or smeared.

4. Wrap Parafilm around the cap of the vial by stretching as you wrap.

5. Place the vial in the vial storage box.

6. Complete the Sea Turtle Biopsy Sample Collection Log (Appendix E).

7. Attach a copy of the STSSN form (Appendix F) to the Collection Log - be sure to indicate on the STSSN form that a genetic sample was taken.

At the end of the calendar year submit all genetic samples to:

Kate Sampson
NOAA/NMFS/NER
Protected Resources Division
55 Great Republic Drive
Gloucester, MA 01930
O: (978) 282-8470
C: (978) 479-9729

APPENDIX E
Sea Turtle Biopsy Sample Collection Log

				Stranding Date																				
NER ID	SPECIES CODE	FIELD ID	FLIPPER TAG	YEAR	MONTH	DAY	Sample Date (if diff. from stranding date) (mm/dd/yy)	COUNTY	STATE	CAPTURE TYPE	SEX	SCL (cm)	CCL (cm)	TTYPE	TSTORE	LAT D	LAT M	N OR S	LONG D	LONG M	E OR W	OCEAN BASIN	DATE XFER	WHERE?
																						Atlantic		
																						Atlantic		
																						Atlantic		
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																						Atlantic		

Notes:

Leave Blank: NMFS to fill in
Species Code: Use CC, DC, LK, EI or CM
Year/Month/Day: Stranding Data (should also be listed on vial)
Capture Type: Use Stranding or Incidental Capture
Ttype: Tissue Type, will likely be muscle

SEA TURTLE STRANDING AND SALVAGE NETWORK – STRANDING REPORT

OBSERVER'S NAME / ADDRESS / PHONE:
First ____________ M.I.____ Last ____________
Affiliation ____________
Address ____________
____
Area code/Phone number ____________

STRANDING DATE:
Year 20☐☐ Month ☐☐ Day ☐☐
Turtle number by day ☐☐

State coordinator must be notified within 24 hrs; this was done by ☐***phone (860)572-5955 x107*** ☐***email*** ☐***fax (860)572-5969***

SPECIES: (check one)
☐ CC = Loggerhead
☐ CM = Green
☐ DC = Leatherback
☐ EI = Hawksbill
☐ LK = Kemp's Ridley
☐ LO = Olive Ridley
☐ UN = Unidentified
Check Unidentified if not positive. Do Not Guess.

STRANDING LOCATION: ☐Offshore (Atlantic or Gulf beach) ☐Inshore (bay, river, sound, inlet, etc)
State ____________ County ____________
Descriptive location (be specific) ____________
____
____
Latitude ____________ Longitude ____________

Carcass necropsied? ☐Yes ☐No
Photos taken? ☐Yes ☐No
Species verified by state coordinator? ☐ Yes ☐ No

CONDITION: (check one)
☐ 0 = Alive
☐ 1 = Fresh dead
☐ 2 = Moderately decomposed
☐ 3 = Severely decomposed
☐ 4 = Dried carcass
☐ 5 = Skeleton, bones only

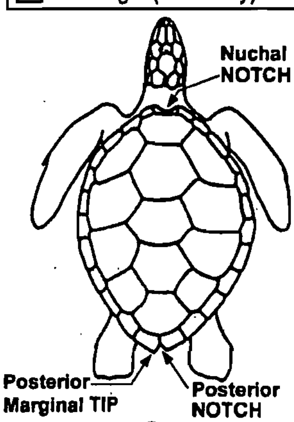
FINAL DISPOSITION: (check)
☐1 = Left on beach where found; painted? ☐Yes* ☐No(5)
☐2 = Buried: ☐ on beach / ☐ off beach;
carcass painted before buried? ☐ Yes* ☐ No
☐3 = Salvaged: ☐ all / ☐ part(s), what/why? ________
____
____
☐4 = Pulled up on beach/dune; painted? ☐Yes* ☐No
☐6 = Alive, released
☐7 = Alive, taken to rehab. facility, where? ________
____
☐8 = Left floating, not recovered; painted? ☐Yes* ☐No
☐9 = Disposition unknown, explain ________
____
If painted, what color? ________

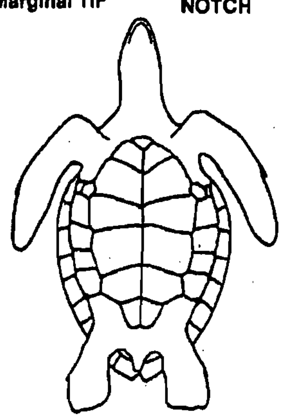
SEX:
☐ Undetermined
☐ Female ☐ Male
Does tail extend beyond carapace?
☐ Yes; how far?______ cm / in
☐ No
How was sex determined?
☐ Necropsy
☐ Tail length (adult only)

TAGS: ***Contact state coordinator before disposing of any tagged animal!!***
Checked for flipper tags? ☐ Yes ☐ No
Check all 4 flippers. If found, record tag number(s) / tag location / return address
____
____
____
PIT tag scan? ☐ Yes ☐ No
If found, record number / tag location
____
____
Coded-wire tag scan? ☐ Yes ☐ No
If positive response, record location (flipper)
____
Checked for living tag? ☐Yes ☐ No
If found, record location (scute number & side)
____

CARAPACE MEASUREMENTS: (*see drawing*)

Using calipers		**Circle unit**
Straight length (NOTCH-TIP)	________	cm / in
Minimum length (NOTCH-NOTCH)	________	cm / in
Straight width (Widest Point)	________	cm / in
Using non-metal measuring tape		**Circle unit**
Curved length (NOTCH–TIP)	________	cm / in
Minimum length (NOTCH-NOTCH)	________	cm / in
Curved width (Widest Point)	________	cm / in
		Circle unit
Weight ☐ actual / ☐ est.	________	kg / lb





Mark wounds / abnormalities on diagrams at left and describe below (note tar or oil, gear or debris entanglement, propeller damage, epibiota, papillomas, emaciation, etc.). **Please note if no wounds / abnormalities are found.**
____
____
____
____
____
____

APPENDIX G
ENDANGERED SPECIES OBSERVER FORM
Borrow Area Dredging
NASA Wallops Island Project

Daily Report

Date: ______________________________
Geographic Site: ____
Location: Lat/Long ___________________ Vessel Name ___________________

Weather conditions: ____
____

Water temperature: Surface ____________ Below midwater (if known) ____________

Condition of screening apparatus: ______________________________________
____
____

Incidents involving endangered or threatened species? (Circle) Yes No
(*If yes, fill out Incident Report of Sea Turtle/Shortnose Sturgeon Mortality*)

Comments (type of material, biological specimens, unusual circumstances, etc:)
____
____
____

Observer's Name: ____
Observer's Signature: _____________________________________

Species	# of Sightings	# of Animals	Comments

APPENDIX H

Incident Report of Sea Turtle Take

Species ____________ Date ______________ Time (specimen found) _______________

Geographic Site ____
Location: Lat/Long ____
Vessel Name ______________________ Load # ____________________________
Begin load time ______________________ End load time______________________
Begin dump time _____________________ End dump time ______________________

Sampling method ____
Condition of screening ____
Location where specimen recovered____
____
Draghead deflector used? YES NO Rigid deflector draghead? YES NO
Condition of deflector ____
____
Weather conditions____
____
Water temp: Surface _______________ Below midwater (if known) ________________

Species Information: *(please designate cm/m or inches.)*
Head width _________________________ Plastron length ______________________
Straight carapace length _______________ Straight carapace width___________________
Curved carapace length ________________ Curved carapace width ___________________

Condition of specimen/description of animal (please complete attached diagram)
____
____
____

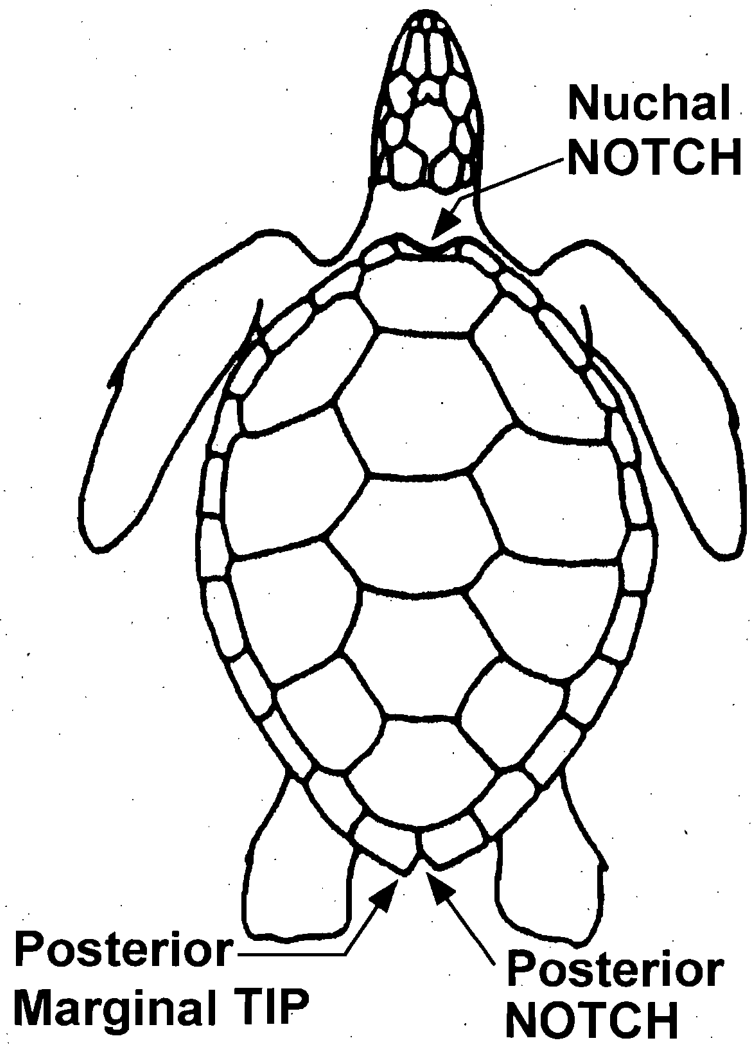
Turtle Decomposed: NO SLIGHTLY MODERATELY SEVERELY

Turtle tagged: YES NO *Please record all tag numbers.* Tag # _____________________
Genetic sample taken: YES NO
Photograph attached: YES NO
(please label *species, date, geographic site* and *vessel name* on back of photograph)

Comments/other (include justification on how species was identified) __________________
____
____
Observer's Name _____________________________________
Observer's Signature __________________________________

Incident Report of Sea Turtle Take

Draw wounds, abnormalities, tag locations on diagram and briefly describe below.



Description of animal:

National Aeronautics and space Administration Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program: Cultural Resource Remote Sensing Survey of Two Proposed Offshore Sand Borrow Locations in Federal Waters

Prepared for:

Goddard Space Flight Center's Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337

Prepared by:

Anthony Randolph, M.A., R.P.A.
Bridget Johnson, M.A, R.P.A.
J.B. Pelletier, M.A., R.P.A.
Gregory Brooks, Ph.D.

Principal Investigator

J.B. Pelletier, M.A., R.P.A.
URS Group, Inc.
200 Orchard Ridge Drive, Suite 101
Gaithersburg, Maryland 20878
301-258-9780

January 2010

URS

ABSTRACT

This report presents results of a cultural resources remote sensing survey of two proposed sand borrow areas located off of Wallops Island, Virginia as part of the National Aeronautics and Space Administration (NASA) Shoreline Restoration and Infrastructure Protection Program (SRIPP). URS Group, Inc. (URS) conducted this work to assist WFF with compliance with Section 106 of the National Historic Preservation Act of 1966, as amended; with the Abandoned Shipwreck Act of 1987; and with the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) of 1970. NASA is the lead agency preparing an Environmental Impact Statement under NEPA for their SRIPP at WFF; the U.S. Army Corps of Engineers and the Minerals Management Service are cooperating agencies on the EIS and other SRIPP-related compliance including Section 106 of the National Historic Preservation Act of 1966, as amended and the Abandoned Shipwreck Act of 1987. This investigation and report were completed in accordance with guidelines established in the Mineral Management Service (MMS) Notice to Lessees (NTL) 2005-G07, entitled *Archaeological Resource Surveys and Reports*, and with the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (Federal Register 48, No 190, 1983). MMS regulates activities on the portions of the Outer Continental Shelf that contain these proposed sand borrow areas. WFF and URS consulted with MMS staff during 2008 and 2009 to ensure that the requirements set forth in NTL 2005-G07 would apply to the current project.

The primary objective of this study was to identify maritime related cultural resources, particularly submerged watercraft, and buried prehistoric sites within the survey areas. Archival research and a remote sensing survey were used to accomplish these tasks. Research indicated a moderate potential to encounter submerged historic resources, and a relatively low potential to encounter buried prehistoric resources within the project area. Review of the National Oceanic and Atmospheric Administrations Automated Wreck and Obstruction System (AWOIS) and other pertinent sources suggests a total of 12 shipwrecks within a 13-mile (21 kilometer) radius of Wallops Island.

The survey array consisted of a Hemisphere Crescent R130 Digital Positioning System (DGPS), a Geometrics G882 marine cesium magnetometer, an ODEM Hydrotrac digital echo sounder, a Benthos Chirp 3 Sub Bottom Profiler and a 600 kHz Marine Sonics side scan sonar system. Survey control and data quality control were achieved with Hypack's *Hypack 2009a* ® survey software.

A total of five target groups were identified as representing modern debris. None of the five target clusters have the potential to represent significant submerged cultural resources. They are instead consistent with modern fishing and dumping activities. No further work is recommended for the five targets identified during this survey.

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(Included in Addendum)

1.0 INTRODUCTION

This report presents results of the cultural resources remote sensing survey of two proposed sand borrow areas located off of Wallops Island, in Accomack County, Virginia. URS Group, Inc. (URS) conducted this work on behalf of Wallops Flight Facility (WFF) to assist the National Aeronautics and Space administration's (NASA) Wallops Flight Facility (WFF) with compliance with Section 106 of the National Historic Preservation Act of 1966, as amended; with the Abandoned Shipwreck Act of 1987; and with the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) of 1970. NASA is the lead agency preparing an Environmental Impact Statement under NEPA for their Shoreline Restoration and Infrastructure Protection Program (SRIPP) at WFF; the U.S. Army Corps of Engineers (USACE) and the Minerals Management Service (MMS) are cooperating agencies on the EIS and other SRIPP-related compliance including Section 106 of the National Historic Preservation Act of 1966, as amended and the Abandoned Shipwreck Act of 1987. The EIS analyzes potential impacts to human health and the environment from the SRIPP proposed action of borrowing sand from either of two offshore sand shoals (Unnamed Shoal A and Unnamed Shoal B) in order to replenish the eroded beach faces of WFF. This investigation was undertaken in consultation with MMS, and in accordance with guidelines established in MMS Notice to Lessee (NTL) 2005-G07, entitled *Archaeological Resource Surveys and Reports*, and the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (Federal Register 48, No 190, 1983). MMS regulates activities on the portions of the Outer Continental Shelf (OCS) that contain these proposed sand borrow areas. WFF and URS consulted with MMS staff during 2008 and 2009 to ensure that the requirements set forth in NTL 2005-G07 would apply to the current project.

The primary objective of this study was to identify maritime related cultural resources, particularly submerged watercraft, and buried prehistoric sites within the survey areas. Archival research and a remote sensing survey were used to accomplish these tasks. Research indicated a moderate potential to encounter submerged historic resources, and a relatively low potential to encounter buried prehistoric resources within the project area. Review of the National Oceanic and Atmospheric Administrations Automated Wreck and Obstruction System (AWOIS) and other pertinent sources suggests a total of 12 shipwrecks within a 21 kilometer (13 mile) radius of Wallops Island.

This investigation took place between March and September of 2009. Christopher Polglase, RPA served as project manager for this project. Jean B. Pelletier, RPA served as principal investigator and as senior remote sensing specialist and analyst. Anthony Randolph served as remote sensing specialist and analyst. Bridget Johnson conducted archival research and produced graphics for the report.

Survey operations were conducted from the 14 meter (46 foot) research vessel, Venture III, chartered from Captains Paul and Ruth Hepler of Belmont, New Jersey. The survey array consisted of a Hemisphere Crescent R130 Digital Positioning System (DGPS), a Geometrics G882 marine cesium magnetometer, an ODEM Hydrotrac digital echo sounder, and a 600 kHz Marine Sonics side scan sonar system. Survey control and data quality control were achieved with Hypack's *Hypack 2009a* ® survey software.

This report is divided into seven sections, including this introduction. Section Two is a review of previous archaeological and architectural sites and contains surveys within 1.6 kilometers (1 mile) of the project area, followed by a discussion of known shipwrecks within 21 kilometers (13 miles) of the project area. Section Three contains the prehistoric and historic cultural contexts, which are used to evaluate the potential for encountering submerged prehistoric and historic cultural resources within the project area. Section Four contains the environmental setting of the region. Section Five presents the research methods and repositories used during background investigations, survey methods, and the expected results of the survey. Section Six contains the results of the remote sensing survey. Section Seven presents the summary and recommendations for targets identified in Section Six. Section Eight contains the List of References Cited. Report figures and plates are included as an addendum. Appendix A contains a table of side scan sonar images and Appendix B contains the Qualifications of Investigators.

2.0 PREVIOUS INVESTIGATIONS

2.1 ARCHAEOLOGICAL INVESTIGATIONS

A review of previously investigated sites provides a context used to assess the potential to encounter archaeological materials within the project area. A total of seven archaeological surveys were conducted within 1.6 kilometers (1 mile) of the beach area where sand is to be deposited (Table 2-1). These surveys identified a total of 10 archaeological sites within this radius (Table 2-2). Site 44AC558 was identified by the Eastern Shore Archaeological Society, but no formal report has been filed.

Table 2-1. Archaeological Surveys within 1.6 kilometers (1 mile) of the Beach Area

Sites Identified	Company Name	Report Date
None	Mark Wittkofski (Wittkofski 1980)	1980
None	Greenhorn & O'Mara, Inc (Dinnell and Collier 1990)	1990
None	Telemarc, Inc (Otter 1991)	1991
None	3D/Environmental Services Inc. (Miller 1991)	1991
None	Louis Berger Group, Inc (Ahlman and LaBudde 2001)	2001
44AC9, 44AC89	Darrin Lowery (Lowery 2000, 2003)	2000, 2003
44AC159, 44AC459	URS Corporation (Myers 2003)	2003

Mark Wittkofski conducted a Phase I reconnaissance for a proposed parking lot on Wallops Island for the US Navy in 1980. He determined that the area had a low potential to contain archaeological resources as it had been disturbed and graded with modern fill (Wittkofski 1980). Wittkofski conducted a comprehensive survey of Accomack and Northampton Counties throughout the 1980s. This survey identified 281 previously unrecorded archaeological sites, none of which are within the beach area.

Greenhorne & O’Mara, Inc. (Dinnell and Collier 1990) conducted a study of the southwestern portion of the Main Base for the Wallops Naval Facilities Engineering Command. They identified one site, but it was outside the 1.6 kilometer (1 mile) radius of the current beach area in which sand will be deposited.

Telmarc, Inc (Otter 1991) conducted a Phase I archaeological survey adjacent to the WFF in 1991. This study was conducted as part of a property acquisition west of a runway. No cultural resources were identified.

3D/Environmental Services, Inc. (Miller 1991) completed a cultural resources inventory which included an evaluation of archaeological and architectural resources of the WFF in 1991. The study was designed to produce a predictive model and sensitivity assessment for archaeological resources, as well as acting as a planning document for future evaluations at WFF.

Louis Berger Group, Inc. (Ahlman and LaBudde 2001) conducted an archaeological survey for the proposed Route 709 bridge replacement located northwest of the island. They identified three archaeological sites. These sites are all located beyond the 1.6 kilometers (1 mile) radius of the proposed sand deposit area.

Darrin Lowery (2000, 2003) conducted an archaeological survey of the Chesapeake and Atlantic shorelines associated with Accomack and Northampton Counties of Virginia. His findings were presented in two volumes designed to assess the impact of natural and human activities to archaeological sites along the shore. He documented numerous previously identified sites, both historic and prehistoric in nature, as well as documenting several new sites. His report identified seven sites (44AC9, 44AC77, 44AC78, 44AC79, 44AC80, 44AC81, 44AC89) within a 1.6 kilometer (1 mile) radius of the project area. Site 44AC9 represents an Archaic shell midden that is limited to the plowzone and includes a few prehistoric ceramics sherds. Sites 44AC78, 44AC79, 44AC80, and 44AC81 all represent shell middens from an undetermined prehistoric period. Site 44AC77 was a historic artifact scatter consisting primarily of ceramics which date to the second and third quarters of the 19th century. Site 44AC89 consists of a possible Revolutionary War earthwork located on Wallops Island.

URS conducted a cultural resources assessment of WFF in 2003 (Meyers 2003). The goal of this study was to further assess archaeological and architectural potential. Two archaeological sites, 44AC159 and 44AC459 were encountered within the 1.6 kilometer (1 mile) radius of the current project area. Site 44AC159 is located on Wallops Island and consists of a clam and oyster shell midden approximately 3 feet in height. Site 44AC459 was a late 19th to early 20th century structure associated with the US Coast Guard. A total of 291 artifacts were recovered from this site including nails, brick, glass, ceramic, and shell.

Table 2-2. Archaeological Sites within 1.6 kilometers (1 mile) of the Beach Area

Site Number	Site Type	Cultural Period
44AC9	Shell Midden	Archaic
44AC77	Historic Artifact Scatter	Late 19th century
44AC78	Shell Midden	Undetermined Prehistoric
44AC79	Shell Midden	Undetermined Prehistoric
44AC80	Shell Midden	Undetermined Prehistoric
44AC81	Shell Midden	Undetermined Prehistoric
44AC89	Military Earthworks	Revolutionary War
44AC159	Shell Midden	Unknown
44AC459	Historic Coast Guard Site	Late 19th-20th century
44AC558	Artifact Scatter	Undetermined Prehistoric

2.2 ARCHITECTURAL INVESTIGATIONS

Two previously identified historic properties are located within a 1.6 kilometer (1 mile) radius of the project area (Table 2-3). Within the Wallops Flight Facility itself are two historic properties that were found to be eligible for listing in the NRHP in the 2004 *Historic Resources Survey and Eligibility Report for Wallops Flight Facility, Accomack County, Virginia* (URS/EG&G 2004): the Wallops Exchange and Morale Association (WEMA) Recreational Facility/U.S. Coast Guard (USCG) Lifesaving Station (V-065, VDHR# 001-0027-0100), and the Observation Tower (V-070, VDHR#001-0027-0101). In a letter dated November 4, 2004, VDHR concurred with NASA's determination of eligibility for these two properties.

Table 2-3. Architectural Sites within a 1.6 kilometer (1 mile) of the Project Area

DHR ID #	Name	National Register Eligible
001-0027-0100	U.S. Coast Guard Lifesaving Station	Yes
001-0027-0101	Observation Tower	Yes

2.3 KNOWN SHIPWRECKS IN THE WALLOPS ISLAND AREA

Twelve shipwrecks have been recorded in the vicinity of Wallops Island, extending 20.9 kilometers (13 miles) off shore (Table 2-4). These wrecks were identified primarily using NOAA's Automated Wreck and Obstruction Information System (AWOIS), and Bruce Berman's *Encyclopedia of American Shipwrecks* (1972).

The proximity of Wallops Island to the Chincoteague Inlet, which serves as the entrance to Chincoteague Bay, resulted in extensive commercial and recreational vessel traffic along the Wallops Island coastline en route to Chincoteague and other barrier islands. Reported craft losses in the vicinity of Wallops Island are consistent with vessel classes commonly operated within the Chesapeake region. All craft were lost during the 20th century. A total of four wrecks were sailing schooners and three were barges. A single tug boat and fishing trawler were also lost, along with three unidentified vessels.

Table 2-4. Vessels Sunk within 20.9 kilometers (13 miles) of Wallops Island

Vessel Name	Vessel Type	Date of Loss	Date Built	Tonnage	Cause of Loss	Location
E.R. Smith	Unknown	1/25/1943	Unknown	Unknown	Sunk	Lat: 37.8167 Long: 75.3663
Florence and Lillian	Schooner	9/19/1921	1874	252	Foundered	SW of Chincoteague Lighthouse
Jennie N Huddell	Schooner	2/4/1910	1870	279	Stranded	Carter's Shoal, Chincoteague
Lizzie Godfrey	Schooner	7/12/1914	1890	77	Stranded	Chincoteague Inlet
Nancy Jane	Fishing Trawler	3/2/1968	Unknown	Unknown	Sunk, broken up	Lat: 37.8667 Long: 75.4163
P. J Hooper	Tug	3/26/1971	Unknown	Unknown	Unknown	Lat: 37.8367 Long: 75.3399
Ruhama Shaw	Barge	12/8/1917	1915	473	Foundered	Blackfish Bank, VA.
Ruth	Barge	12/9/1917	1908	435	Foundered	Blackfish Bank, VA.
Steel Barge No. 2	Barge	1/23/1935	1889	2217	Foundered	Blackfish Bank Buoy, VA.
Unknown	Sailing	Unknown	Unknown	Unknown	Unknown	Lat: 37.8646 Long: 75.4005
Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Lat: 37.8001 Long: 75.2463
Wm. Meekins	Schooner	12/22/1918	1874	79	Stranded	Chincoteague, VA.
Source: AWOIS, Berman 1972						

3.0 CULTURAL CONTEXT

The Virginia Department of Historic Resources (VDHR) has developed a chronological framework for the prehistory and history of the Commonwealth. This framework provides the basis for understanding prehistoric and historic cultural development in the area, as well as providing a context for predicting the types and kinds of archaeological sites expected in the project area. Included in this background section are Prehistoric Context and Historic Contexts.

3.1 PREHISTORIC CONTEXT

VDHR has defined three major periods of prehistory. These are the Paleoindian Period (10,000 – 8000 BC), the Archaic Period (8000 – 1000 BC), and the Woodland Period (1000 BC – AD 1600). Table 3-1 summarizes the chronology of these periods. The Archaic and Woodland Periods are further subdivided into Early, Middle, and Late Periods, which are characterized by changes in material culture (e.g., projectile point styles), environmental adaptation, subsistence strategies (e.g., hunting and gathering, fishing, and horticulture), settlement patterns, technology, and socio-political configurations. Each major time period is discussed below, along with relevant data concerning settlement and subsistence patterns established by excavations and study of archaeological sites in the Coastal Plain.

Table 3-1. Prehistoric Culture Chronology

Culture Period	Sub-Period	Date Ranges
Paleoindian	n/a	10,000 – 8000 BC
Archaic	Early	8000 – 6500 BC
	Middle	6500 – 3000 BC
	Late	3000 – 1000 BC
Woodland	Early	1000 BC – AD 300
	Middle	AD 300 – AD 1000
	Late	AD 1000 – AD 1600
Contact	n/a	ca. AD 1600

3.1.1 Paleoindian Period (10,000 – 8000 BC)

The region was first inhabited approximately 12,000 years ago with an influx of people who practiced a hunting and foraging lifestyle. Although there is evidence of human occupation in western North America and South America before 10,000 – 12,000 BC, there is no conclusive evidence in the Middle Atlantic region for human occupation before the Paleoindian Period. There is a great deal of debate over the issue of a "pre-Clovis" culture in the Americas that predates the traditional "Clovis" culture of the Paleoindian Period. Archaeological sites such as Cactus Hill in Virginia (e.g., McAvoy and McAvoy 1997), Meadowcroft Rockshelter in southwestern Pennsylvania (e.g., Adovasio et al. 1978), and the Topper Site in South Carolina (e.g., Parfit 2000; Rose 1999) have provided tantalizing but inconclusive evidence for human occupations predating the Paleoindian Period. There is currently no evidence for pre-Paleoindian occupations on the Delmarva Peninsula although shifts in survey strategies in recent decades (e.g. Lowery 2001, 2003) have resulted in new discoveries that may change the focus of research in this area. There are also extensive aeolian soils on the coastal plain that may cover more ancient fluvial sediments (Foss et al. 1978). Some of the depositional contexts may eventually reveal buried Paleoindian or pre-Paleo occupations. The discussion below focuses on the widely accepted definition of the Paleoindian culture in the Middle Atlantic region.

The end of the Pleistocene epoch (ca. 12,000 – 10,000 years ago) represents the terminus of the Ice Age or at least the beginning of a long interglacial episode. The environment during this time was quite different from modern conditions. Moisture locked in glacial ice sheets resulted in lower sea levels and greater exposure of coastal lands. Areas exposed during this time were subsequently inundated by the global sea level rise that began at the end of Pleistocene, when climatic amelioration resulted in melting continental ice sheets. During this period of post-glacial warming, the climate was probably three to eight degrees Celsius colder than at present, and the vegetation consisted of an open spruce parkland forest composed of spruce, pine, fir and alder (Brush 1986:149; Owens et al. 1974; Sirkin et al. 1977).

The Paleoindian toolkit included fluted projectile points, which were typically manufactured from high-quality lithic materials chosen for their predictable and consistent flaking properties. Projectile point types include Clovis, Cumberland/Barnes, Crowfield, Hardaway-Dalton, and Hardaway Side-Notched (Dent 1995; Lowery 2001, 2003). Other tools in the Paleoindian toolkit include endscrapers, sidescrapers, gravers, burins, denticulates, knives, *pieces esquillées*, wedges, perforators, and generalized unifaces and bifaces (Dent 1995).

Preferred lithic materials for these projectile points were high-quality cryptocrystalline rock such as jasper and chert (Brown 1979; McCary 1984), though tools made from locally available quartz and quartzite cobbles have been documented at sites in the Middle Atlantic region (e.g., Ebright 1992; McAvoy and McAvoy 1997). Archaeologists have postulated that Paleoindian hunter-gatherers traveled long distances to obtain raw materials for tool production (e.g., Custer 1984a; Gardner 1977). Recent research, however, has documented the availability of high-quality cherts and jasper cobbles in the Coastal Plain (e.g., Lowery 2001, 2003), suggesting that Paleoindians did not necessarily travel long distances to obtain lithic raw materials.

Paleoindian Period settlements consisted of seasonally-occupied camps, from which forays were made to obtain specialized resources, such as stone for tool manufacture (Custer 1984a; Dent 1995; Gardner 1977). Site types postulated for the Paleoindian Period include base camps, quarry sites, quarry reduction stations, quarry-related base camps, base camp maintenance stations, outlying hunting stations, and isolated projectile point finds (Custer 1989; Gardner 1989). These site types are considered part of the “seasonal round” of Paleoindian settlement patterning.

The isolated point find is the most common of these manifestations and the distribution of such finds on the Delmarva Peninsula shows a concentration on the Mid-peninsular drainage divide where bay-basin features represent Pleistocene surface water sources (Custer 1989:29). This is not to say that other areas were not frequented; perhaps it simply reflects the availability of more exposed acreage for occupation in the Middle of the peninsula. These sites are in headwater areas where streams flow to the bay and the ocean. Davidson (1981) also notes the use of interior drainages during this period; a trend that continues though the Middle Archaic. A single fluted point site is recorded in Virginia on the lower Delmarva Peninsula, (Custer 1989:93), but this find is not noted in McCary's (1984) fluted point survey.

Custer (1984a, 1989) classifies upper Delmarva Paleoindian sites within the Delaware Chalcedony Complex, which focuses on outcrops of high quality cryptocrystalline lithic raw materials, specifically Delaware chalcedony. Settlement patterns focused on these high quality lithic resources and on environmental resource gathering zones such as upland or interior swamps, headwater zones and similar early Holocene environmental settings.

Paleoindian subsistence patterns are difficult to discuss for the Middle Atlantic region due to the paucity of recovered faunal and floral remains. Paleoindians in the western United States are considered to be "big game" hunters of extinct Pleistocene megafauna such as the mammoth, caribou, musk ox, and giant beaver. There is no concrete evidence for a similar subsistence pattern in the Middle Atlantic region, though megafaunal remains have been recorded in the area (Custer 1989; Dent 1995; Edwards and Merrill 1977; Lowery 2001, 2003). Paleoindians in this area likely subsisted on mammals such as white-tailed deer, caribou and moose, along with smaller mammals. While Paleoindian subsistence probably focused on hunted game, there is evidence to suggest that plant foods and fish were also important food resources (Dent 1995; McNett l985). It should also be noted that a rich array of megafauna (e.g., mammoth, mastodon, walrus, and ground sloth) recovered from the continental shelf of the east coast may represent some of the key species that were hunted at the end of the Pleistocene (Edwards and Merrill 1977). One of the mammoth finds, for example, comes from the outer edge of the coastal plain in the lower Delmarva Peninsula area of Virginia (Edwards and Merrill 1977:11).

Paleoindian sites are not widely known in the Virginia Coastal Plain. Much of what archaeologists know about Paleoindians comes from isolated finds of fluted projectile points. Few intact Paleoindian sites have been identified in the region (Dent 1995; Lowery 2001, 2003), however, dozens of isolated fluted point finds have been documented on the Delmarva Peninsula (e.g., Custer 1989; Dent 1995). The Paw Paw Cove site, located in the northern Chesapeake Bay area in Maryland, is currently the only excavated Paleoindian site on the Delmarva Peninsula (Dent 1995; Lowery 2001, 2003). One theory explaining the lack of documented Paleoindian sites is that they are located on the Continental Shelf of the Atlantic Ocean in areas that would have been dry land during the Paleoindian Period (e.g., Dent 1995; Lowery 2001, 2003).

3.1.2 Archaic Period (8000 – 1000 BC)

The Archaic Period dates to ca. 10,000 to 3,000 years ago, and is conventionally sub-divided into the Early (8000 – 6500 BC), Middle (6500 – 3000 BC), and Late (3000 – 1000 BC) Sub-Periods. In the Middle Atlantic area, Archaic sites are much more numerous, larger, and richer in artifacts than earlier Paleoindian sites. They represent a series of adaptations that engendered an increasingly sedentary existence, and focused on resources available along large rivers and major tributaries. Other, often smaller sites of this period located away from the main streams probably represent seasonal or other specialized activities. Increasing territoriality and regional diversity are reflected in numerous artifact varieties, especially projectile points, throughout the Archaic Period. Evidence from Paleoindian and Early Archaic sites suggests that the transition from the Paleoindian way of life was a gradual transition (Custer 1990).

This transition was associated with a major climatic change that marks the end of the Pleistocene and beginning of the Holocene. The cool and moist climate of the late Ice Age shifted to a warmer and drier climate that approximates that of today. Rising sea levels inundated the lower Susquehanna River Valley and began forming the Chesapeake Bay estuary and its large salt and brackish water marshes, habitats that provided a rich and diverse subsistence base (Kraft 1976). As temperatures increased during the early Holocene, vegetation in the region shifted from coniferous forests of spruce to mixed deciduous/coniferous forests of hemlock, birch, hickory, and oak (Brush 1986:149; Custer 1990:10; Owens et al. 1974; Sirkin et al. 1977). The spread of deciduous woodlands into upland areas after 7000 BC opened up new habitats to be exploited by animals and humans (Custer 1990).

3.1.3 Early Archaic Period (8000 – 6500 BC)

Environmental conditions during the Early Archaic Period were not drastically different from the Paleoindian Period. Glacial recession continued and deciduous forests expanded, possibly leading to a proliferation of temperate fauna. The most distinctive cultural characteristic of the Early Archaic was the appearance of notched projectile points, most notably the Palmer and Kirk varieties. There was a continuation of the Paleoindian tradition of using high quality cryptocrystalline lithic materials until the end of the Early Archaic Period, when lower quality quartz and quartzite materials were more frequently used. Archaeological investigations in the Patuxent River drainage showed that the majority of Kirk points found were made of rhyolite. This indicates that by the Kirk phase, people traveled long distances in order to obtain preferred lithic raw materials, or that by this time long-range trade networks had been established (Steponaitis 1980:68). Although rhyolite is certainly exploited as a lithic raw material by this time, it still does not represent the intensive use evident during the Late Archaic.

There was significant innovation in stone tool kits during the Early Archaic Period. Stemmed and side-notched serrated projectile points replaced fluted projectile point varieties. The variety of projectile points associated with these periods indicates possible changes in subsistence strategies and exchange networks, and a possible regionalization of cultural traditions. Projectile point styles characteristic of the period include: corner-notched, serrated point styles such as Kirk, Palmer, Charleston, Lost Lake, Decatur, Amos, Kessel, and Fort Nottoway/Thebes; and stemmed points such as the Kirk stemmed and Pequea types (Custer 1984a, 1989, 1996; Dent 1995; Lowery 2001, 2003). Other tool types characteristic of Early Archaic Period assemblages include grinding slabs, milling stones, nutting stones, chipped stone adzes, wedges, perforators, knives, and scrapers, as well as unifacial and bifacial tools (Dent 1995; Lowery 2001, 2003).

Early Archaic Period inhabitants continued to show a preference for high-quality lithic materials, either transported into the area through trade or travel, or obtained from cobble sources in river and stream beds. Some researchers (e.g., Lowery 2001, 2003) have noted that Early Archaic people appear to have a preference for non-local cherts, chalcedonies, and jaspers, and have also noted the increased use of rhyolite for tools during this period (e.g., Custer 1984a; Dent 1995; Lowery 2001, 2003).

Both Gardner (1974) and Custer (1980) have hypothesized that Early Archaic Period peoples banded together into macro-base camps, or groups of families, in the spring and summer, and dispersed into smaller micro-base camps in the fall and winter months. Larger base camps were located in the valley floodplains while the smaller autumn and winter encampments were located in upland regions.

There is little faunal evidence from archaeological sites dating to the Early Archaic period, though "it is assumed that this environment supported bear, deer, elk, and a variety of small game adapted to a northern climate" (Kavanagh 1982:9). One exception is the Cactus Hill site (44SX202) which contains the remains of species that are still common in the region today (Whyte 1995). Floral evidence from sites such as the Crane Point site, in Talbot County, Maryland, includes hickory nut, butternut, acorn, amaranth, and chenopodium (Lowery 2001, 2003). Other sites in the Chesapeake Bay region have produced similar results (Dent 1995). The floral remains recovered from Early Archaic contexts indicate that a variety of plants were used for food. Stone artifacts such as grinding slabs, milling stones, and nutting stones are also indicative of increased reliance on plant foods, while adzes indicate increased manufacture of items from wood (e.g., shelter). The changes in tool types have been interpreted as a shift in subsistence strategies towards a broad-spectrum adaptation, utilizing a variety of species of animals and plants, rather than focusing primarily on large animals.

Numerous Early Archaic Period sites are located throughout the Delmarva Peninsula (Custer 1989; Dent 1995), mostly from surface finds in estuarine and shore locations. Early Archaic Period base camps on the Eastern Shore may have been located on floodplains or river terraces that have since become submerged by sea level rise. Smaller procurement or temporary camps may be located on the high terrace areas (elevations above 25 feet amsl), though none have been recorded in Accomack County. The same terraces that produced fluted points have also produced numerous finds of Early Archaic points, recovered by artifact collectors who search shoreline surfaces at low tide. These submerged manifestations represent significant clusters of Early Holocene sites. Nearby upland areas may also contain a variety of procurement sites and lithic scatters.

3.1.4 Middle Archaic Period (6500 – 3000 BC)

The beginning of the Middle Archaic Period coincides with the on-set of the Atlantic climatic episode, which was a warm, humid period with a gradual rise in sea level that led to the development of inland swamps. It was a period marked by an increase in summer drought, sea level rise, grassland expansion into the Eastern Woodlands, and the appearance of new plant species (Carbone 1976:106; Hantman 1990:138). Human settlements consisted of small base camps located in or near inland swamps that were convenient to access seasonally available subsistence resources as well as small, temporary upland hunting sites. This adaptation, along with the use of a greater variety of plant resources, allowed for an increase in general foraging (Kavanagh 1982:50).

The Middle Archaic Period is characterized by a variety of projectile point styles, including bifurcated styles (e.g., St. Albans, LeCroy, and Kanawha) that were introduced at the end of the Early Archaic Period (Dent 1995). Other projectile point styles used during the Middle Archaic Period include Stanly Stemmed, Neville, Morrow Mountain I and II, Halifax, and Guilford types (Dent 1995; Lowery 2001, 2003). Morrow Mountain and Neville points are more rarely found in Virginia. The former are found principally in the Southeast whereas Neville points are a typical Northeast type. Brewerton and Otter Creek styles were introduced during the latter part of the Middle Archaic Period, and persist into the early Late Archaic Period. Other artifact types characteristic of the Middle Archaic Period include groundstone tools (e.g., adzes and gouges), as well as scrapers, perforators, spokeshaves, and expediently-made flake tools for a variety of functions (Dent 1995; Lowery 2001, 2003). Rhyolite became more commonly used for making tools, though other local resources such as quartz and quartzite were utilized as well. The tendency towards greater reliance on local lithic sources led to a marked increase in numbers of informal flake tools for short-term use.

Middle Archaic Period sites have been documented on the Delmarva Peninsula, and include isolated point finds as well as sites with buried components (Dent 1995; Lowery 2001, 2003). Community pattern and settlement data are somewhat limited due to the scarcity of Middle Archaic Period sites with good, interpretable depositional contexts. Surface sites are, however, located in a variety of settings including uplands, river terraces, and wetland areas. Middle Archaic Period sites on the Delmarva Peninsula have been documented along Carolina Bay features, spring-fed interior wetlands, upland terraces, and confluences of freshwater streams (Lowery 2001, 2003). Subsistence patterns appear to be very similar to the preceding Early Archaic Period, based on the limited data that are available (Dent 1995; Lowery 2001, 2003). Middle Archaic points in nearby areas of Maryland have been found on sites (e.g., 18SO75 and 18SO105) along Kings Creek and the Manokin River. Like earlier Holocene manifestations, most of sites are known through isolated point finds on river terraces and along eroding shorelines.

3.1.5 Late Archaic Period (3,000 – 1000 BC)

Modern vegetation had become established in the region by approximately 3,000 BC, and the climate was punctuated by alternating periods of dry and moist conditions (Brush 1986:150). The Late Archaic Period is characterized by a warmer and drier climate than today, with the development of xeric forests (e.g., oak and hickory) and open grasslands (Carbone 1976; Custer 1984b). Sea level continued to rise, but was relatively stable by the end of the Late Archaic Period (Dent 1995; Lowery 2001, 2003). The warmer and drier climate appears to have stabilized stream valleys and estuaries in the region, making such localities more attractive for settlement. These settings developed into rich habitats with a great diversity of exploitable resources, particularly shellfish and anadromous fish (Davidson 1981; Hughes 1980). This is reflected in the changes manifested in Late Archaic tool kits as well as in the number of site types and site locations utilized. For example, settlement data from the lower Eastern Shore show increased use of riverine and estuarine settings, and there is a concomitant use of ephemeral settings as well, including headwaters, and low and high order stream areas (Davidson 1981, Hughes 1980).

The Late Archaic Period is characterized by a large variety of projectile point styles, including Otter Creek, Vosburg, and Brewerton, Lackawaxen, Bare Island, Halifax Side-Notched, Vernon, Clagett, Piscataway (a type that persists into the Woodland Period), and Holmes (Dent 1995). The initial sequence for the Late Archaic was developed by Stephenson and Ferguson (1963) and referred to Piscataway, Otter Creek, Vernon, and Brewerton projectile point styles. Otter Creek points have been recovered from Middle and Late Archaic contexts including an Otter Creek component identified at the Higgins site (Ebright 1989). Other Otter Creek sites in the Middle Atlantic region and the Northeast in general are described by Steponaitis (1980) and Funk (1965).

Projectile point styles characteristic of the end of the Late Archaic (sometimes referred to as the Terminal Archaic Period) include “broadspears” such as the Savannah River, Susquehanna Broadspear, Koens-Crispin, Lehigh, and Perkiomen types (Dent 1995). Other projectile point types found during the Terminal Archaic that persist into the Early Woodland Period include the

Orient Fishtail and Dry Brook types. The Fishtail phase marks the end of the Archaic period and the beginning of the Early Woodland.

Besides the established formal projectile point styles, there appears to have been an increase in the production of informal tools made out of flakes (Klein and Klatka 1991:98). Other artifacts characteristic of the period include steatite (soapstone) bowls, groundstone tools (axes, adzes, celts, gouges), perforators and drills fashioned from broken projectile points, and scrapers (Dent 1995). Rhyolite was established during this period as a preferred lithic raw material for tool manufacturing. It was during the Terminal Archaic as well as the succeeding Early Woodland Period that large amounts of rhyolite were transported from sources in the Blue Ridge to the Coastal Plain. The network that facilitated trade in rhyolite is not well understood (Kavanagh 1982:99).

Surface collections in the Delmarva region show greater use of locally available lithic raw materials (e.g., quartz and quartzite) during the Late Archaic. Broadspears recovered from eastern shore sites, especially the Susquehanna broadspears, are almost exclusively made from South Mountain (Blue Ridge) rhyolite. In the lower eastern shore of Maryland, these have been recovered, along with bannerstones and gorgets, from sites (e.g., site 18WO32) along the Pocomoke River.

The Late Archaic was characterized in the eastern United States by evidence of population growth, patterns of regional differentiation, and increased technological specialization. Trade networks appear to have been established for the exchange of raw materials and finished goods. The first large, semi-sedentary (i.e., occupied for several months or seasons) base camps were established along rivers and streams, and along estuaries on the Delmarva Peninsula. Surface site data show increases in site size, which may simply represent multiple, repeated occupations rather than single, large group manifestations. Site types postulated for the area include base camps, temporary camps, and resource procurement stations (Dent 1995).

Subsistence was still largely based upon gathering and hunting, although there was an increased reliance on riverine resources toward the end of the period (Steponaitis 1980). Seasonal hunting and foraging continued, but exploitation of riverine resources rapidly became an important part of the subsistence base. This continues the earlier trend toward a broad spectrum adaptation in which a variety of resources were exploited in many different environmental settings. The result has been the identification of Late Archaic sites in just about every habitable setting in the region. This broad spectrum adaptation is another way of characterizing what Caldwell (1958) originally called *primary forest efficiency* in the Archaic of the Eastern Woodlands.

A number of indicators point to an intensification of certain subsistence strategies ca. 2000 BC, which represents a major change in lifeways. This intensification has been explained as a consequence of gradual change (Caldwell 1958) and as episodic change relating to a shift in the composition of the environment (Carbone 1976). Structures such as fish weirs, used to exploit anadromous fish runs, were constructed during this period, and reflect the intensive riverine focus of the latter part of this period. While riverine resources were certainly important, interior and upland areas continued to be utilized by Late Archaic peoples. Late Archaic subsistence economies may be described as diffuse, considering the use of upland areas for a broad range of resource procurement activities gathering foods such as acorns, hickory nuts, and butternuts as well as large and small game (Cleland 1976). Subterranean storage pits and steatite containers appear in the archaeological record by 1500 BC. These technological developments led to food surpluses and the subsequent preservation of these surpluses over an extended period. The appearance of large numbers of implements, useful in processing seed and fiber products, is further evidence of this emerging economic pattern.

3.1.6 Woodland Period (1000 BC – AD 1600)

The Woodland Period dates from 1000 BC – AD 1600, and is conventionally divided into the Early (1000 BC – AD 300), Middle (AD 300 – 1000), and Late (AD 1000 – 1600) sub-periods based on changes in ceramic types, lithic technologies, subsistence patterns, and social development. The climate during the Woodland Period is characterized by a return to cool, moist conditions and establishment of vegetation that is characteristic of the region today. The Woodland Period is marked by the introduction of ceramics, significant population growth, and an increasingly sedentary way of life. Hunting and gathering of wild floral and faunal resources remained important, but incipient horticulture, based on maize cultivation, eventually formed an important part of the subsistence base.

3.1.6.1 Early Woodland Period (1,000 BC – AD 300)

It was previously thought that the transition between the Late Archaic and Early Woodland Period represented the introduction of horticulture (e.g., Fritz 1993; Smith 1992, 1995). Although Early Woodland groups in the South and Midwest used cultivated plants, there is presently no evidence that cultivated foods played a role in the diet of Early Woodland people in the Chesapeake Bay area. Efficient hunting and gathering systems stemming from several millennia of development (e.g., Caldwell 1958), including the exploitation of riverine and marine species, apparently slowed the acceptance of viable cultigens. Cultivated foods begin to assume an important role after 800 to 900 AD, when varieties of tropical cultigens arrived in the Middle Atlantic area (Smith 1995). These complemented cultigens of the eastern agricultural complex (e.g. sunflower, goosefoot, sumpweed, little barley) that had been developing for centuries.

The introduction of pottery around 1,000 BC marks the beginning of the Woodland Period. Potters’ innovations, as reflected in ceramic types, have become a significant basis for dating Woodland Period archaeological site components. The earliest ceramic types from the Eastern Shore are the steatite-tempered Marcey Creek ware and the crushed rock-tempered Dames Quarter ware. Both of these wares were later replaced by the sand or crushed quartz-tempered Accokeek wares, Wolfe Neck wares, and the grog-tempered (crushed clay) Coulbourn wares (Custer 1983, 1989; Dent 1995; Egloff and Potter 1982; Mouer 1991; Stephenson et al. 1963).

Stone artifacts characteristic of the Early Woodland Period include Calvert, Rossville, Potts, and Piscataway types, some of which are also found in Late Archaic contexts (Dent 1995; Lowery 2001, 2003; Hranicky 1991, 1993, 1994; Hranicky and Painter 1989). Other artifact types include drills, perforators, flake tools, scrapers, bifaces, anvil stones, net sinkers, mortars, pestles, manos, metates, groundstone tools (axes, adzes, celts), ground slate, gorgets, and tools made from animal bone and teeth (Dent 1995).

The Early Woodland Period is marked by an intensification of burial ceremonialism. Influences from the Ohio River Valley include the Adena culture, which is represented on a few key sites in the Middle Atlantic region during the Early Woodland Period. Artifacts associated with the Adena culture include Cresap stemmed points, large bifaces, blocked-end tubular pipes, effigy pipes, copper beads and other copper artifacts, gorgets, pendants, bird stones, bar stones, ground slate objects, and red ochre (Dent 1995; Lowery 2001, 2003). Although these artifacts are most typically found associated with cremation burials, Adena artifacts have been recovered from habitation sites in the region (Dent 1995; Lowery 2001, 2003). Evidence for Adena influence in the region has also been documented as surface finds of trade items (e.g., Adena blocked-end tubular pipes) along major streams and occasional finds of Adena projectile points (e.g., site 18WO144). The Nassawango site near Salisbury (Wise 1974) contained more substantial evidence of an Adena presence on the Coastal Plain in Maryland. Mortuary data have also come from Adena sites in nearby Delaware, such as Killens Pond (7K-E-3), Saint Jones (7K-D-1), and the Frederica site (7K-F-2) (Custer 1984a:121-2). On the western shore of Chesapeake Bay, a cremation site (West River Site) from which Adena artifacts were recovered is one of the few buried features dating to this time period in the region (Ford 1976).

Early Woodland settlement patterns were still predominantly riverine, with sites most often identified at the junction of freshwater and brackish water streams. Early Woodland sites are generally larger than those of previous times, and there seems to have been an increasing reliance on riverine and estuarine resource areas. The smaller camps were established seasonally in areas where ripening resources or concentrations of game could be found. Gardner (1982:60) notes that the settlement-subsistence system of this period was focused primarily on a series of base camps where people gathered together to exploit seasonally available resources. These base camps were used to harvest anadromous fish in the spring and early summer, and to exploit estuarine resources in the fall and early winter. Barber (1991) contends that an increase in sedentism was in part a result of a stabilized sea level that facilitated the establishment of resource-rich environments. Other than a trend toward sedentism and more focused hunting and gathering, subsistence patterns were similar to the preceding Late Archaic period with increasing reliance on marine resources (e.g., shellfish) and cultivated plants (Dent 1995; Lowery 2001, 2003).

3.1.6.2 Middle Woodland Period (AD 300 – 1000)

The Middle Woodland Period (AD 300 – 1000) generally is not well-defined, and researchers disagree about the exact boundaries of the period. Dent (1995:235) has referred to this period of "technological homogenization" where "ceramic and projectile point variability becomes limited to fewer types." Despite the presence of fewer ceramic and projectile point styles, the Middle Woodland Period represents a continuation and further development of cultural complexity that culminates in the Late Woodland Period. The intensification in trade networks over a large region is one of the notable trends evident by the onset of the Middle Woodland Period. It is thought that warmer and drier conditions may have prevailed during this period (Kellogg and Custer 1994; Lowery 2001, 2003).

The major ceramic types for the period are Popes Creek and Mockley wares (Dent 1995). Popes Creek ceramics were first manufactured in the Early Woodland Period, and the style persisted through the early Middle Woodland Period in the region (Maryland Archaeological Conservation Laboratory 2002). Mockley shell-tempered ceramics are common in the latter half of the Middle Woodland Period.

Stone tool kits utilized by Middle Woodland peoples are basically the same as those used during the succeeding Late Woodland, but more exotic lithic materials are evident in Middle Woodland assemblages. The technology evident in many Middle Woodland sites seems to favor bifacial tool production rather than the prepared core and blade flake technology that typifies Ohio Valley cultures. Projectile points characteristic of the Middle Woodland Period include Selby

Bay/Fox Creek and the Jack's Reef types (Custer 1989; Dent 1995; Potter 1993; Stewart 1992). Other tool types found during the Middle Woodland Period are similar to those found during the Early Woodland Period, and include drills, perforators, flake tools, scrapers, bifaces, anvil stones, net sinkers, mortars, pestles, manos, metates, groundstone tools (e.g., axes, adzes, celts), ground slate, gorgets, and tools made from animal bone and teeth (Dent 1995). Dent (1995) notes that bone tools, such as awls and needles, appear to be more ubiquitous during the Middle Woodland than the Early Woodland Period. The presence of non-local rhyolite, argillite, and jasper at a few sites suggests that exchange networks may have been established between the Costal Plain and areas near western Maryland and the New Jersey Fall Line.

There are a few sites in the Chesapeake Bay region that evidence an elaboration of mortuary ceremonialism, with projectile points, ceramics, bone artifacts, shell beads, large pentagonal bifaces, platform pipes, bannerstones, and pendants (Lowery 2001, 2003). These sites appear later in Middle Woodland period, suggesting a reemergence of mortuary ceremonialism and continued selective influences from the Ohio River Valley/Great Lakes region (Lowery 2001, 2003).

Settlement patterns were largely similar to those of the Early Woodland Period, although base-camp settlements located at freshwater/brackish water junctions appear to have been abandoned in favor of broader floodplain sites where maximum resource exploitation of both non-tidal and tidal aquatic resources was possible. The large number of sites for this time period and the extensive size of some of the sites support the argument for possible seasonal aggregation and dispersal. There is some evidence for a significant shift toward settlement of coastal and estuarine areas (Davidson 1981) though Hughes (1980) notes that inland areas along swamps and small streams are still being utilized at that time. Hunting and gathering continued as the primary food sources, with increased reliance on riverine and domesticated plant resources. The presence of large, shell Midden sites during the Middle Woodland Period indicates the increased reliance on shellfish. There is also an intensification of horticultural practices, although hunting, fishing, and plant collecting are still important subsistence pursuits. The subsistence economy is also marked by the initiation of maize horticulture.

3.1.7 Late Woodland Period (AD 1000 – 1600)

Cultivated crops came to play an important role in subsistence for much of the region during the Late Woodland Period (AD 1000 – 1600 (Dent 1995). Some researchers (e.g., Lowery 2001, 2003) suggest, however, that agriculture did not play a big role on the Delmarva Peninsula, and that hunting, gathering, and fishing were the basis of the subsistence economy. The climate had stabilized by this period, and "environmental conditions were essentially modern in character" (Lowery 2001:87).

Chesapeake Bay region artifacts characteristic of the Late Woodland Period include a variety of ceramic types, including Cashie Currioman, Gaston, Killens, Minguannan, Moyaone, Potomac Creek, Rappahannock, Roanoke, Sullivan Cove, Townsend, and Yeocomico wares (Dent 1995; Maryland Archaeological Conservation Laboratory 2002). Only the Killens, Minguannan, Rappahannock, and Townsend wares appear on Delmarva Peninsula archaeological sites (Custer 1989; Dent 1995).

Projectile points characteristic of the Late Woodland Period include small triangular styles, such as the Madison and Levanna types and their variants (Custer 1989; Dent 1995; Lowery 2001, 2003). There is an apparent preference for locally available stone material for making points.

Other stone artifacts recovered from Late Woodland Period sites include scrapers, perforators, bifaces, hoes, choppers, net sinkers, groundstone axes, celts, adzes, mauls, grinding slabs, metates, manos, mortars, pestles, pendants, boatstones, bannerstones, and abraders (Dent 1995; Stephenson et al. 1963). Artifacts made from shell and bone are recovered from Late Woodland Period sites, including fish hooks, scraping implements, pendants, beads, awls, bodkins, beamers, needles, pins, and beads (Dent 1995). Clay tobacco pipes were manufactured during this period. Copper beads and pendants are also, but rarely, found (Dent 1995).

Unlike the rich mortuary traditions of the Early and Middle Woodland Periods, Late Woodland mortuary sites consist of large ossuaries containing human remains and few grave goods. Exotic items found in Early and Middle Woodland Period mortuary contexts are absent from Late Woodland ossuaries (Dent 1995; Lowery 2001, 2003). Smaller, single interments are found throughout the Chesapeake region. Late Woodland Period dog burials have also been recorded in Virginia (Dent 1995).

The establishment of stable agriculture during the Late Woodland Period led to the development of sedentary floodplain village communities. Villages were often located within palisades near agricultural fields. The reliance on agriculture, and the presence of village palisades, hearths, storage pits, Middens, and burials, is indicative of the greatest degree of sedentism seen until this time. Settlements were generally located on broad floodplains, often near the junction of a tributary stream and river. Small transient camps have been found in upland settings (Gardner et al. 1984:18-20). Hunting and gathering was conducted from larger estuarine camps surrounded by micro-band camps. Other trends include shifts in lithic raw material preferences, perhaps related to the development of more sedentary lifestyles. Smaller foraging and hunting ranges would have resulted in more limited exploration for lithic raw materials and greater dependence on resources found near the camps, as well as those regularly obtained through exchange with other groups.

Increased population density and competition for choice land and resources led to the rise of chiefdoms and a hierarchical type of political organization. Hunting, gathering, and fishing were still practiced, but to a lesser extent than earlier. Agriculture does not appear to have played a major role in the Late Woodland Period subsistence economy on the Delmarva Peninsula, though populations do seem to have adopted a more sedentary lifestyle. There was an increase in social and political interaction among native tribes in the region after AD 1500, and Potter (1993:151) has suggested that an alliance of coastal plain Algonquian groups was formed prior to European contact.

3.1.8 Potential to Encounter Prehistoric Sites within the Project Area

The most likely sites to be encountered in the project area are Paleoindian in nature, because the offshore landforms being evaluated may have been exposed during the Late Pleistocene. Paleoindian sites are rare on the Delmarva Peninsula, and usually consist of isolated projectile point finds. Large habitation sites that may be detectable with remote sensing technologies are not associated with early prehistory.

A sub bottom profiler array can, in theory, detect buried relict channels that may have been exposed during the Late Pleistocene. The margins and confluences of these buried channels represent locations where Paleoindian Period peoples may have frequented. The preservation potential within the survey areas, which will be discussed in the next section, is very low, and it is highly unlikely that any buried relict channels have survived intact to the present time. By extension, there is a very low possibility to find an intact prehistoric site where there are no intact buried relict channels.

3.2 MARITIME HISTORIC CONTEXT

Wallops Island is a barrier land mass located on the eastern shore of the Delmarva Peninsula in Accomack County, Virginia. The maritime history of this sparsely inhabited island is intimately related to the political, economic, and cultural background of Virginia's Eastern Shore, particularly Accomack County. This maritime context will focus on the history of this portion of Virginia for this reason. Details regarding the history of Wallops Island are included throughout.

3.2.9 Contact Period (1524-1606)

The Contact Period begins as European explorer's first venture into North America in search of a northwestern passage to Asia and Cathay. Early voyages to the Eastern Shore of Virginia began in the early 16th. The first documented landing took place in 1524, when French adventurer Giovanni da Verrazano landed approximately 16.1 kilometers (10 miles) north of Cape Charles. Contracted to explore the new world by Francis I of France, Verrazano hastily mapped the eastern shore of the Chesapeake Bay and daringly penetrated the headwaters of the Pokomoke River in his carrick, *La Dauphine*. He also documented lifeways of the indigenous Accomac peoples, including the construction and use of seaworthy dugout canoes. Verrazano dubbed the region Arcadia in a subsequent report to the French crown (Wise 1911, Lowery 2000). A second landing took place in 1525. Explorer Lucas Vasquez d' Ayllon cruised the interior of the Eastern Shore of Virginia in an effort to identify a northern passage out of the Chesapeake Bay. He surveyed numerous waterways during this venture and landed several times to provision his vessel (Wise 1911).

Other explorers who sailed Virginia's Eastern Shore between 1571 and 1606 were Englishman Bartholomew Gilbert and Dutch captain Richard Hakluyt (Wise 1911, Lowery 2000). Bartholomew Gilbert explored the southern coasts of Virginia, beginning in 1602, in search of the lost residents of Roanoke Island. Sailing a fifty ton bark with a small crew, Gilbert was caught in a storm off the Capes of Virginia during the summer of 1603. To escape the storm he sailed into the Chesapeake and anchored one mi (1.6 km) off the eastern shore. In need of provisions and water, Gilbert and a small well armed party went ashore. After travelling only a short distance on the beach they were attacked by the local Accawmack tribe, and Gilbert and a crew member were killed (Wise 1911).

Vessels employed by European explorers between 1525 and 1600 shared similar characteristics. The 16th century was the first period during which ship design was based on predetermined mathematical projections. Vessels developed from these projections maintained rounded hulls with a length to breadth ratio between 2.8 and 3.1 to 1. These characteristics resulted in slow, seaworthy ships with a massive tonnage or carrying capacity. Waterline length varied between 20 and 45 meters (65.6 and 147.6 feet) (Steffy 1994). Ships of this time were called carrick, galleon, nao, caravel, pinnace, bergaitin, and fluit (Unger 1994).

3.2.9.1 Settlement to Society (1607-1750)

Much like the rest of the Chesapeake Bay region, Virginia's eastern shore was primarily settled by English immigrant farmers. Explorer John Smith attracted his countrymen to the area in 1607 when he exclaimed that the area was a fertile, wooded land with many creeks, bays and inlets that permitted navigation into the interior. The first settlement in the area was a satellite community hailing from Jamestown. Governor Thomas Dale sent Lieutenant William Craddock and a score of men to Smith Island in 1614 to provide salt and fish for the struggling Virginia colony (Wise 1911, Ames 1940). The success of this small town, called Dale's Gift, generated interest among colonists, thus initiating the permanent settlement of the region. Salt production became the first industry of Virginia's Eastern Shore, and it remained a profitable one until the early 18th century (Ames 1940).

The southern portion of the Delmarva Peninsula was formally recognized by the English crown in 1634 when the House of Burgesses established Accomac Shire under the direction of England and King Charles I. It stood as one of the original eight shires of Virginia and was named for the local Accawmack tribe. This shire was divided into Accomack and Northampton Counties in 1671 (Wise 1911). The earliest permanent settlement on Virginia's eastern shore was located on the southwestern side of the peninsula along the Chesapeake Bay where it was more protected from the elements. This settlement, known as Accomack Plantation, was composed of three distinct settlements along Kings Creek, Old Plantation Creek, and Magothy Bay at Cape Charles (Turman 1964). The town of Accomac became the location of a county courthouse on the seaward side of the peninsula.

English and Dutch settlement on the eastern shore gradually increased throughout the 17th century, and land grants were routinely issued throughout Accomack County for parcels ranging from 200 to 2,000 acres. The grant for Wallops Island was awarded during this land rush. Englishman John Wallop was given 1,450 acres on then Kickotank Island in 1672 to reward his effort to seed Accomack with British colonists. This grant was later revised to 1,800 acres in 1682 and then 1,500 acres in 1692. The island, which was later dubbed Wallops Island, is shown on the 1693 map of the region done by Daniel of St. Thomas Jenifer (Figure 3-1) It was intended that all lands granted by the English crown be farmed speculatively by the owner for the benefit of mother England and the still isolated peninsula (Whitelaw 1968). After being granted to Wallop, the island became known as Wallops Island and was passed down to his children and grandchildren.

The colonial economy of the Delmarva Peninsula was more diverse than that of the tobacco dominated western shore. Salt making began on Smith Island in 1619, and became a luxury commodity throughout the colonies until the first quarter of the 18th century. Fertile fields throughout Accomack and Northampton Counties yielded excellent grain, corn, and tobacco. Industries associated with these crops, such as grain mills and tobacco cask manufacturing houses, dotted the landscape as additional plantations were established. Hemp and flax were also grown for the manufacture of cloth, and bricks were made for the construction of permanent structures on plantations and at Accomac Town. Fishing and boat manufacture were also growing industries at coastal settlements (Ames 1940). Vessel production was so vital to the success of the region that the Accomack assembly offered an incentive in 1661 of 50 pounds of tobacco for every vessel ton produced (Wise 1911). The diverse eastern shore economy established in the early 17th century continued with little change over the next 300 years.

Prospective buyers in Amsterdam, Boston, Baltimore, London, and the Greater Antilles clamored for eastern shore products, and maritime trade became key to the prosperity of this isolated community between 1630 and 1750. Dutch and English trading houses located throughout Accomack County owned seaworthy vessels that traveled between Boston, England, Baltimore, and the Greater Antilles with cargoes of grain, tobacco, flax, and salt. These moderately sized 20 to 40 ton ships returned laden with molasses, sugar, rum, and refined goods slated for re-distribution among prospering colonists (Ames 1940). These trading craft, called *Africa*, *Blessing of Virginia*, *Deliverance*, *Anne Clear, May Flower*, and *Artillery*, became the face of eastern shore commerce for 120 years, and generated fortunes for merchants such as Richard Scarburgh and William Claybourne (Wise 1911).

The success of merchant fleets throughout colonial America did not go unrecognized by the English Crown, and Parliament passed a series of acts that restricted the local trade of competing nations. The first of these navigation acts was passed in 1651, and it stated that goods shipped to England had to be carried by English vessels. This declaration infuriated foreign merchants, particularly the large Dutch population on the eastern shore. The resultant regional conflict between Dutch and English traders became known as the Dutch War, which raged between 1651 and 1653. The war was contested politically on land and between Dutch and English privateers at sea, and many merchant vessels were sunk or taken as prizes as a result (Wise 1911, Ames 1940). Dutch interests suffered terribly during the conflict, and they ceased to be a major economic factor in the region after the war.

Maritime prosperity on the eastern shore also enticed those motivated by quick profit, and piracy was a looming threat along the eastern seaboard throughout the seventeenth and early eighteenth centuries. The isolated barrier islands of the southern Delmarva Peninsula served as excellent havens for captured prizes and pirate vessels alike (Shomette 1985). John James of *Providence Frigate*, William Kidd of *Adventure Galley*, Edward Davis, and John Cook all harried merchant shipping in the region (Middleton 1953). Fear of piracy along the eastern shore prompted local officials to establish lookouts along the coast; Captain Gilbert Moore was commissioned to patrol the coast in search of possible culprits. Accomack assembly member John Custis also petitioned the Virginia governor for a royal frigate to discourage further predation. Captain Edward Teach, commonly known as Blackbeard of *Queen Anne's Revenge*, was born and raised in Accomack County (Wise 1911, Shomette 1985).

As the Eastern Shore is relatively isolated from the mainland of Virginia, the most expedient way to travel between the two locations was by boat. In order to facilitate travel, a ferry system was established. A ferry had been making two round trips per week from the port of Northampton to York and Hampton since 1705. John Masters was given rights to operate a ferry from the Eastern Shore to the ports of York and Hampton in 1724. During his operation of the ferry the main port was soon moved to Mattawoman Creek, the main branch of Hungars. He provided one transport for the passage of foot passengers and one for men and horses (Turman 1964).

The importance of shipping on Virginia's Eastern Shore in this period became evident in the increased restrictions placed on shipping. Towns that could become ports and attract shipping grew exponentially both in population and wealth. Virginia passed "An Act for Cohabitation and Encouragement of Trade and Manufacture" in 1680 (Henning 1819b). This act was designed to establish towns for storehouses in order to better control the moment of tobacco and other exports. All produce was to be carried to the designated towns before export and all goods brought into the colony including "servants, Negros, and other slaves" were to be landed only in these towns (Henning 1819b: 477). Only one such town was established for Accomack County, called Onancock, on the bay side of the peninsula. This town was the site of brisk trade with the western shore of Virginia and was one of the major ports of the colony. In an attempt to limit the number of ports to concentrate prosperity, customs began being collected. Each port from which boats entered and departed had a customs collector, and each ship captain was responsible for ensuring that goods loaded aboard his ship had been properly inspected and a certificate from the customs collector (Turman 1964).

In 1691, Virginia passed an act concerning the establishment, location, and operation of ports throughout Virginia (Henning 1819a). This designated where vessels could load and unload goods and where goods could be sold (Henning 1819a). It also decried the home of the Naval Officer who kept track of the vessels coming and going for each district. This port was located in Accomack County at Onancock, where by 1691 "the court house, several dwelling houses and warehouses are already built" (Henning 1819a). The court remained at Onancock until 1786 when it was moved to the sea ward side of Accomack, as this location was considered more convenient for the local population (Wise 1967:233). Ports at Accomack in Folly Creek (seaside) and Onancock (bayside) were designated official ports in the same year (Henning 1819c:321). The two towns are only 4.5 mi apart by land.

As ports became larger and supported greater volume of incoming and outgoing traffic, it became necessary to protect the channels leading to these ports. Sailing vessels brought in significant amounts of sand, gravel and ballast stone, which were often dumped in the channels and wharves surrounding these ports. The General Assembly passed a law requiring every county adjacent to a navigable stream to provide a place to deposit ballast on shore where it would not wash back into the waterway and obstruct navigation (Turman 1964). They were also required to provide an overseer to regulate this process. Ship captains were required to pay the overseer a fee for unloading ballast on shore, which prompted many vessel operators to load their vessels with paying ballast such as limestone, chalk, bricks, and stones to avoid paying the ballast fee while earning freight charges.

Virginia, as a colony of Great Britain, was discouraged from manufacturing finished goods, and the crown mandated importation of nearly all housekeeping materials. Colonial officials reported to the Lords of Trade in 1741 that "The colonial Virginias has all the necessities they wished for the adornment of their persons or for the furnishing of the homes just as if they lived in Great Britain" (Coulter 1945:296). The majority of manufactured goods came from Great Britain, but other goods arrived from all over the known world. Five British ports dominated trade with Virginia during the 18th century; these were (in order of importance) London, Bristol, Glasgow, Liverpool and Whitehaven. England's center of shipping was London, and "Drawing into its markets the manufactures of Britain, continental Europe, and Asia, and having its own special products, 18th century London was the world emporium of trade" (Coulter 1945:297). Vessels destined for Virginia may have originated in Britain, but the cargo came from all over the world.

There was considerable trade between Virginia and the British West Indies during the colonial period. The islands of Barbados, Antigua, St. Kitts and Jamaica were producers of sugar and rum, and imported food and wood from the colonies in return. Vessels traveling to Virginia from the West Indies usually carried a cargo of sugar and a few slaves. The vessels were smaller sloops, not the larger African ships devoted to slaving (Kline 1975). Moreover, slaves that had spent time in the West Indies were considered "seasoned" or acclimated to the climate and culture of colonial America. These were preferred to slaves that came directly from Africa for reasons associated with disease, language, and conduct (Coulter 1945).

Accomack County and its district port of Accomack were a common destination for the smaller coastal vessels from northern American colonies and the West Indies (Kline 1975). Larger vessels, such as the slavers coming directly from Africa, would call on the larger ports of the South Potomac, Rappahannock, and York River districts (Klien 1975). Accomack, being small and removed from the rest of the colony, was not a favored destination of slave traders. Only 125 slaves were brought to the county (via the port at Accomack) during the 42 year period of 1727 to 1769. None of the voyages to Accomack came directly from Africa, but from the West Indies and other colonies. In contrast, the district of York River received 15,607 slaves during the same period, with 60 percent of the voyages coming directly from Africa (Kline 1975). There was a direct correlation between the size of the vessels and the size of the port it was able to enter.

Craft common to the southern eastern shore between 1607 and 1750 were varied. During both the 17th and 18th century, vessels operating in the Wallops Island area would have been small craft used to move small amounts of goods and produce up and down the seaside of the peninsula. Their capacity would have been that of livery, or transport, to the larger transatlantic vessels that would carry hundreds of large hogsheads of tobacco to London and beyond. One colonist described the Chesapeake Bay and the surrounding waterways in 1724 as "navigable for sloops, shallops, long-boats, flats, canoes and *Periaguas*" (Brewington 1953). Vessels used in the American colonies were very similar to their European counterparts, as locally constructed vessels were not typically built for a specific purpose, but could be used for anything befitting their size (Chapelle 1951). There were few distinctly colonial vessel types recorded during this period. Modifications of previously used vessels were made, but there are seldom detailed descriptions or terms for these regionally modified vessels. The major vessel types used during this period include the dugout/log canoe, the punt or flat boat, bateau, the sloop, and the shallop.

The dugout represents the earliest vessel type employed in the Chesapeake region. It originated from the local Native American population that inhabited Virginia's Eastern Shore. These vessels were typically carved from a single log to form a trough-like vessel (Brewington 1963). This vessel type, which was embraced and modified by the colonists, ultimately resulted in a craft ranging from 12 to 40 feet in length that could be constructed of several logs shaped and mortised together. Adaptations of this general form included the addition of multiple logs, which allowed the vessels to be larger, more stable, and have a deeper draft. They were typically undecked, and sometimes had framed and planked topsides with sharp ends. These canoes were likely originally rowed and punted, but were adapted to be rigged with one or two spritsails and could have a jib set on raking, unstayed pole masts (Brewington 1966). Large dugout canoes fitted with sails were often referred to as *periaguas* (Chapelle 1951).

The punt and flat represent very similar vessel types; the distinction between the two was the presence or absence of sails. The flat was frequently employed as a ferryboat, and possessed curved ends with platforms at the bow and stern with the rest of the hull left open (Chapelle 1951). This vessel was typically flat bottomed, and double ended. The flat was commonly rowed or punted, and generally did not have a sail. The punt was constructed very similarly to the flat but it possessed a single forward mast and a boomless spritsail (Chapelle 1951). Both the flat and the punt were simple to construct and very efficient in the shallow, shoal waters of the Chesapeake. They were used as ferry boats and for transporting goods.

The *bateau*, which translates to boat in French, became a specialized vessel type in the Chesapeake during the 18th century. Regionally, the term bateau was applied to a chine built hull that averaged 40 to 45 feet long (Chapelle 1951). These vessels could be rowed or poled. They were occasionally fitted with sails and external keels to facilitate sailing close-hauled.

The sloop was the most popular vessel type used in the British colonial period. Sloops varied in capacity from 25 to 70 tons during the 18th century, and were typically rigged fore and aft (Chapelle 1951). These vessels would have a single mast with a gaff mainsail, two to three headsails, a square topsail and a square lower sail (Chapelle 1935). Sloops were designed with an external rudder, a flat transom, a slightly curved bow, and a single mast with no bowsprit (Chapelle 1935). They tended to be at least partially decked. Sloops were small in the beginning of this period, but were constructed larger as the 18th century progressed.

The shallop represents one of the many vessel types used during the colonial period for which the name can represent many vessel configurations. The authors of the 17th and 18th century were not overly familiar with nautical terminology, and used various terms to describe them. The shallop was often referred to as a ship's boat, longboat, or launch. These vessels were initially used to lighter crew from ship to shore, and were very popular in the Chesapeake due to a shallow draft and ease of handling. It was a versatile vessel that was easy and inexpensive to construct. Shallops could be used for fishing and transportation of goods and people in a region that favored water transport over road travel (Baker 1966). The shallop often acted as a farm and household boat to be used for everyday purposes. These vessels were typically two masted, open boats without a boom on the main mast which could range from 18 to 28 feet along the keel (Chapelle 1951). A less common variation included decking with a boomed mainsail.

3.2.10 Colony to Nation (1750-1789)

The second half of the 18th century along Virginia's Eastern Shore was fraught with conflict. The Seven Year's War, which began in 1755 and lasted nine years in Virginia, was a dispute between England and France. It had a notable influence upon Virginia. Fighting occurred throughout North America, including the Eastern Shore. The Virginia General Assembly met in 1755 to establish a quota of men to be recruited from each county (Turman 1964). The conflict was to establish British supremacy on the North American continent, but Eastern Shore residents were more concerned with preventing British occupation of their homes. Many local men were placed on guard duty or sent to occupy the frontier to such an extent that tobacco production diminished and overall trade declined. Militiamen were placed on guard in all navigable creeks and rivers. Several forts were also established (Turman 1964).

The war had a detrimental effect on tobacco production and trade on the Eastern Shore, but it also began to make the local population more self sufficient. With a limited ability to receive goods from British ships, Eastern Shore residents began making many of their own goods. Travelling weavers, tailors, and shoemakers also went from town to town making necessary items. Virginia-made linen sheets and pillow cases became more prevalent, and weaving equipment became a necessity on every plantation (Turman 1964).

King George III succeeded his grandfather as ruler of England after the Seven Year's War, and began exerting his authority over the colonies in ways that had never before been experienced. Parliament passed the Townshend duties in 1767, which taxed lead, paint, paper, tea, and glass (Turman 1964). This act had a dramatic impact on residents of the Eastern Shore, as the paper tax affected all legal documents as well as newspapers and almanacs. The paint tax represented a hardship to ship builders who were now unable to paint ship bottoms. It also challenged the residents who painted their homes in order to preserve the wood in the damp seaside climate. This act was repealed in 1770 following intense protest and the boycott of goods, with the exception of the tax on tea.

The boycotts of British made goods, as well as the difficulty in receiving imported goods during the Seven Years War, made Virginia's Eastern Shore largely self sufficient. They were capable of producing many necessities themselves, saving money typically used for imported products from England and other European nations. Tobacco remained the principal cash crop, but pork, beef, hides, shoes, corn, wheat, salt and sea food also became major exports. Records show that castor oil, which could be used for medicine, soap, axle grease, and paint, was also produced in quantities large enough for export (Turman 1964). Flax was also produced for domestic use and export. It could be used to produce linen, and its seeds were used in the production of house and boat paint.

When the war for independence broke out with England, the general sentiment on the Eastern Shore was in favor of colonial independence. The two Eastern Shore counties supplied seven companies of soldiers, one captain, two lieutenants, one ensign, four sergeants and a drummer to the Ninth Virginia Regiment (Turman 1964).

War soon touched the lives of residents of Accomack and Northampton Counties, as British warships took control of the mouth of the Chesapeake Bay. The ports of these two counties soon became a major part of the Colonial supply line. The 1751 Fry and Jefferson map illustrates many of the important creeks and islands which became vital cogs in supplying the Continental Army (Figure 3-2). Ports along the ocean side of the peninsula, including Metompkin and Chincoteague Creeks, were able to receive supplies from France and other neutral countries and transport them to the interior. Medicine, munitions, and other necessary supplies were received along the seaside, transported over land, and reloaded onto small vessels in the creeks and rivers of the Chesapeake, where they were transported to the head of the Bay and down the western side of Virginia and Maryland (Turman 1964). This round-about route was necessary to avoid blockading British vessels and raiding barges operating throughout the Chesapeake region.

A fort was established on Parramores Beach in order to prevent British raiding barges from entering the vital port of Metompkin Creek, and to protect incoming ships (Turman 1964). The fort and other defensive measures along the Eastern Shore peninsula did not prevent the British from seizing a portion of the shore in 1779. This action, and the establishment of a base on Hog Island under the command of Captain John Kidd, infuriated Virginians. This base allowed the British to send out small ships, tenders, and barges to raid surrounding farms and plantations to supply nearby warships. Raids typically took place at night when livestock were corralled and poultry were in their roosts. It was not uncommon for British raiding parties to burn the property of, and steal silver and valuables from, resistors (Turman 1964).

Ferry service between the Eastern Shore and the mainland was discontinued during the British occupation. Vessels that had been involved in the ferry service were leased to the fledgling American government and used to transport troops and goods along the Bay (Turman 1964). These ferries and similar privately owned transport vessels were used to transport Washington and his troops from the Head of the Chesapeake to just north of Yorktown in 1781 where the decisive battle of the war was fought.

Yorktown, which is commonly touted as the last battle of the American Revolution, was fought in 1781, but the last naval engagement of the war involving the Eastern Shore took place in November 1782. The Battle of the Barges occurred when Commodore Whaley of Maryland, who was charged with barges ordered to protect Maryland from British Commodore Kidd's marauding vessels, traveled into Onancock Creek to select volunteers for a skirmish with six enemy barges (Turman 1964). Buoyed by 25 new volunteers and a vessel to be commanded by Colonel John Dropper, Whaley and his fleet successfully discerned the size of the British fleet and their location at Cadger's Strait (Shomette 1985). After a quick, forceful attack by Whaley, the British vessels nearly fled. The battle would have been a victory for the Americans, but the powder magazine exploded on one of the colonial vessels, causing death, destruction, and general pandemonium. The ensuing chaos allowed the British to board and capture Whaley's fleet, rending the conflict an embarrassing loss (Shomette 1985).

A significant trade conflict arose on the Eastern Shore between the adoption of the Virginia Constitution in 1776 and the adoption of the United States Constitution. Virginia's right to charge a toll on ships travelling between the Virginia Capes and Maryland was disputed along with the right to build piers and fish on the south bank of the Potomac. The agreement that was reached allowed Maryland ships to travel through the entrance to the Chesapeake without being charged in exchange for use of the Potomac River by Virginia citizens for commerce and fishing (Turman 1964). This agreement remains in effect to the present and illustrates the importance of maritime commerce and navigation to the residents of Virginia and Maryland.

Vessels used during this era were the same as those of the previous period with few additions. General craft continue to be small to accommodate travel in the often shallow, shoal prone waters of the Chesapeake and the barrier islands. This period and the one prior continue to exhibit ambiguity in vessel and rig types. A vessel could be described by its hull form or its rigging. The major addition of this period was the schooner.

The schooner is mentioned at various times during the first quarter of the 18th century in reference to a rigging style that was largely un-standardized (Chapelle 1935). The term "schooner" supposedly arose in 1713 when upon the launch of a new vessel, a spectator commented "Oh, how she scoons!" The owner of the vessel was enamored with this comment, and declared that it should be called a schooner (MacGregor 1997). While this may or may not be the origin of the term, these vessels became standardized by the second half of the 18th century (Chapelle 1935). Howard Chapelle (1935) suggests that the schooner is one of the first distinctive American vessels. These vessels were the most common type found in colonial waters by the time of the American Revolution because they were fast and relatively simple to construct and sail. The schooner was quickly adopted for legal and illegal trade throughout the colonies.

Most schooners were sloop hulls with two fore and aft rigged masts, with the occasional topsail added (Chapelle 1935 and Brewington 1966). They were designed to be very sharp and fast with a large sail plan. Schooners tended to be relatively small, ocean going vessels that were often used by the Royal Navy as transports (Chapelle 1935). The schooner that became the workhorse of the Chesapeake Bay had a shorter sail plan, more upright spars, and a topmast on the main mast only. This adaptation contrasted with the schooners involved in the ocean trade (Brewington 1966). Schooners would increase in length over time and ultimately transformed into clipper ships.

3.2.11 Early National and Antebellum (1789-1860)

The end of the American Revolution and the establishment of the fledgling United States ushered in a period of peace and growth on the Eastern Shore. The Eastern Shore accounted for three percent of the Virginia population with a total of 20,848 people during the first United States census in 1790 (Turman 1964). The population of the two Virginia Eastern Shore counties had increased slightly by 1800 to 22,456 with 8,479 in Accomack County (Turman 1964). Wallops Island had 30 residents, 14 of them above the age of 16.

Industry on the Eastern Shore continued unchanged. Tobacco was still a major cash crop, with warehouses constructed near ferry landings to store the crop before transportation to market. Tobacco was placed in a “rolling house” before being transported via a “rolling road” constructed from the bayside to a warehouse along the seaside. The large hogsheads of tobacco could be attached to a frame which allowed it to roll and be pulled by a horse or ox (Turman 1964). Madison’s 1807 map of Virginia illustrates the major islands and creeks of the Eastern Shore that were vital for the tobacco trade (Figure 3-3).

The production of flax was also important, and was used in the production of linen cloth, boat sails, thread, fishing lines, nets, and rope. Flax seed was also a lucrative byproduct of flax production, for the seeds could be used for making medicine and linseed oil for paints. Wool had also become an important home industry on the Eastern Shore (Turman 1964).

Ferry service between the Eastern and Western shores resumed, with two trips per week made from the port of Hungars. The major change to the ferry service was the addition of a mail contract. The operators of the Hungars ferry were to pick up the mail from the Western Shore on each trip across the Bay to deliver it to the post office on the Eastern Shore (Turman 1964).

War was again declared between the United States and Great Britain in June 1812, and the Eastern Shore was vulnerable to attack and possible occupation. The militia continued to drill regularly, and men from both Accomack and Northampton counties were called to defend their homes. The militia rotated watches along the mouths of bayside creeks. The British did not bother landing on the seaward side of the peninsula, but instead concentrated on taking control of the Chesapeake Bay. The appearance of enemy ships at the mouth of the Chesapeake once again brought an end to ferry service between the Eastern and Western shores (Turman 1964).

The British soon turned their attention to preparing to attack the American capital, Washington, D.C. The British navy selected Accomack County as its base of operation. The attack was to be a naval campaign and the Navy needed a base out of reach of the Eastern Shore militia. They selected Tangier Island located on the Chesapeake Bay to this end. Tangier Island was occupied on April 5, 1814, under command of British Rear Admiral George Cockburn. They constructed a fort there and used it until the end of the war.

The first record of attack on Virginia from this base occurred near Pungoteague on May 30, 1814. Known as the Battle of Pungoteague, British barges and tenders fired cannon at the mouth of Onancock Creek in order to draw the American militia there. The British soon crossed the bar of Pungoteague Creek in 11 tenders and barges before landing on the north side of the creek and advancing more than one mile (1.6 km). The militia engaged them briefly with no notable results. The British soon retreated back to Tangier Island. This battle, however, marked the only battle on the Eastern Shore against a European nation (Turman 1964).

Trade during the war was impaired but not paralyzed. Eastern Shore residents found themselves experiencing great difficulty transporting and receiving goods from northern cities, but local industry had developed to such an extent that they were largely self sufficient. This self sufficiency produced most of the necessities and allowed them to purchase goods from New England, France, and other friendly European countries as vessels were able to evade the British and land at seaward ports.

The war ended with little damage to the Eastern Shore, and ferry service resumed in 1815 at Hungars Ferry. This ferry, which had operated since 1724, soon faced competition from the Port of Pungoteague. The new ferry also ran two trips per week from one shore to the other (Turman 1964). A steamboat ferry service was established by the early 1840s, and it ran between the Eastern Shore and Norfolk, Hampton, and Yorktown on the Western Shore. A steamboat company was able to obtain a franchise to operate in both Northampton and Accomack Counties, and the terminal was moved to Cherrystone Creek where two trips per week were made to the mainland (Turman 1964). Once per week a steamer was sent to Pungoteague. The vessels used on this route included steamboats *Star* and *Joseph E. Coffee.*

The end of the war ushered another period of growth on the Eastern Shore. The principal crops were wheat, rye, oats, beans, peas, Indian corn, cotton, and potatoes. Castor beans were also frequently produced to manufacture castor oil. Tobacco, while still produced, was slowly being replaced by other crops. The first agricultural figures were officially recorded in the 1840 census, and the transition from staple crops to production of commercial vegetables had begun (Turman 1964). The census reports that 10,254 pounds of cotton, 107 tons of flax, and 112 pounds of tobacco were produced along with 173 pounds of beeswax, 4,598 bushels of salt, and 3,372 cords of firewood (Turman 1964). Farm products produced here were in demand in Washington, D.C., Baltimore, Philadelphia, and New York. Completion of the Chesapeake and Delaware Canal across the 14 mi neck of the Delmarva Peninsula in 1829 aided the transport of goods to the northern markets. The eventual development of steam also allowed Eastern Shore produce to be transported to market with greater speed than sailing vessels.

The increase in commercial agricultural production, especially wheat and corn, prompted the construction of mills for grinding these crops. There were a total of 75 mills between both counties by 1840. There were also five lumber mills and one brick making plant (Turman 1964). The seafood industry was also becoming increasingly important. It had become such a booming industry that the legislature was required to prohibit the sale of oysters between the first of May and the first of September in order to conserve the supply.

The location of Virginia's Eastern Shore on a peninsula with numerous small creeks, shoals, and tributaries made vessel travel necessary and hazardous. The need for lighthouses had been clear since colonial times, but the first lighthouse was not started until the late 1820s. The Cape Charles Light on Smith Island was completed in 1832 at a cost of $7,398.82. Lighthouses were completed on Assateague Island and Watts Island in 1833. A study was conducted at this time regarding the placement of a lighthouse on Hog Island, but it was not until 1852 that Congress appropriated money for its construction. Dwellings for the light keeper and assistant keeper were also constructed. Smaller lighthouses also marked the entrances to Occohannock and Pungoteague Creeks. The lights were fueled by oil with reflectors, which required regular cleaning and daily care by the lighthouse keeper. The lighthouse keeper was a vital part of Eastern Shore life until the lights were electrified nearly a century later.

19^{th} century vessel types were designed to meet demand. The main economic stimulus in the Chesapeake was the oyster harvest, and this encouraged vessel development. Vessels became larger but retained the sails, shallow drafts, and flat bottoms necessary for navigation in the marshes, cuts, and islands of both the seaward side and bay of the Eastern Shore. Centerboard, or drop keel vessels became popular in the Eastern Shore region after 1850 (Chapelle 1951). Vessel names varied by region, but were largely dependent on the type of rigging employed.

Craft used during this period included the earlier forms like the sloop and schooner, but also boasted the clipper, various regionalized watercraft, and steam powered vessels.

The heyday of the fast clipper ships, regionally known as Baltimore Clippers, was 1845 to 1860 (Crothers 1997). This vessel type is a result of the rising demand for fast ships. Their construction design often sacrificed cargo space and low operating costs in favor of speed (Chapelle 1935). It was this disregard for practical aspects of sailing and ship construction that led to a relatively short period of use. The clippers which have been greatly popularized and romanticized are not constructed with a single characteristic hull form but rather used three basic models. These consisted of the Baltimore Clipper, which was characterized by a very sharp deadrise and fine ends, the sharp ended clipper with a very full midrise and very small deadrise, and a compromise between the two extremes, which was characterized by a noticeable, but not extreme amount of deadrise (Chapelle 1967). None of these models became dominant, as all had advantages and disadvantages and were used for different purposes. The common clipper varied in length along the waterline from 105 feet to 228 feet (Crothers 1997). The bow and stern were extremely V-shaped and very sharp at the waterline. They were typically wide at midship to accommodate cargo. Most clipper ships were three masted, but four masted vessels were also common. Four masted variants were rigged with a spanker gaff and boom on a smaller mast set near the stern (Crothers 1997). Typical rigging plans had as many as 15 yards to support sails (Crothers 1997).

A number of more regional watercraft were also being used during this period. These include the scow and the pungy. The scow first appeared in the 1750s, but was most popular in the early 19th century. It was characterized by square raked ends, hard chines, and a flat bottomed hull (Brewington 1966). They were typically rigged as a sloop or a schooner, and were fitted with a leeboard rather than a keel or centerboard. Ranging from 30 to 50 feet in length, these watercraft were considered workhorses used to haul goods and crops (Brewington 1966).

The pungy was another regional craft operating along the Eastern Shore, and has been considered the best of all native Chesapeake watercraft. While very similar in configuration to the schooner, this vessel type was characterized by a much deeper stern than bow, with a greater deadrise. The beam was greatest further forward, the ends were more raking, and a log rail was employed rather than the bulwarks of the schooner (Brewington 1966). The transom was also hewn from a solid timber rather than built plank over frame. It employed a very similar sail plan to that of the schooner but tended to be taller with lighter spars and more sharply raked rigging (Brewington 1966). While lamenting its demise, one waterman noted “no pungy was ever lost except by bad management. A pungy is all keel and no hold. She can’t carry much more than a common freight car” (*Peninsula Enterprise*, July 20, 1907). A few variations on the pungy existed, including one fitted with a centerboard for navigating shoal waters. That same waterman also commented on the speed and maneuverability of the pungy saying “a deep model, what I call long-legged, with only one topsail, no jibboom and nothin’ but a standin’ jib is surely goin’ to be a little lazy in a calm. But the more it blows the faster a pungy is. In oyster weather, fall and winter, she’s a goer. She’s got the stern to be fast” (*Peninsula Enterprise*, July 20, 1907). One of the most obvious traits of the pungy was its distinctive paint scheme. They would be painted with “the bottom, copper; the boot-top, “flesh” pink the bends, bottle green; and the bead, scarlet” (Brewington 1966).

Schooner hulls were converted into steam vessels in the Chesapeake region by making room below decks for engines and equipment and installing exhaust piping on deck. When purpose built steam vessels were constructed, they had long, narrow hulls with a vertical single cylinder engine and side paddle wheels (Labaree et al. 1998). The boilers, like those on locomotives, were first wood burning, then coal and later diesel. Bay and river vessels employed a superstructure to prevent hogging and to stiffen the vessel (Labaree et al. 1998). They typically had two decks with the greater part of the vessel above the waterline. These vessels were ideal for carrying bulk cargo.

Steamboats in the Chesapeake region retained a shallow draft and stern paddle wheels that suited the calmer waters of the region. Ocean going steam vessels employed propellers and were constructed with a sharper hull (Labaree et al. 1998). There was great variation in hull form in steam powered vessels, but a majority of builders eventually moved both storage and cabins from below to above deck. One example of an early steamboat is the *Alabama*. This wooden hull, side wheeler was built in 1838 and was "210 feet in length, by 24.6 beam and 13.5 depth of hold" (Brown 1938:392). This vessel was owned by the Maryland and Virginia Steamboat Company and did the Baltimore to Norfolk run (Brown 1938). Vessels of this period boasted speeds of up to 10 to 14 miles-per-hour (Brown 1938).

The Chesapeake Bay was home to some of the earliest steam powered vessels, and by 1813 steam service began between Baltimore, Frenchtown and Philadelphia (Labaree et al. 1998:256). The first steamboat operating on the Eastern Shore was owned by the Floyd family and ran from Townfields to the Hampton Roads area (Whitelaw 1968). Steam vessels were employed as transport ships that offered regular service from cities such as New York and Baltimore to Norfolk and New Orleans; "In the year 1838 Maryland had nineteen registered steamboats and Virginia, sixteen" (Brown 1938:391). The railroads and steamships worked in tandem to move produce, goods and people up and down the bay by the 1850s.

Different types of work vessels evolved with the advent of steam. The steam tug boat was used to move sailing vessels through canals and rivers out to sea (Labaree et al. 1998). These hulls were both wood and metal. They set low in the water and were designed with a low, rounded stern to accommodate lines off the aft deck.

3.2.12 Civil War (1861-1865)

Virginia's Eastern Shore had become a vital farming and maritime region on the eve of the Civil War. Water transportation was far more expedient than road travel during this period. Steamboats were making scheduled stops on both the bayside and seaside ports to take on cargoes of produce, seafood, and other goods. While steam had gained a significant foothold in shipping commercial goods, the local people still relied upon sail transport (Turman 1964). Sailing vessels and rigging had improved to the point that more speed could be gained with smaller crews. Sail propelled vessels could also be locally produced while steam was more costly and complicated. Fleets of sailing vessels under the ownership and direction of local people were trading as far as Cuba and northern cities.

Delegates from Accomack and Northampton Counties traveled to Richmond in February of 1861 for a convention considering a referendum that allowed people to determine whether to join the Confederacy or remain in the Union. The convention chose to allow the referendum and it was scheduled for May 23, 1861 (Turman 1964). Union ships blockaded the lower Chesapeake before the referendum could take place. Lighthouses were darkened by Confederate forces and ferry service was once again halted between the Shore and the mainland. The only lighthouse that continued operation was the Assateague Light. Both counties, with the exception of the Chincoteague precinct, voted to join the Confederacy when the referendum took place.

The courts of both Accomack and Northampton Counties authorized funds for recruiting, arms, and ammunition after deciding to join the Confederate cause. This resulted in 800 men being organized into eight companies of infantry, two cavalry, and one light artillery. These men were later divided into three regiments, two from Accomack County and one from Northampton. This arrangement was a holdover from the War of 1812 (Turman 1964). Every capable man on the peninsula was already in the militia and was required to drill three times per year.

The Eastern Shore of Virginia was a prime location for smugglers due to the many miles of coastline and small inlets that made hiding a vessel from Union patrols a relatively simple task. Fake licenses to operate were being issued to Virginia boat owners that identified them as Maryland residents. These documents allowed them to fill up their small schooners and rowboats and take them down to the Eastern Shore to supply the Confederacy (Mills 1996). Supplies could also be smuggled from the North to Chincoteague on the ocean side, and then transported overland to waiting boats along the Bay (Mills 1996). The prevalence of smuggling led to a boat burning expedition led by the Union army. They ran from Fort Monroe up Back Creek and successfully captured or destroyed several vessels engaged in smuggling (Mills 1996).

Major General John Dix was put in command of the defense of Maryland to prevent goods and men from flowing through Maryland to the Confederacy and to intimidate rebel troops (Mills 1996). His major responsibilities including ensuring supplies did not flow into Accomack and Northampton Counties. To achieve this end he devised a plan to occupy the two Eastern Shore Counties.

Brigadier General Henry H. Lockwood was to head the occupying army. He received a report on Confederate activities in the region and requested an army large enough to convince them that resistance was unwise (Turman 1964). Dix sent a letter to the people of Virginia's Eastern Shore offering protection of private property if the people would not resist occupation. He also promised to restore trade with those counties and to restore the lights in the lighthouses (Mills 1996).

Confederate General Smith ordered his men and the militia to the northern part of Accomack County to mount a defense, but he had no choice but to retreat when he received the proclamation from Dix (Turman 1964). A total of 44 officers and 64 enlisted men were able to escape to the Western Shore by boat before the Union army completely occupied the Shore. Young men who were away in college also enlisted, and others ran the blockade to join the Confederate army (Turman 1964). A total of 197 men from Accomack County and 255 from Northampton County served in the Confederacy.

Several attempts were made to run the blockade during the Union occupation, so guards were placed at the mounts of 16 streams and landings including Cape Charles, Cherrystone Inlet, Hungars Creek, and Pungoteague Inlet. Strict orders were issued that no trade was to be permitted between locals and soldiers except under very strict regulations (Turman 1964). Penalty for violation of these orders was one month hard labor or one month's imprisonment with bread and water. Once occupied, the Eastern Shore was cut off both geographically and politically from the rest of Virginia. Smuggling and blockade running continued throughout the war, but it was not as flagrant or frequent as it was originally (Mills 1996).

Despite the fact that Virginia had seceded from the Union, there were those who lived on the Eastern Shore with no interest in the war. They were simply interested in selling their daily catch of oysters. Many on Chincoteague Island remained loyal to the Union and signed an oath of allegiance on October 15, 1862, which gained them Union protection and permission to sell their oysters as far north as New York and Philadelphia (Mills 1996).

The Eastern Shore had become an important link in communication between Washington D.C. and Fort Monroe in the Hampton Roads area. A telegraph line was quickly constructed through the Eastern Shore to Cherrystone Inlet and a cable was laid to Old Point. Troops could also be moved down the shore to reinforce Fort Monroe. Steamboat service was established by the army to more easily transport goods and soldiers (Turman 1964).

There were no new vessel types introduced on the Chesapeake during the Civil War, but local craft continued to be used, as well as steam powered vessels. Vessels employed during the period leading up to the Civil War continued in use. It was not uncommon for residents of the Eastern Shore to construct work vessels for their own use in blockade running or for everyday work. The oyster industry was disrupted during the war to such an extent that watermen found the freight and ferry business to be far more profitable than oystering (Wennersten 1978)

3.2.13 Reconstruction and Growth (1865-1914)

Virginia was designated a territory following the surrender at Appomattox in 1865, and was part of Military District Number 1 (Turman 1964). This included Accomack and Northampton Counties. A constitutional convention was held in 1867, and produced a constitution that was ratified by voters in 1869. Virginia was readmitted to the Union in 1870 (Turman 1964). After being under military rule for more than eight years, residents of the Eastern Shore were excited to have self government restored.

The Federal Government realized the need to establish lifesaving stations along the Shore in 1874. Congress created the Life Saving Service in 1871 but it took three years for stations to be authorized and funds appropriated for construction in Accomack and Northampton Counties (Turman 1964). Stations authorized in 1874 included Assateague Beach Station, Wachapreague Beach Station, Hog Island Station, Cobbs Island Station, and Smith Island Station. Four more stations were authorized in 1878 and 1882, including one on Wallops Island, which is visible in the 1892 Coast and Geodetic Survey Map (Figure 3-4, Turman 1964).

Prior to the authorization of life saving stations, volunteers stepped in whenever they found a ship in distress. The addition of formal life saving stations meant that trained men with the proper equipment were always on duty and ready to assist a vessel or sailor in distress. The stations were composed of two story frame houses constructed with rooms for lifeboats which were always ready for deployment, as well as living quarters for the men. Those serving at a station were on duty for one week with at least that much time off before the next shift (Turman 1964). The keeper of the station had the same status as a commissioned officer and was tasked with training and drilling the men and directing a rescue. The coastline from Delaware Bay to the Mouth of the Chesapeake Bay made up Life Saving District 6 (Turman 1964). This district was under command of Captain Benjamin Rich from 1875 until his death in 1901. While under his command more than 800 disasters involving 6300 people were addressed as well as $12 million in property of which more than $8 million was saved. During this 26 year period, only 45 lives were lost (Turman 1964).

The Eastern Shore and much of Virginia was forced to shift from a tobacco and slave based economy to one more diversified. This eastern coastal region of Virginia began to export produce, peanuts, fish, and oysters to the western part of the state and beyond (Surface 1907). Chincoteague Island and the Bay islands of the Chesapeake became known for oyster harvesting, tonging, dredging, and dragging. Chesapeake oysters were exported all over the world. Oysters were harvested in vessels including sloops, schooners, bugeyes and skipjacks, first via wind power, then steam.

In the late 19th century, truck farming—the cultivation of a few crops for shipment to localities in which such crops cannot be grown, became very important to the Eastern Shore of Virginia and Maryland (Gemmill 1926). Large farms producing a few main crops for sale to the open market, often at some distance from the farm, became the norm on the peninsula. This required seasonal labor and reliable transportation. The need for transportation was met by wagon, boat, and rail. Farmers brought their produce to local wholesale markets by wagon and boat, where it was then transported by rail to Baltimore, Philadelphia, and New York. Skipjacks and buyboats brought the produce from remote areas. Steam vessels would transport large loads of produce from areas without ready access to the railway. Remote areas were able to receive a wider range of goods due to new transportation routes.

A railroad line was initially proposed for the Eastern Shore of Virginia and Maryland as early as 1835 (US Senate 1937). It was considered again in 1855 when plans and maps were drawn but the project abandoned (Turman 1964). The oyster trade prompted the establishment of the first rail line on the Eastern Shore. "The railroad first touched the Eastern Shore seaside in 1876 when a line… laid southwestward of Snow Hill, Maryland reached its terminus just below the Maryland-Virginia boundary and next to the Chincoteague Bay oyster grounds at what became Franklin City" (Thomas, Barnes, and Szuba 2007). This area was not only famous for oysters but also for the outdoor sports of duck hunting and fishing. Advertisements highlighted the easy transportation to the Virginia Eastern Shore: "The upper portion of the peninsula can be reached daily by rail from Philadelphia, the terminus being Greenbackville, on the sea side opposite to Chincoteague Island, and distant from it about five miles. A steam ferryboat conveys passengers from the depot to the island" (Hallock 1877).

Ready access to the railroad, and the advent of refrigerated boxcars encouraged the growth of the seafood industry. It opened many new markets and increased the demand for Chesapeake Bay seafood. A rail line was established in 1884, serving the length of the peninsula (Turman 1964). The New York, Philadelphia and Norfolk Railroad, which also owned steamships, undertook the construction of the line, running north to connect with the existing rail line near the state boarder (General Assembly of Virginia 1884). This coincided with the construction of a harbor and wharf at Cape Charles that was deep and large enough to accommodate steamships (Turman 1964). "By 1889 more than one hundred vessels from 5 to 65 tons and about two hundred decked vessels of under five tons participated in the upper seaside oyster trade" (Thomas, Barnes, and Szuba 2007). These transportation advancements promoted both truck farming and the oyster trade as tomatoes, potatoes and oysters could be put on the train in the morning and served in a restaurant in Baltimore or New York that same evening.

There was a pleasure club on Wallops Island by 1891, complete with a steam powered pleasure boat for excursions (*Peninsula Enterprise*, May 16, 1891). Other sporting clubs soon opened as the news of the fine hunting and fishing spread; "There are three clubs located on the ocean side of Accomack, one on Wallops Beach, composed principally of Pennsylvanians; one on Revels

Island and one of Wachapreague" (Johnson 1899). This was all made possible by trains and motor powered boats operating in the region.

Many of the vessels used during this period were similar to those of the previous period, with developments and innovations most often focused on the oyster business. The Chesapeake Bay was known for producing regionalized vessels designed for the oyster harvest and to meet local needs. Many of these vessel types and the miniscule distinctions between them have been lost with the shipwrights who constructed them. The vessels which became prominent during this period included the flattie, the skipjack, the bugeye, and the buyboat.

The flattie was originally used to transport produce on the Virginia and Maryland tidewater streams, as well as for use in oystering, crabbing, and duck hunting (Chapelle 1951). These vessels likely first appeared prior to the Civil War, but were most prominent during the last portion of the 19th century and represent the smaller predecessor to the skipjack. They are characterized by a V-bottom with some deadrise aft. They ranged from 16 to 30 feet in length, and tended to be partially decked (Chapelle 1951). This vessel type was supposedly out of use by the 1890s, but Chapelle notes seeing a number on the Eastern Shore in 1940 (Chapelle 1951). This vessel is said to have been created to "produce a wide sharpie that would sail well" (Chapelle 1951:312). They were said to sail very well when properly canvassed and were commonly constructed by Eastern Shore mariners for their own use. Accomack County is said to have produced the greatest number of these vessels (Chapelle 1951).

The skipjack, which was a dead-rise skiff with a V-bottom, first appeared after 1860 but did not become popular until the 1880s (Chapelle 1951). The term skipjack is frequently associated with the rigging of the Chesapeake oyster boats rather than a specific hull form. The name is said to be after the bluefish that is known to "skip" across the surface of the Bay (Wennersten 1978). The characteristic rigging is a sprit sail and a jib, without the topsail which was characteristic of older, similar vessels (Chapelle 1951). Construction was done in a very plain, craftsman-like fashion. Skipjacks usually had one raking pole mast on the foredeck and an external rudder on a square transom. One author in 1880 comments that skipjacks are "very wide, with sharp rise of floor the full length of the bottom, jib-and-mainsail rigged, heavily canvassed, and with a reputation for being very fast and Weatherly (Chapelle 1951:306)." A very specialized type originated at Chincoteague Island with masts located fore and aft that could be operated single-handedly (Chapelle 1951:330).

The bugeye originated in the Chesapeake region in the second half of the 19th century when the demand for simple, inexpensive to construct oyster dredging vessels peaked. The bugeye persisted as a popular type until nearly 1920, and is noted as the preferred vessel for oyster dredging due to its simple operation and the ability to be operated by one man (Wennersten 1978). The bugeye was originally little more than an enlarged, decked log canoe with a fixed rig, but it gradually grew and was refined. Employed primarily in oyster dredging, this vessel has been described as a "flat-bottomed centerboard schooner of small size (3 to 15 tons) decked over and with a cabin aft" (Brewington 1964:35). These watercraft typically have two masts, one situated on the foredeck and one located aft of amidships with a leg-of-mutton foresail, a mainsail and jib with a single halyard and sheet (Brewington 1964:59). They tend to have a sharp bow with a stubby bowsprit. This vessel type ranged in size between three to fifteen tons, 30 to 80 feet in length, 10 to 23 feet in beam and 2.5 to 5.5 in draft. The average vessel measured 50 feet in length, 15 feet in beam with a 4 foot draft (Brewington 1966). Hull variations began appearing in the 1880s as a means of gaining deck space. These variations included round and square sterned vessels as well as the “patent stern” which developed in 1908 as an outboard projection of the deck. They are characterized by flat bottoms and hard bilges (Chapelle 1935).

One of the more notable vessels used in oystering, specifically tonging, was a round bottomed boat that was formed from three dug out logs that were joined together. This vessel type was used through the end of the 19th century and was rigged with a jib and one or two sails, and had no deck. They tended to be approximately eight to 25 feet in length and are noted to be especially seaworthy (Wennersten 1978).

The buyboat is synonymous in the modern Chesapeake Bay. The term “buy-boat” originated from their utility. These vessels met oyster boats, purchased their catch and transferred it on the water from boat to boat. The buyboat, though engine powered, continued to possess a main mast and limited rigging needed for a boom crane. It was developed at the dawn of the 20th century with the advent of the gas motor (Chowning 2003). It represents the end of sail power and the beginning of motor vessel ascendancy. Even though steam powered vessels were in use before gas or diesel engines, early bay vessels were too small for the boiler assembly (Chowning 2003).

The traditional schooner, skipjack or bugeye hulls would be fitted with an engine during the early years of motor adaptation, but appearance of the vessel was largely unchanged (Chowning 2003:34). Some early buyboats were bugeyes or skipjacks with cut masts, the bow sprit removed, and a small cabin on deck for shelter. The buyboat hull was designed and built to utilize both sail and motor propulsion. Buyboats were versatile and purpose designed for watermen as they could use sail power to harvest oysters (in Maryland waters power harvesting was restricted for preservation purposes) and could be used under power for hauling and other types of fishing (Chowning 2003). They ranged in length from 40 to 100 feet, with a stub mast and boom forward of the hold, a pilothouse aft, and a decked hull (Chowning 2003:3). They have three main hull configurations: frame-built, log built, and deadrise or box-built (Chowning 2003:3). The buyboat was used to haul grain, coal, log wood, produce, people, and sometimes vehicles in a time before bridges and extensive roadways (Chowning 2003). They continue to be used to the present.

Two shipwrecks from this time period are known to have been lost within 13 mi (21 km) of the Wallops Island area. Both vessels were schooners. The first, the *Jennie N. Huddel*, was a 279 ton vessel built in 1870 that was stranded at Carters Shoal in Chincoteague in 1910. The second vessel was the *Lizzie Godfrey*, a 77 ton schooner stranded at Chincoteague Inlet in 1914. These two vessels represent the first craft identified to have been lost in the vicinity. While there were likely many vessels lost here in the preceding periods, these are the first for which documentation exists.

3.2.14 World War I to the Present (1915-Present)

World War I was officially declared in 1917, and the US Coast Guard was the only armed protection available on the Eastern Shore (Turman 1964). Beaches were closely patrolled to prevent landing of enemy spies and submarines. Watch was also kept at the Cape Charles Station for enemy ships and submarine periscopes. The Life Saving Service had been combined with the Revenue Cutter Service to form the US Coast Guard in 1915. It remained under the Treasury Department, but the men serving in the Coast Guard became naval reserve units for use in time of war. The Eastern Shore became part of the Fifth Coast Guard District. Stations were linked by telephone so that in the event of a large disaster men and resources could be drawn upon from multiple stations (Turman 1964).

World War I did not have a dramatic influence upon life on the Eastern Shore of Virginia, but the end of the war and the return of troops brought remarkable changes and prosperity. Automobile use had grown so much that it had to be regulated, jobs were plentiful, and a college education was attainable (Turman 1964). Every steamboat returning to the Eastern Shore brought new cars from Baltimore. Trains also brought them on flat cars (Turman 1964). Filling stations and garages had to be erected to accommodate the flood of new automobiles. Land prices were also spiraling upward as people invested in stocks, bonds, or loans to others to grow more Irish potatoes, a major cash crop. Approximately 53,267 acres of Irish potatoes were grown in 1920 with amounts increasing yearly.

Prompted by rapid growth, the Chincoteague Toll Road and Bridge Company was organized in 1919 (Turman 1964). The road and bridge was a lifelong dream of John B. Whealton. He surveyed the land from the south of Chincoteague Island to Wallops Neck before convincing Company directors that the bridge should run into the business section of town (Turman 1964). The land was resurveyed and permission was granted by the Federal Government for a drawbridge spanning the Chincoteague Channel. The Virginia General Assembly then granted permission to build

> “A road from A.F. Jester’s dock, next to the Atlantic Hotel Dock, leading across Chincoteague Channel to the marsh and then across Black Narrows Channel and marsh, then in a southwestern direction across Wide Narrows to Queen Sound at the mouth of Shell Bay, then in a westerly direction to W.H. Hickman’s Farm in Wallops Neck” (Turman 1964:226).

The road was opened on November 15, 1922 with nearly 4,000 visitors arriving on the island to witness the ribbon cutting and hear the Governor speak. The newly constructed earthen causeway was eroded by rain during the speech, and many travelers became stranded on the causeway to be rescued by small boats (Turman 1964). The following day the stranded cars were rescued by ferry and renovations of the road began. The causeway reopened by Christmas of the same year.

The 1920s continued to bring changes to Accomack and Northampton Counties, including new buildings, changes to the school system, troopers appointed for highway safety, and increased public involvement by women who had been granted the right to vote. Farmers, watermen, and professionals associated with these two industries also experienced renewed success during this period (Turman 1964).

The prosperity of the 1920s was evident in the local recreational facilities. Hotels were built and visited by sportsmen during both hunting and fishing seasons. Local people also enjoyed these facilities which included three country clubs, each with a nine hole golf course (Turman 1964). Many residents also owned pleasure boats that were often raced.

The railroad was also prospering, and the railroad companies invested in several new ferries, including *Virginia Lee*, which was touted as the finest steamboat running between Norfolk, Old Point, and Cape Charles (Turman 1964). This steamer was 300 feet long with an auto deck capacity of 80 cars. *Virginia Lee* and *Maryland* made three round trips per day between Cape Charles, Norfolk, and Old Point. While *Maryland* was capable of ferrying cars on an improvised automobile deck, fares were high enough on all steamers to encourage travel by train rather than private automobile (Turman 1964).

A ferry franchise was granted to the Peninsula Ferry Company in 1930. They began operating between the north side of Cape Charles and Pine Beach (Turman 1964). They ran a large open steamer with a 100 car capacity. The Peninsula Ferry Company was able to charge fares lower than the Pennsylvania Railroad Steamers, which contributed to their success. The Virginia Ferry Company, partially owned by the Pennsylvania Railroad, superseded the Peninsula Ferry Company in 1933 with *Delmarva*, a streamlined steamer designed to carry cars and trucks (Turman 1964). The ferry terminal was moved that same year to the Pennsylvania Railroad Terminal, while the southern terminal was at Little Creek, where the railroad had built tracks for box car barges (Turman 1964).

The stock market crashed in October 1929, but the real impact of the Depression did not peak until 1934 (Turman 1964). The price of Irish potatoes fell dramatically, which brought hardship to farmers, merchants, and professionals due to the prevalence of the potato as a cash crop. When the price of potatoes fell below the cost to produce them, Virginia's Eastern Shore felt the effects of the Great Depression in earnest.

Canning and gardening began to increase in an attempt to recover from the effects of the potato failure, and thrift and industry again returned. The WPA stepped in to assist in the recovery by developing roads, mosquito control, and water systems, and opening sewing rooms for women to produce linen curtains (Turman 1964). Flax was once again produced for linen.

Farmers were harvesting crops that did not include potatoes when World War II broke out in 1939. Soybeans and vegetables that could be canned were being grown, and many of them were shipped by truck to canneries and a newly opened quick-frozen food plant (Turman 1964). Farmers were growing tomatoes, potatoes, sweet potatoes, corn, peas, string beans, lima beans, turnip greens, broccoli, spinach, and strawberries both for personal use and for sale to the military (Turman 1964). The war also expanded the poultry industry that had begun in the 1930s, and 5,745,420 chickens were fattened in Accomack County in 1945 (Turman 1964). Many other veterans were seeking employment in shipyards and war material plants by 1940.

The war brought recovery to the region, but it also brought uncertainty. The return of the draft and quotas made the war more of a reality. The Federal Government acquired land at the mouth of the Chesapeake Bay in 1940 to construct Fort John Custis (Turman 1964). This represented the first visible sign of war on the Eastern Shore.

Coastlines were being very closely monitored by 1942, especially the Atlantic side of the peninsula. Small army posts had been established at the towns of Chincoteague and Accomack, and were responsible for patrolling the shores with trained dogs from dusk to dawn (Turman 1964). These patrols were designed to locate submarines and to prevent enemy landings. While the number of submarines sunk in the Atlantic by the Civil Air Patrol operating out of Accomack and Northampton counties is unknown, there were at least 10 American ships recorded as torpedoed by enemy submarines (Turman 1964). It was not unusual for those living near the coast to hear explosions or feel their homes shake when the Civil Air Patrol was working (Turman 1964).

The government purchased land on Wallops Neck for a naval air station in 1942 and subsequently constructed a landing strip and buildings for officers and members of the unit. The

Chincoteague Naval Air Station was commissioned in March of 1943 (Turman 1964). This was soon followed by the opening of a base on Wallops Island under the command of Langley Field Research Center of the National Advisory Committee for Aeronautics. They surveyed the island in 1945, which was then owned by a group of sportsmen using it for fishing and hunting, and a portion was owned by the U.S. Lifesaving Service (Figure 3-5, Turman 1964). A total of 80 acres at the south end of the island were purchased and 1000 acres leased. Construction of facilities for firing rockets started in May 1945 and the first test rocket was fired in June. The remaining portions of Wallops Island were purchased by the Federal Government in 1949 (Turman 1964).

The end of World War II brought another period of growth to Accomack and Northampton Counties. Crops were bringing in good prices and canneries were operating to full capacity (Turman 1964). Televisions, refrigerators, and new cars were popular post-war purchases.

The Virginia Ferry Company was taken over by the Chesapeake Bay Ferry Commission in 1954 by authorization of the General Assembly (Turman 1964). The fleet boasted five vessels, three of which would be enlarged, with two more joining the fleet. They began exploring the possibility of constructing a combination bridge and tunnel across the Bay not long after the Commission was formed. This would be completed in the 1960s.

The Chincoteague Naval Air Station closed in June 1959 and preliminary negotiations were underway to allow NASA to acquire the 1,000 acres of land west of Wallops Island (Turman 1964). It was ultimately decided that the NASA expansion would take place on the former Naval Air Station site. The administrative and technical support facilities on Wallops Island were moved to the mainland on July 1, 1959, which allowed NASA to occupy the location formerly used by the Langley Field Research Center (Turman 1964). NASA was now in control of Wallops Island, which was connected to the mainland by bridge in 1960.

The close of the 20^{th} century and the beginning of the 21^{st} century was marked by a period of declining numbers of farms, but the rise of large farms made it possible for fewer permanent workers (Turman 1964). The major crops included potatoes, both Irish and sweet, tomatoes, snap beans, strawberries, soybeans, and other assorted vegetables. The food packing and processing industry as well as the frozen food industry also became very profitable. The seafood industry remained important but was in decline. Clams, oysters, and crabs continued to be sold in large quantities, and a number of deep sea fishing fleets operate from Virginia's Eastern Shore (Turman 1964).

Lifeboat stations operate on the ocean islands including Smith, Cobb, Hog, Little Machipongo, Parramore, Metompkin, Assateague, and Popes Islands to provide protection for mariners. These stations are under the purview of the Fifth Coast Guard District. Each station continues to provide living quarters for men on duty as well as rescue equipment and boats. While employees live on the mainland and work in shifts, all personnel will be subject to duty around the clock in the event of a disaster (Turman 1964).

The 20^{th} century is not characterized by any distinctive regional vessel types. The primary forms operating in the region were ferries, barges, fishing vessels, tugs, and pleasure craft. These vessel types were all associated with the various maritime activities of the region.

Numerous barges and ferries were operating in the Wallops Island region during the early 20^{th} century. Barges were used as a means of transporting large objects along the coast. There are several reports of tug towed barges transporting cars or boxcars being lost in storms (Turman 1964). One 1906 newspaper remarked that, “there are some 100 barges, with 15 tugs to attend exclusively to bay towing” (Turman 1964: 237). Fishing boats were extremely prominent in this area and remain so to the present. The Chesapeake Bay produced nearly nine times more tons of fish per square mile (2.6 square km) than did the fishing grounds of New England in the late 1920s (Labaree et al. 1998).

A 1912 report from the United States Army to Congress to assess the necessity of dredging the Chincoteague Inlet produced the following list of vessels registered in the area during this period (United States Secretary of War 1912).

600 small boats, not registered, value each $250	$150,000
300 gasoline boats, value each $700	$210,000
100 boats between 5 and 20 tons, value each $800	$80,000
18 vessels over 20 tons, value each $2,000	$36,000
500 barges, scows, etc., value each $40	$20,000
1 steamer (ferryboat)	$10,000
1 steamer (tugboat)	$3,000

These vessels provide a snapshot of the types and importance of the vessels operating in the Wallops Island vicinity during the early 20th century. The emphasis is on practical, working vessels.

The majority of the documented wrecks in within 21 kilometers (13 miles) of the Wallops Island area occurred during this period. The eight vessels lost include two schooners, one fishing trawler, one tug, three barges, and one of unknown type. This likely does not represent the full range of vessels lost in the vicinity, but does provide a cross section of the types of vessels operating in the area during the post World War I era.

3.2.15 Shipwreck Potential within the Project Area

There was a moderate potential to encounter shipwrecks in the project area. This determination was based upon evaluation of known shipwrecks in the area and upon archival research. The likelihood of encountering vessels from the Contact Period through the late 18th century is slight because relatively few vessels traversed the Wallops Island coastline during this time period. Vessels common to this period, which include sloops, bateau, punts, flats, and shallops, were also small coastal vessels that rarely ranged that far from shore. They were also lightly constructed and less likely to have survived to the present.

Potential for encountering vessels from the 1840s to the present increases over the previous periods because the relative prosperity of Virginia’s Eastern Shore generated a sharp rise in seagoing merchant vessel traffic and a general increase in seaworthy vessel forms. The most common seagoing craft operating near the project area were schooners, steamboats, barges, and assorted regional watercraft such as larger skipjacks and bugeyes.

A total of 12 known ships were reported wrecked in the project area vicinity (Table 2-4), and all were lost during the 20th century. The loss of four schooners constructed during the last quarter of the 19th century, along with three turn of the century barges, are illustrative of the vessel classes expected offshore of Wallops Island. The preponderance of these two forms on the list suggests that schooner type vessels and barges were common sights along the Wallops coastline, and that they were susceptible to loss in sea conditions endemic to that stretch of the sea. The overall potential to encounter shipwrecks in the project area is moderate, and those that may have been encountered would most likely date from 1840 to the present, and would represent schooners, barges, or other working vessels.

4.0 ENVIRONMENTAL CONTEXT

4.1 INTRODUCTION

This chapter focuses on the natural settings of the coastal and nearshore marine environment of Wallops Island, Virginia. The primary objective is to present the overall setting of the study area, including geologic materials and associated processes, as they pertain to archaeology and the preservation potential of material culture in the geologic record. The report begins with a general overview of the study area, followed by the setting, which includes climate, physiography, oceanography, and biology. The geologic development of the study area will then be reviewed, followed by modern configuration/processes, and finally archaeological implications.

4.2 OVERVIEW

The study area includes the coastal and inner continental shelf environment of Wallops Island, Virginia. Specifically, the study area extends seaward from the shoreline to approximately 24.1 kilometers (15 miles) offshore. Wallops Island is located in Accomack County, Virginia, immediately south of the Maryland border and just south of the island of Chincoteague, a popular tourist destination. Wallops Island is part of the barrier island system characteristic of the eastern side of the Delmarva Peninsula (Figure 4-1). Barrier islands in this area consist of a band of narrow, sandy islands, separated from the mainland by a series of shallow lagoons, salt marshes, and dissecting channels (Cuffey and Dade 2006). The area is characterized by a variety of neritic and back barrier environments ranging from nearly freshwater to near normal marine, and from high energy and turbulent to calm conditions.

The Delmarva Peninsula, nearby Chesapeake Bay, and offshore marine environments have been the subject of numerous studies, but there have been very few published scientific works dealing specifically with Wallops Island.

4.3 SETTING

4.3.1 Climate

The study area, from a marine perspective, occupies a region known as the Mid-Atlantic Bight, which extends from Cape Cod, Massachusetts south to Cape Hatteras, North Carolina. The weather and climate in this region is influenced by five main factors which include: the warm waters of the Gulf Stream, water flowing southwestward from the Scotian shelf, the winter cold air from central North America, the warm moist air from the Gulf of Mexico, and the position of the jet stream across eastern North America.

The general climate exhibits a substantial annual variation in temperature, but a fairly uniform precipitation rate. Most meteorological elements originate in the west, steered by the dominant eastward flow in the middle and upper troposphere. This basic flow pattern is commonly modified by upstream topography, such as the Appalachian mountain range and other regional and local features. Annual mean temperatures vary considerably. The mean monthly temperature in nearby Norfolk, Virginia ranges from approximately 40 degrees Fahrenheit (F)

(4.4 degrees Celsius [C]) in January to near 90 degrees F (32.2 degrees C) in June through August (Hertzman 1996).

Precipitation, on average, is relatively well distributed at approximately 40 to 44 in (101.6 cm to 111.8 cm) per year, with the highest rates occurring during the summer. Snow is relatively rare with an average of less than two snow days (defined as greater than 2.5 millimeters (mm) water equivalent) annually. Estimates of offshore precipitation are less well known, but the coastal information discussed above can be considered a reasonable first approximation (Hertzman 1996).

Winds are dominant from the south or southwest most of the year. Wind speeds at nearby Norfolk, Virginia vary from a low of 4 to 5 meters per second (m/s) during the summer months to a high of 5 to 6 m/s during the late winter.

The strong temperature difference during the winter contrasts between the relatively cold landmass and warm waters of the nearby Gulf Stream may create strong winter storms. Strong wind and heavy precipitation during the summer may occur along this region of the coast, associated with convective systems that generate local thunderstorms lasting only an hour or two. Atlantic hurricanes occasionally pass along this part of the coast during the summers as well. Hurricanes are accompanied by extremely heavy precipitation extending up to 1500 km (27.3 mi) from the center of the storm. Most hurricanes that reach these mid-latitudes are speeding up and beginning to acquire mid-latitude storm characteristics, and hurricane tracks also show a pronounced turning to the east by the time they reach these latitudes (Hertzman 1996).

4.3.2 Biology

The discussion of the biology will be restricted to the marine environment only. The focus will be on the benthos, as it is this group that stands to be impacted the most by the proposed action. A large-scale, comprehensive study of the benthic invertebrate fauna of the Mid-Atlantic bight region by Wigley and Thoreau (1981) produced a detailed description of the benthic communities on a regional scale. They further subdivided the Mid-Atlantic Bight into three sub-regions known as Southern New England, the New York Bight, and the Chesapeake Bight. The study area, which is located seaward of Wallops Island, resides in the center of the Chesapeake Bight sub region.

Wigley and Thoreau (1981) describe six dominant taxa on the continental shelf: Bivalvia, Annelida, Crustacea, Echinoidea, Ophiuroidea, and Holothuroidea. The density of all taxa (defined as the number of individuals per square meter of seafloor) in the study area is among the highest of those measured for the entire Mid-Atlantic Bight, and more than one order of magnitude greater than adjacent areas on the continental shelf (Figure 4-2). Mollusks are by far the dominant tax throughout Chesapeake Bight, including the study area (Figures 4-3 and 4-4). Mollusks consist almost exclusively of bivalves (Figure 4-5), which is dominated by the surf clam *Spisula solidissima*, especially in coarse, sand-sized sediments (Ramey 2008).

While regional benthic fauna is likely controlled by a combination of factors including temperature, water depth, sediment/bottom type, and nutrients, it is the sediments and bottom types that are the major control. The sediment type in the study area is dominated by sand and shell, which is considerably different from surrounding sediments (Figure 4-6). This bottom type likely is responsible for the unusually large density of benthic fauna (Wigley and Thoreau 1981).

The study area, and the majority of the Mid-Atlantic Bight, has a gently undulating ridge and swale topography (Churchill et al. 1994) composed of soft sediments (primarily sands) and local relict sand and gravel ridges. It is not considered to be an area of substantial hard bottom outcrops. Therefore "hard bottom", or "reefal" habitats, have not been considered to be important from a volumetric standpoint. Hard bottom habitats, like many micro-environments, are composed of man made materials placed in the marine environment, including shipwrecks, lost cargo, disposed solid materials, shoreline jetties and groins, submerged pipelines, cables, and artificial reefs. Biological communities supported by these features differ significantly from those of the surrounding soft sediment seabed (Steimle and Zetlin 2000). The addition of these materials to the seafloor likely has caused an expansion of habitat type, and has had an effect on living marine resource distributions and fisheries, including the American lobster, cod, red hake, ocean pout and black sea bass (Steimle and Zetlin 2000).

A list of fisheries species commonly found on "reef like" habitats throughout the Mid-Atlantic Bight is shown in Table 4-1. These species, which are typically found in depths less than 25-m (82.0-ft), include boring mollusks, red algae, hydroids, barnacles, blue mussels, horse muscles, and bryozoans. Fish species expected on hard bottom habitats in the study area include black sea bass, pin fish, scup, cunner, red hake, gray trigger fish, black grouper, smooth dogfish, summer flounder, scads, bluefish and Amberjack (Steimle and Zetlin 2000).

Table 4-1. List of Fishery Species Commonly Found in the Mid-Atlantic Bight.

Species	Life Stage/Reef Habitat Use	Notes
Algae (Kelp, *Laminaria* sp, dulse, etc)	All stages grow attached to estuarine/marine hard surfaces.	Grows in inter/subtidal surfaces along southern New England Coast as deep as light penetration allow and provides shelter; some are harvested.
Invertebrates Mollusks Blue mussel *Mytilus edilis*	All stages grow attached to hard surfaces in polyhaline/estuarine waters.	Colonizes intertidal/subtidal surfaces but becomes scarcer towards N.C; important prey for many reef fishery resources; harvested as adults; increases habitat structural complexity and biodiversity.
Eastern Oyster *Crassotrea virginica*	All stages grow attached to hard surfaces in polyhaline/estuarine waters.	Colonizes hard surfaces and/or creates low profile reefs; harvested as juveniles (spat for transplanting) and adults; increases habitat structural complexity and biodiversity.
Longfin Squid *Loligo paelei*	Eggs are attached to hard objects in marine waters.	Hard surfaces of all sizes seem important for egg mass attachment. Eggs and larvae can be prey.
Crustaceans American Lobster *Homarus americanus*	All post-larval stages use shelter in polyhaline-marine waters.	Lobsters are common reef habitat dwellers but are less common south of Delaware Bay; maintain reef habitat structural complexity by cleaning burrows.
Rock Crab *Cancer irroatus*	All post-larval stages use shelter in polyhaline-marine waters.	Common on reef habitats as well as on most other habitat; juveniles or smaller sizes important prey for fish and lobsters; claws are harvested.
Fish American Eel *Auguilla rostrata*	Adults found in estuarine to coastal marine reefs as well as elsewhere.	This eel is found seasonally in estuarine areas, including holes in peak banks; harvested by trap and recreational fishery.
Conger Eel *Conger oceanicus*	Juveniles and adults common on polyhaline-marine structures.	This larger eel preys on smaller reef fish, hard to catch but desirable.
Atlantic Cod *Gadus morhua*	Juveniles and adults common on polyhaline-marine reefs.	This specie feeds on reef organisms; uses structure for shelter; but only found during cooler seasons south of Long Island, NY to about Delaware.
Pollack	Juveniles and adults	Uses structure for shelter or for feeding but only found

Species	Life Stage/Reef Habitat Use	Notes
Pollachius virens	common on polyhaline-marine reefs.	during cooler seasons south of Long Island, NY to about Delaware.
Red Hake *Urophycis chuss*	Juveniles and adults common on polyhaline-marine reefs.	Common reef habitat dweller; preys on small crabs and other organisms found on or near reefs; commercially and recreationally harvested.
Stripe Bass *Morone saxtilus*	Juveniles and adults common on estuarine and coastal reefs.	Juveniles use estuarine structures for shelter; adults find prey near estuarine and coastal structures.
Black Sea Bass *Centropristis striata*	Juveniles and adults on estuarine and coastal reefs.	Juveniles use estuarine and coastal structures, and adults mostly use coastal and midshelf structures during warm seasons.
Gag Grouper *Mycteroperca microlepis*	Juveniles and adults common on southern Bight reefs habitats.	Important but variably available fishery species off Virginia and North Carolina.
Scup *Stenotomus chrysops*	Juveniles and adults common on estuarine and coastal reefs	Small schools of this species visit coastal reefs for prey and shelter during warmer seasons; found offshore and on the south in the winter
Spot *Leiostomus xanthrus*	Juveniles and adults common on estuarine and coastal reefs.	Warm season user of reef habitats north on Chesapeake Bay.
Sheepshead (Porgy) *Archosargus probatocephalus*	Juveniles and adults common on estuarine and coastal reefs.	Common on estuarine (including oyster beds) and coastal reefs mostly south of Delaware Bay.
Atlantic Croaker *Micropogonias undulates*	Juveniles and adults common on estuarine and coastal reefs.	Common on estuarine (including oyster beds) and coastal reefs mostly south of Delaware Bay.
Black Drum *Pogonias cromis*	Juveniles and adults common on estuarine and coastal reefs.	Common on estuarine (including oyster beds) and coastal reefs mostly south of Delaware Bay.
Tilefish *Lopholatilus chamaeleoticeps*	Juveniles/adults use rocky areas or holes in stiff clay at the edge of continental shelf and upper slope	This specie contributes to the creation and persistence of the rough bottom habitat and associated biological community found in certain areas on the outer shelf and upper slope
Cunner *Tautogolabrus adspersus*	All post-larval stages are associated with marine-polyhaline reef habitats.	A very common small reef fish, especially in the northern Bight; prey for other fish found on or visiting reefs. Hibernates on reefs on cold winters.
Tautog *Tautoga onitis*	All post-larval stages are associated with marine-polyhaline reef habitats.	A common larger reef fish that prey heavily upon mussel; youngest juvenile found in estuarine; may hibernate during cold winters off New England.
Gray Triggerfish *Baalisted capriscus*	Juveniles/adults are warm-season reef dwellers.	Found on marine reefs and preys on reef dwellers; growing in popularity and fish food.
Ocean Pout *Macrozoarces americanus*	All life stages found on reef habitat, including eggs which are nested.	Adults make and possibly guard egg nests within reef structures during winter.
Reptilia Sea Turtles *Eucheloniodea*	Juveniles and adults of several species are associated with reefs.	Sea turtles are common visitors to the Bight and are known to use reef structures as sheltered resting areas and can prey on reef crabs.
Mammalia Harbor Seal *Phoca vitulina*	Juveniles and adults use the above water parts of reefs as nesting areas.	Harbor seals are winter visitors to the northern Bight and are commonly observed on dry parts of submerged structures and may prey on associated reef fish.

Table Source: Wigley and Theroux 1981

4.3.3 Physiography

The coastline bordering the Northwest Atlantic Ocean is, to a large extent, a result of glacial scouring. This scouring has left a complex, incised coastline in the northern sections, with rocky headlands separating small estuaries. The southern sections of coastline, which include the study area, appear as a long, sandy shoreline that is occasionally breached by larger estuarine systems, such as the Chesapeake Bay (Townsend et al. 2006). These estuaries are effective at trapping the majority of suspended sediments delivered to the coastline from extensive coastal plain fluvial systems. The coastline in the Chesapeake Bay area is angular, with long, relatively straight sections of shoreline extending away from either side of major estuaries (Townsend et al. 2006).

The continental shelves are generally wide, but vary with location. They generally become narrower in the southern Bight. Progressive narrowing of the shelf from approximately 150 km (93.2 mi) off New York to approximately 30 km (18.6 mi) off Cape Hatteras, has significant influence on the physical oceanography of the area (Townsend et al. 2006). The inner shelf physiography of the Mid-Atlantic Bight has been described as exhibiting a pervasive ridge and swale topography with an abundance of elongate ridges and parallel depressions (swales) that generally parallel the adjacent coast (Shor and McClennen 1988). Some scientists interpret this ridge and swale topography to represent relict barrier/lagoon pairs formed and abandoned during the most recent sea-level rise. Others interpret ridge and swale topography to represent post-transgressive, shoreface-connected ridges. Cross-shelf channels (valleys) and deltas (aprons) often extend the entire width of the continental shelf. Some of these valleys may be partially, or even completely, filled with sediments, while others retain their valley profile. These features are derived from Pleistocene and/or Holocene sea-level lowstands. They represent fluvial pathways to adjacent canyons on the continental slope, which are associated with clusters of ridges and swales superimposed on elevated shelf areas described as shoal retreat and cape retreat massifs. These massifs are associated with the adjacent shoreline feature for which they are named. The shelf valley complexes and associated sand shoal massifs are separated by broad, plateau-like interfluves, and may represent river valleys excavated during previous Quaternary lowstands of sea level that have been infilled with estuarine sediments during an ensuing sea-level rise. The sea-level rise, when coupled with intense wave activity, likely caused erosional shoreface retreat of river forelands or estuary mouths. This resulted in widely spaced cape retreat massifs with broad intervening plateau-like interfluves that contain extensive fields of sand ridges. Modern shelf valleys have occasionally been incised into previous valley fill (Riggs and Belknap 1988).

4.3.4 Oceanography

The shelf waters of the northwest Atlantic are located in a region of abrupt water temperature change at the confluence of the north-flowing Gulf Stream and the south-flowing Labrador Current (Figure 4-7). Mid-latitude cyclones frequently track across North America and converge in this region, which significantly impacts the vertical mixing and nutrient fluxes of shelf waters. A continuous equatorward coastal current system extends southward from Newfoundland to the Mid-Atlantic Bight. The general southerly flow continues south of Cape Hatteras, which is known as Mid-Atlantic Bight Water. Cross shelf mixing of the flow with slope waters and the Gulf Stream become important as shelf width decreases (Townsend at al. 2006). Shelf and slope waters of the Mid-Atlantic Bight have relatively low salinities (< 34 ‰), augmented by various rivers, including those entering Chesapeake Bay. The cross shelf mixing of waters in this area, along with influxes of deep, offshore waters to inner shelf regions, may have important biological implications (Townsend et al. 2006).

The North Atlantic Oscillation (NAO), which is a decadal-scale oscillation of wintertime surface atmospheric pressure over the Arctic and subtropical Atlantic, has recently been found to have an important influence on water mass properties over the entire northwest Atlantic shelf (Townsend et al. 2006). The NAO, to a great extent, dictates the latitudinal displacement of the boundary between the Gulf Stream and Labrador Current, and it may have important ramifications for the physical and biological environments of the entire northwest Atlantic shelf (Townsend et al. 2006).

Coast and shelf waters throughout the Mid-Atlantic Bight support extensive and productive fisheries. The high biological productivity of the area is the result of a number of interacting factors, including cross shelf fluxes of nutrient-rich deep waters and winter convective mixing. Winter mixing replenishes surface nutrient concentrations, resulting in winter and spring plankton blooms, which in turn influences the benthic population. Following the spring bloom, a strong vertical stratification occurs throughout the warmer summer months, established by freshwater influxes from the nearby landmass and solar warming of surface layers. Vertical mixing by tides further stimulates nutrient fluxes that promote high levels of plankton production (Townsend et al. 2006).

The Wallops Island Atlantic coast has a semi-diurnal tide with a 1 to 2 m (3.3 to 6.60 ft) tidal range. This is considered microtidal, but tidal currents have been known to scour backbarrier channels to depths of several meters (Oertel et al. 1989). The predominant and prevailing winds are from the north to northwest and south, respectively. Atlantic storms, generally coming from the northeast, may be intense, and produce strong winds and large waves capable of overwashing barrier islands along this stretch of the coast (Demarest and Leatherman 1985). The dominant winds produce a wave approach from the north, resulting in a net southerly long-shore current (Cuffey and Dade 2006; Finkelstein and Ferland 1987). Both the long-shore current and incoming waves are capable of re-suspending and transporting sand-size sediments throughout the study area (Churchill et al. 1994).

4.4 GEOLOGIC DEVELOPMENT

4.4.5 Structural Geology and Early Geologic Development

The study area, along with the entire Delmarva Peninsula, occupies the central part of the Salisbury Embayment located within the landward extension of the Baltimore Canyon trough (Figures 4-8 and 4-9) (Hansen 1988). The Baltimore Canyon trough is the deepest of six marginal basins located beneath the US Atlantic margin, all of which were formed by extensional forces associated with early rifting phases of continental breakup (Klitgord et al. 1988). Basement rocks, which floor the Salisbury Embayment and adjacent Baltimore Canyon trough are primarily continental in origin and consist of granitic and metasedimentary units of Paleozoic age (Poag and Valentine 1988). The Salisbury Embayment is one of the major Mesozoic to Cenozoic depocenters on the Atlantic continental margin (Foyle and Oertel 1997). They are a thick sequence of Mesozoic to Cenozoic sediments overlying basement rocks that reach greater than 8 km (4.9 mi) in thickness in the southern part of the Baltimore Canyon trough (Poag 1997). Marine waters presumably entered the Baltimore Canyon trough following initial rifting, and eventually deposited evaporite sediments as a result of the early Jurassic arid climate. These likely represent the basal sedimentary units occupying the trough (Poag and Valentine 1988). During the early to Middle Jurassic, shallow-water carbonate sediments were deposited.

Several small, “reef-like” carbonate buildups were identified during this time period as well. A large shelf edge carbonate buildup (barrier reef) appears to have formed at the end of the Middle Jurassic period. Seaward progradation continued during the late Jurassic, and a larger regional carbonate bank system formed a massive shelf edge barrier. Siliciclastic sedimentation, including the fluvio-deltaic units of the Potomac Formation, took over by the early Cretaceous, (Poag 1997; Hansen 1988) and buried the shelf edge barrier, thereby initiating a period of terrigenous sediment accumulation that lasted throughout the entire Cretaceous Period.

During the Paleogene, carbonate sedimentation resumed with the deposition of calcareous shales, chalks, and limestones, primarily of Eocene age. Paleocene and Oligocene strata are also present, but are less persistent, often being completely missing or only partly represented (Poag and Valentine 1988). The relatively continuous deposition in the southern portion of the Baltimore Canyon trough in the late Eocene was interrupted by a bolide impact on the inner-continental shelf beneath the modern position of the Chesapeake Bay mouth. According to Poag (1997), this event created a large, complex, impact crater, which generated a gigantic tsunami, and fundamentally altered the geological, geo-hydrological, and geographical evolution of the Virginia segment of the Atlantic coastal plain. It also created a structural and topographical low, and may have predetermined the location of modern Chesapeake Bay.

4.4.6 Recent Development and Modern Configuration

The recent geologic evolution of the coastal and nearshore marine environment off Wallops Island can be tied directly to the development and growth of the Delmarva Peninsula and the major sea-level fluctuations of the late Tertiary and Quaternary. Both the terrestrial and marine stratigraphy have been reasonably well documented (see Shideler et al. 1972; Owens and Denny 1979; Mixon 1985; Finklestein and Ferland 1987; Johnson and Berquist 1989; Toscano and York 1992; Hobbs 2004) and are presented in Table 2. The discontinuous nature of the strata proves problematic when attempting to correlate units, especially terrestrial with marine. Consequently, the stratigraphy of the Delmarva Peninsula and the inner continental shelf will be discussed separately. The two will then be correlated in a discussion of the geologic evolution of the study area.

4.4.6.1 Delmarva Peninsula Stratigraphy

The Virginia portion of the Delmarva Peninsula has evolved as a southerly growing spit (Figure 4-10; Hobbs). The base of the Delmarva Peninsula is interpreted to consist of fluvio-deltaic sands of the Pensauken and/or Yorktown Formations of early Pliocene age (Owens and Denny 1979). The Beaver Dam Formation partially overlies these units and occupies the region south of the Maryland to Virginia border (Owens and Denny 1979). The Beaver Dam Formation is thought to represent a river-dominated deltaic system deposited during a late Pliocene sea-level transgression and regression sequence. The overlying Walston Silt is believed to be of marine origin, likely deposited under a single transgression during the Pliocene (Owens and Denny 1979). The Omar Formation partially overlies the Yorktown Formation and is interpreted as lagoonal and estuarine deposits encompassing most of the Pleistocene section of the Delmarva Peninsula (Mixon 1985).

The Omar in Virginia, however, has been described as a high-energy barrier, and nearshore shelf deposit. The Pleistocene Era Ironshore Formation consists of a narrow, discontinuous band of sand and gravelly sand stretching from Delaware to the southern tip of the Delmarva Peninsula. This formation has been largely eroded south of Chincoteague Island (Hobbs 2004, Owens and

Denny 1979). The overlying Sinepuxent Formation has been described as a Pleistocene marginal marine unit that likely represents a major transgression in sea level (Owens and Denny 1979). The overlying Nassawadox and Kent Island Formations, which are identified in southern Virginia, likely represent ancestral Chesapeake Bay sediments (Owens and Denny 1979; Mixon 1985; Hobbs 2004). The Joynes Neck Sand is the surficial unit that overlies the Omar and Nassawadox Formations along the eastern shore of the southern Delmarva Peninsula. Joynes Neck Sands are interpreted to have been deposited during a single marine transgression (Mixon 1985) and were likely deposited during the late Pleistocene (Hobbs 2004).

4.4.6.2 Inner Continental Shelf Stratigraphy

The inner continental shelf seaward of the Virginia portion of the Delmarva Peninsula has been described as having four stratigraphic units, termed Units A, B, C, and D (Shideler et al. 1972). Unit A, the deepest and oldest, is interpreted to represent the top of the Miocene, although some suggest that it may actually represent the Yorktown Formation, which is now considered to be Pliocene in age. The overlying Unit B is considered to be a complex of fluvial, estuarine, lagoonal tidal channels and barrier ridges. Although the exact age is uncertain, it is believed to have formed some time during the late Pleistocene. Unit C has been described as consisting of relatively uniform horizontal strata, with only occasional indications of minor local channeling. No other interpretation has been given. The surficial and youngest sedimentary unit, Unit D, represents the modern seafloor, and was likely deposited as a transgressive sand sheet during the most recent rise in sea level.

4.4.6.3 Neogene/Quaternary Geologic Evolution

The recent geologic evolution of the study area is tied to the southerly progradation of the Delmarva Peninsula, coupled with the late Tertiary/Quaternary fluctuations in sea level. The southerly progradation of Delmarva Peninsula has been a major control on the evolution of Chesapeake Bay. Major drainage systems entering modern Chesapeake Bay substantially predate the development of the estuary, and originally emptied directly into the open ocean (Hobbs 2004). The first indication of a bay, separated from the open ocean, appeared in the late Pleistocene with the initial growth of the Delmarva Peninsula from the Pleistocene deltas of these ancestral rivers. During early Pleistocene sea-level highstands, the older, deltaic peninsula prograded seaward and southward as a major barrier spit, beginning the processes that have continued to the present (Hobbs 2004). The peninsula/spit continued to grow during ensuing sea-level highstands by lengthening southward. The more northerly river systems could no longer flow directly southeast across a wide continental shelf during each sea-level regression, and were diverted southward around the tip of the lengthening peninsula. Consequently, deep river channels were incised into what is now the continental shelf.

The inner shelf has been sediment starved throughout the Pleistocene because of the limited amount of sediments available for deposition, and the time available for strata formation has been relatively short (on the order of tens of thousands of years). The resultant strata on the inner shelf are quite thin and discontinuous as a result, and are difficult to correlate with units on the nearby Delmarva Peninsula and coastal plain (Hobbs 2004). Correlation is made even more difficult because these inner shelf strata are primarily derived from older, reworked sediments, and many are lacking diagnostic fossils. The surficial unit consists of a thin, transgressive sand sheet mantling the inner shelf and overlying the incised channels discussed above. This configuration has important ramifications for the modern morphology of the coast/inner shelf and preservation potential of material culture.

4.4.6.4 Modern Configuration

The morphology of the present day barrier beaches and adjacent inner continental shelf off the Delmarva Peninsula, including the study area, is controlled by wave climate, tidal energy, sediment texture, and sand supply (Demarest and Leatherman 1985). The actual position of the barrier islands and associated inlets are more a function of antecedent topography (Oertel et al. 1989; Finkelstein and Ferland 1987). Topographic lows provide pathways for drainage and inlet formation, while topographic highs create sites for barrier island development (Oertel et al. 1989). Evidence indicates that between 3 to 7 m (9.8 to 22.9 ft) of relief probably existed on the pre-transgressional surface of the southern Delmarva Peninsula, creating ideal sites for barrier development (Finkelstein and Ferland 1987).

Demarest and Leatherman (1985) discuss four main types of barriers on the Delmarva Peninsula. The study area is located in the zone of drumstick (short, bulbous) barriers characteristic of the Virginia shoreline (Figure 4-11). These barriers are likely related to the relative stability of major tidal inlets and largely infilled lagoons. These stable tidal inlets have resulted in the evolution of large, well-developed ebb tidal deltas, which in turn are believed to have a pronounced effect on barrier dynamics and island morphology (Demarest and Leatherman 1985). These island types were originally described for mesotidal (2 to 4 m tidal range) environments, but exist here in a microtidal environment. These islands are also generally formed where there are no updrift headlands to supply sand, which suggests that new sediment is supplied from shore face erosion and moved onshore to replace sand lost to littoral drift or inlet deposition (Demarest and Leatherman 1985).

The study area is located in what Demarest and Leatherman (1985) refer to as the “arc of erosion” (Figure 4-11). The lack of updrift headlands means that there is no source of sediment to input onto the shoreline, except for new sediments supplied by shoreface erosion and moved onshore. Finkelstein and Ferland (1987) maintain that the net sand deficit in the study area has occurred because sands are trapped at the southern tip of Assateague Island rather than transported downdrift to nourish the islands to the south. They also maintain that relatively little sand is extracted from the underlying substrate by shoreface erosion in the study area (Finkelstein and Ferland 1987). Sediment supply to the beaches by shoreface erosion has not happened, and the Wallops Island beach and nearshore can be expected to be highly erosional in nature. There is no evidence that any of the Delmarva beaches receive coarse grain sediments from the rivers directly, as most of the material is trapped in the estuarine and lagoonal systems.

4.5 ARCHAEOLOGICAL IMPLICATIONS

The majority of physical oceanographic, stratigraphic, sedimentologic, and geomorphologic data concerning the coastal and inner continental shelf off Wallops Island, Virginia is consistent with low to very low preservation potential of cultural materials in inner shelf sediments. Thin layers of sediments have been deposited during sea-level highstands throughout the Quaternary, and only a thin sediment veneer has been deposited since the last low stand approximately 20 thousand years ago. Therefore, the sedimentary record during this time is very thin. Also, the deposition of this transgressive sand sheet during sea-level rise has occurred by continuous reworking of sediments by physical processes (which continues to the present), which would likely disturb any materials that were originally buried. Sediments in the study area, which consist of shells and sand, are coarser than sediments to the north and south, suggesting higher energy, which is consistent with even more intense bottom sediment reworking. The location of the study area in the “arc of erosion” suggests that the sediment supply to the study area is even lower than for surrounding areas, once again inconsistent with preservation of materials by sediment burial. The sediment supplied to the beaches is derived from previous shoreface erosion, which would not be conducive with preservation in the sedimentary record.

The most likely regions of preservation would be the thicker sedimentary units associated with buried channels originally cut by rivers traversing the continental shelf during sea-level lowstands. Deposition is generally promoted in these areas (since they represented bathymetric depressions), sediment accumulation rates were likely higher, and sediments are less subject to reworking. This would only apply to the last sea-level transgression, and major buried valleys have not been described in the study area. The preservation potential may be greater in buried channels, but it should still be considered relatively low for the objectives of this study.

5.0 RESEARCH DESIGN

5.1 OBJECTIVES

The remote sensing survey was designed to locate and identify magnetic and acoustic anomalies that could represent potentially significant submerged cultural resources, such as shell middens or other prehistoric sites, shipwrecks, or historic maritime structures. The project consists of two survey blocks located northeast of Chincoteague Inlet east of Blackfish Bank in U.S. waters. Each block measures two square mi (5 square km) (Figures 5-1A, 5-1B, 5-2A, and 5-2B). Block One, centered upon Unnamed Shoal A, is directly adjacent to Blackfish Bank, and measures approximately 15,300-ft long (4664-m) by 4,400-ft wide (1,341-m), or 1,545.6 acres. Block One has 80 transects spaced at 50-ft (15.2-m) intervals, which yields 1,144,861 linear survey ft (348,953.6-m) or 216.8 survey mi (348.9-km). Block Two, centered upon Unnamed Shoal B, is located 2.25 mi (3.62 km) to the northeast of Block One, and measures approximately 13,300-ft (4055-m) long by 4,000-ft (1220-m) wide, or 1,221.4 acres. This parcel has 84 transects spaced at 50-ft (15.2-m) intervals, which yields 1,044,421 linear ft (318,339.5 m) or 197.8 linear survey mi (318.3 km).

5.2 METHODS

5.2.1 Background Research

The purpose of background research was to develop cultural contexts for identifying and evaluating archaeological sites that may be encountered within the project area. Research was conducted at the National Archives in Washington, D.C. and at various online repositories. Reports of previous cultural resources investigations and previously recorded architectural and archaeological sites as well as known shipwrecks were obtained from the Virginia Department of Historic Resources. Historic maps and accounts of the development of Wallops Island were obtained from the National Archives and through books and periodicals.

5.2.2 Remote Sensing Methods

The process of land inundation and shipwreck site formation distributes ship remains and other artifacts (cargo, fittings, and ballast) in relatively large clusters based on water depth, artifact size, seafloor topography, and water currents. Submerged prehistoric features, such as hearths and shell middens, can also survive the ravages of the sea intact if protected by certain sediment types. A well-designed survey that is conducted with sensitive, high resolution sensors can detect submerged habitation sites and shipwreck debris, and can reliably differentiate these finds from the earth's ambient magnetic field and natural bottom topography.

A well-defined set of criteria were used to distinguish naturally occurring magnetic and acoustic anomalies from significant cultural resources. Magnetic anomalies were evaluated based on data points that include anomaly duration (both time and distance), magnetic amplitude in nanoTesla (nT), and magnetic signature. Magnetic signatures were denoted as dipoles (D), monopoles (±M) or multi-components (MC) (Figure 5-3). Positive and negative monopoles refer to one half of a dipolar perturbation, and usually indicate an isolated magnetic source located some distance from the sensor. Monopoles produce either a positive or negative deflection from the ambient magnetic field. The polar signature depends on whether the positive or negative pole of the object is oriented toward the magnetometer sensor. Dipolar signatures display both a rise and a fall from the ambient field, and they are generally associated with single source anomalies located directly under the magnetic sensor. Multi-component magnetic perturbations represent several, randomly scattered ferrous objects with different magnetic orientations. Anomalies with these signatures are likely associated with man-made objects, possibly shipwrecks. The last two criteria are the location of the anomaly center, and the distribution and patterning of anomalies within the survey area.

Side scan sonar data were used to image the sea floor or river bed, to locate and identify culturally significant materials, and to map the geomorphic and bathymetric anomalies within each survey area. A sub bottom profiler was used to detect buried structures or geomorphic features, such as buried relict channels, shell middens, shipwrecks, or buried cables and pipelines.

Data acquired from these instruments were first evaluated separately, and then as an integrated data set. Potential cultural targets are often comprised of related magnetic and acoustic anomaly groups. Targets are identified as significant if the various anomaly groups reflect parameters established for shipwrecks and other significant cultural features.

The survey array used for the WFF SRIPP survey consisted of the following: a Differential Global Positioning System (DGPS), a cesium vapor marine magnetometer, side scan sonar, a continuous transmission FM chirp sub bottom profiler, and an echo sounder (Plates 5-1 and 5-2). Hydrographic and navigational controls were achieved by the use of Hypack's® survey software.

5.2.2.1 Positioning

A Hemisphere Crescent R130 DGPS with inertial navigation corrections (for up to 45 minutes after loss of signal) was used for this survey. The Hemisphere system transmits information in NMEA 0183 code to a computer navigation system using the *Hypack® 2009a* survey software. The *Hypack*® software incorporates the NMEA 0183 data string and displays vessel position on a computer screen relative to pre-programmed track lines and each instrument sensor. It also performs instantaneous data translations between various geodetic projections, which combine all incoming data with accurate positions for seamless data integration and post acquisition processing. Navigation files within *Hypack® 2009a* can be utilized to produce track line maps and derive X, Y, and Z data sets for analysis and contour plotting. Positioning control points were obtained every 30.5 meters (100 feet) along survey transects. The Hemisphere Crescent 130 DGPS is considered to be accurate to within 20.3 centimeters (8 inches) Root Mean Square (RMS) values under optimal conditions.

5.2.2.2 Magnetometer

A Geometrics G882 marine magnetometer was used for the magnetic survey. The G882 magnetometer is a 0.01 nT (RMS) sensitivity cesium magnetometer that is linked to *Hypack® 2009a*, which enables precise, real-time positions for recorded magnetic data. Survey was terminated if induced magnetic background noise exceeded +/-3 nanoTesla (nT). The magnetometer sensor was towed a sufficient distance from the transom of the survey vessel to avoid magnetic interference from the propulsion and electrical systems.

5.2.2.3 Side Scan Sonar

A MarineSonic 600 kHz side scan sonar system was used to collect acoustic data for this survey. The 600 kHz system produces high resolution images with moderate ranges of a few hundred feet. Navigation fixes are imbedded with the acoustic data in real time, which allows images to be geo-referenced and side scan mosaics created for analysis.

5.2.2.4 Sub Bottom Profiler

A Benthos Chirp III sub bottom profiler was used to record sediment structure and any cultural material deposited beneath sediments. The Benthos system uses a continuously transmitted acoustic pulse that begins at 2 kHz and continues to a maximum of 20 kHz. This swept frequency can image sediment structure with up to 2 centimeters (0.78inches) resolution. The DGPS system feeds positioning data to the sub bottom profiler receiver and is used to control recording speed and data point position.

5.2.2.5 Echo Sounder

An ODEM Hydrotrac digital echo sounder was used to record bathymetric data for each survey transect. *Hypack® 2009a* recorded the position and bottom depth every tenth of a second and corrected for transducer layback and offset values. The bathymetric data is used to better understand the geomorphology of the survey area and how that affects the distribution of magnetic and acoustic anomalies, as well as to delineate any features sitting above the sediment surface.

5.2.2.6 Data Collection and Position Control

Hypack® 2009a survey software was used for survey planning and data collection. Once the survey was designed and track lines planned, *Hypack®* survey module was used to establish survey control and data collection and correction. While surveying, the planned transects were projected onto the navigation screen and the data being collected, which permits “real time” quality control and field data logging of anomalous data.

All remote sensing data were correlated with DGPS positioning data and time through *Hypack® 2009a*. Positions for all data were then adjusted for sensor layback and offsets. Positioning was recorded using Virginia State Plane North, US Survey foot, referencing the North American Datum of 1983 (NAD-83), and US survey feet were the units of measure.

5.2.3 Marine Data Analysis

Magnetic and acoustic data were reviewed for anomalies during data collection, and those data were reviewed again during post-processing using *Hypack®* data review module, Chesapeake Technology’s *SonarWiz.Map®* 4.04, and Golden Software’s *Surfer®* (Version 8). These computer programs were used to assess the duration, amplitude, and complexity of individual magnetic disturbances, and to review side scan sonar (SSS) and sub bottom profiler (SBP) data for anomalies. The software was also used to plot anomaly positions within the project area to better understand their spatial distribution and association with other anomalies.

Nautical archaeologists maintained field notes on the locations of modern sources of ferrous material, such as pipeline and cable corridors as well as fishing grounds and charted shipwrecks that would have altered regional magnetic field readings. Magnetic perturbations of 3 nT or greater with durations greater than 3 meters (10 feet) were cataloged for further analysis. Acoustic imaging was reviewed for anomalous returns that could be associated with significant submerged cultural resources. SBP data were reviewed for buried shipwrecks, submerged prehistoric features, and relict landforms that have potential to contain intact prehistoric deposits.

All data sets were cross-checked for relevant correlations. Anomalies in clear association were identified as targets and underwent further analysis. The presence of known shipwrecks in the vicinity of Blackfish Bank suggested that the area has a moderate potential for containing shipwrecks and other maritime cultural resources.

5.3 EXPECTED RESULTS

Research and analysis presented in Sections Two through Four suggested that there was a moderate probability to encounter historic shipwrecks or other historic maritime cultural materials, and a very low potential to encounter buried prehistoric sites. It was also anticipated that the actual results of the survey represent modern fishing and trawling activities that constantly take place on or near the sand borrow areas. Acoustic, magnetic, sub bottom profiler anomalies were anticipated to depict debris associated with modern fishing activities, such as anchors, cables, chains, and trawls. The survey array was also expected to detect debris deposited by recent storm events, such as saturated logs and dock and pier construction elements. The majority of vessel traffic in the region has taken place over the last 75 to 100 years and shipwrecks encountered within the project area would likely be fishing or recreational craft lost during those decades.

6.0 RESULTS OF ARCHAEOLOGICAL INVESTIGATIONS

Magnetic and acoustic (side scan sonar, sub bottom profiler, and echo sounder bathymetric) data were reviewed during data collection for anomalies, and reviewed a second time during post-processing efforts using the *Hypack*® (version 2009a) data review module and Golden Software's *Surfer*® (Version 8). These software programs were used to assess the duration, amplitude, and complexity of individual magnetic disturbances, and to plot the positions of these anomalies within the survey areas to better understand spatial patterning and their association with acoustic and bathymetric anomalies.

Archaeologists maintained field notes on the locations of modern sources of ferrous material such as underwater cables, pipelines, and discarded or lost fishing equipment (clamming and crab trawls, anchors, or other jettisoned debris). Any magnetic perturbation of 3 nT or greater, with durations longer than 6.1 meters (20 feet), was cataloged for further analysis. Acoustic imaging data were reviewed for anomalous returns that could be associated with significant submerged cultural resources. Acoustic images and magnetic contouring were checked against bathymetric data for potential correlation.

6.1 SURVEY RESULTS

The project consists of two survey blocks, Block One and Block Two, that each measure approximately 5 square kilometers (2 square miles). They are located northeast of Chincoteague Inlet in the vicinity of Blackfish Bank in U.S. waters (Figure 1-1 and 1-2). Both areas are regularly transited by commercial fishing vessels, barges, sport and charter fishing boats. Large commercial trawling vessels (clam and crab d raggers) and sport fishing boats were seen on and near the survey blocks during the survey, but moved to other areas once survey operations began. A total of 28 magnetic anomalies (Table 6-1) and 30 acoustic anomalies (Table 6-2) were recorded during the survey of Blocks One and Two. Each anomaly was assigned a number preceded by A (acoustic anomaly) or M (magnetic anomaly).

6.2 BLOCK ONE

Block One measures approximately 4,664 meters (15,300 feet) by 1,341 meters (4,400 feet), or 1,545.6 acres. It was divided into 80 transects spaced at 15.2 meter (50 foot) intervals, which yielded 348,953.63 linear survey meters (1,144,861 feet) or 348.9 linear survey kilometers (216.8 miles). This area is centered upon an unnamed sand shoal that ranges in depth between 7.62 meters (25 feet) and 20.4 meters (67 feet) (Figures 1-2 and 5-1). Block One contained 24 magnetic anomalies and 18 side scan sonar anomalies, which account for 85.7 percent of the total magnetic perturbations, and 64.3 percent of the total acoustic anomalies (Figure 6-1). A total of five target clusters were identified from these anomalies in Block One; these are discussed in detail below (Table 6-3, Figure 6-1).

Table 6-1. Magnetic Anomalies

Anomaly #	Block #	Line #	Virginia State Plane S, US Srv Ft X (Center)	Virginia State Plane S, US Srv Ft Y (Center)	Latitude (Degree Min Dec Sec NAD83)	Longitude (Degree Min Dec Sec NAD83)	Amplitude (nT)	Sign	Duration (ft)	Height of Sensor (ft)	Ferrous Mass (lbs) Dipole	Ferrous Mass (lbs) Monopole
M1	2	44	12459112.95	3856689.81	37.86688595	75.11767794	30	+M	110	20	249.2	12.5
M2	2	50	12458563.47	3855950.805	37.86491188	75.1196718	10	D	136	17	51.0	3.0
M3	2	54	12458259.81	3855505.385	37.86371932	75.12077821	3	D	130	17	16.0	0.9
M4	2	62	12457063.76	3854211.194	37.86028502	75.1250788	10	D	38	15	35.9	2.4
M5	1	59	12434102.92	3848914.341	37.84797506	75.2052012	12	D	153	15	42.4	2.8
M6	1	58	12436133.56	3850807.515	37.85297605	75.19794374	3	D	192	15	10.4	0.7
M7	1	51	12432532.81	3848032.923	37.84570634	75.21074181	14	D	155	12	25.5	2.1
M8	1	51	12436870.81	3851934.793	37.855999	75.19525526	4	D	177	12	7.2	0.6
M9	1	50	12436792.32	3851926.231	37.85598305	75.19552799	5	M-	101	12	9.5	0.8
M10	1	50	12432691.1	3848249.244	37.84628489	75.21016787	4	D	808	8	2.1	0.3
M11	1	45	12430051.54	3846203.226	37.84092178	75.21954959	17	D	139	15	59.2	3.9
M12	1	46	12438055.09	3853335.923	37.85973046	75.1909859	2	M-	143	25	32.3	1.3
M13	1	46	12432988.33	3848796.139	37.8477574	75.20907315	3	D	722	20	28.9	1.4
M14	1	46	12430033.47	3846133.658	37.84073258	75.21962049	4	D	311	20	31.3	1.6
M15	1	47	12432728.31	3848471.545	37.84689143	75.21001226	4	D	333	20	34.0	1.7
M16	1	42	12436094.73	3851850.277	37.85584161	75.19795185	3	M-	296	25	46.7	1.9
M17	1	42	12431368.87	3847587.257	37.84459449	75.21482388	3	M-	96	20	24.3	1.2
M19	1	39	12435347.21	3851369.413	37.85459365	75.20059753	3	M+	355	20	22.1	1.1
M20	1	37	12429231.17	3846005.345	37.84045693	75.22241248	6	D	124	15	22.0	1.5
M21	1	36	12429137.53	3845982.409	37.84040291	75.22273931	6	D	110	15	21.0	1.4
M22	1	35	12435795.04	3852041.344	37.85639477	75.19896607	4	D	655	15	13.7	0.9
M23	1	32	12432918.68	3849665.319	37.85014952	75.2092093	20	D	230	18	118.2	6.6
M24	1	31	12432908.65	3849725.236	37.85031493	75.20923679	57	D	149	20	474.4	23.7
M25	1	24	12432854.9	3850127.046	37.85142283	75.20937433	21	D	109	20	171.6	8.6

Anomaly #	Block #	Line #	Virginia State Plane S, US Srv Ft X (Center)	Virginia State Plane S, US Srv Ft Y (Center)	Latitude (Degree Min Dec Sec NAD83)	Longitude (Degree Min Dec Sec NAD83)	Amplitude (nT)	Sign	Duration (ft)	Height of Sensor (ft)	Ferrous Mass (lbs) Dipole	Ferrous Mass (lbs) Monopole
M26	1	15	12435718.04	3853319.502	37.85991004	75.19907784	5	D	226	24	69.5	2.9
M27	1	14	12434212.06	3852023.991	37.85649899	75.20444759	5	D	194	25	74.0	3.0
M28	1	14	12438094.13	3855518.353	37.86571631	75.19058581	5	D	543	25	74.3	3.0
M29	1	33	12429808.24	3846792.861	37.84256325	75.22032067	3	D	405	18	19.6	1.1

Table 6-2. Acoustic Anomalies

Anomaly Number	Block/ Line	Magnetic Association	Dimensions L x W x H (Ft)	Shape	Latitude NAD 83 Coordinates (in decimal degrees)	Longitude NAD 83 Coordinates (in decimal degrees)	Minimum Avoidance Distance (Ft)	Identification	Anomaly Number	Block/ Line	Magnetic Association
A1	B1L7	No Association	24ft x 12ft x 3ft	Amorphous	37 51.5671	75 12.1455	NA	Debris Field	A1	B1L7	No Association
A2	B1L10(06)	No Association	2ft x 3ft x 1 ft (2 Pieces)	Roughly Circular	37 50.9082	75 13.0137	NA	2 Pieces of Debris	A2	B1L10(06)	No Association
A3	B1L10(18)	No Association	52ft x 27ft x 2ft	Amorphous	37 51.7131	75 11.8008	NA	Debris Field	A3	B1L10(18)	No Association
A4	B1L14(01)	No Association	1ft x 1ft x 2ft (2 Pieces)	Linear	37 50.5139	75 13.5527	NA	Two linear objects protruding from sea floor	A4	B1L14(01)	No Association
A5	B1L15(17)	No Association	4.5ft x 4.5ft x 2ft	Circular	37 51.0286	75 12.8350	NA	Debris	A5	B1L15(17)	No Association
A6	B1L17(00)	No Association	3ft x 2ft x 1 ft	Oblong	37 50.4863	75 13.5659	NA	Debris	A6	B1L17(00)	No Association
A7	B1L19(05)	No Association	16ft x .5ft x 1.5 ft	Linear	37 50.7925	75 13.047	NA	Pipe Fragment	A7	B1L19(05)	No Association
A8	B1L23(04)	No Association	14.5ft x .5ft x 2ft	Linear	37 50.6855	75 13.1465	NA	Pipe Fragment	A8	B1L23(04)	No Association
A9	B1L44(20)	No Association	2.5ft x 2.5ft x 1 ft	Circular	37 50.6199	75 12.9780	NA	Possible Tire	A9	B1L44(20)	No Association
A10	B1L50(19)	No Association	9ft x 9ft x 2ft	Circular	37 50.610	75 12.8110	NA	Encrusted Ring	A10	B1L50(19)	No Association
A11	B1L59(50)	No Association	1ft x 1ft x 2ft	Linear	37 51.8257	75 10.9561	NA	Linear object protruding from sea floor	A11	B1L59(50)	No Association
A12	B1L59(69)	No Association	13ft x .6ft x 3ft	Linear	37 50.5486	75 12.8687	NA	Linear object protruding from sea floor	A12	B1L59(69)	No Association

Anomaly Number	Block/ Line	Magnetic Association	Dimensions L x W x H (Ft)	Shape	Latitude NAD 83 Coordinates (in decimal degrees)	Longitude NAD 83 Coordinates (in decimal degrees)	Minimum Avoidance Distance (Ft)	Identification	Anomaly Number	Block/ Line	Magnetic Association
A13	B1L59(153)	No Association	.5ft x .5ft x 2ft	Linear	37 51.4231	75 11.6128	NA	Linear object protruding from sea floor	A13	B1L59(153)	No Association
A14	B1L60(05)	No Association	11.2ft x 2ft x 1.5 ft	Linear	37 50.4917	75 12.8325	NA	Linear object on sea floor	A14	B1L60(05)	No Association
A15	B1L61(13)	No Association	6.1ft x 6ft x 1 ft	Circular	37 50.9885	75 12.1519	NA	Encrusted Debris	A15	B1L61(13)	No Association
A16	B1L78(11)	No Association	20.5ft x 6ft x 3ft	Amorphous	37 50.9822	75 11.8848	NA	Debris	A16	B1L78(11)	No Association
A17	B1L78(15)	No Association	17.1ft x 3ft x 1 ft	Amorphous	37 50.7378	75 12.2568	NA	Debris	A17	B1L78(15)	No Association
A18	B1L75(48)	No Association	10ft x .5ft x 2ft	Linear	37 51.5405	75 11.0098	NA	Linear object protruding from sea floor	A18	B1L75(48)	No Association
A19	B2L4(04)	No Association	13.5ft x 13ft x 2ft	Amorphous	37 52.5942	75 06.6265	NA	Clam Dredge	A19	B2L4(04)	No Association
A20	B2L6(14)	No Association	6ft x 6ft x 1 ft	Circular	37 52.1309	75 07.5112	NA	Encrusted Debris	A20	B2L6(14)	No Association
A21	B2L12(040	No Association	25ft x 1.5ft x 1ft	Linear	37 52.6790	75 06.4004	NA	Possible Cable Section	A21	B2L12(040	No Association
A22	B2A22	No Association	15ft x 13ft x 2ft	Amorphous	37 52.0923	75 07.4873	NA	Possible Clam Dredge	A22	B2A22	No Association
A23	B2L36(20)	No Association	4ft x 1ft x 1ft	Linear	37 51.6208	75 07.9707	NA	Debris	A23	B2L36(20)	No Association
A24	B2L39(00)	No Association	9ft x 6ft x 2ft	Amorphous	37 52.6882	75 05.8325	NA	Debris	A24	B2L39(00)	No Association
A25	B2L40(01)	No Association	2.33ft x 1ft x 2ft	Linear	37 52.7129	75 05.7803	NA	Debris	A25	B2L40(01)	No Association
A26	B2L49(06)	No Association	1.67ft x .5ft x 1.5ft	Linear	37 52.4089	75 06.3760	NA	Debris	A26	B2L49(06)	No Association

Anomaly Number	Block/ Line	Magnetic Association	Dimensions L x W x H (Ft)	Shape	Latitude NAD 83 Coordinates (in decimal degrees)	Longitude NAD 83 Coordinates (in decimal degrees)	Minimum Avoidance Distance (Ft)	Identification	Anomaly Number	Block/ Line	Magnetic Association
A27	B2L42(02)	No Association	2.33ft x 1ft x 2ft	Linear	37 52.6582	75 05.8438	NA	Debris	A27	B2L42(02)	No Association
A28	B2L44(03)	No Association	2.6ft x 1ft x 2ft	Linear	37 52.5747	75 05.9619	NA	Debris	A28	B2L44(03)	No Association
A29	B2L45(18)	No Association	87ft x 27ft x 2ft	Amorphous	37 52.4946	75 06.0278	NA	Biological	A29	B2L45(18)	No Association
A30	L46	No Association		Amorphous	37 52.0310	75 06.5884	NA	Debris	A30	L46	No Association

Table 6-3. Identified Targets within the WFF Offshore Sand Borrow Survey Project

Target No.	Magnetic Anomalies Associated with Each Target	Associated Acoustic Anomalies
T1	M23, M24	N/A
T2	M7, M10, M13, M15	N/A
T3	M20, M21	N/A
T4	M11, M14	N/A
T5	M8, M9	N/A

6.2.1 Block One Target Descriptions

Each target cluster is comprised of associated acoustic or magnetic anomalies, or combinations of both. These data were grouped based on proximity, spatial patterning, and magnetic signature, amplitude, or duration. Each target was assigned the prefix T to aid in plotting and differentiation.

6.2.1.1 Target 1

Target 1 is comprised of magnetic perturbations M23 and M24. Anomaly M23 is a dipolar anomaly with a low amplitude of 20 nT, a long duration of 70.1 meters (230 feet), and a calculated ferrous mass of approximately 53.5 kilograms (118 pounds) with the height of sensor at 5.5 meters (18 feet) off the bottom (Tables 6-1 and 6-3, Figure 6-1). Anomaly M24 is a dipolar anomaly with a medium amplitude of 57nT, a medium duration of 44.8 meters (147 feet), and an estimated ferrous mass calculated to be 215 kilograms (474 pounds) with the height of sensor at 6.1 meters (20 feet) off the bottom. The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-2).

Analysis indicates that this anomaly consists of a single large ferrous mass with material extending onto an adjoining survey line. It likely represents lost trawling equipment or other ground tackle. Target One is located on a bathymetric rise where trawlers run parallel to the long axis of the sand feature. It is common for fishermen to lose, or “hang”, trawling equipment if they are unaware of abruptly changing bathymetry and moving too fast.

Acoustic data recorded in the vicinity of Target 1 does not reveal any anomalous acoustic images. The lack of side scan sonar correlates and the simple magnetic signatures of the anomalies indicate that Target 1 is likely buried ferrous debris associated with lost commercial fishing gear or ground tackle. No avoidance or further work is recommended for Target 1.

6.2.1.2 Target 2

Target 2 is composed of magnetic perturbations M7, M10, M13, and M15 (Tables 6-1 and 6-3, Figure 6-1). Anomaly M7 is a dipole with a medium duration of 47.5 meters (156 feet), a low amplitude of 14 nT, and an calculated ferrous mass of 11.3 kilograms (25 pounds). Anomaly M10 is a dipolar anomaly with a low amplitude of 4 nT, a long duration of 246.3 meters (808 feet), and a calculated ferrous mass of 0.9 kilograms (2.1 pounds). Anomaly M 13 is a dipole with a low amplitude of 3 nT, a long duration of 220 meters (722 feet), and a calculated ferrous mass of 12.7 kilograms (28 pounds). Anomaly M 15 is a dipole with a long duration of 101.5

meters (333 feet), a low amplitude of 4 nT, and a calculated ferrous mass of 15.4 kilograms (34 pounds). The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-3). The dipolar signature of all perturbations indicates that the magnetic sensor passed directly over or just next to the detected ferrous mass. Magnetic analysis indicates that Target 2 is a simple isolated ferrous object, such as a section of wire rope or cable that has drifted along the margin of the sand rise in Block One. Sudden changes in the aspect ratio of the magnetic sensor to the seafloor (i.e. depth changes), will create a low amplitude deflection along the region of bathymetric change in areas that are magnetically inert. The acoustic data recorded in the vicinity of Target 2 shows a featureless surface adjacent to a drop off of the sand ridge. Target 2 does not represent a significant submerged cultural resource and no further avoidance or work is recommended.

6.2.1.3 Target 3

Target 3 is comprised of magnetic anomalies M20 and M21 (Tables 6-1 and 6-3, Figure 6-1). Anomaly M20 is a dipolar anomaly with a low amplitude deflection of 6 nT, a medium duration of 37.8 meters (124 feet), and a calculated ferrous mass of 10 kilograms (22 pounds). Anomaly M21 is a dipole with a low amplitude deflection of 6 nT, a medium duration of 33.5 meters (110 feet), and a calculated ferrous mass of 9.5 kilograms (21 pounds). The data were reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-4). The magnetic analysis of this Target 3 indicates that it is a simple dipolar anomaly that lacks the complexities associated with submerged cultural resources. This target, much like Target 2, is probably a section of wire rope or chain lost or discarded by fishing vessels. It could also represent sudden changes in the aspect ratio between the magnetic sensor and the seafloor. Acoustic data recorded in this vicinity does not show any anomalous surface features. Target 3 is clearly not associated with any significant cultural resource; no further work is recommended.

6.2.1.4 Target 4

Target 4 consists of magnetic anomalies M11 and M14 (Tables 6-1 and 6-3, Figure 6-1). Anomaly M11 is a dipolar perturbation with a low amplitude deflection of 17 nT, a medium duration of 58.8 meters (139 feet), and a calculated ferrous mass of 26.8 kilograms (59 pounds). Anomaly M14 is a dipolar anomaly that has a low magnetic deflection of 4 nT, a long duration of 94.8 meters (311 feet), and a calculated ferrous mass of 14.4 kilograms (31 pounds). The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-5). Acoustic data recorded in this area shows a seafloor covered in shallow sand waves and deep trawl scarring. Analysis of this target indicates that it has a simple magnetic pattern indicative of a lost modern anchor and chain, and not a significant cultural resource. No further avoidance or work is recommended for Target 4.

6.2.1.5 Target 5

Target 5 consists of magnetic anomalies M8 and M9 (Tables 6-1 and 6-3, Figure 6-1). Anomaly M8 is a dipolar perturbation with a low magnetic deflection of 4 nT, a medium duration of 53.9 meters (177 feet), and a calculated ferrous mass of 3.6 kilograms (8 pounds). Anomaly M 9 is also a simple dipolar anomaly with a low magnetic deflection of 5 nT, a long duration of 30.5 meters (100 feet), and a calculated ferrous mass of 3.6 kilograms (8 pounds). Data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-6). Side Scan Sonar did not record any anomalous surface features in this area other than low amplitude sand waves. Analysis of Target 5 indicates that anomalies M8 and M9 likely represent isolated ferrous material lost or jettisoned from sport or commercial fishing vessels. Target 5 lacks the characteristics of a sunken ship or other significant submerged cultural resource. No further avoidance or work is recommended for Target 5.

6.2.1.6 Sub Bottom Profiler

Sub bottom data recorded in Block One did not reveal any buried cultural resources. Transect 1 (B1L01) shows approximately 20- t (6.1 m) of penetration with minor bedded sands and no other structure (Figure 6-7). Transects 20 and 40 also depict comparably bedded sands with no other structure (Figures 6-8 and 6-9). No structures or geomorphic features likely to be associated with buried maritime cultural resources or prehistoric habitation or activity sites were recorded in Block One.

6.3 BLOCK TWO

Block Two is located 3.6 kilometers (2.25 miles) to the northeast of Block One, and measures approximately 4,055 meters (13,300 feet) by 1,220 meters (4,000 feet), or 1,221.4 acres. It was divided into 84 transect lines spaced at 15.2 meter (50 foot) intervals, which yields 318,339.5 linear survey meters (1,044,421 feet), or 318.3 linear survey kilometers (197.8 miles). (Figures 1-2 and 5-2). Block Two contained 12 side scan sonar anomalies and four magnetic anomalies, which account for 14.3 percent of the total magnetic perturbations and 35.7 percent of the total acoustic anomalies (Tables 6-1 and 6-2, Figure 6-10). No target clusters were identified from the anomalies in Block 2.

Acoustic and magnetic anomalies recorded in Block Two represent debris jettisoned from passing vessels or deposited by storm events. Objects include possible tires, logs, wire rope, chain, and pipe sections. Acoustic anomalies A19 and A22 in Block Two are thought to be the remains of clam dredges that have been snagged and pulled apart (Table 6-2). These clam dredges appear modern in design, and given the amount of clam draggers operation in the local area (Plate 6-1), it is not surprising that there are remains of both clam and crab trawls lost on these submerged sand platforms.

6.3.2 Sub Bottom Profiler

Sub Bottom Profiler data from Block Two was similar to Block One. Approximately 4.6 meters (15 feet) of penetration was achieved with comparable resolution. A good example of this is seen on Line B2L02, where penetration reaches approximately 4.6 meters (15 feet) into sediments. The acoustic signal is attenuated after this depth, and only AC interference and surface reflections (duplet) are recorded (Figure 6-11). No structures or geomorphic features likely to be associated with buried maritime cultural resources or prehistoric habitation or activity sites were recorded in Block Two.

6.4 DISCUSSION

The magnetic and acoustic anomaly distribution numbers in Blocks One and Two are heavily skewed toward Block One (85.7 percent of the total magnetic perturbations, and 64.3 percent of the total acoustic anomalies). The proximity of Blackfish Bank to Block One may indicate that some anomalies represent loss or trash originally discarded on or near that submerged landform and the heavily fished artificial reef that was created there. These objects would have then slowly migrated and hung up on the sand shoals of Block One and later Block Two. This theory is supported by the fact that there are far fewer anomalies in Block Two, which lies over two mi (3.2 km) from Block One. The greater the distance from the more commonly trafficked and fished banks, the lower the number of recorded ferrous materials and acoustic anomalies.

Sub bottom profiler data indicated that subsurface sediment patterns varied little between Blocks One and Two. Weak bedding within sediments in these areas is indicative of a homogenous sediment package created by preferential grain sorting that resulted from normal currents and wave action, and more dramatic storm events. This homogeneity, as stated in Section Four, has resulted from preferential grain sorting that has taken place since the most recent sea level rise. This sorting has reduced to almost nothing the potential for these sand features have to contain intact maritime cultural resources and prehistoric features.

7.0 SUMMARY AND RECOMMENDATIONS

This chapter offers recommendations for the cultural resources survey of two proposed sand borrow sites, Unnamed Shoal A and Unnamed Shoal B, located northeast of Chincoteague Inlet in the vicinity of Blackfish Bank in U.S. waters (Figures 1-1 and 1-2). This survey was undertaken as a part of the proposed NASA WFF SRIPP, Wallops Island, Virginia.

Comprehensive analysis of survey data was conducted using criteria that included magnetic complexity, amplitude, duration, and contouring, along with the spatial patterning of all anomalies. Analysis included review of all side scan sonar and sub bottom profiler data to identify any structures or geomorphic features associated with submerged historic cultural materials and prehistoric habitation or activity sites.

A total of 28 magnetic anomalies (Table 6-1) and 30 acoustic anomalies (Table 6-2) were recorded during the survey of Block One (Unnamed Shoal A) and Block Two (Unnamed Shoal B). Block One contained 18 side scan sonar anomalies and 24 magnetic anomalies, which yielded five target clusters for further analysis (Tables 6-1, 6-2, and 6-3, Figure 6-1). Block Two contained 12 side scan sonar anomalies, four magnetic anomalies, and no target clusters (Tables 6-1 and 6-2, Figure 6-10). A total of 85.7 percent of the recorded magnetic anomalies were found in Block One, while only 14.3 percent were located within Block Two. The distribution of acoustic anomalies followed a similar pattern, in that 64.3 percent of acoustic anomalies were located in Block One, and the remaining 35.7 percent were found in Block Two (Figures 6-1 and 6-7).

Sub bottom profiler data analysis for Blocks One and Two indicated that these sand features have relatively poor bedding, which indicates that the sands are homogenous in nature. This sediment homogeneity has likely resulted from long term preferential grain size sorting by current, wave action, and large storm events.

Overall, the greatest the amount of material was detected in Block One, which is located closer to Blackfish Bank and the adjacent fish haven. The acoustic and magnetic signatures from the five targets and isolated anomalies are consistent with modern debris that originated from two sources. The first source was sport and commercial fishermen, who often lose anchors, chains, wire rope sections, trawls, and general flotsam in areas they frequent. The second source is barges, which have transported and dropped a variety of ferrous debris intended as structure for fish haven locations near Blackfish Bank (Figure 1-2). Data analysis, when coupled with the fishing that takes place on or near the survey areas, indicated that none of the detected anomalies have potential to represent significant submerged cultural resources. No further avoidance or work is recommended for the isolated anomalies or five target clusters identified in Blocks One and Two.

7.1 UNANTICIPATED DISCOVERY

While it is unlikely that any cultural material will be discovered during dredging operations, an unanticipated discovery of archaeological resources would result in the immediate cessation of operations within 1,000 feet of the area of the discovery. NASA is then required to report said discovery to the Regional Supervisor, Leasing and Environment, Gulf of Mexico Region within 72 hours of discovery. The Regional Supervisor would then inform NASA as to how to proceed.

7.1.1 MMS Project Review

AS part of the MMS review of the proposed offshore sand borrows, all of the required data was provided to MMS for review as promulgated in NTL No. 2005-G07. Two large digital geo-tifs were provided to the MMS reviewers and were not reproduced for this report due to the size of the high resolution acoustic images (100 gigabytes each). Since the MMS is a cooperating agency with NASA in regards to this project, MMS reviewed the draft report and has concurred with the findings of the report, and stated that archaeological mitigation is not required for this project (Dirk Herkhof [Meteorologist-MMS], Email to Joshua A. Bundick [Lead, Environmental Planning- NASA Wallops Flight Facility], December 15, 2009, 16:13).

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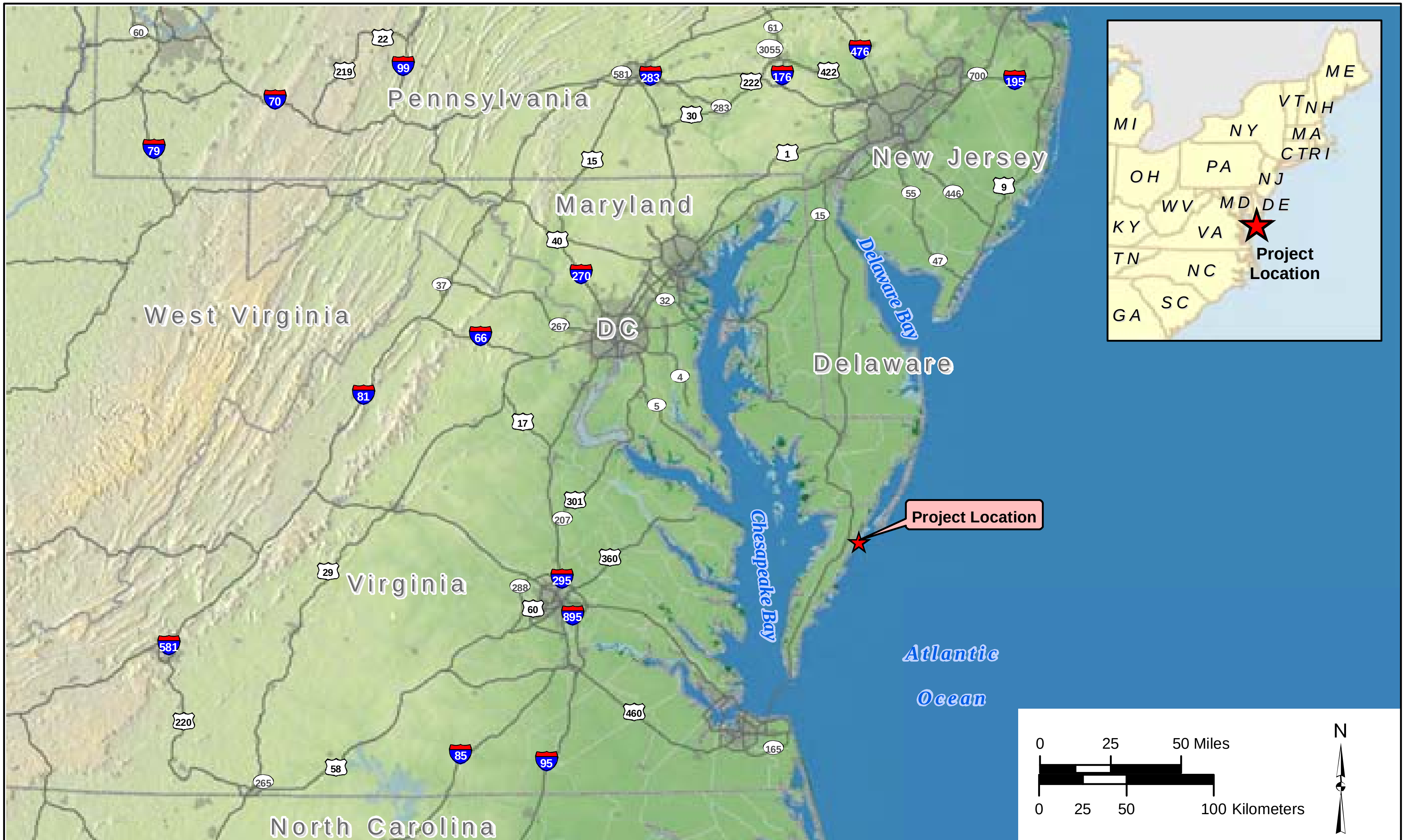
Addendum:

Report Figures and Plates



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SCALE	1 inch = 50 miles
SOURCE	ESRI, USGS

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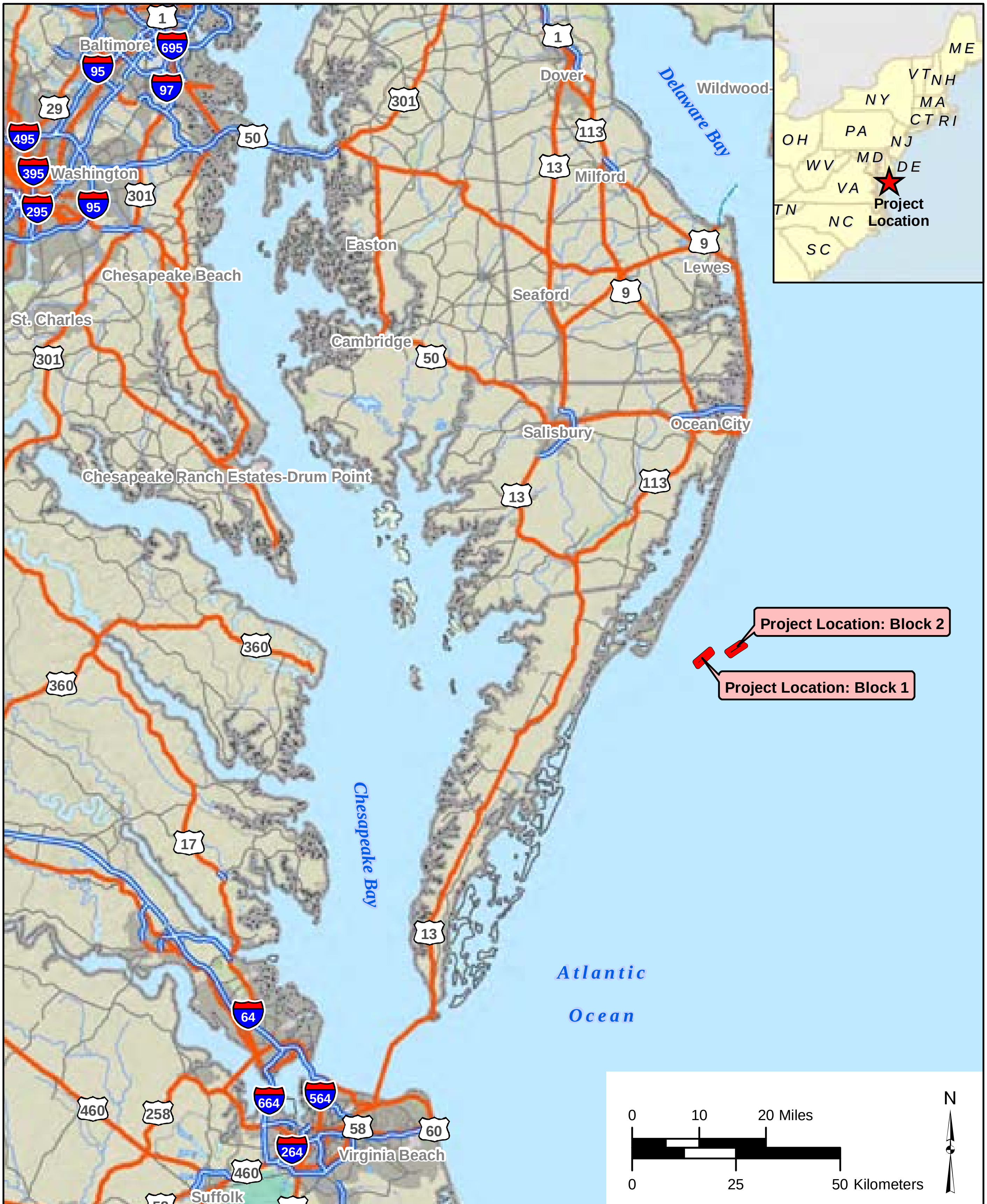
Project Location

PROJECT NO.	15299035
FIGURE NO.	1-1



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SOURCE	ESRI, USGS

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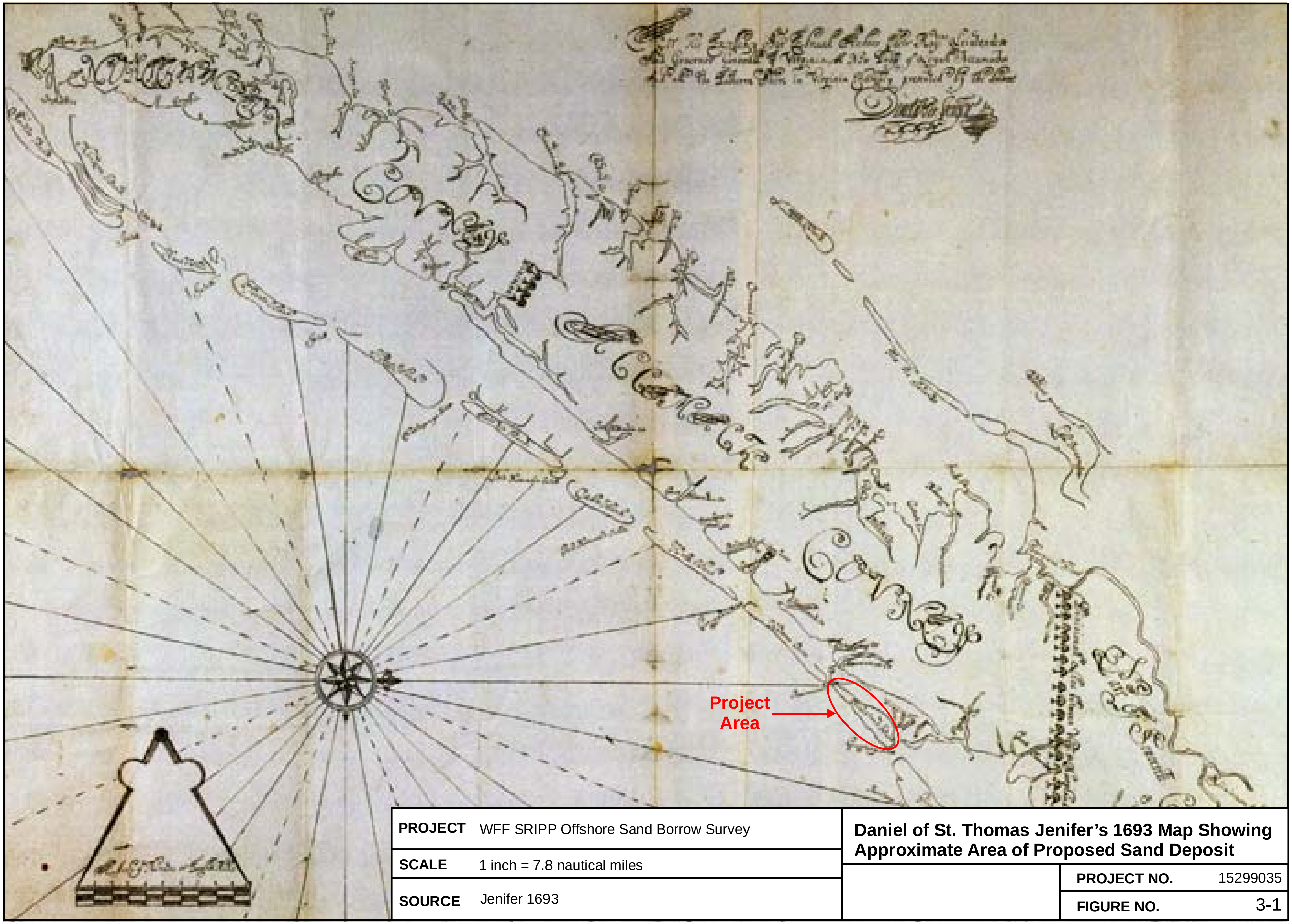
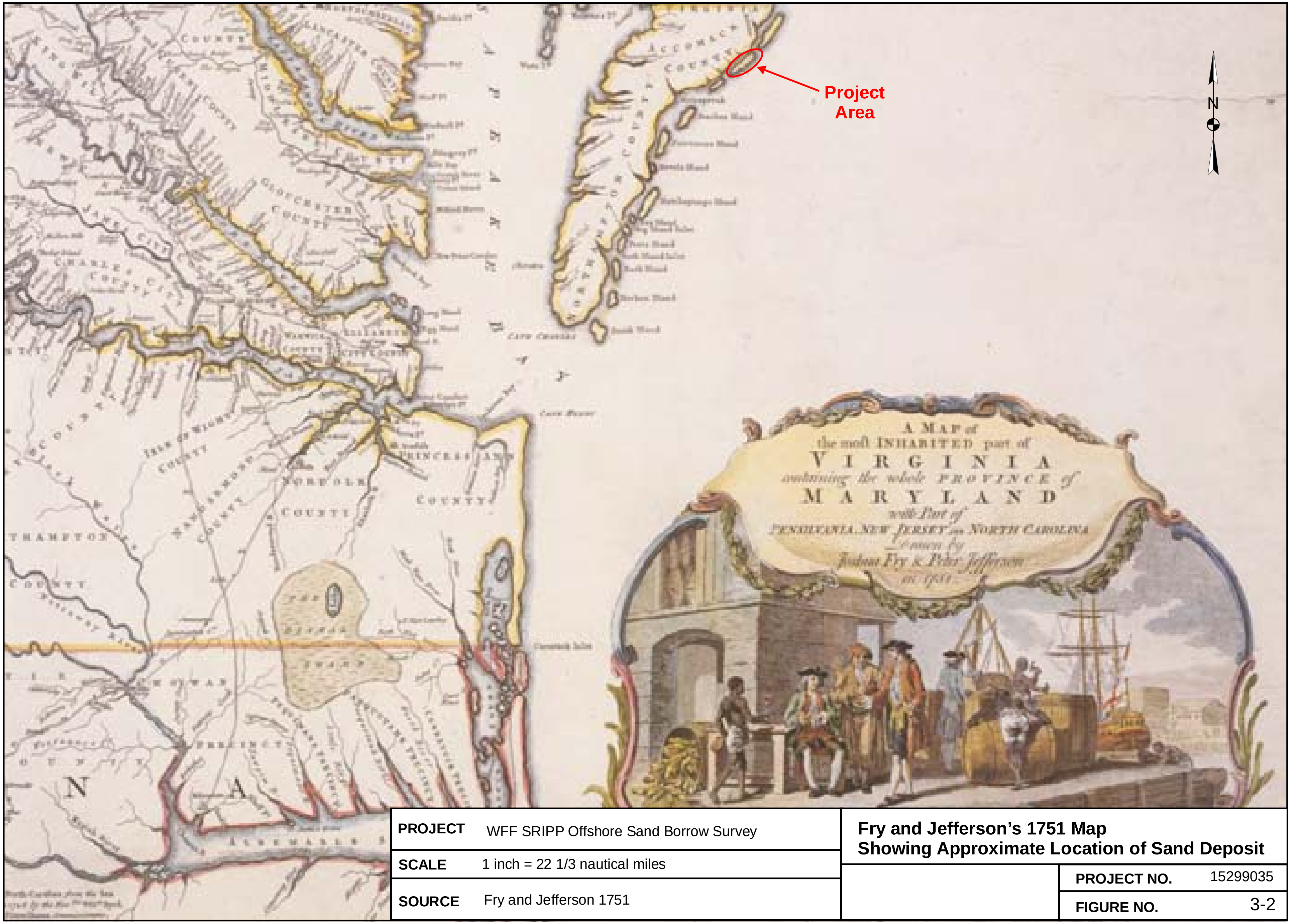
Location of Proposed Sand Borrow Areas in Chincoteague Inlet of Blackfish Bank in U.S. Federal Waters

PROJECT NO.	15299035
FIGURE NO.	1-2



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Daniel of St. Thomas Jenifer's 1693 Map Showing Approximate Area of Proposed Sand Deposit**
SCALE	1 inch = 7.8 nautical miles	PROJECT NO. 15299035
SOURCE	Jenifer 1693	FIGURE NO. 3-1



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 22 1/3 nautical miles
SOURCE	Fry and Jefferson 1751

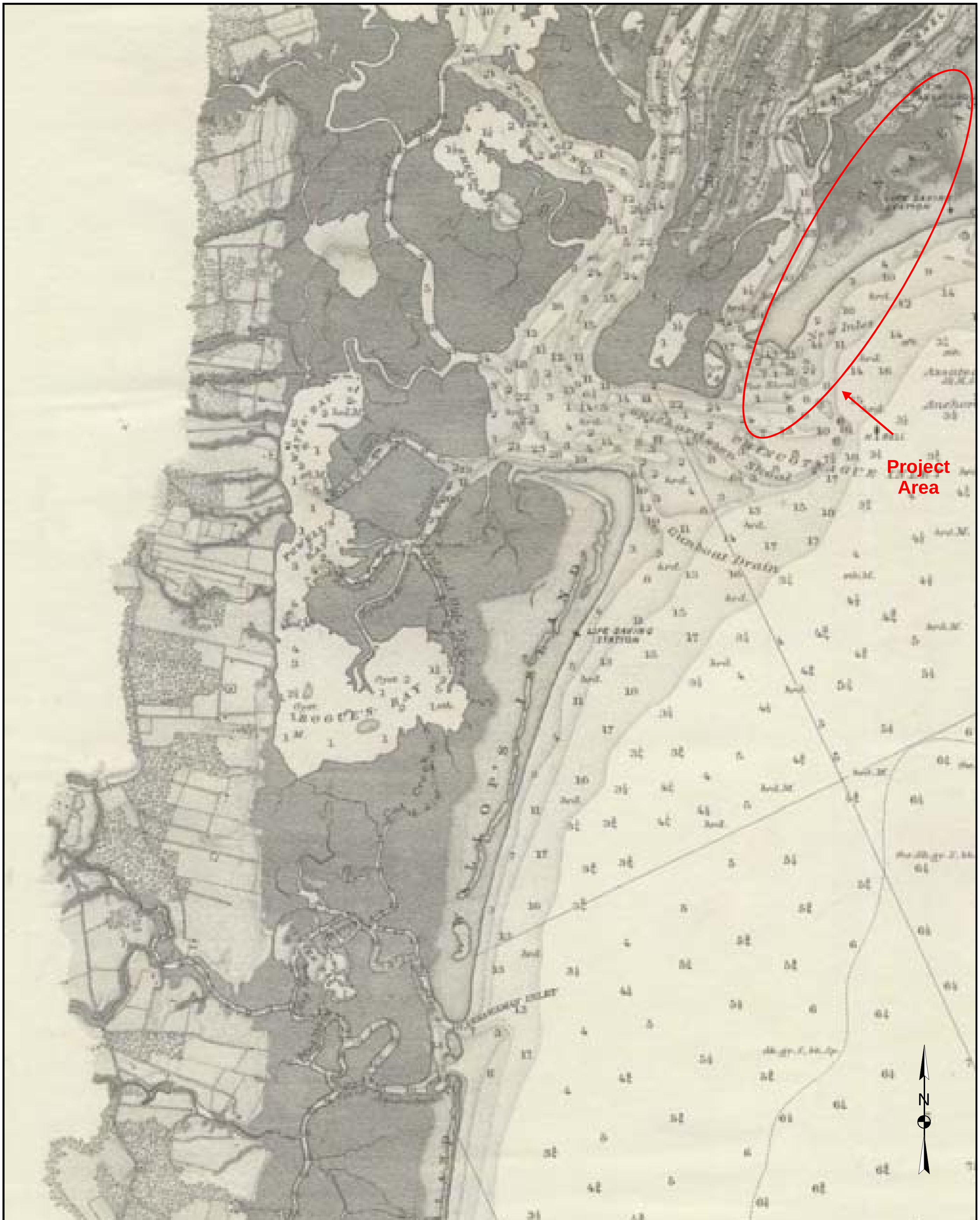
Fry and Jefferson's 1751 Map Showing Approximate Location of Sand Deposit

PROJECT NO.	15299035
FIGURE NO.	3-2

PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 20 nautical miles
SOURCE	Madison 1807

Madison's 1807 Map of Virginia Showing Approximate Location of Proposed Sand Deposit

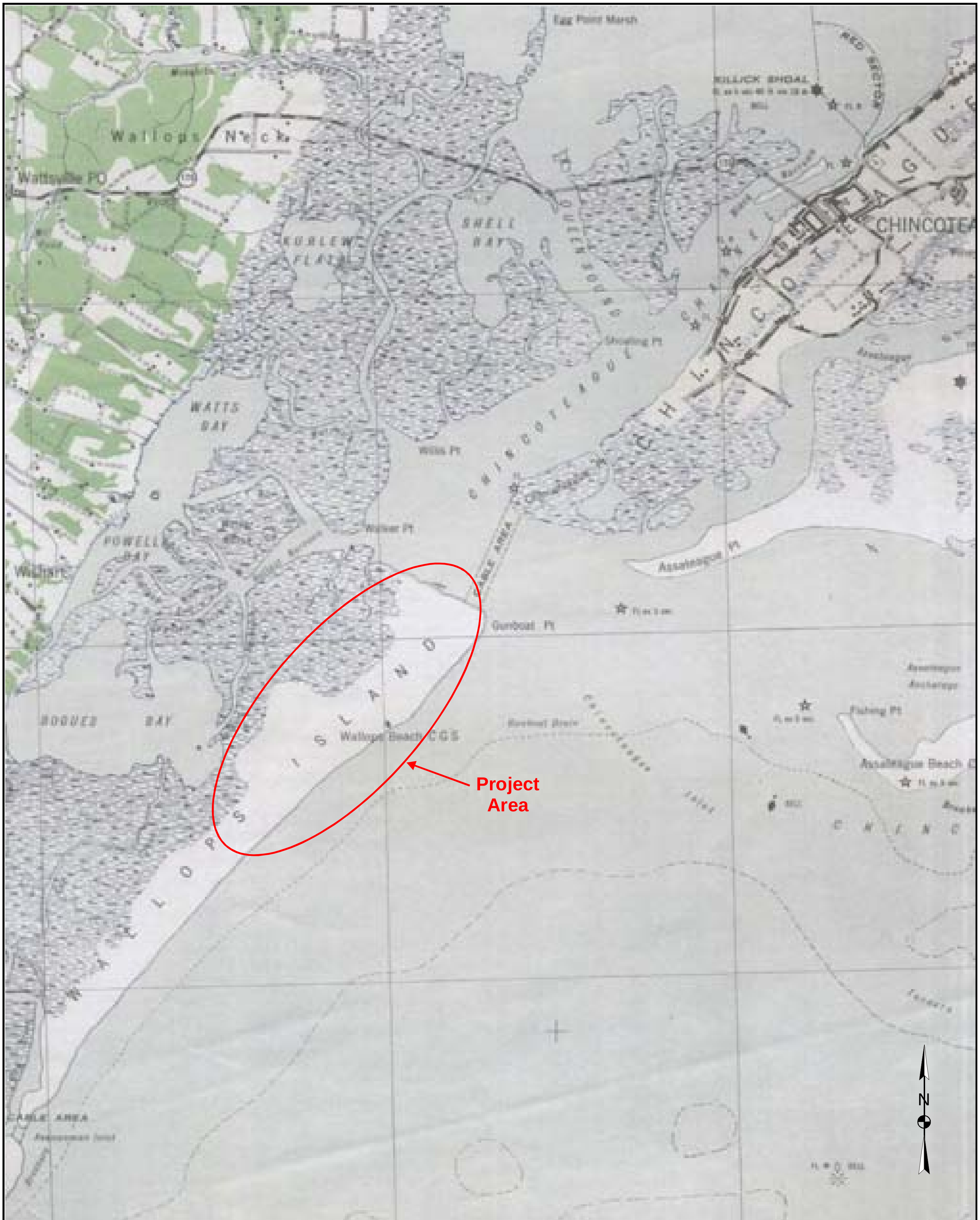
PROJECT NO.	15299035
FIGURE NO.	3-3



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	3.5 inches = 5 nautical miles (1 to 80,000)
SOURCE	USC&GS Coast Chart No.129, 1892

US Coast and Geodetic Survey 1892 Map Showing Area of Proposed Sand Deposit

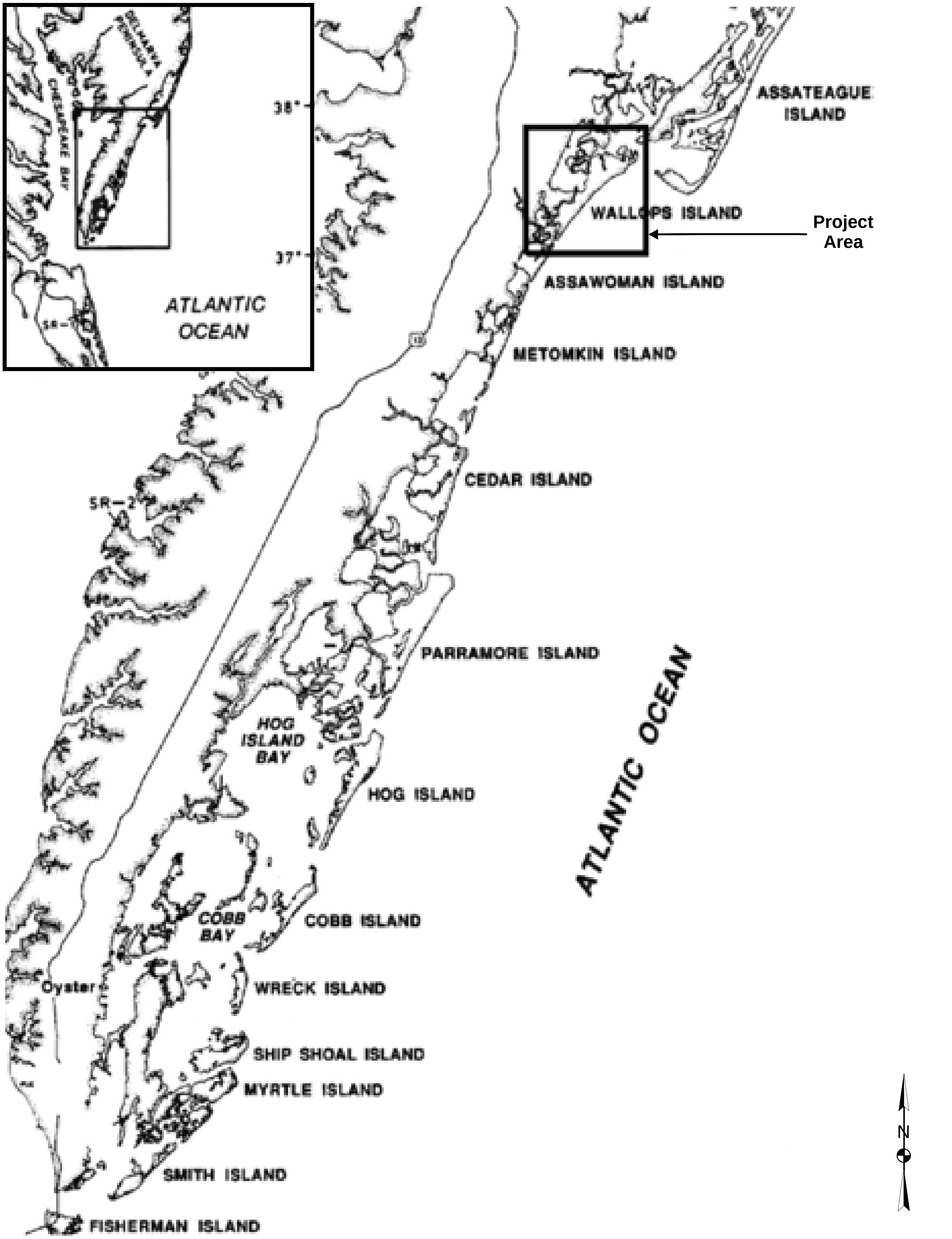
PROJECT NO.	15299035
FIGURE NO.	3-4



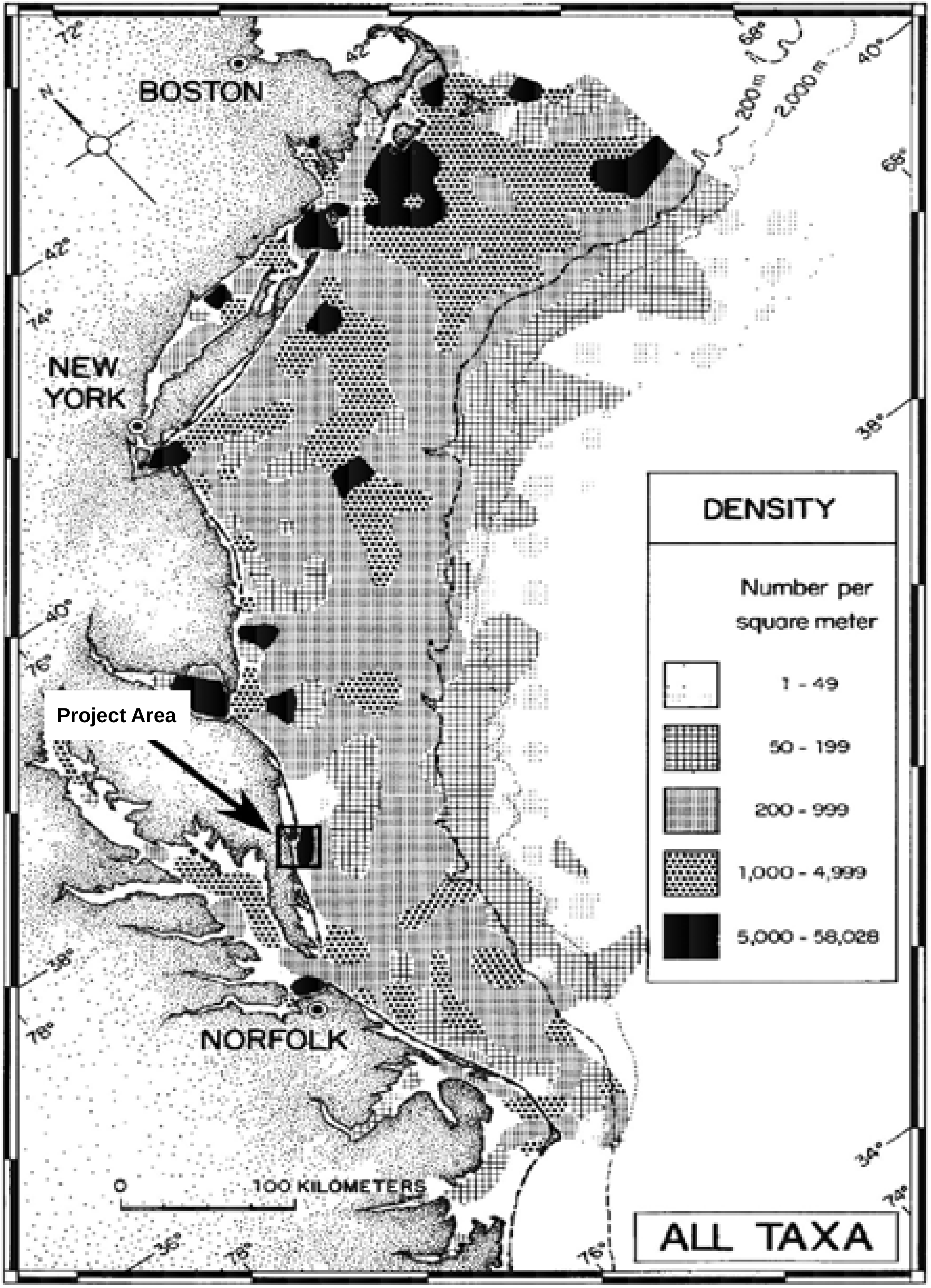
PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1 mile
SOURCE	USGS 15 Minute Series, 1937

USGS 1937 Map Showing Approximate Location of Proposed Sand Deposit

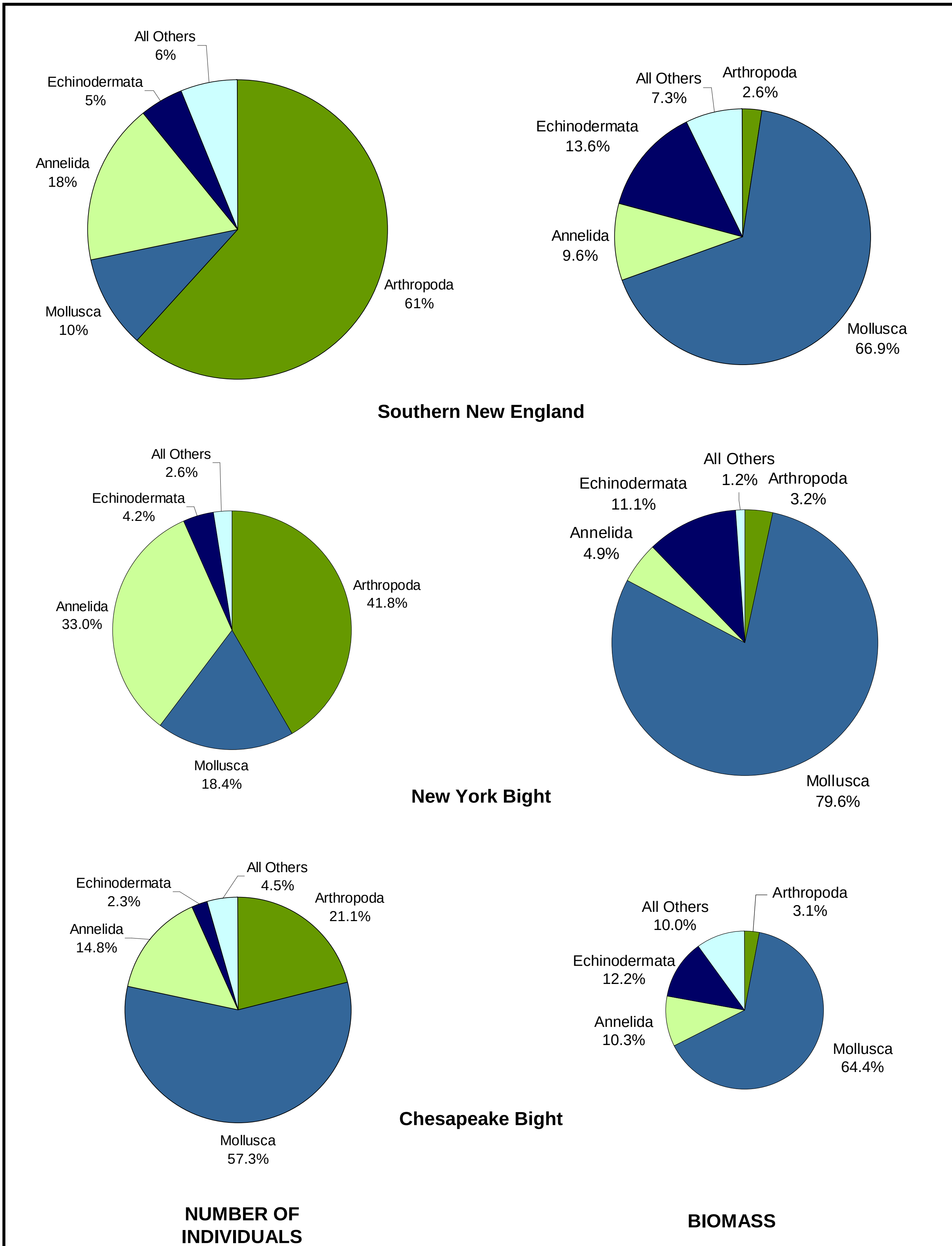
PROJECT NO.	15299035
FIGURE NO.	3-5



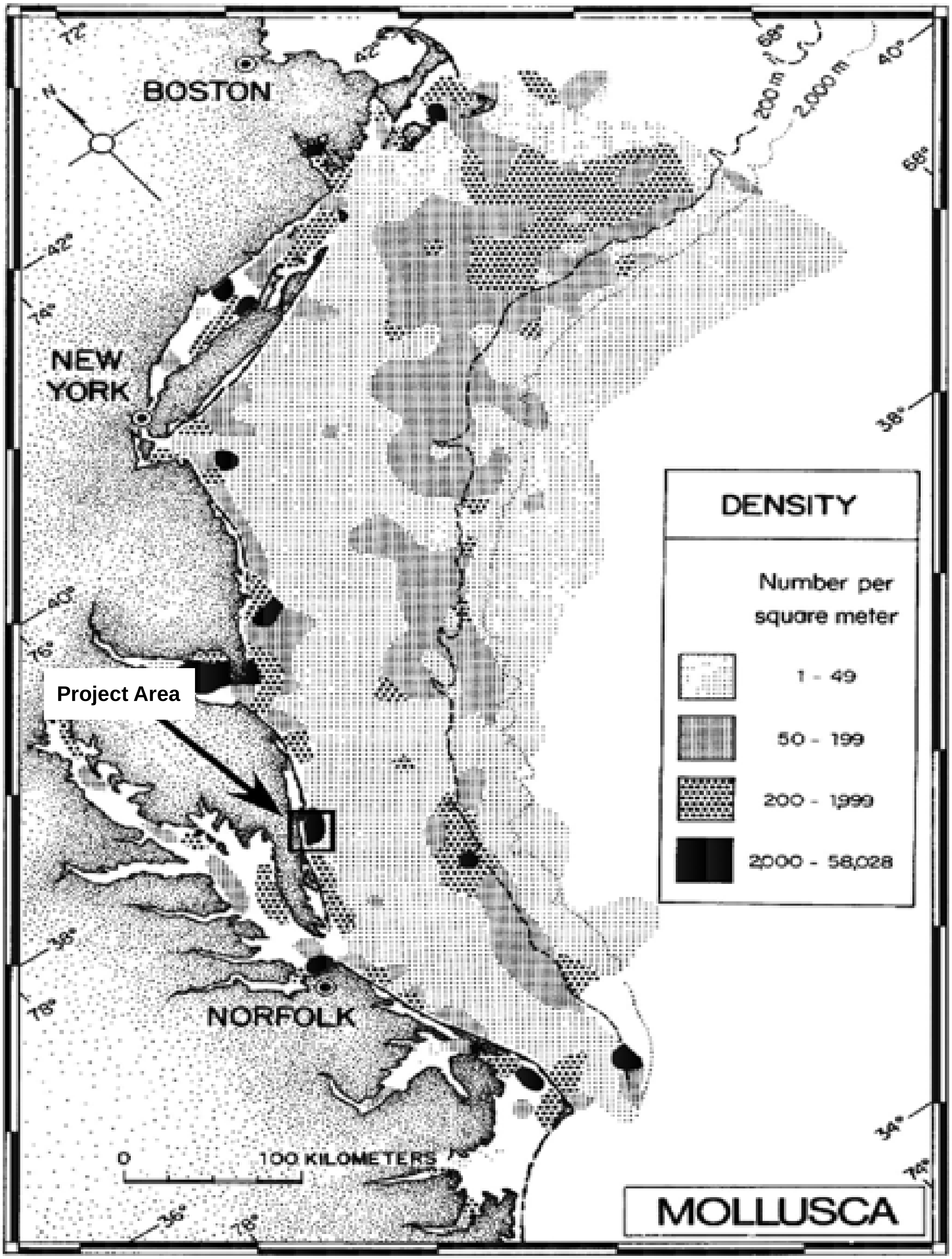
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Location Map of the Delmarva Peninsula Showing Study Area**	
SCALE	Unknown	PROJECT NO.	15299035
SOURCE	Oertel et al. 1989	FIGURE NO.	4-1



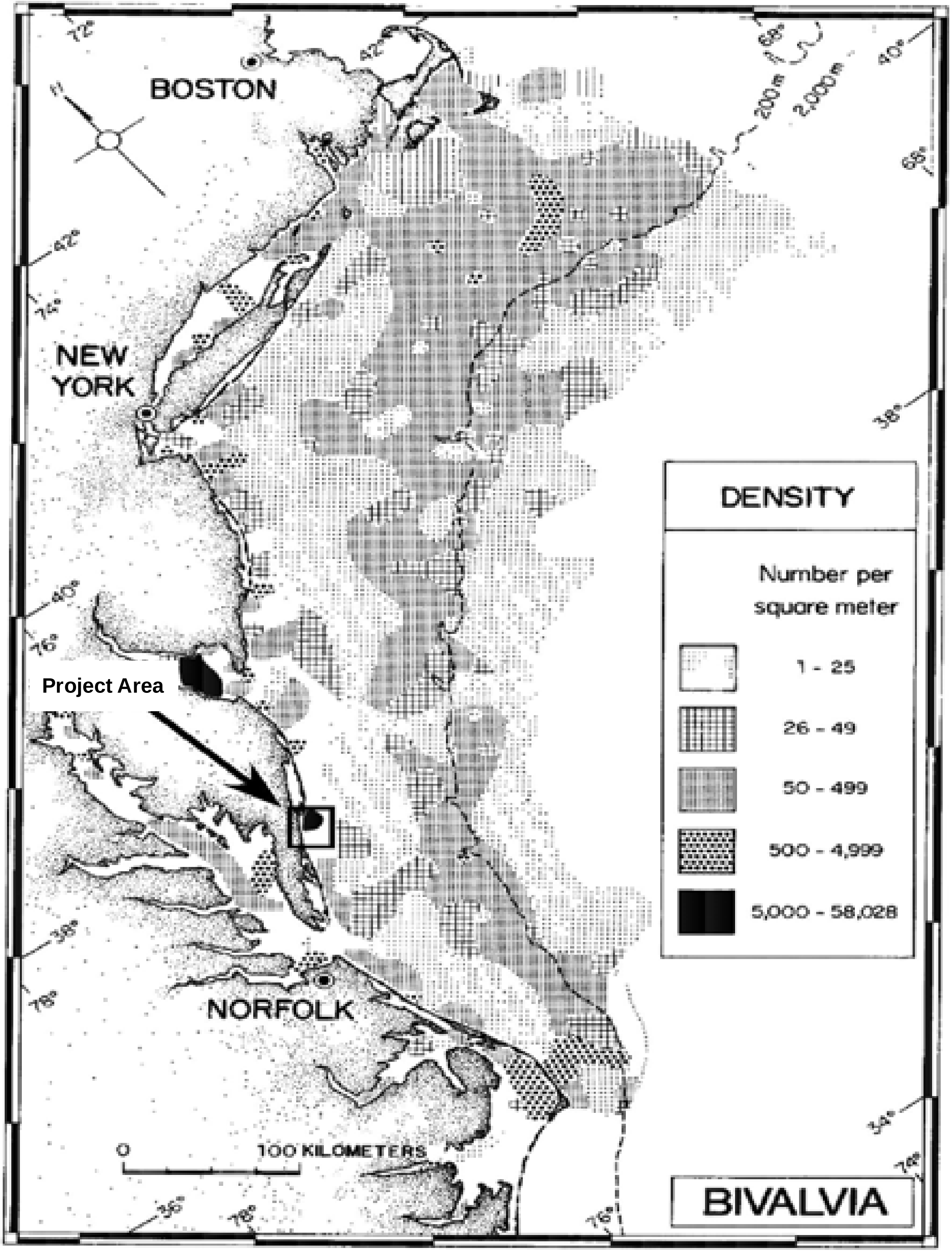
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Map of Density of Taxa in Mid-Atlantic Bight Bottom Sediments (Note High Density of Taxa in Project Area)**	
SCALE	1 inch = 52 miles (84 kilometers)	**PROJECT NO.**	15299035
SOURCE	Wigley and Theroux 1981	**FIGURE NO.**	4-2



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Diagram Showing Benthos Dominated by Mollusca in the Chesapeake Bight**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	Wigley and Theroux 1981	**FIGURE NO.**	4-3



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Map Showing Density of Mollusca in Bottom Sediments of the Mid-Atlantic Bight**	
SCALE	1 inch = 52 miles (84 kilometers)	**PROJECT NO.**	15299035
SOURCE	Wigley and Theroux 1981	**FIGURE NO.**	4-4

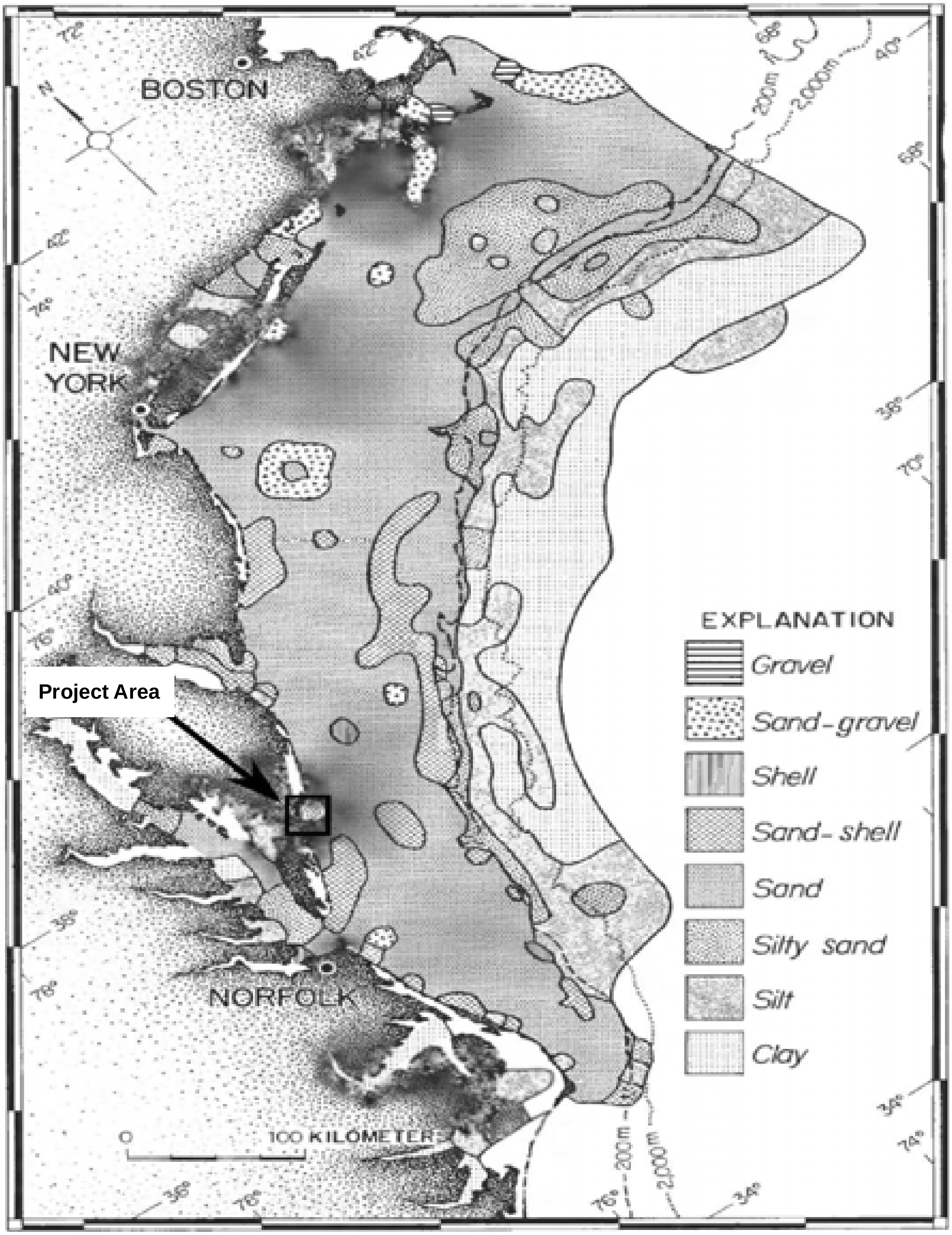


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 52 miles (84 kilometers)
SOURCE	Wigley and Theroux 1987

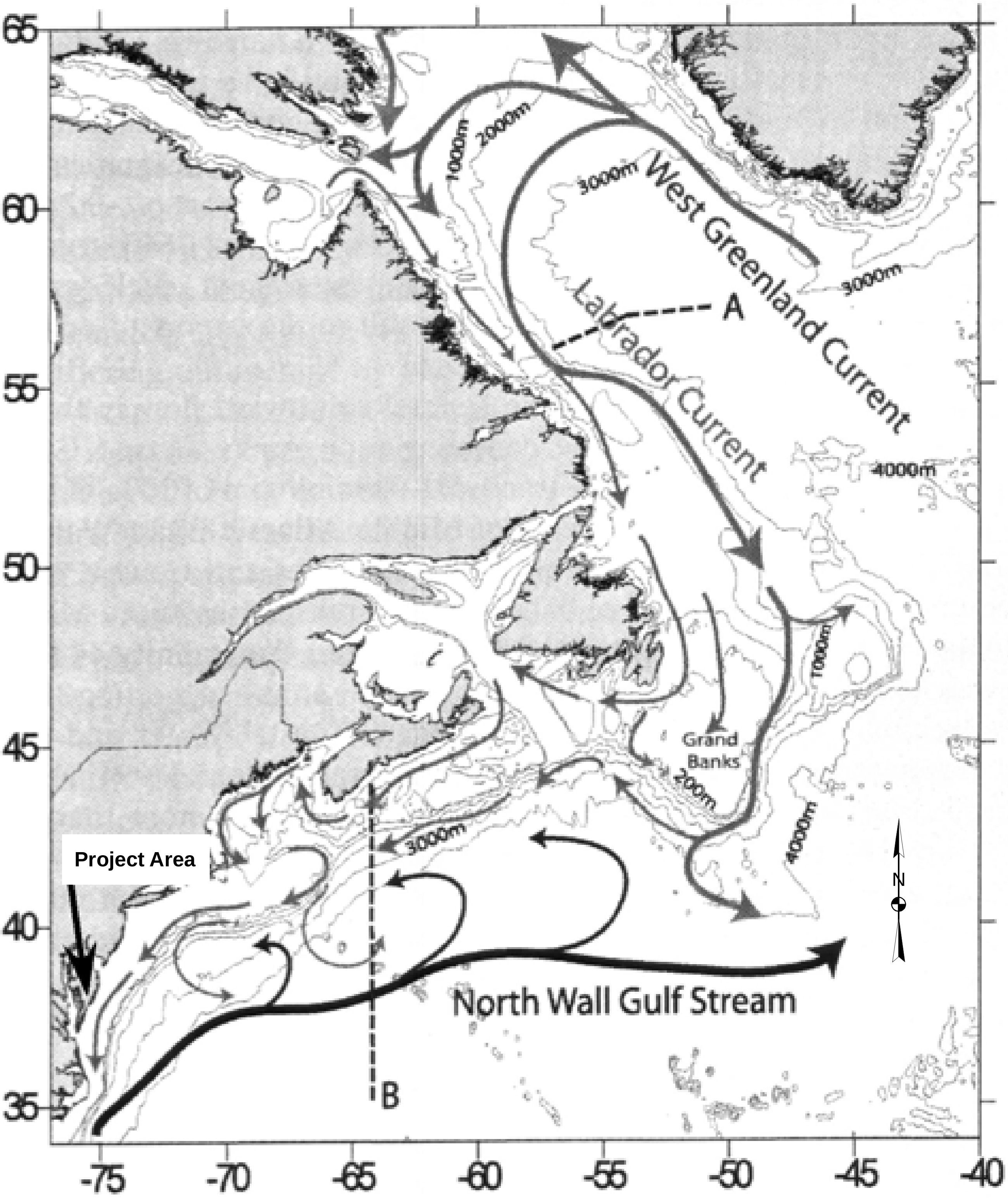
Map Showing Density of Bivalvia in Bottom Sediment of the Mid-Atlantic Bight

PROJECT NO. 15299035

FIGURE NO. 4-5



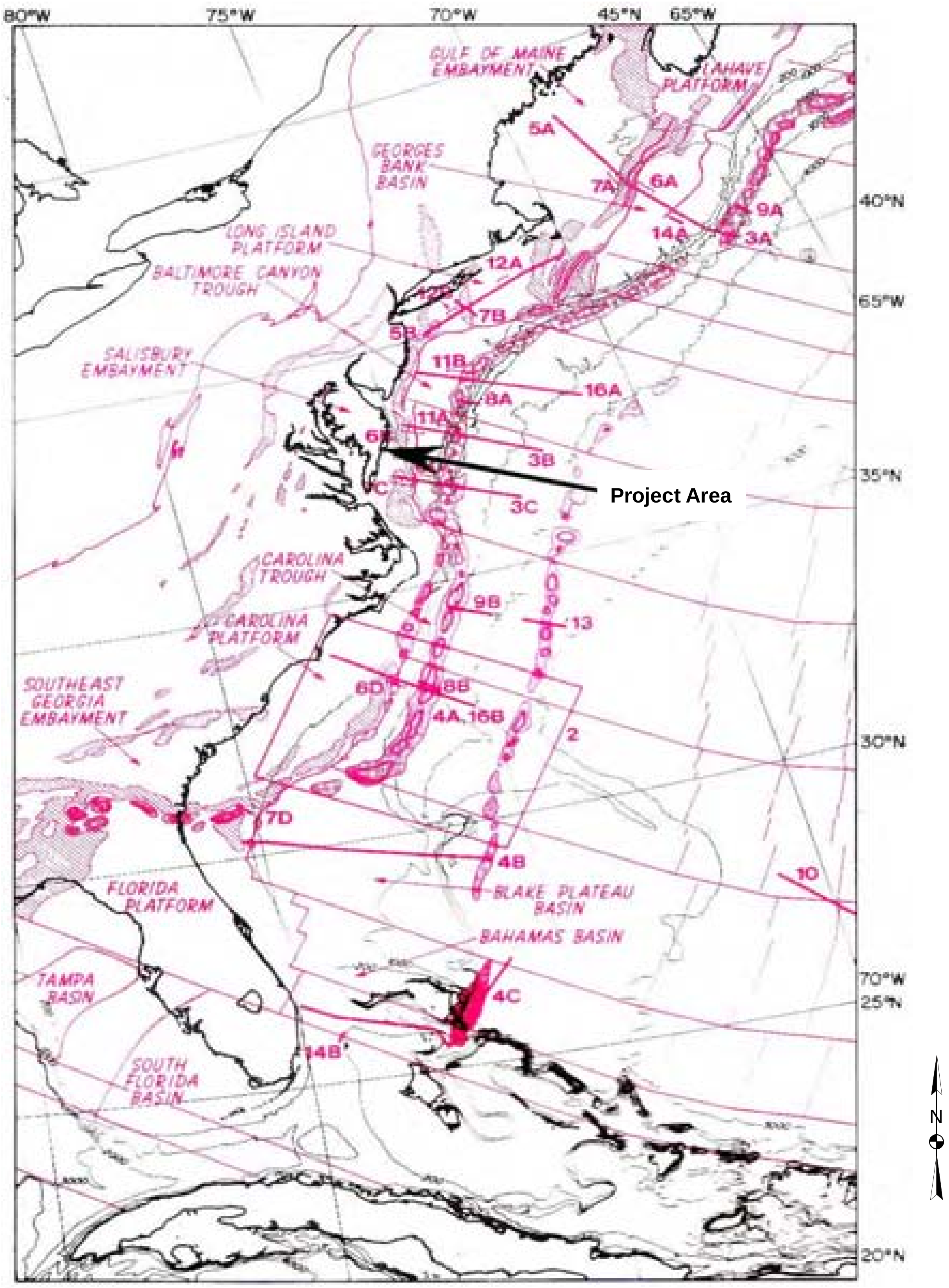
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Map of Bottom Sediment Types in the Mid-Atlantic Bight (Note Patch of Sand-shell Sediment in Project Area)**	
SCALE	1 inch = 52 miles (84 kilometers)	**PROJECT NO.**	15299035
SOURCE	Wigley and Theroux 1981	**FIGURE NO.**	4-6



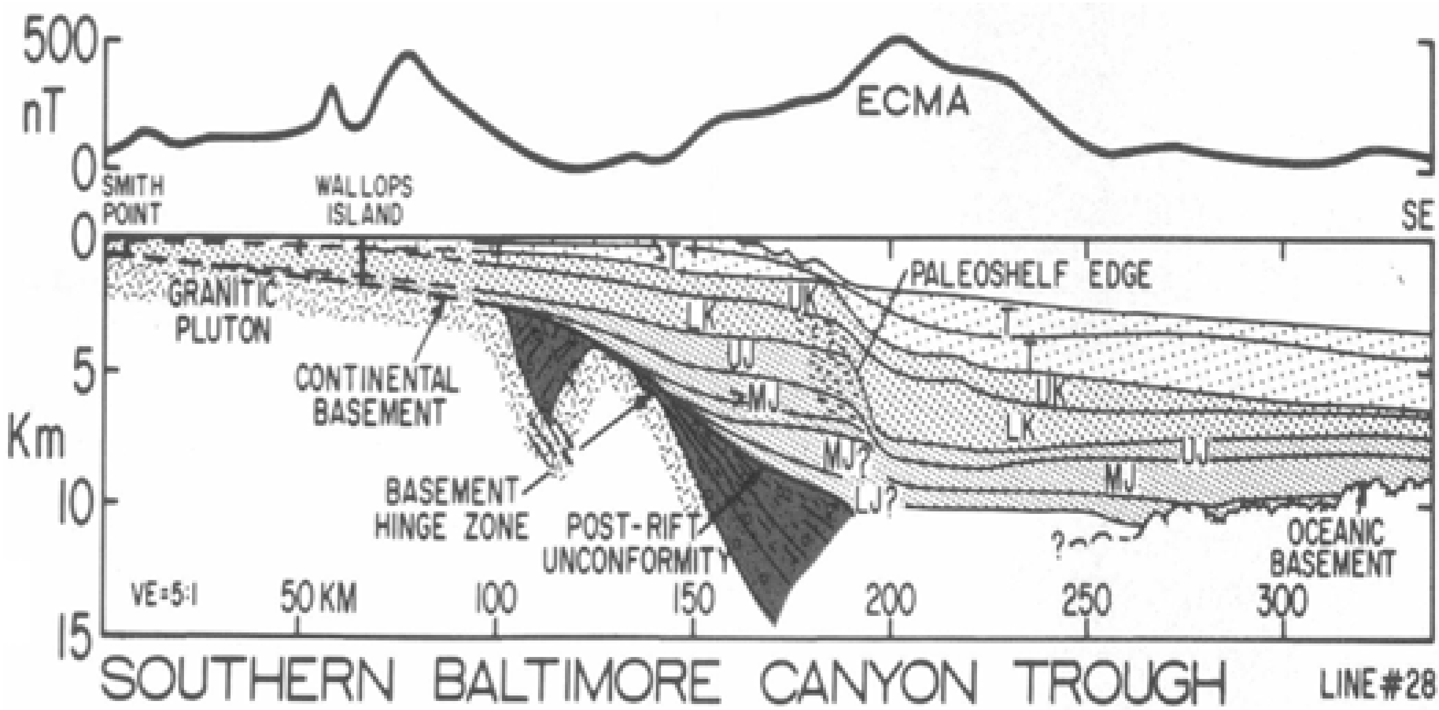
PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	N/A
SOURCE	After Townsend et al. 2006

Major Oceanographic Currents Influencing the Northwest Atlantic Ocean

PROJECT NO.	15299035
FIGURE NO.	4-7



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Major Structural Features of the US Atlantic Coast. Project Area Resides in Salisbury Embayment Underlain by the Baltimore Canyon Trough**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	Klitgord et al. 1988	**FIGURE NO.**	4-8



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Profile of the South Baltimore Canyon Trough Through Wallops Island Area**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	Klitgord et al. 1988	**FIGURE NO.**	4-9

<table>
<tr><th rowspan="2"></th><th colspan="4">Southern and Central Delmarva Peninsula
(Mixon 1985)</th><th colspan="2" rowspan="2">VA West of Chesapeake Bay
(Johnson and Berquist 1989)</th><th colspan="4" rowspan="2">Delmarva and Offshore
(Toscano and York 1992)</th><th rowspan="2">Offshore Virginia
(Shideler et al. 1972)</th></tr>
<tr><th>Eastern Maryland Part</th><th>Eastern Virginia Part</th><th colspan="2">Central and Western Parts
Virginia and Maryland</th></tr>
<tr><td>Holocene</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="4"></td><td>Unit D
Reflector 3</td></tr>
<tr><td rowspan="8">Pleistocene</td><td rowspan="2">Sinepuxent and
Ironshire Formations</td><td rowspan="2">Wachapreague Formation</td><td colspan="2" rowspan="2">Kent Island Formation</td><td rowspan="3">Tabb Formation</td><td>Poquoson Member</td><td rowspan="4">Nassawadox Formation</td><td rowspan="2">Occohannock
Member</td><td rowspan="2">Kent Island
Formation</td><td rowspan="2">Wachapreague
Formation</td><td rowspan="8">Unit C</td></tr>
<tr><td>Lynnhaven Member</td></tr>
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Bluff</td><td rowspan="2">Joynes
Neck</td><td rowspan="2">Iron-
shire</td></tr>
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(as restricted by Owens
and Denny 1979)</td><td rowspan="3">Omar Formation

(Accomack Member)</td><td colspan="2" rowspan="3">Omar Formation

(Accomack Member)</td><td colspan="2">Chuckatuck Formation</td></tr>
<tr><td colspan="2">Charles City Formation</td></tr>
<tr><td colspan="2">Windsor Formation
(restricted)</td></tr>
<tr><td>Pliocene</td><td></td><td></td><td colspan="2"></td><td colspan="2">"Moorings" unit</td><td colspan="4">Yorktown Formation and
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Unit B</td></tr>
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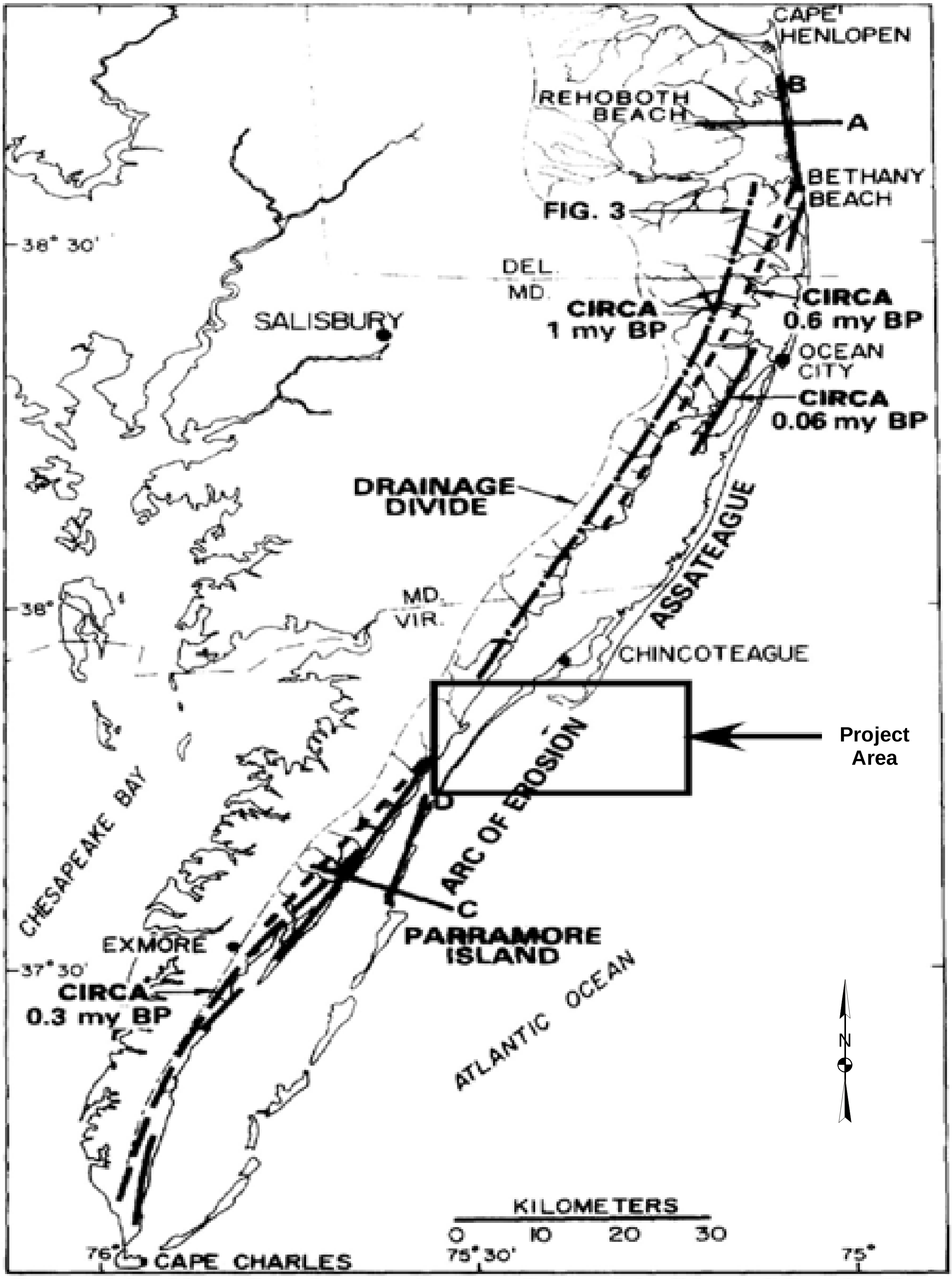
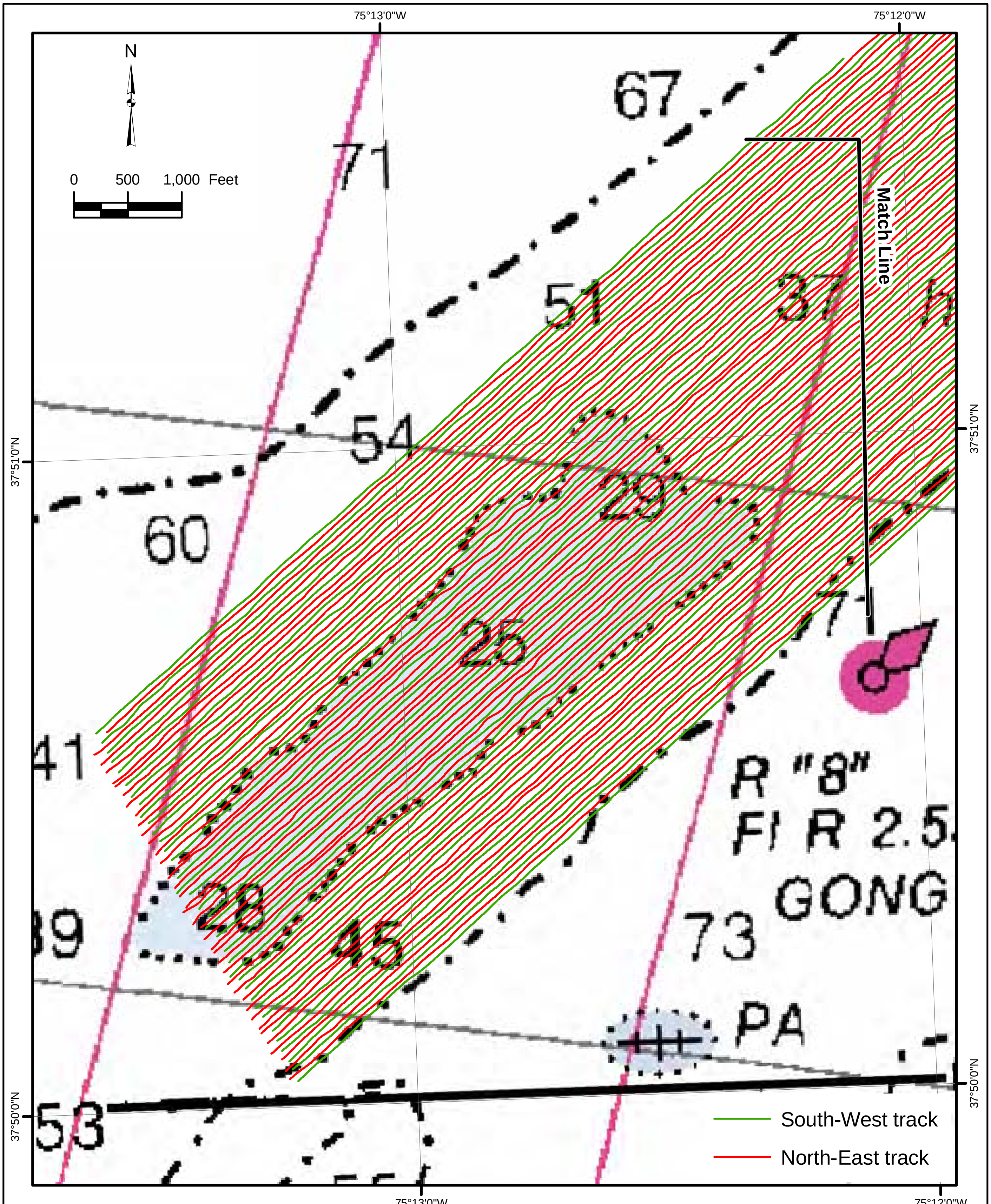
PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	N/A
SOURCE	Hobbs 2004

Temporal Relationships of Strata in the Chesapeake Bay, Delmarva Peninsula and Inner Continental Shelf

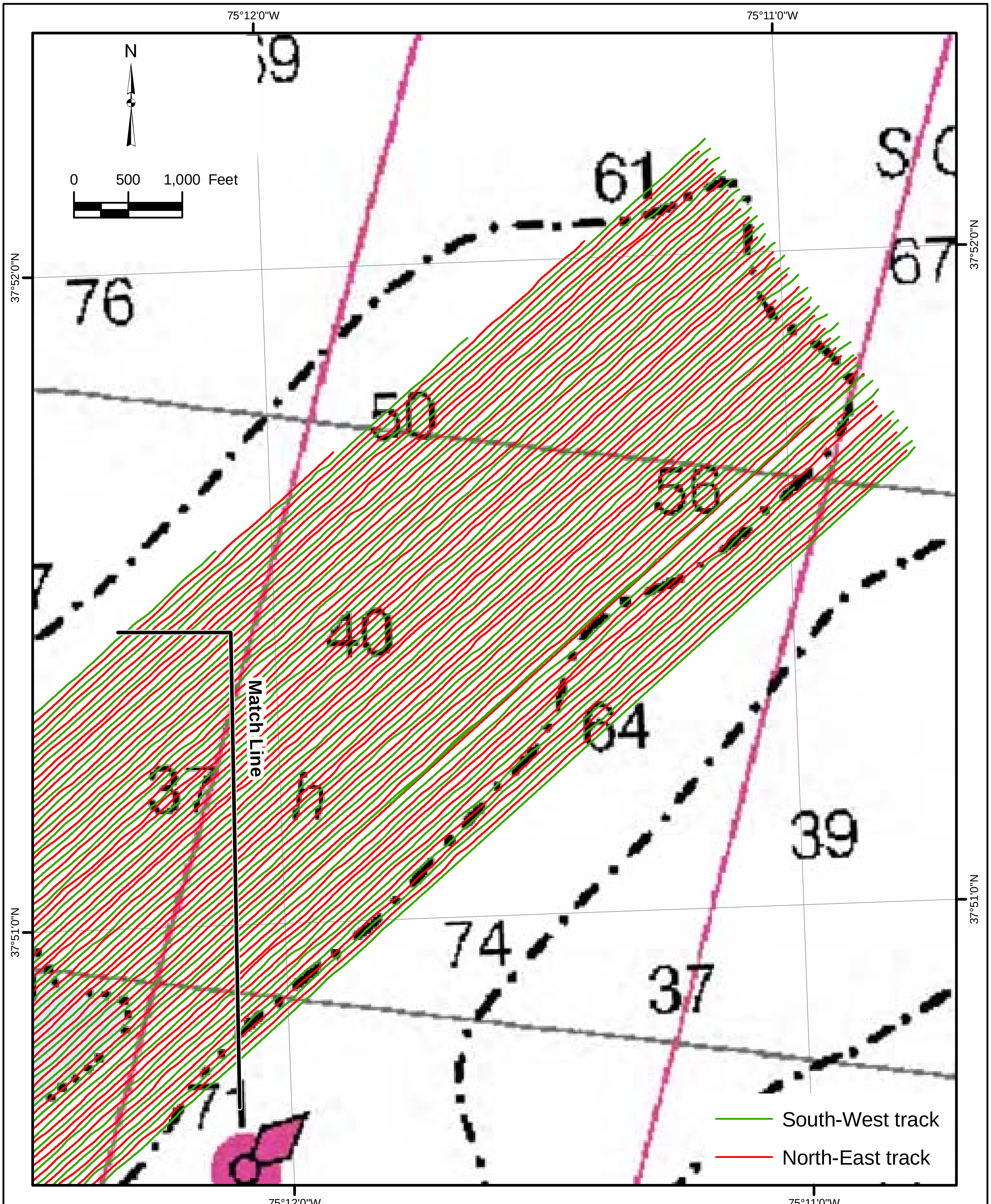
PROJECT NO.	15299035
FIGURE NO.	4-10



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Map Showing Project Area in "Arc of Erosion"**	
SCALE	1 inch = 10.9 miles (17.5 kilometers)	**PROJECT NO.**	15299035
SOURCE	Demarest and Leatherman 1985	**FIGURE NO.**	4-11



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Location of Block One with Survey Lines on NOAA Chart 12210 (Part A)**
SCALE	1 inch = 1250 ft	
SOURCE	NOAA, URS	**PROJECT NO.** 15299035
\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig5_1_block_one_20090918.mxd		**FIGURE NO.** 5-1A

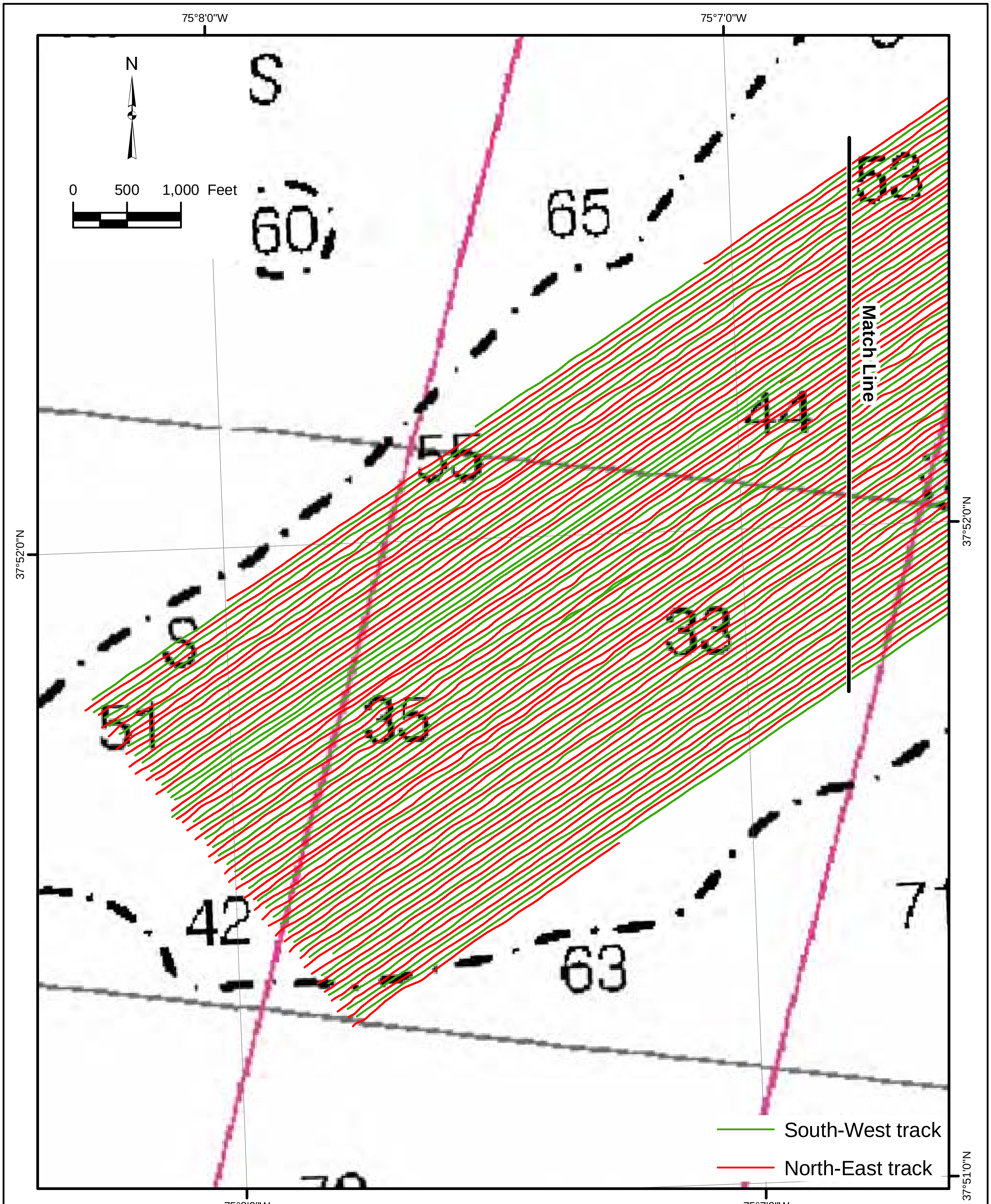


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

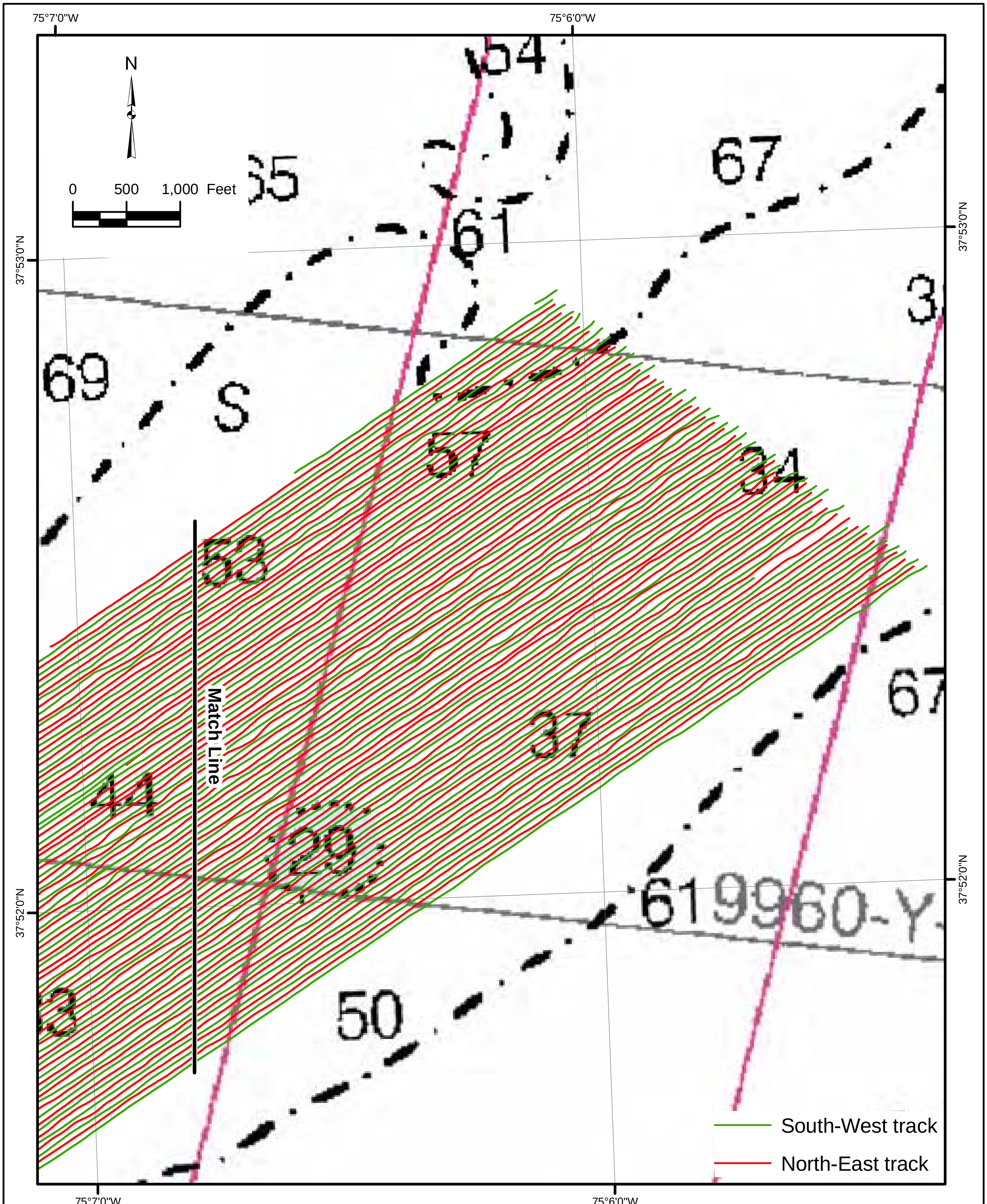
\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig5_1_block_one_20090918.mxd

Location of Block One with Survey Lines on NOAA Chart 12210 (Part B)

PROJECT NO.	15299035
FIGURE NO.	5-1B



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Location of Block Two with Survey Lines on NOAA Chart 12210 (Part A)**	
SCALE	1 inch = 1250 ft		
SOURCE	NOAA, URS	**PROJECT NO.**	15299035
\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig5_1_block_one_20090918.mxd		**FIGURE NO.**	5-2A

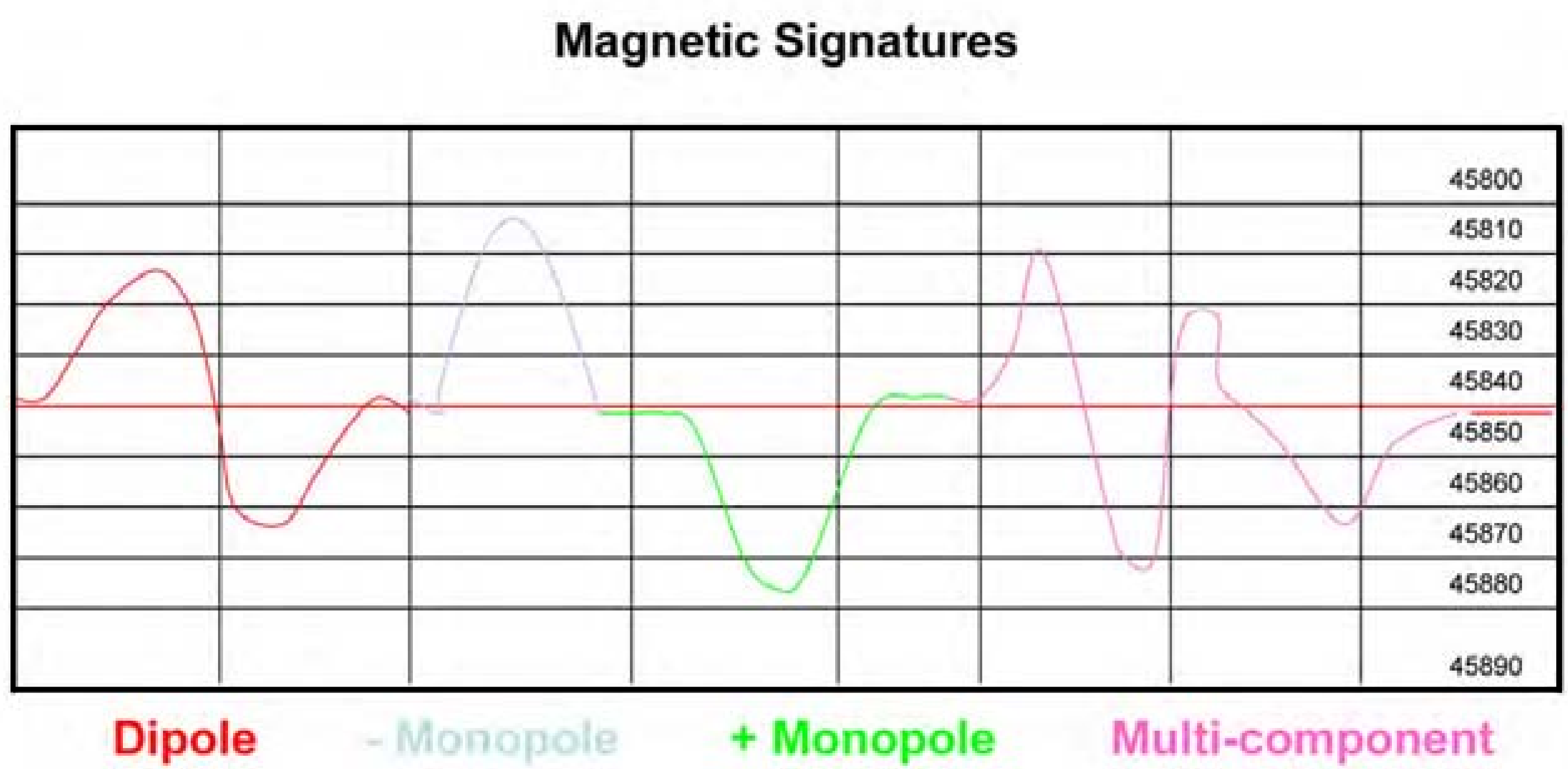


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

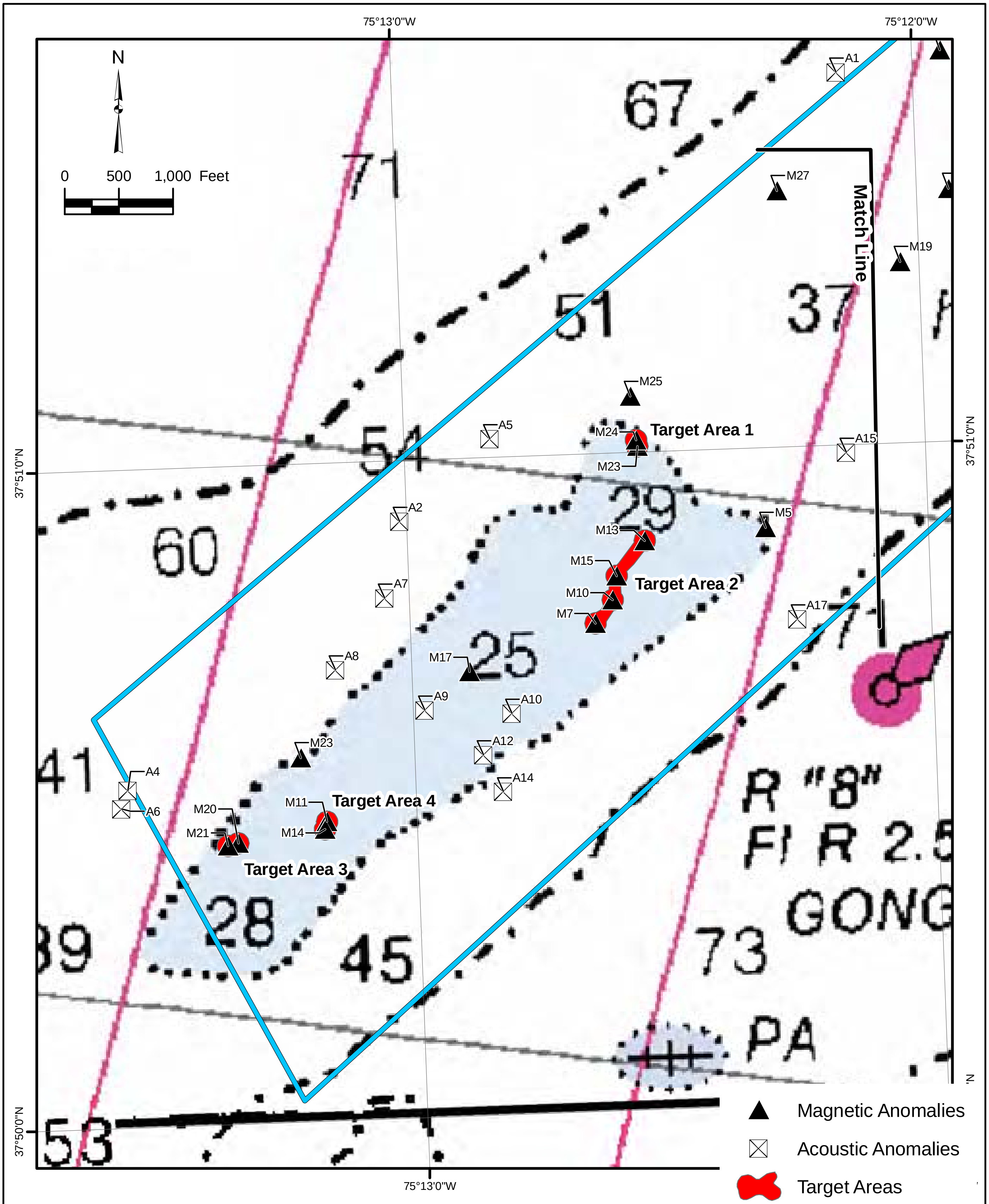
\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB
\mag_accoustic_anomolies\GIS_Projects\fig5_1_block_one_20090918.mxd

Location of Block Two with Survey Lines on NOAA Chart 12210 (Part B)

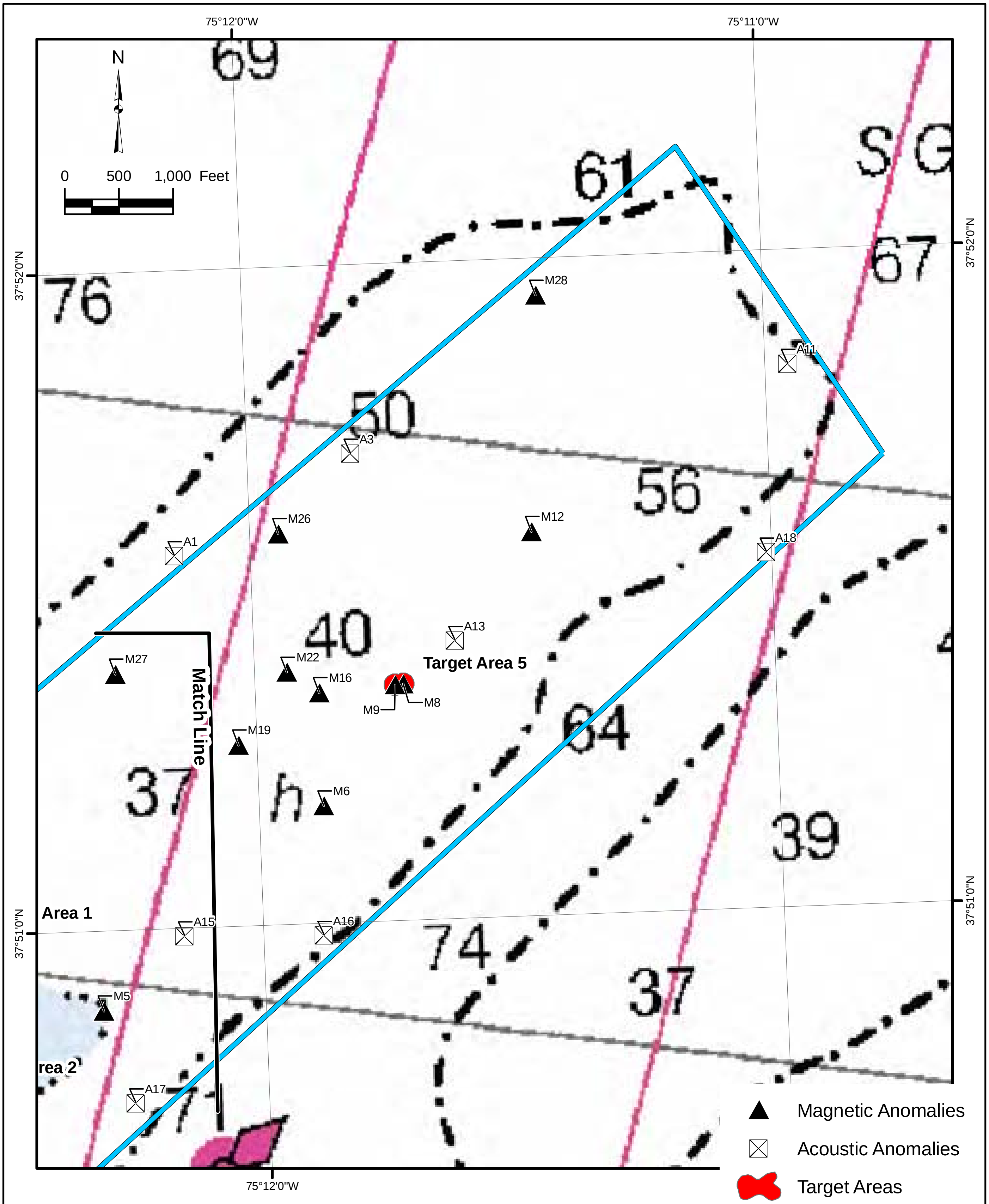
PROJECT NO.	15299035
FIGURE NO.	5-2B



PROJECT	WFF SRIPP Offshore Sand Borrow Survey	Illustration Showing Four Magnetic Signature Types	
SCALE	N/A	PROJECT NO.	15299035
SOURCE	URS	FIGURE NO.	5-3

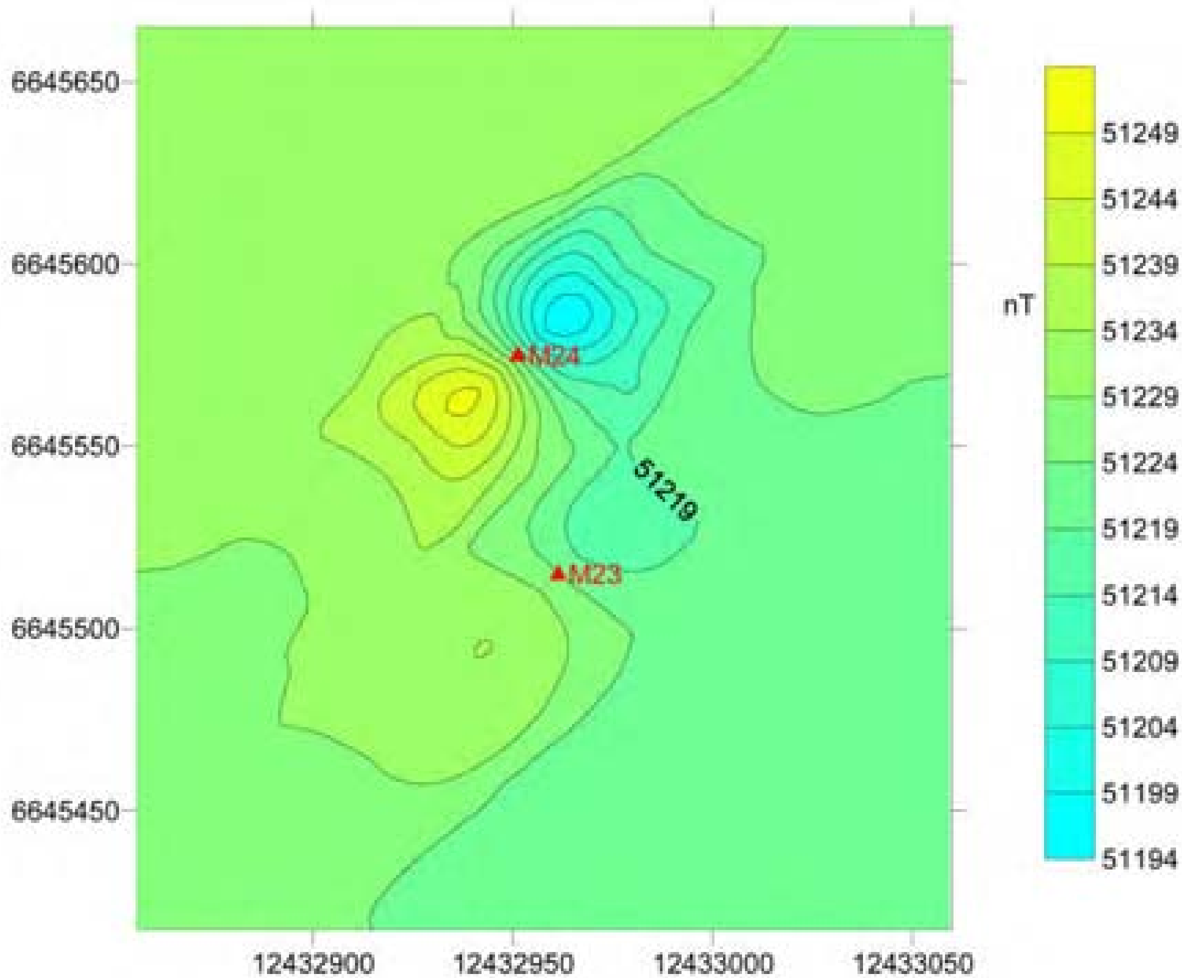


PROJECT WFF SRIPP Offshore Sand Borrow Survey		**Map of Block One with Magnetic and Acoustic Anomalies with Target Clusters (Part A)**	
SCALE 1 inch = 1250 ft			
SOURCE NOAA, URS		**PROJECT NO.**	15299035
\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig6_1_block_one_20090918.mxd		**FIGURE NO.**	6-1A

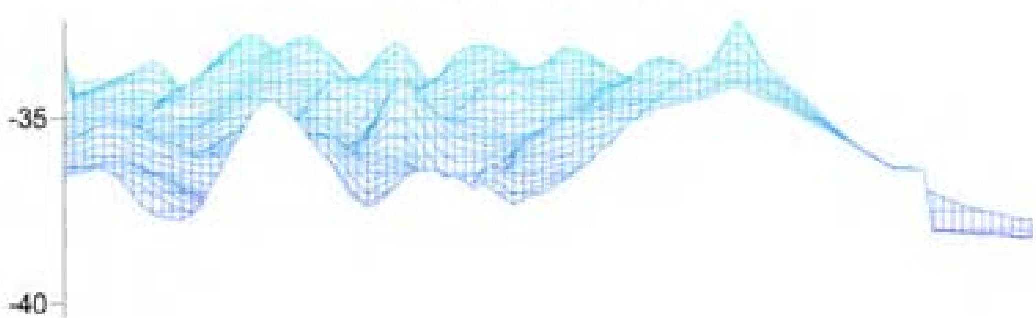


PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Map of Block One with Magnetic and Acoustic Anomalies with Target Clusters (Part B)**	
SCALE	1 inch = 1250 ft		
SOURCE	NOAA, URS	**PROJECT NO.**	15299035
\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig6_1_block_one_20090918.mxd		**FIGURE NO.**	6-1B

Target One Magnetic Contours



Target One Depth Contours



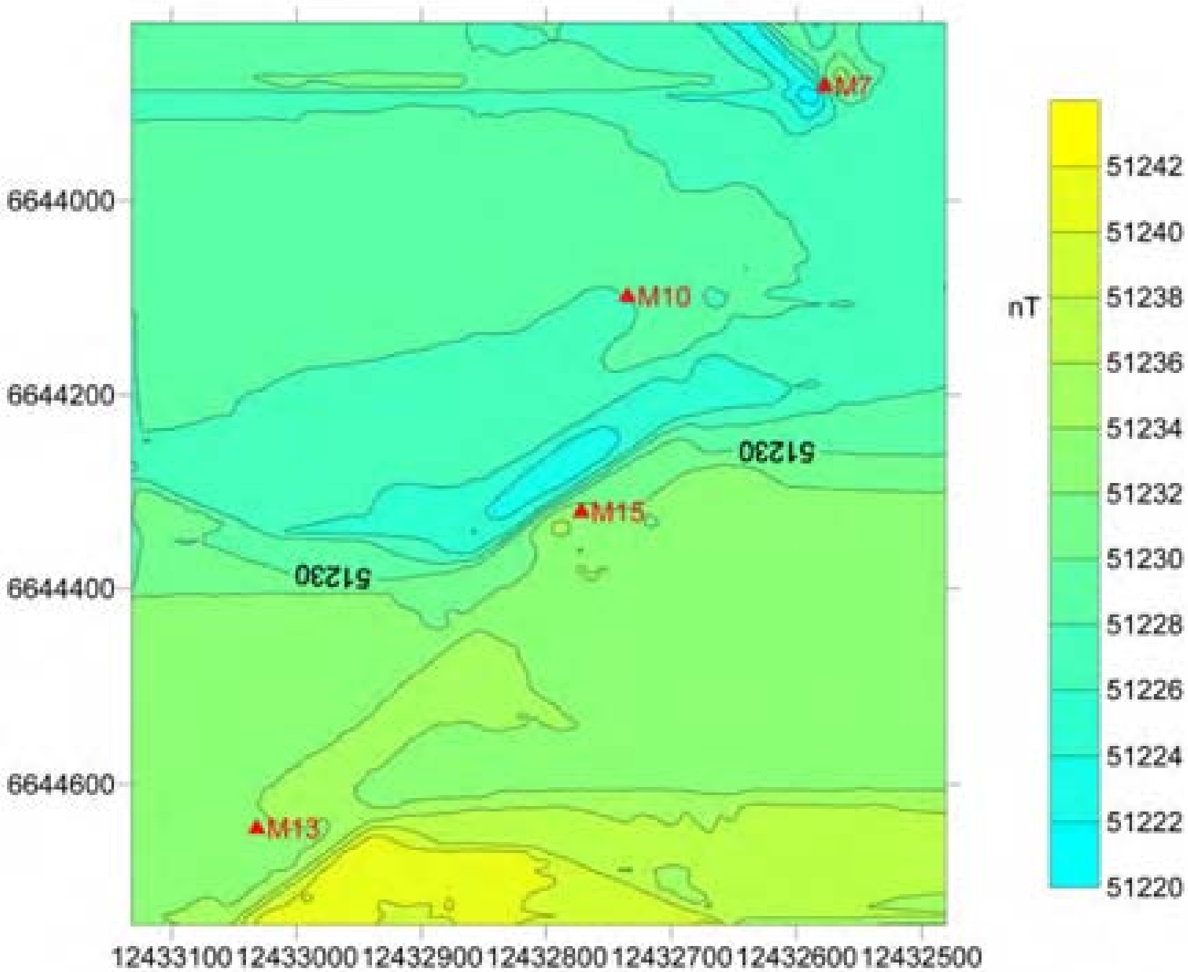
N

PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	N/A
SOURCE	URS

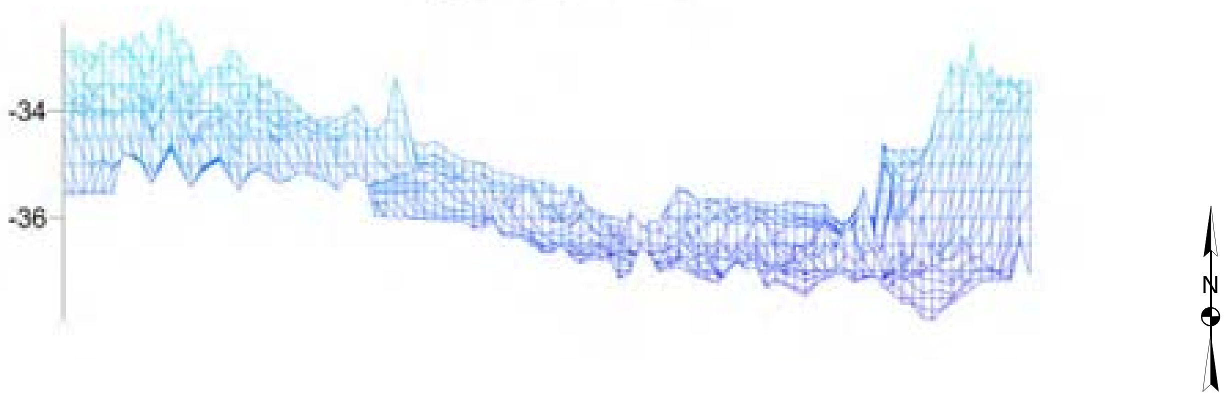
Target One Magnetic and Depth Contour Maps

PROJECT NO.	15299035
FIGURE NO.	6-2

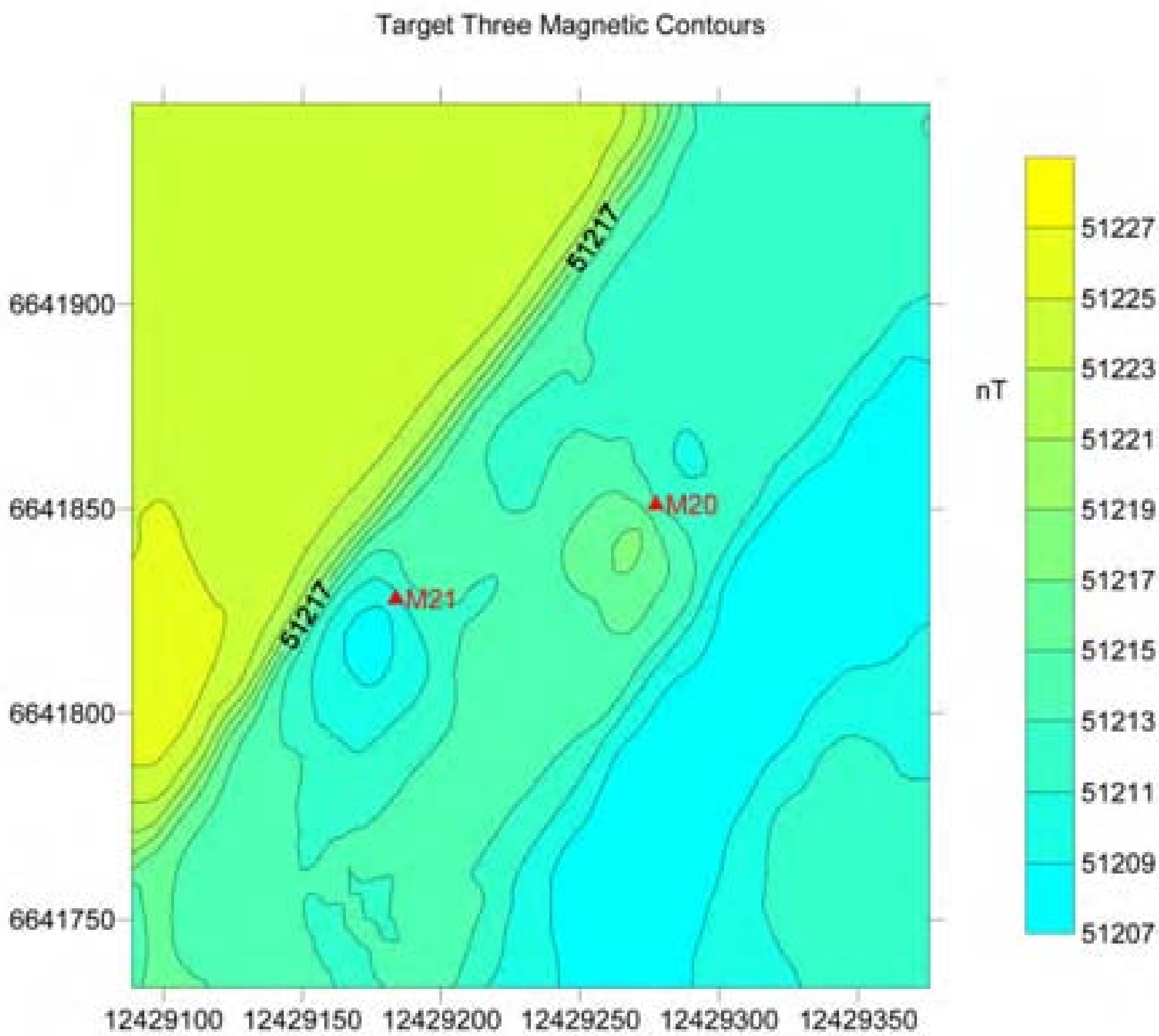
Target Two Magnetic Contours

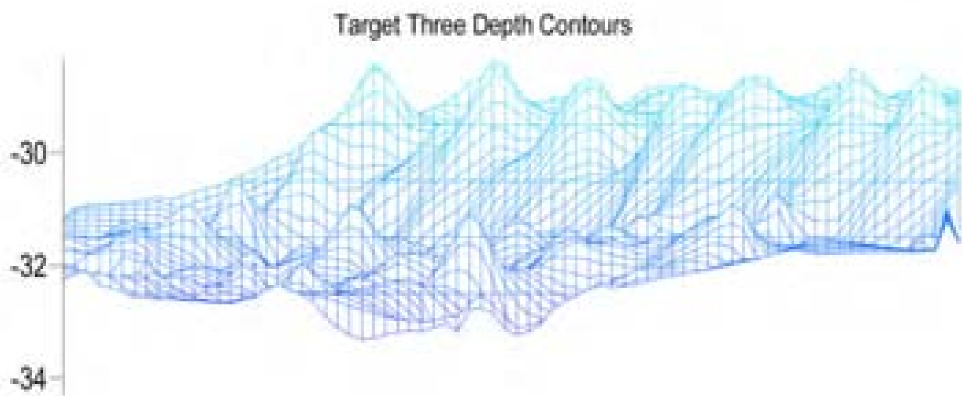


Target Two Depth Contours



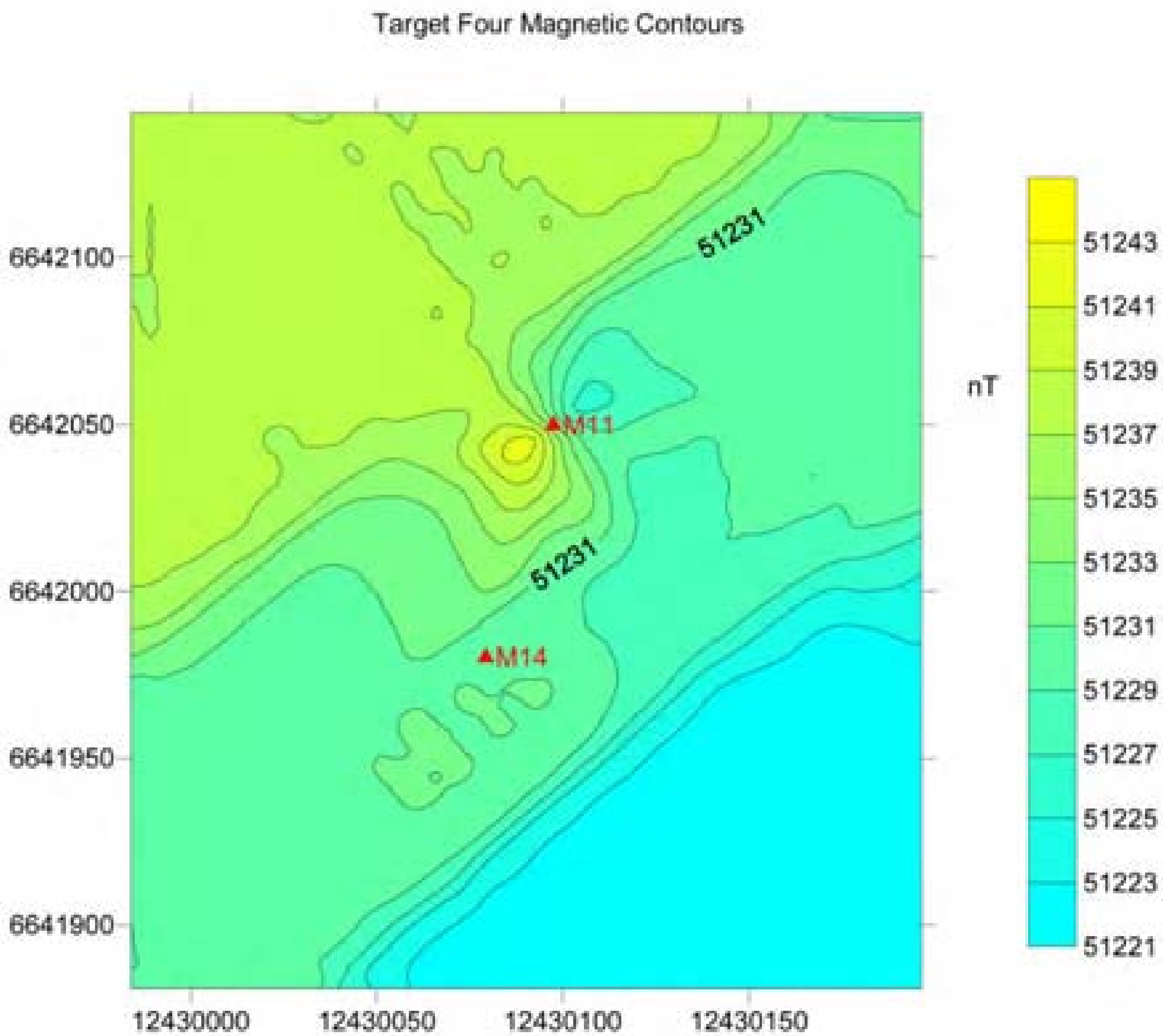
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Target Two Magnetic and Depth Contour Maps**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**FIGURE NO.**	6-3

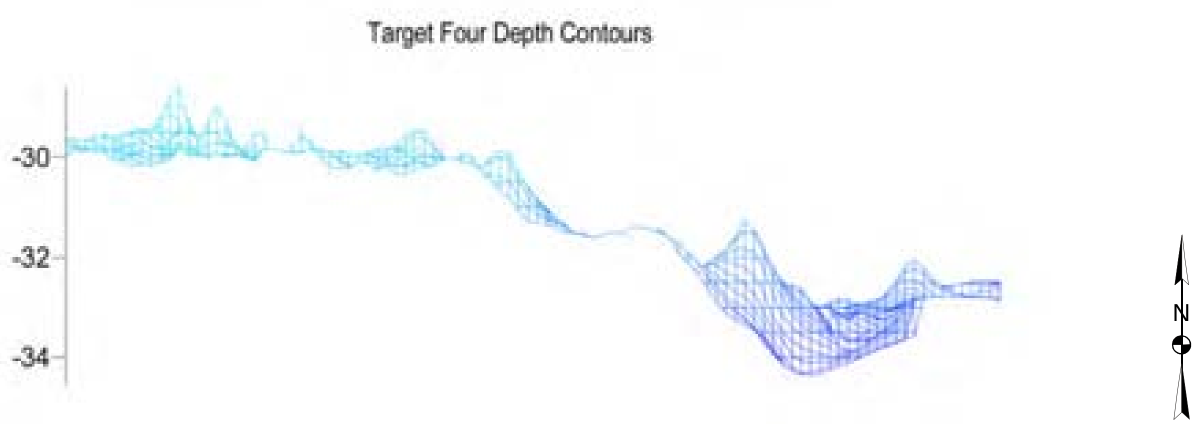




N

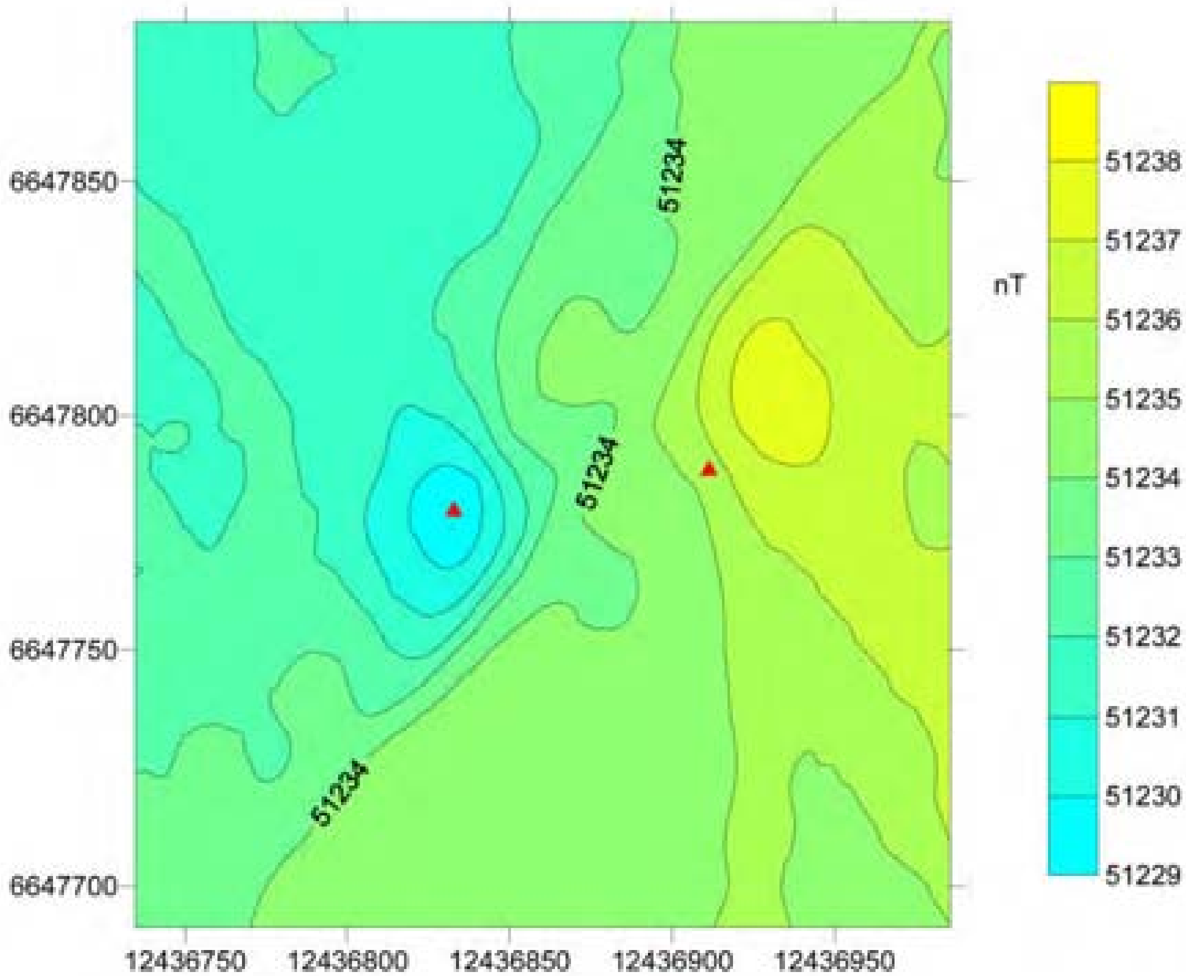
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Target Three Magnetic and Depth Contour Maps**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**FIGURE NO.**	6-4



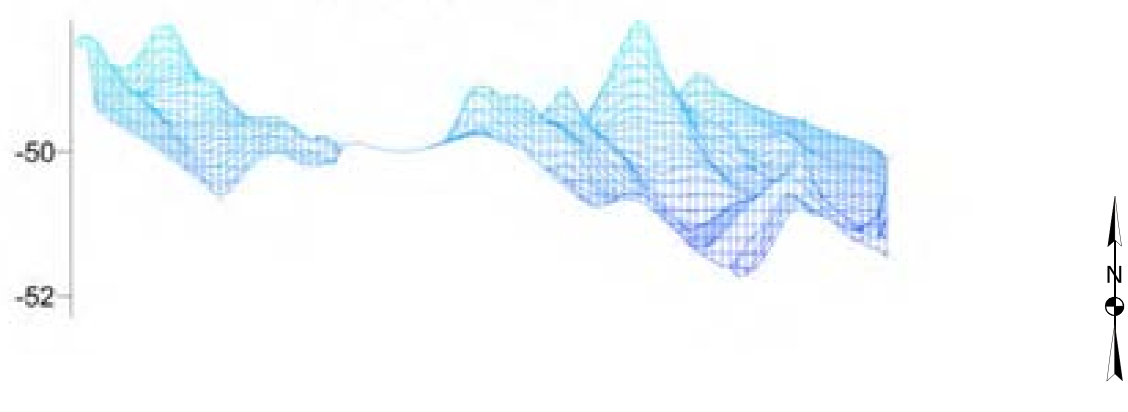


PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Target Four Magnetic and Depth Contour Maps**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**FIGURE NO.**	6-5

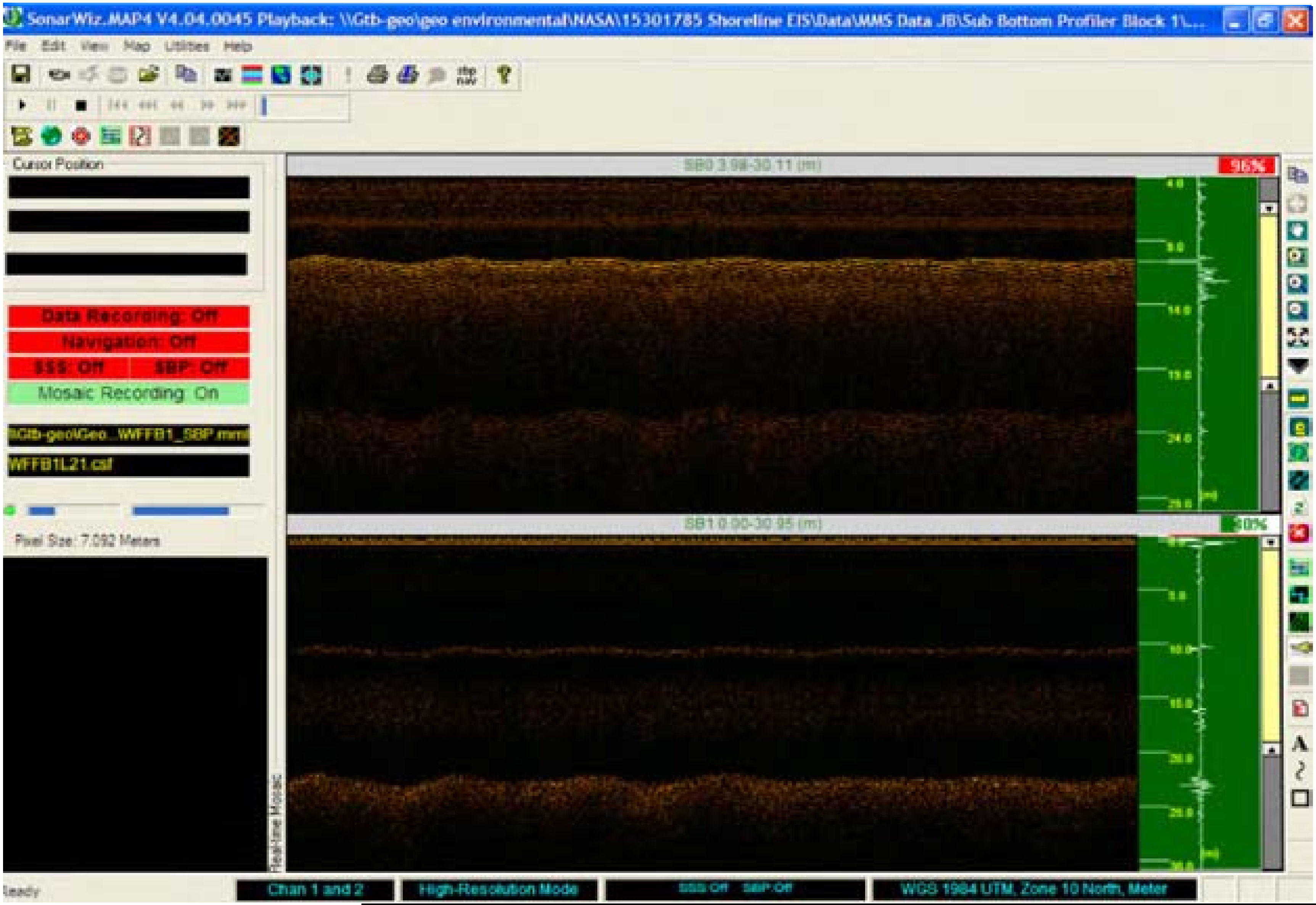
Target Five Magnetic Contours



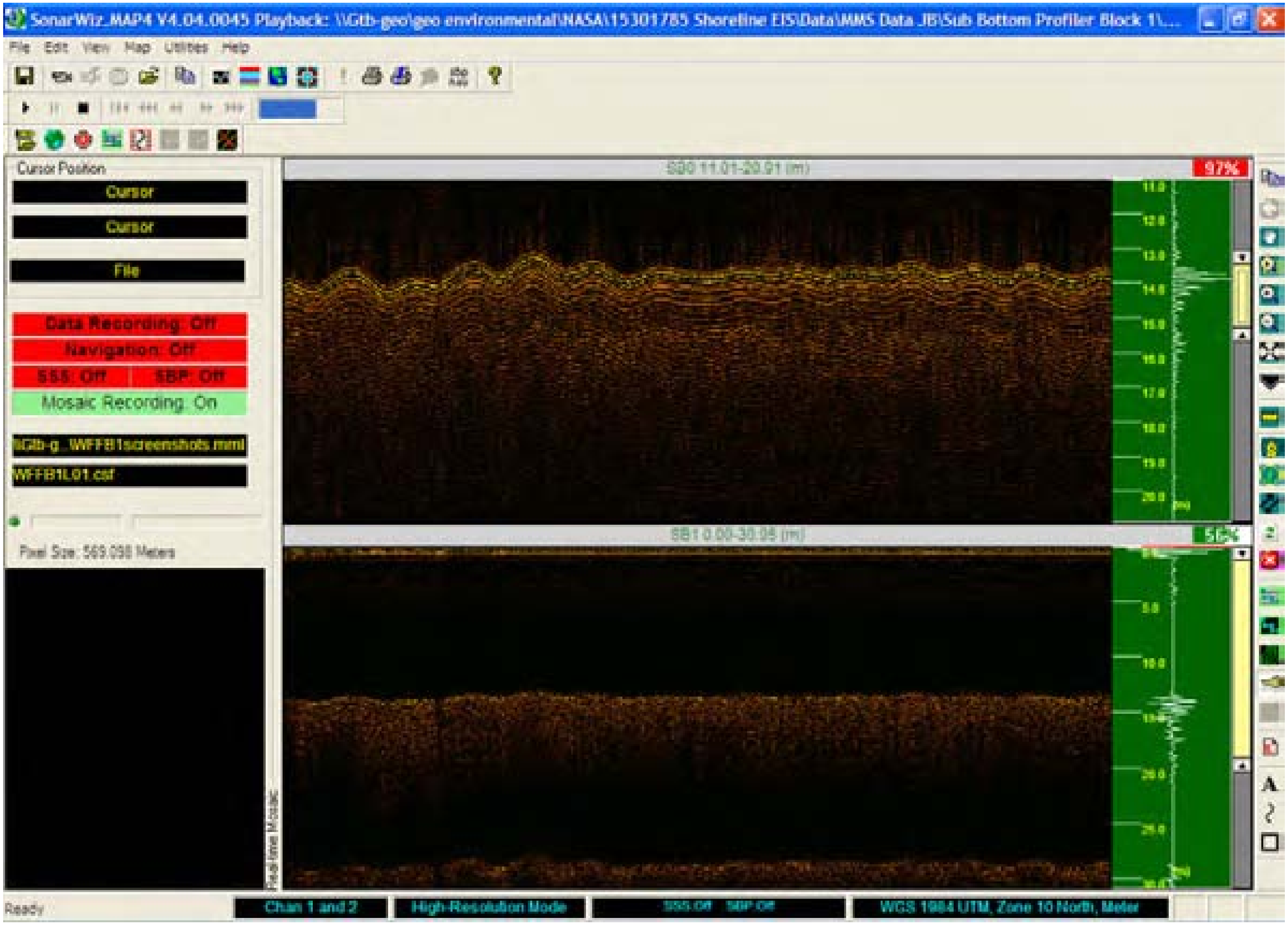
Target Four Depth Contours



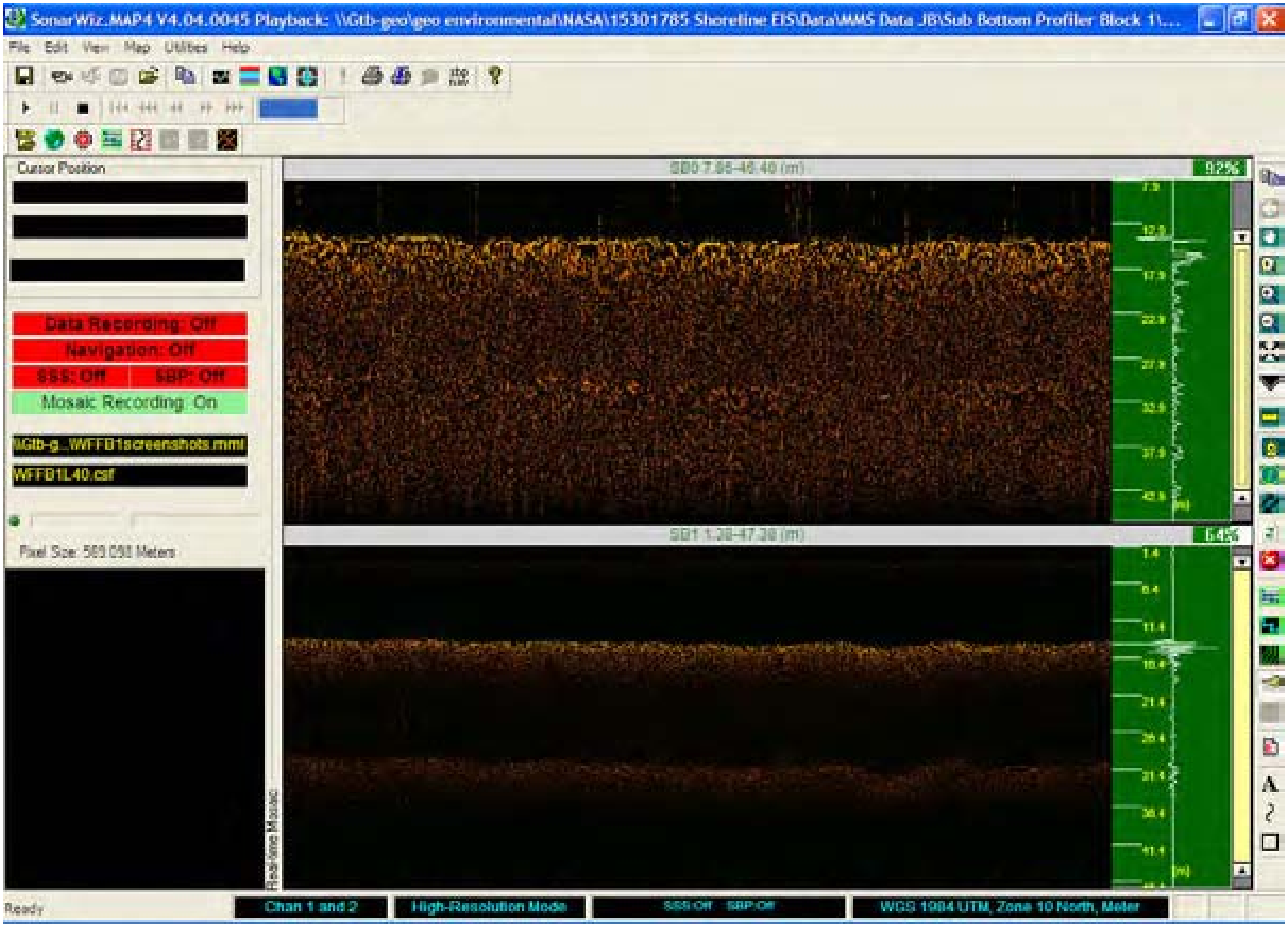
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Target Five Magnetic and Depth Contour Maps**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**FIGURE NO.**	6-6



PROJECT WFF SRIPP Offshore Sand Borrow Survey		**Sub Bottom Data of Line 20 in Block One Showing Sedimentary Structure and Acoustic Penetration**	
SCALE N/A		**PROJECT NO.**	15299035
SOURCE URS		**FIGURE NO.**	6-7



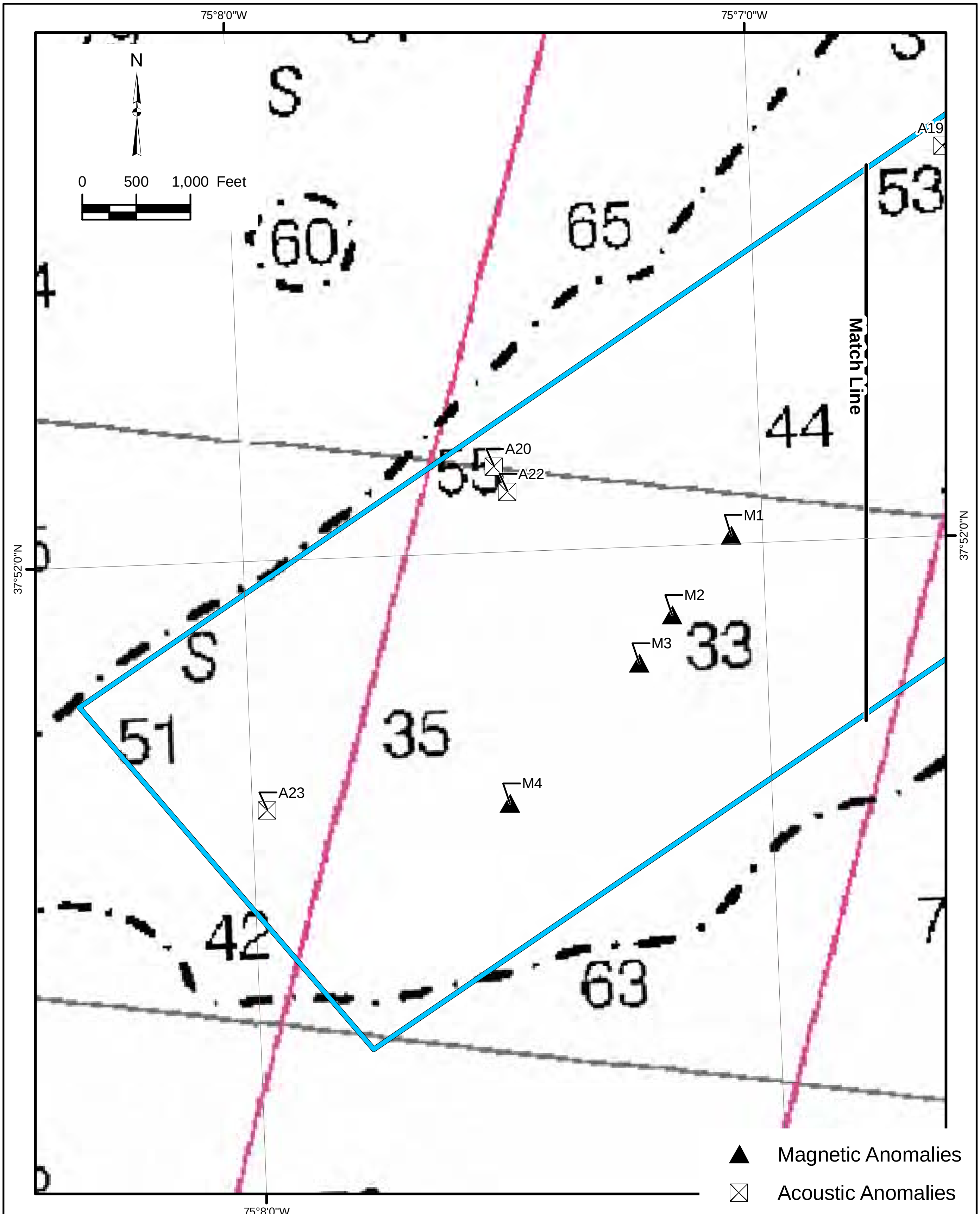
PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Sub Bottom Data of Line 01 in Block One Showing Sedimentary Structure, Acoustic Penetration and Surface Reflections**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**FIGURE NO.**	6-8



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	N/A
SOURCE	URS

Sub Bottom Data of Line 40 in Block One Showing Sedimentary Structure, Acoustic Penetration and Surface Reflections

PROJECT NO.	15299035
FIGURE NO.	6-9

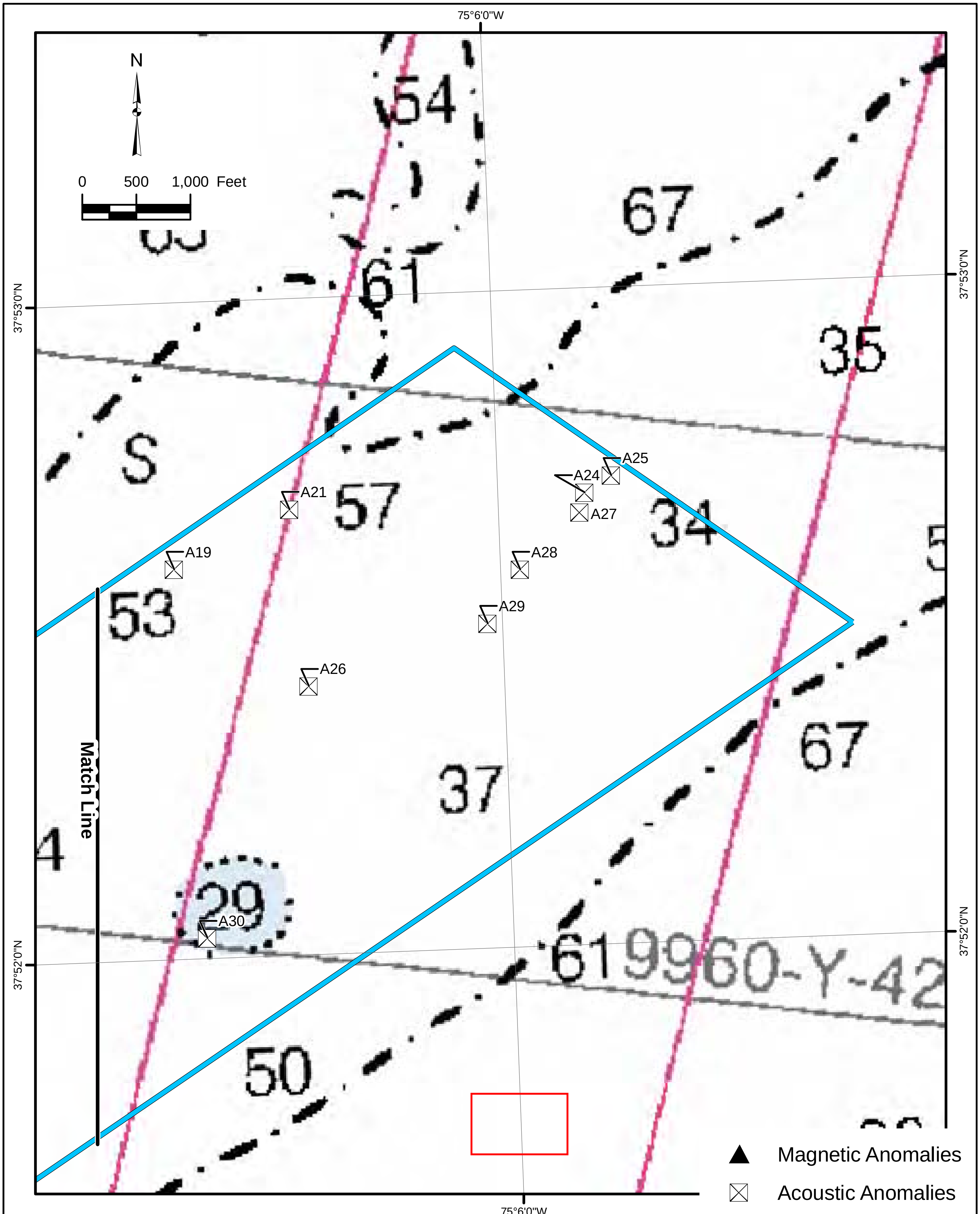


PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS

\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB
\mag_accoustic_anomolies\GIS_Projects\fig6_10_block_two_20090918.mxd

Map of Block Two with Magnetic and Acoustic Anomalies (Part A)

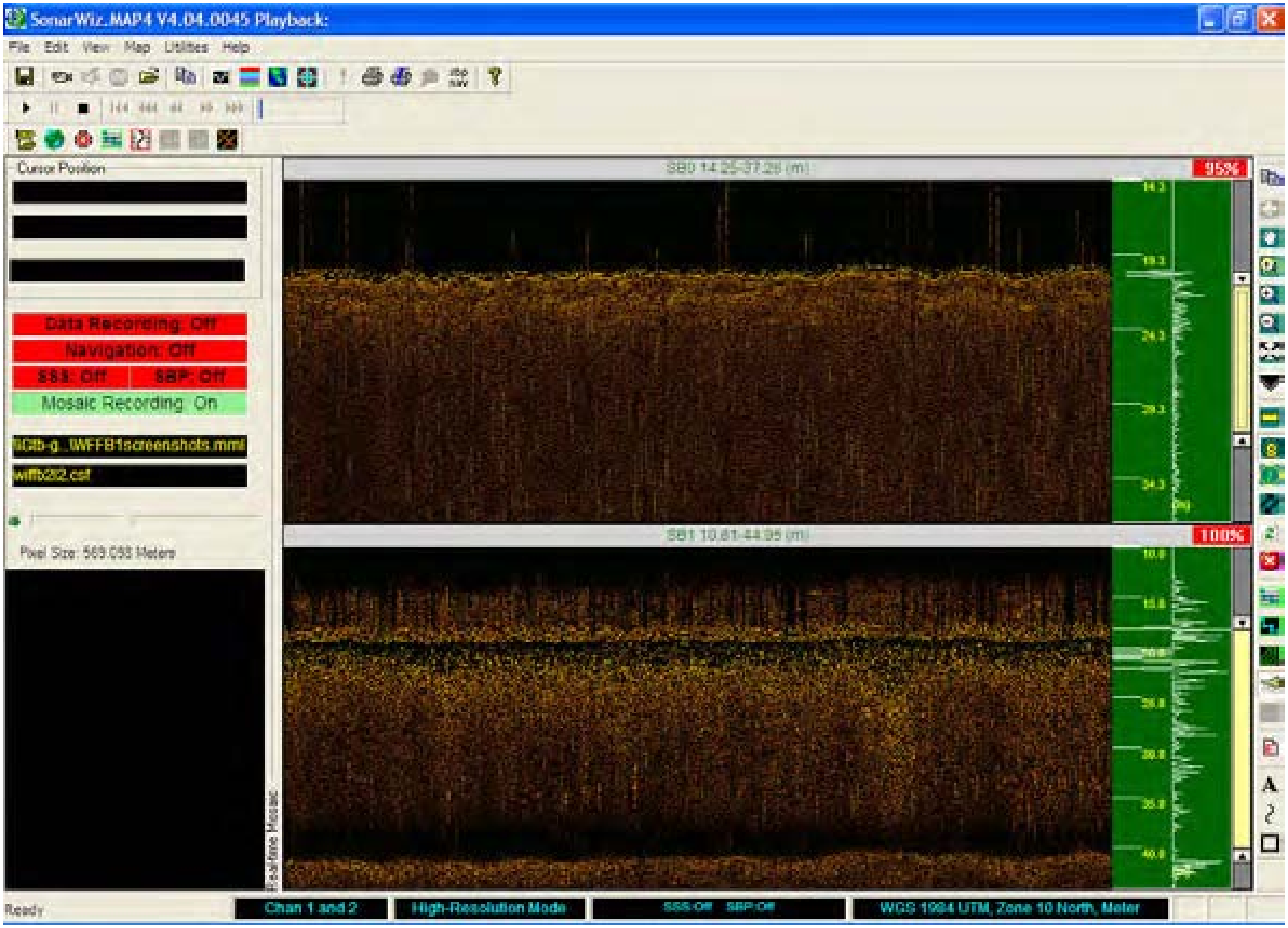
PROJECT NO.	15299035
FIGURE NO.	6-10A



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	1 inch = 1250 ft
SOURCE	NOAA, URS
\\10.67.4.9\geo environmental\NASA\15301785 Shoreline EIS\Data\MMS Data JB \mag_accoustic_anomolies\GIS_Projects\fig6_10_block_two_20090918.mxd	

Map of Block Two with Magnetic and Acoustic Anomalies (Part B)

PROJECT NO.	15299035
FIGURE NO.	6-10B



PROJECT WFF SRIPP Offshore Sand Borrow Survey	**Sub bottom data of Line 02 in Block Two Showing Sedimentary Structure, Acoustic Penetration and Surface Reflections**	
SCALE N/A		**PROJECT NO.** 15299035
SOURCE URS		**FIGURE NO.** 6-11

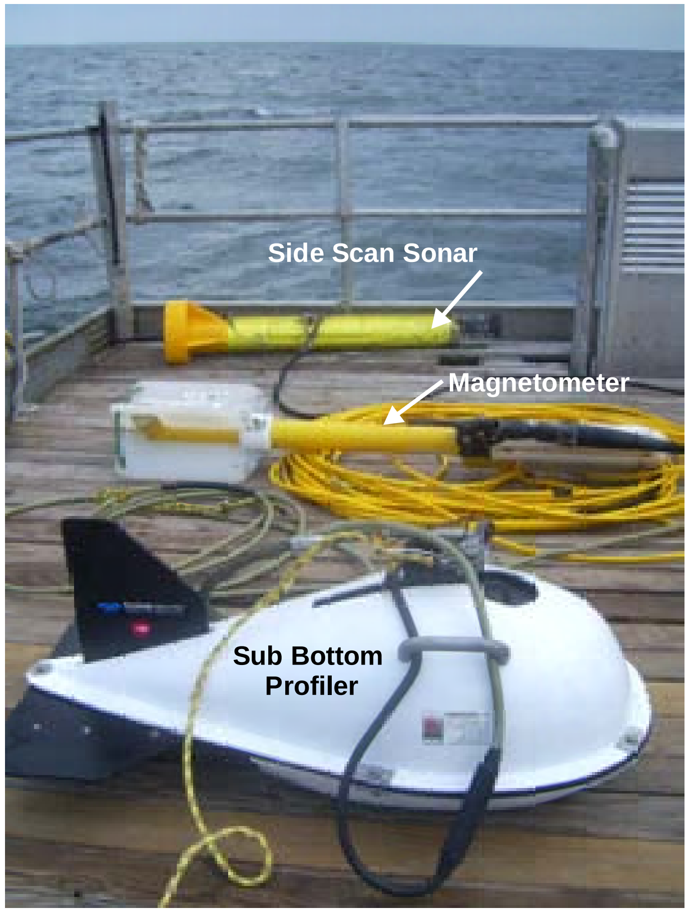


Plate 5-1. View of Survey Equipment

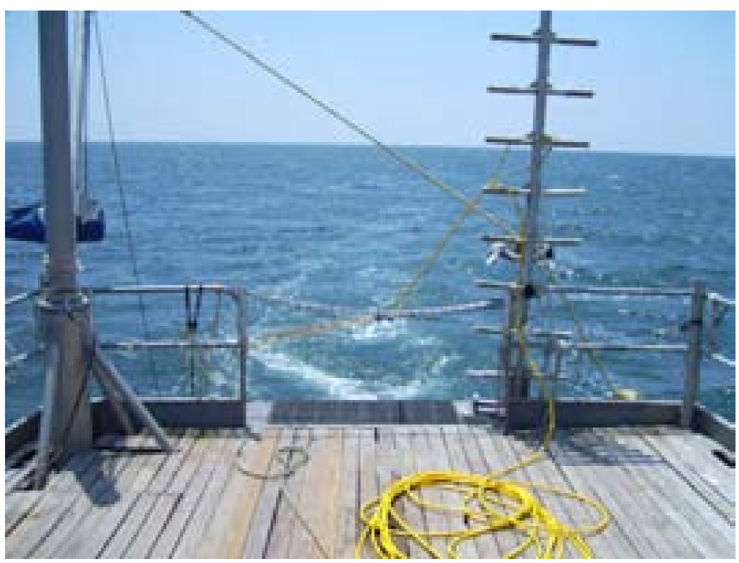
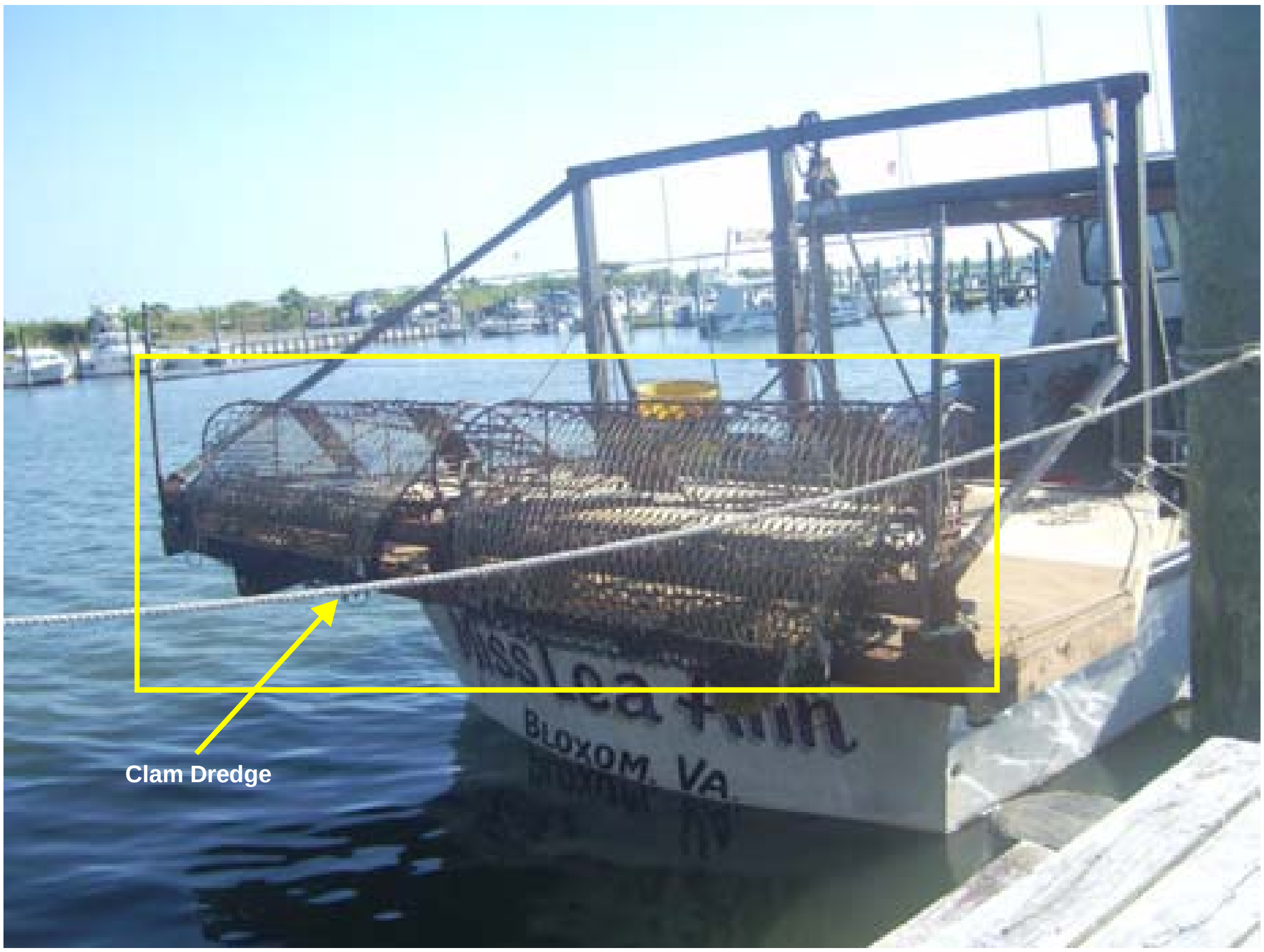


Plate 5-2. Overview of Survey Conditions

PROJECT	WFF SRIPP Offshore Sand Borrow Survey	**Project Photographs**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**PLATE NO.**	5-1 and 5-2



PROJECT	WFF SRIPP Offshore Sand Borrow Survey
SCALE	N/A
SOURCE	URS

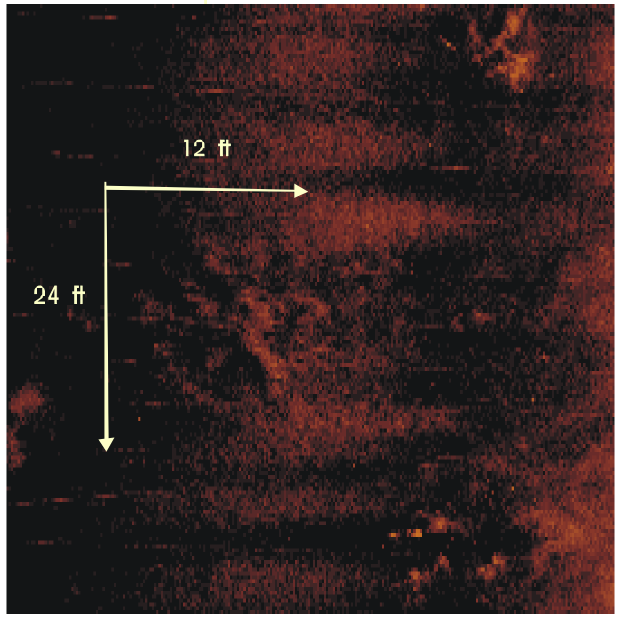
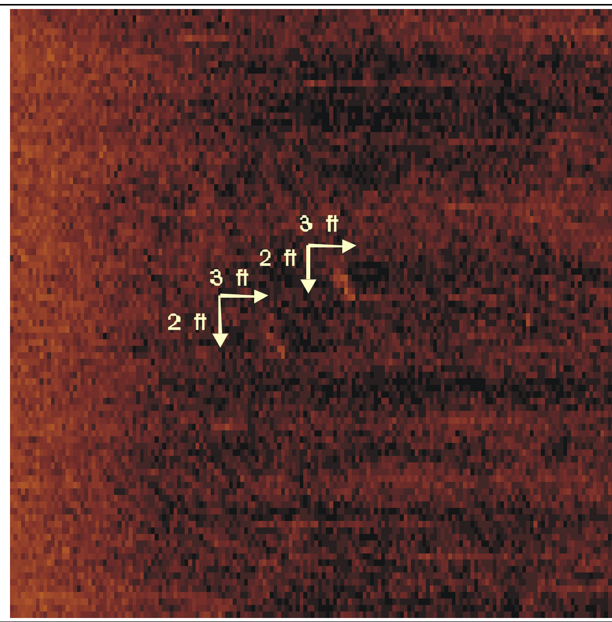
View of Clam Dredge Similar to Those Found in Survey Areas (Acoustic Anomaly Table 6-2)

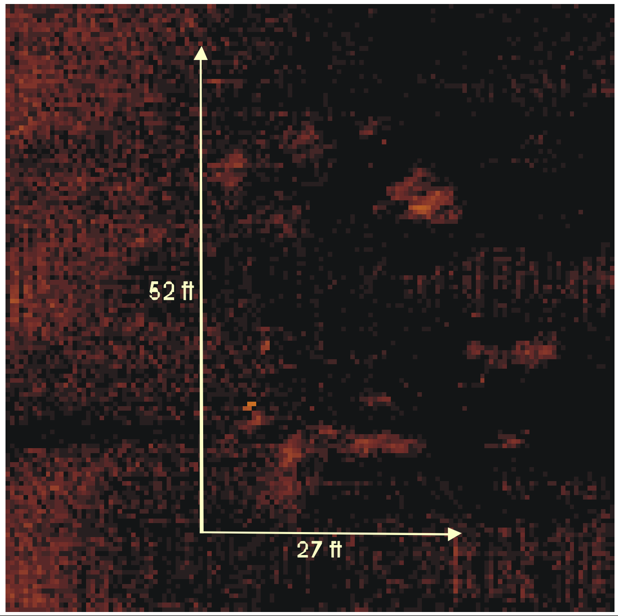
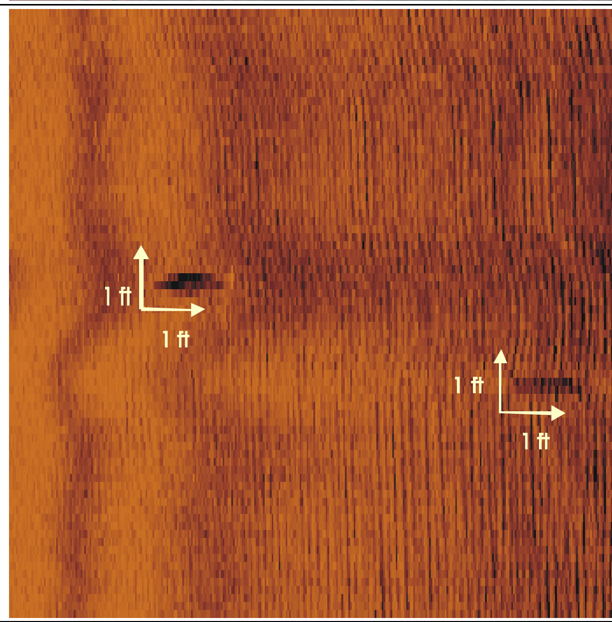
PROJECT NO.	15299035
PLATE NO.	6-1

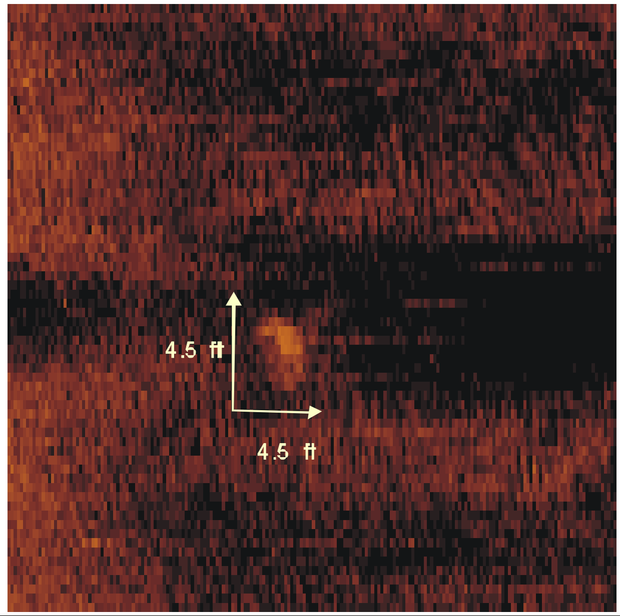
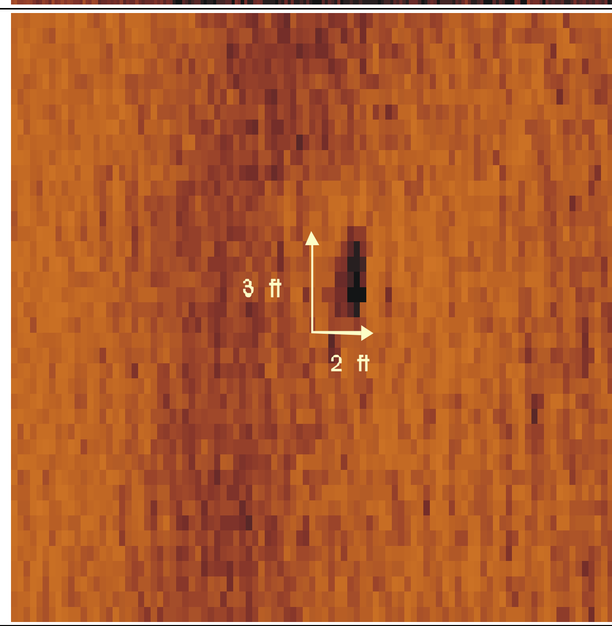
Appendix A:

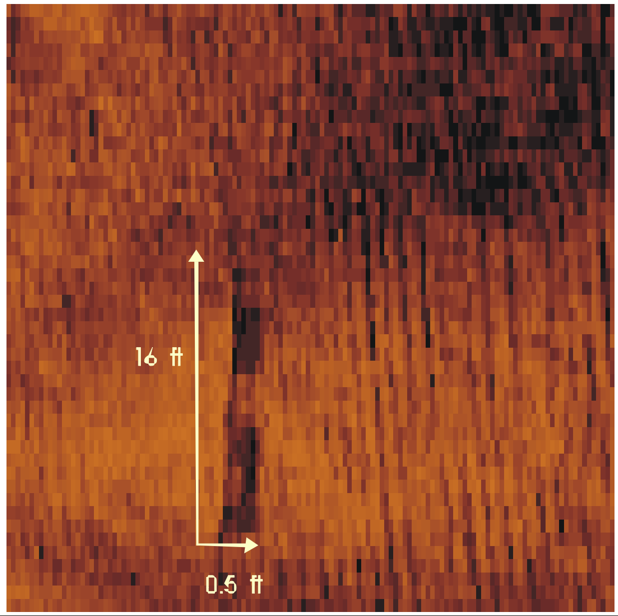
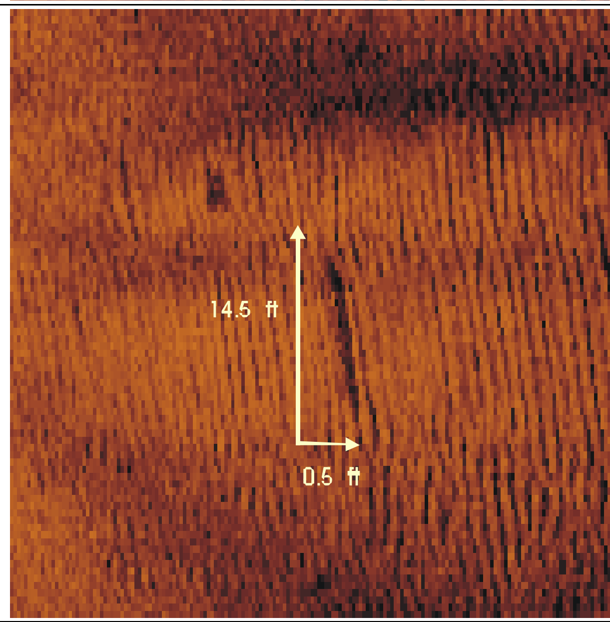
Side Scan Sonar Anomalies

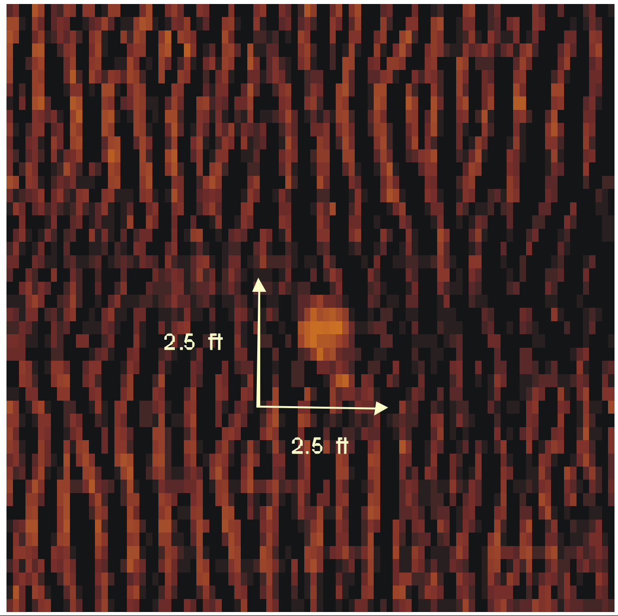
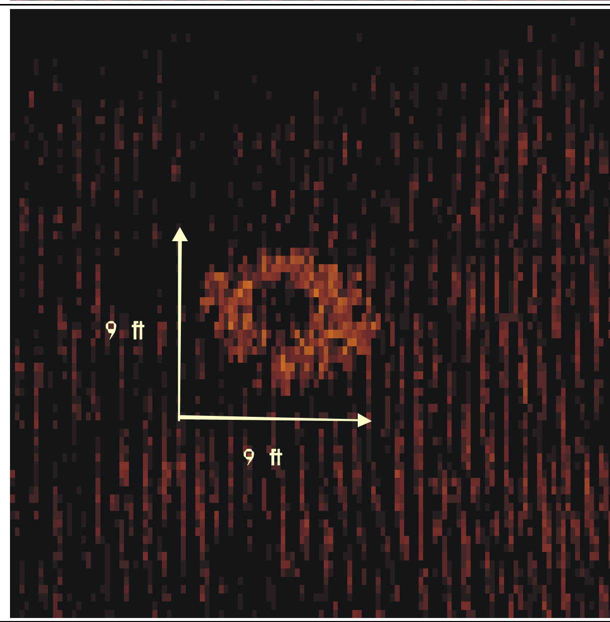
Side Scan Sonar Anomalies

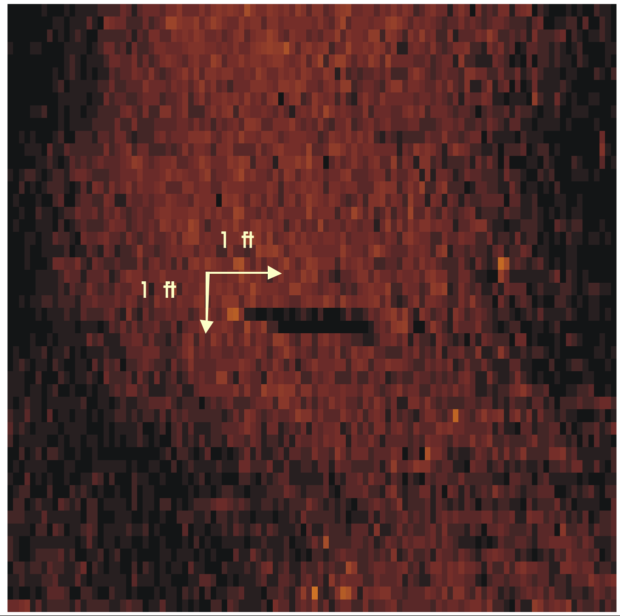
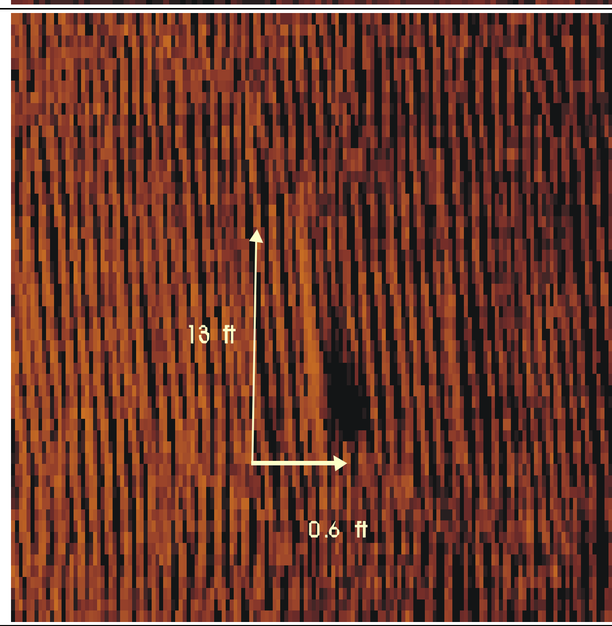
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A1	B1L7	24ft x 12ft x 3ft	
A2	B1L10(06)	2ft x 3ft x 1 ft (2 Pieces)	

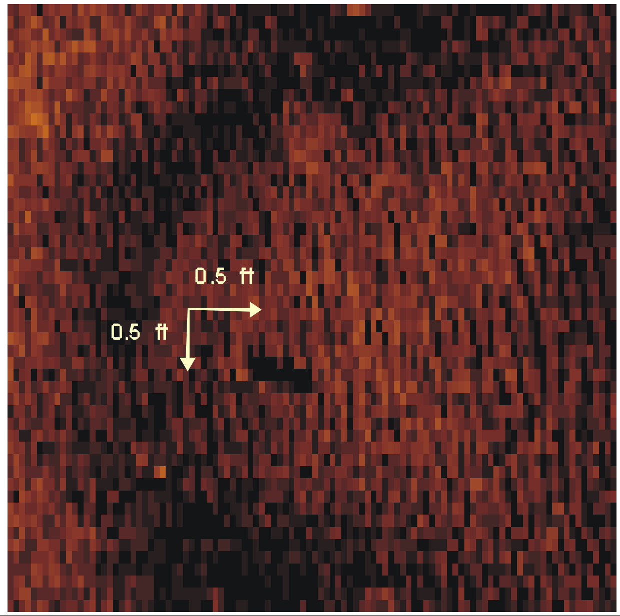
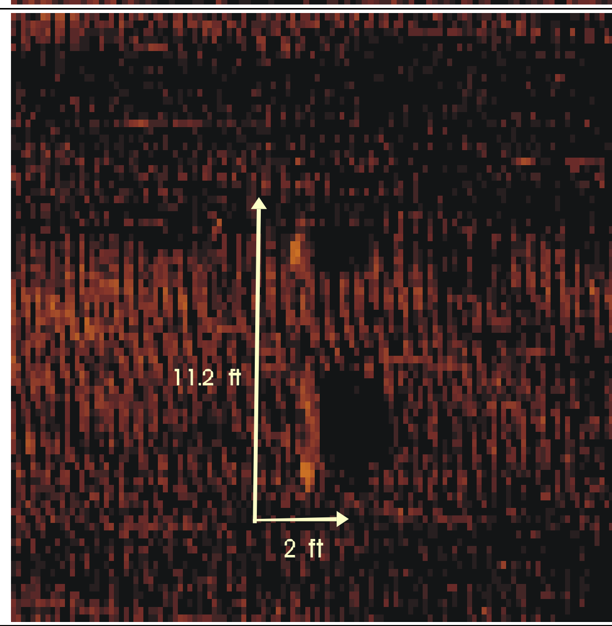
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A3	B1L10(18)	52ft x 27ft x 2ft	
A4	B1L14(01)	1ft x 1ft x 2ft (2 Pieces)	

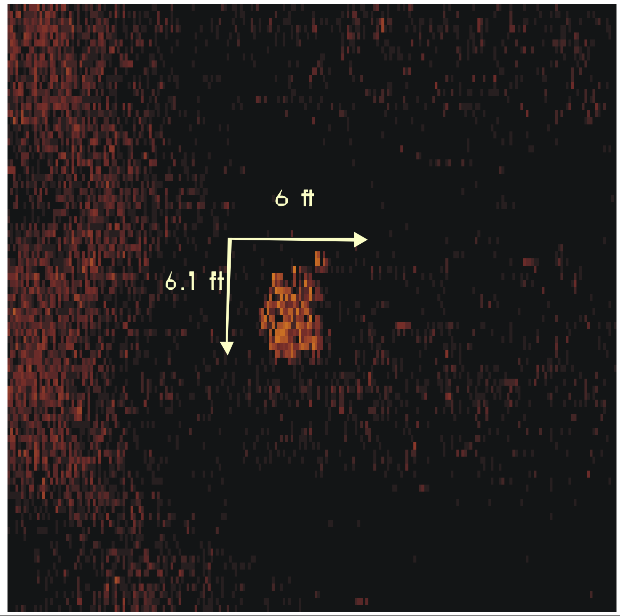
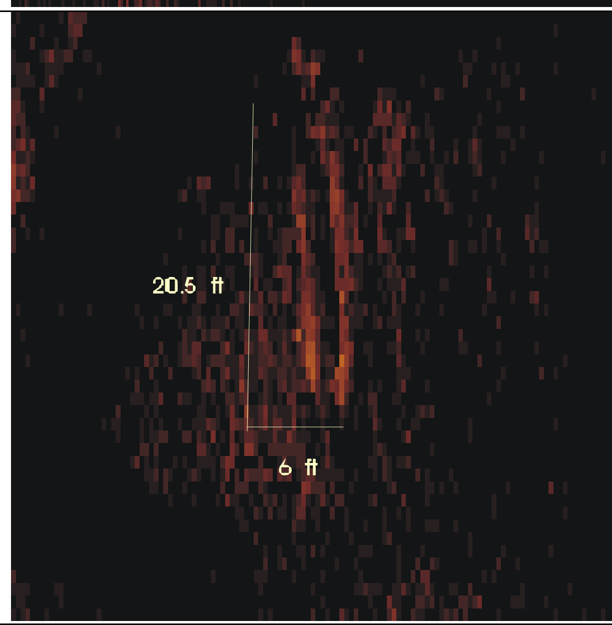
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A5	B1L15(17)	4.5ft x 4.5ft x 2ft	
A6	B1L17(00)	3ft x 2ft x 1 ft	

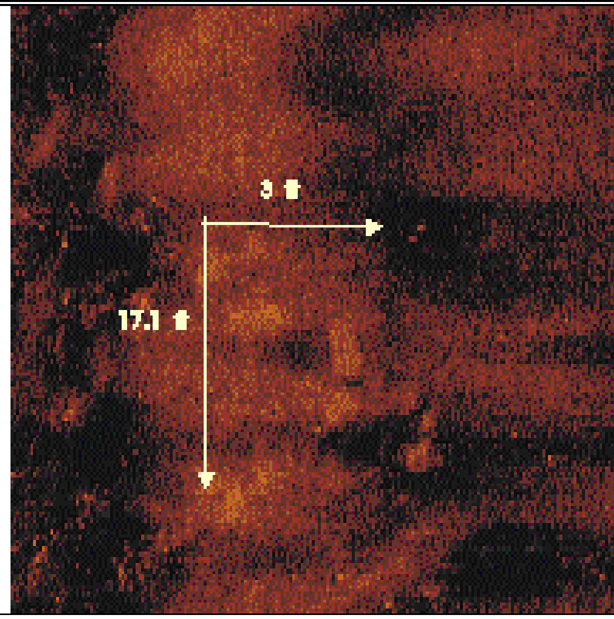
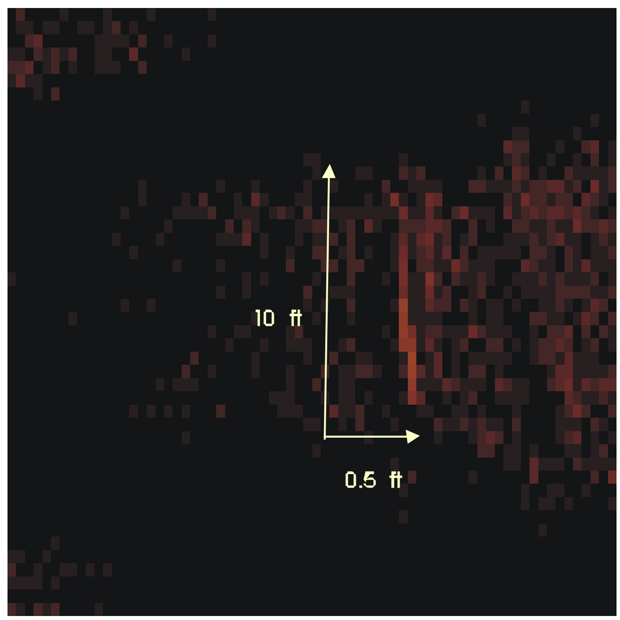
Anomaly Number	**Block/ Line**	**Dimensions L x W x H (Ft)**	**Image**
A7	B1L19(05)	16ft x .5ft x 1.5 ft	
A8	B1L23(04)	14.5ft x .5ft x 2ft	

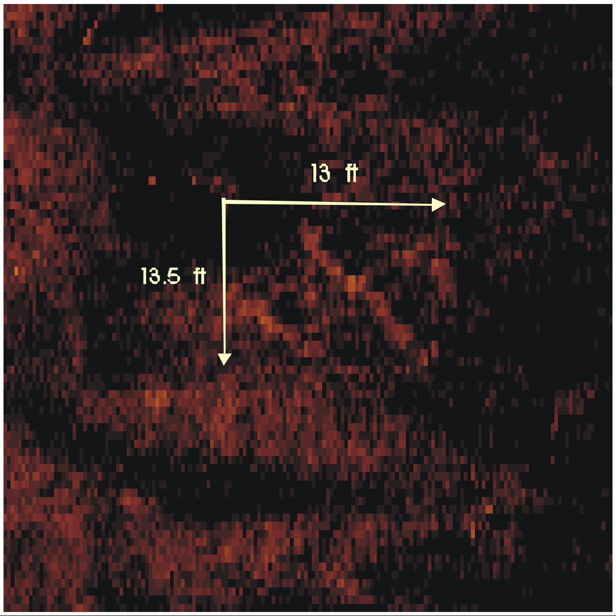
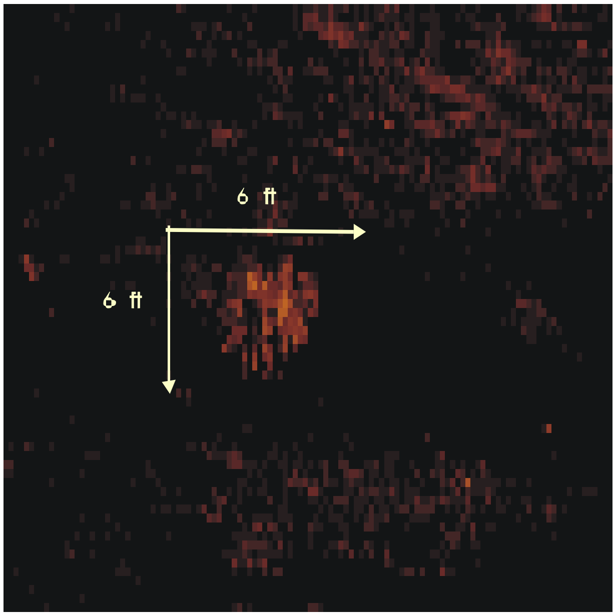
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A9	B1L44(20)	2.5ft x 2.5ft x 1 ft	
A10	B1L50(19)	9ft x 9ft x 2ft	

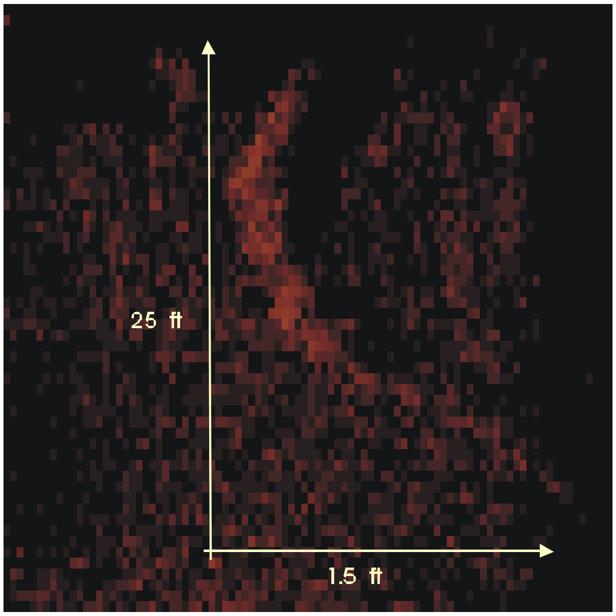
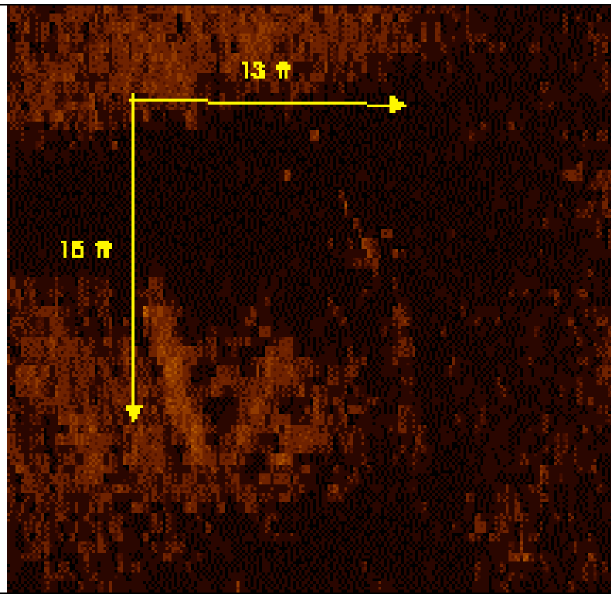
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A11	B1L59(50)	1ft x 1ft x 2ft	
A12	B1L59(69)	13ft x .6ft x 3ft	

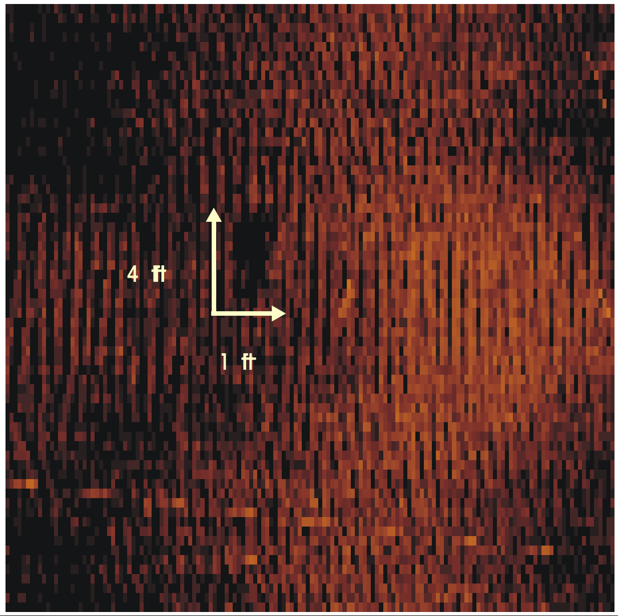
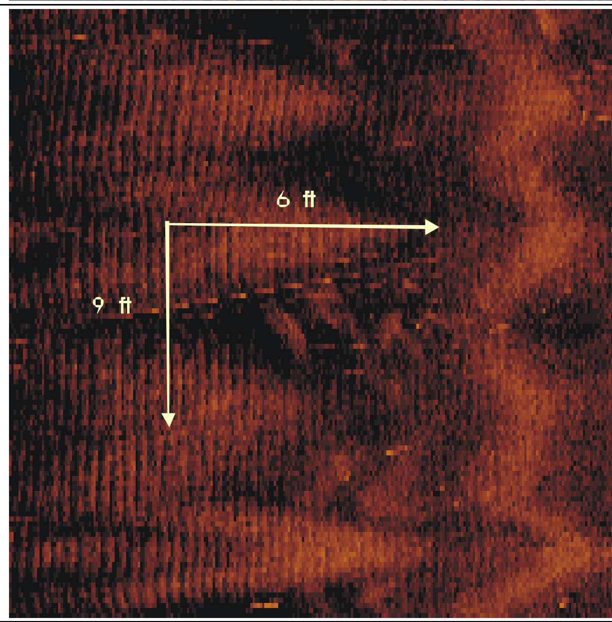
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A13	B1L59(153)	.5ft x .5ft x 2ft	
A14	B1L60(05)	11.2ft x 2ft x 1.5 ft	

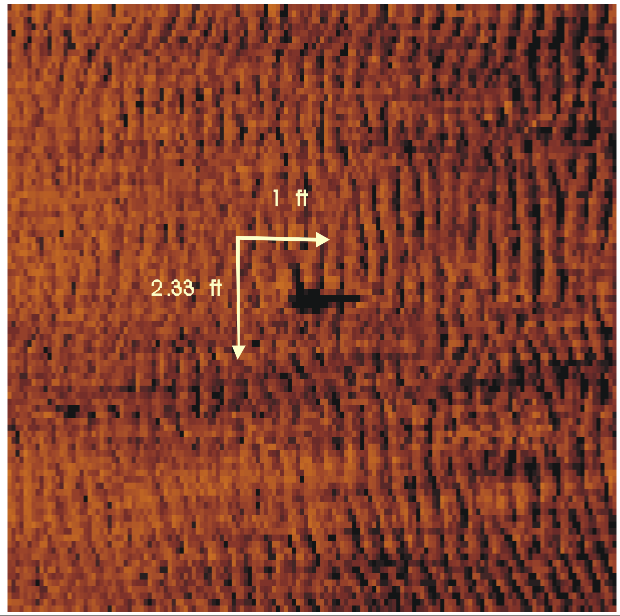
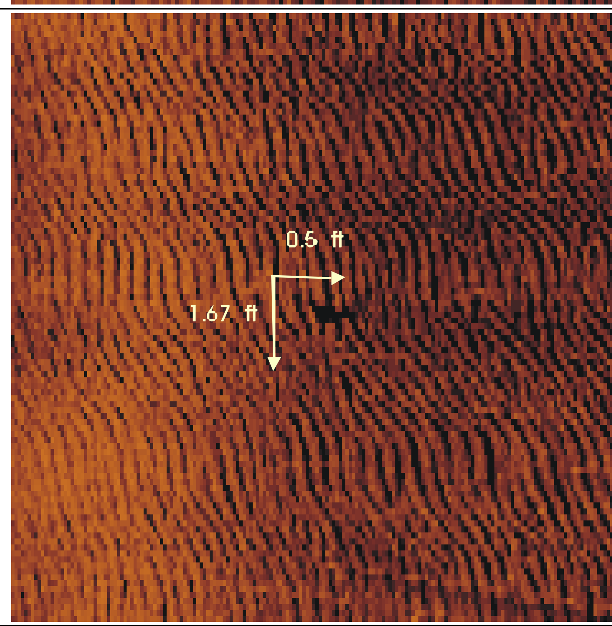
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A15	B1L61(13)	6.1ft x 6ft x 1 ft	
A16	B1L78(11)	20.5ft x 6ft x 3ft	

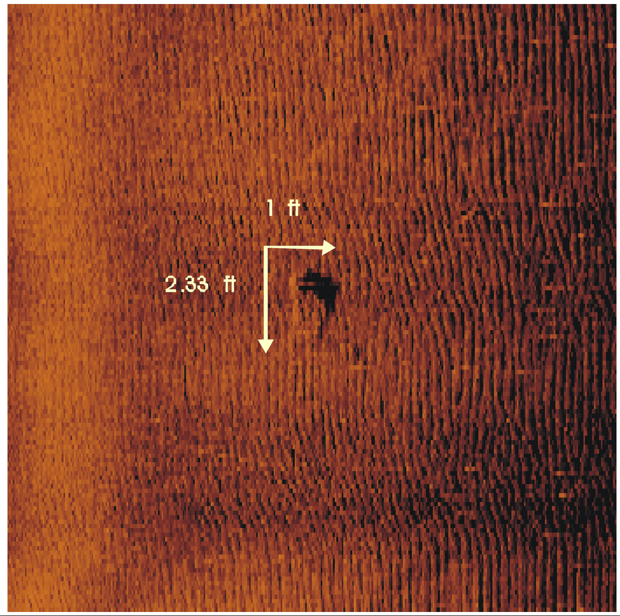
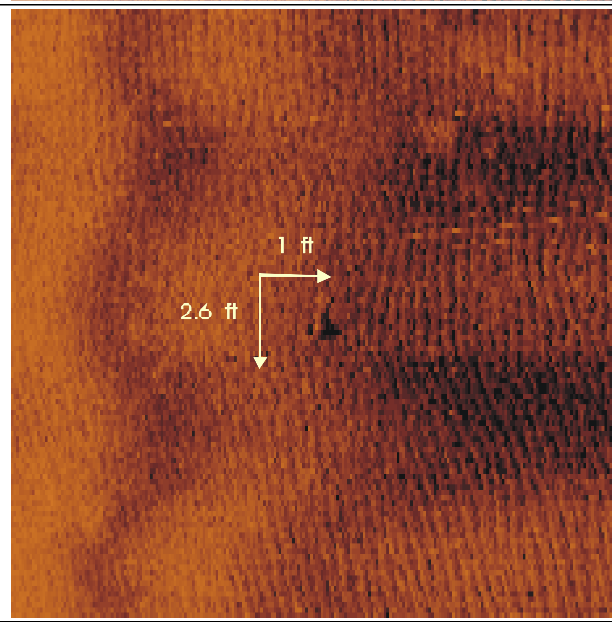
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A17	B1L78(15)	17.1ft x 3ft x 1 ft	
A18	B1L75(48)	10ft x .5ft x 2ft	

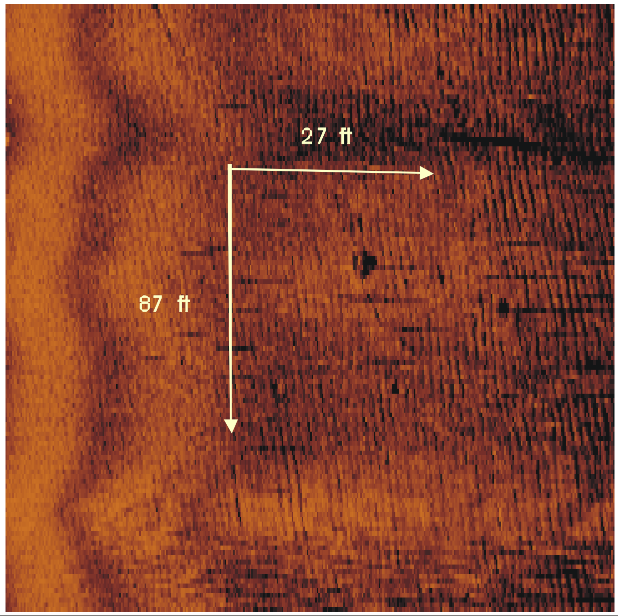
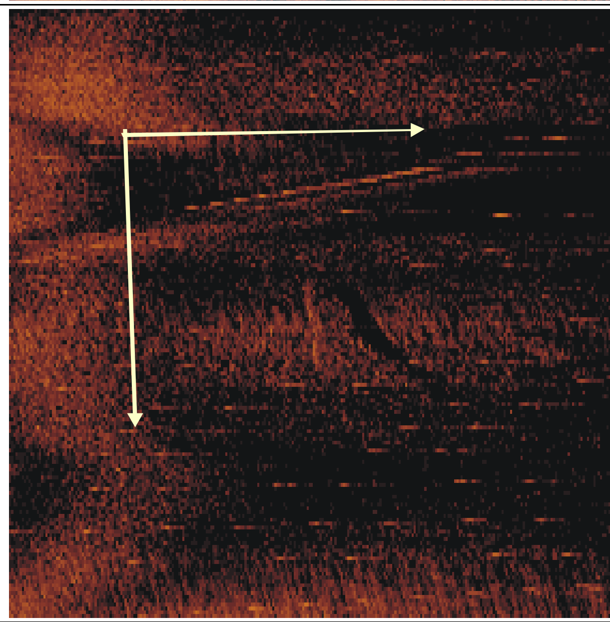
Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A19	B2L4(04)	13.5ft x 13ft x 2ft	
A20	B2L6(14)	6ft x 6ft x 1 ft	

Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A21	B2L12(040	25ft x 1.5ft x 1ft	
A22	B2A22	15ft x 13ft x 2ft	

Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A23	B2L36(20)	4ft x 1ft x 1ft	
A24	B2L39(00)	9ft x 6ft x 2ft	

Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A25	B2L40(01)	2.33ft x 1ft x 2ft	
A26	B2L49(06)	1.67ft x .5ft x 1.5ft	

Anomaly Number	**Block/ Line**	**Dimensions L x W x H (Ft)**	**Image**
A27	B2L42(02)	2.33ft x 1ft x 2ft	
A28	B2L44(03)	2.6ft x 1ft x 2ft	

Anomaly Number	Block/ Line	Dimensions L x W x H (Ft)	Image
A29	B2L45(18)	87ft x 27ft x 2ft	
A30	L46		

Appendix B:

Qualifications of Investigators

Jean Bernard (J.B.) Pelletier has over 20 years experience in marine geophysics, nautical archaeology, marine and terrestrial remote sensing, remotely operated vehicle operation and maintenance, underwater photography and video, technical diving, and diving safety. He is URS' Lead Nautical Archaeologist and Marine Remote Sensing Specialist. He exceeds the Secretary of the Interior's Professional Qualification Standards for Archaeology. Mr. Pelletier is an expert in the use of side-scan sonar, sub bottom profilers, single-beam echo sounders, and marine magnetometers and gradiometers. He also has extensive knowledge of Hypack Max software for data collection and interpretation. He has served a wide array of Federal, State, and private sector clients including the: USACE; U.S. Navy; MMS; National Oceanic and Atmospheric Administration; Delaware, Rhode Island, Florida, and Maryland DoTs; Maryland Department of Natural Resources; Maryland Port Authority; and BP. He received his M.A. in History and his B.A. in Geological Sciences from the University of Maine.

Anthony Randolph has 15 years of experience in cultural resources management, and exceeds the *Secretary of Interior Standards for Archaeology* (36CFR Part 61). Mr. Randolph has extensive experience in the management and execution of archaeological investigations. He has managed reconnaissance and investigations on prehistoric, historic and maritime sites throughout the eastern United States, Caribbean, and Europe. He also has extensive experience as an archaeological conservator through positions at Mariners Museum, and the government of Portugal. He received his Masters Degree in Anthropology from Texas A&M University in 2003 and his Bachelor's Degree in Neuroscience/Anthropology from the University of Pittsburgh in 1993.

Bridget Johnson has a broad background in historic and archaeological research. She has extensive experience in data collection and management for archaeological and historical projects. Ms. Johnson has extensive experience conducting historic research on a variety of topics and regions throughout the United States. Specialized experience includes the creation of three dimensional models of archaeological sites both terrestrial and underwater, as well as the management of archaeological collections. She received her Masters degree in Anthropology from Texas A&M University in 2008 and her Bachelors degree in History and Archaeology from St. Mary's College of Maryland in 2006.

WALLOPS FLIGHT FACILITY SHORELINE RESTORATION AND INFRASTRUCTURE PROTECTION PROGRAM: PROPOSED GROIN, BREAKWATER AND SHORELINE CULTURAL RESOURCE SURVEYS, ACCOMACK COUNTY, VIRGINIA

Prepared for:

Goddard Space Flight Center's Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337

Prepared by:

Anthony Randolph, M.A., R.P.A.
J.B. Pelletier, M.A., R.P.A.
Bridget Johnson, M.A., R.P.A.
Gregory Brooks, Ph.D.

Principal Investigator

J.B. Pelletier, M.A., R.P.A.

URS Group, Inc.
200 Orchard Ridge Drive, Suite 101
Gaithersburg, Maryland 20878
301-258-9780

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URS

ABSTRACT

This report presents results of four cultural resource tasks at Wallops Flight Facility (WFF), in Accomack County Virginia as part of the National Aeronautics and Space Administration (NASA) Shoreline Restoration and Infrastructure Protection Program (SRIPP). These tasks include a remote sensing survey of a proposed breakwater location, a scientific diving survey of a proposed groin location, a pedestrian survey of the Wallops Island shoreline, and the archaeological monitoring of geotextile tube installation on the same shoreline. A total of 37.3 hectares (92.1 acres) was evaluated during the four survey efforts. It was undertaken to assist NASA with compliance with Section 106 of the National Historic Preservation Act of 1966, as amended; with the Abandoned Shipwreck Act of 1987; and with the National Environmental Policy Act (42 U.S.C. 4321 et seq.) of 1970. These investigations and report were completed in accordance with Virginia Department of Historic Resources (VDHR) guidelines outlined in *Guidelines for Archaeological Investigations in Virginia* (1996), and with the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (Federal Register 48, No 190, 1983). NASA has consulted with VDHR staff regarding these project efforts between 2006 and 2009.

The primary objective of this study was to identify maritime related cultural resources, particularly submerged watercraft, and buried archaeological sites within the survey areas. The archaeological predictive model presented in *Cultural Resource Assessment of Wallops Flight Facility* (Myers 2003) identified the potential to encounter prehistoric and historic sites on WFF (which was approved by VDHR in a letter dated December 3, 2003), including the Atlantic coast shoreline and near shore waters. That report indicated that there was a moderate potential to encounter significant historic resources on this portion of WFF. Cultural resources surveys were required as a result of this determination before construction actions could begin. These actions include the construction of a new beach groin and breakwater, the installation of geotextile tube to arrest beach erosion, and the replenishment of beach sands lost to erosion.

No significant cultural resources were identified during the Phase I pedestrian survey of the Wallops Island coastline, the archaeological monitoring of geotextile tube placement, and the scientific diving survey of the proposed beach groin location. A total of five target groups were identified during the remote sensing survey of the proposed breakwater. None of these target clusters have the potential to represent significant submerged cultural resources. They instead represent debris associated with the previous wooden piling and steel cable breakwater demolished at this location. As previously stated, the four archaeological tasks undertaken for SRIPP did not identify any significant cultural resources. No further work is recommended.

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1.0 INTRODUCTION

This report presents results of four cultural resource tasks at Wallops Flight Facility (WFF), in Accomack County Virginia, as part of the proposed National Aeronautics and Space Administration (NASA) Shoreline Restoration and Infrastructure Protection Program (SRIPP) (Figure 1-1). URS Group, Inc. (URS) conducted this work to assist WFF with compliance with Section 106 of the National Historic Preservation Act of 1966, as amended; with the Abandoned Shipwreck Act of 1987; and with the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) of 1970. NASA is the lead agency preparing an Environmental Impact Statement under NEPA for their SRIPP at WFF; the U.S. Army Corps of Engineers and the Minerals Management Service are cooperating agencies on the EIS and other SRIPP-related compliance including Section 106 of the National Historic Preservation Act of 1966, as amended and the Abandoned Shipwreck Act of 1987. The four cultural resources tasks include a remote sensing survey of a proposed breakwater location, a scientific diving survey of a proposed groin location, a pedestrian survey of the Wallops Island shoreline, and the archaeological monitoring of geotextile tube installation on the same shoreline. A total of 37.3 hectares (92.1 acres) was evaluated during the three survey efforts. These investigations were undertaken in consultation with the Virginia Department of Historic Resources (VDHR) between 2006 and 2009, and in accordance with guidelines established in *Guidelines for Archaeological Investigations in Virginia* (1996), and the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (Federal Register 48, No 190, 1983).

The project area is composed of three separate survey parcels, which includes the proposed beach groin location, the proposed breakwater location, and the entire Wallops Island coastline contained within the bounds of WFF (Figure 1-2). The area of potential effect (APE) for the Wallops Island shoreline is 6.2 kilometers (3.85 miles), or approximately 28 hectares (69 acres), of coastal beach in Accomack County, on Virginia's Eastern Shore. The pedestrian survey was undertaken from the waterline to the beach edge within this portion of WFF. Archaeological monitoring of the 1,402 meters (4,600 feet) of shoreline that received geotextile tubes occurred within this study area, beginning at the southern terminus of the seawall and extended to the camera station at the southern end of NASA Property. The APE for the proposed groin is located in the Atlantic Ocean, directly opposite of the camera station at the southern end of NASA property. It measures approximately 152.4 meters (500 feet) by 30.5 meters (100 feet), or 0.45 hectares (1.1 acres). The APE of the proposed breakwater is located on the seaward edge of the proposed beach groin, and extends 121.9 meters (400 feet) to either side of the groin. It measures approximately 365.9 meters (1,200 feet) by 243.9 meters (800 feet), or 8.9 hectares (22 acres).

The primary objective of this study was to identify maritime related cultural resources, particularly submerged watercraft, and buried archaeological sites within the survey areas. The archaeological predictive model presented in *Cultural Resource Assessment of Wallops Flight Facility* (Myers 2003) identified the potential to encounter prehistoric and historic sites on WFF (which was approved by VDHR in a letter dated December 3, 2003), including the Atlantic coast shoreline and inland waters. This report indicated that there was a moderate potential to encounter significant historic resources on this portion of WFF. A series of cultural resources surveys was required as a result of this determination before construction actions could begin. Construction actions include the construction of a new beach groin and breakwater, the placement of geotextile tube to arrest beach erosion, and the replenishment of beach sands lost to erosion.

The investigations were undertaken between September 21, 2006, and August 28, 2009. Christopher Polglase, R.P.A., served as project manager for this project. Jean B. Pelletier R.P.A., served as principal investigator, scientific diver, senior remote sensing specialist and analyst. Anthony Randolph, R.P.A., served as scientific diver, remote sensing specialist and analyst. Bridget Johnson, R.P.A., conducted archival research. Amanda Hale, R.P.A., served as scientific diver, and Vince Shirbach contributed as archaeological support staff.

This report is divided into seven sections, including this introduction. Section Two is a review of previous archaeological and architectural sites, and contains surveys within 1.6 kilometers (1 mile) of the project area, followed by a discussion of known shipwrecks within 20.9 kilometers (13 miles) of the project area. Section Three contains the prehistoric and historic cultural contexts, which are used to evaluate the potential for encountering submerged prehistoric and historic cultural resources within the project area. Section Four reviews the environmental setting of the region. Section Five presents the research methods and repositories used during background investigations, survey methods, and the expected results of the survey. Section Six contains results of the remote sensing survey. Section Seven presents a summary and recommendations for the overall project. Section Eight contains references cited. Appendix A contains a list of side scan sonar anomalies, Appendix B contains the qualifications of investigators, and Appendix C contains a VDHR response letter to recommendations offered for the archaeological monitoring of geotextile tube installation.

2.0 PREVIOUS INVESTIGATIONS

2.1 ARCHAEOLOGICAL INVESTIGATIONS

A review of previously investigated sites provides a context used to assess the potential to encounter archaeological materials within the project area. A total of seven archaeological surveys were conducted within 1.6 kilometers (1 mile) of the project area (Table 2-1). These surveys identified a total of 10 archaeological sites within this radius (Table 2-2). Site 44AC558 was identified by the Eastern Shore Archaeological Society, but no formal report has been filed.

Table 2-1. Archaeological Surveys within 1.6 kilometers (1 mile) of the Project Area

Sites Identified	Company Name	Report Date
None	Mark Wittkofski (Wittkofski 1980)	1980
None	Greenhorn & O'Mara, Inc (Dinnell and Collier 1990)	1990
None	Telemarc, Inc (Otter 1991)	1991
None	3D/Environmental Services Inc. (Miller 1991)	1991
None	Louis Berger Group, Inc (Ahlman and LaBudde 2001)	2001
44AC9, 44AC89	Darrin Lowery (Lowery 2000, 2003)	2000, 2003
44AC159, 44AC459	URS Corporation (Myers 2003)	2003

Mark Wittkofski conducted a Phase I reconnaissance for a proposed parking lot on Wallops Island for the US Navy in 1980. He determined that the area had a low potential to contain archaeological resources as it had been disturbed and graded with modern fill (Wittkofski 1980). Wittkofski conducted a comprehensive survey of Accomack and Northampton Counties throughout the 1980s. This survey identified 281 previously unrecorded archaeological sites, none of which are within the project area.

Greenhorne & O’Mara, Inc. (Dinnell and Collier 1990) conducted a study of the southwestern portion of the Main Base for the Wallops Naval Facilities Engineering Command. They identified one site, but it was outside the 1.6 kilometer (1 mile) radius of the current project area.

Telmarc, Inc (Otter 1991) conducted a Phase I archaeological survey adjacent to the WFF in 1991. This study was conducted as part of a property acquisition west of a runway. No cultural resources were identified.

3D/Environmental Services, Inc. (Miller 1991) completed a cultural resources inventory which included an evaluation of archaeological and architectural resources of the WFF in 1991. The study was designed to produce a predictive model and sensitivity assessment for archaeological resources, as well as acting as a planning document for future evaluations at WFF.

Louis Berger Group, Inc. (Ahlman and LaBudde 2001) conducted an archaeological survey for the proposed Route 709 bridge replacement located northwest of the island. They identified three archaeological sites. These sites are all located beyond the 1.6 kilometer (1 mile) radius of the project area.

Darrin Lowery (2000, 2003) conducted an archaeological survey of the Chesapeake and Atlantic shorelines associated with Accomack and Northampton Counties of Virginia. His findings were presented in two volumes designed to assess the impact of natural and human activities to archaeological sites along the shore. He documented numerous previously identified sites, both historic and prehistoric in nature, as well as documenting several new sites. His report identified seven sites (44AC9, 44AC77, 44AC78, 44AC79, 44AC80, 44AC81, 44AC89) within a 1.6 kilometer (1 mile) radius of the project area. Site 44AC9 represents an archaic shell midden that is limited to the plow zone and includes a few prehistoric ceramics sherds. Sites 44AC78, 44AC79, 44AC80, and 44AC81 all represent shell middens from an undetermined prehistoric period. Site 44AC77 was a historic artifact scatter consisting primarily of ceramics which date to the second and third quarters of the 19th century. Site 44AC89 consists of a possible Revolutionary War earthwork located on Wallops Island.

URS conducted a cultural resources assessment of WFF in 2003 (Meyers 2003). The goal of this study was to further assess archaeological and architectural potential. Two archaeological sites, 44AC159 and 44AC459 were encountered within the 1.6 kilometer (1 mile) radius of the current project area. Site 44AC159 is located on Wallops Island and consists of a clam and oyster shell midden approximately 3 feet in height. Site 44AC459 was a late 19th to early 20th century structure associated with the US Coast Guard. A total of 291 artifacts were recovered from this site including nails, brick, glass, ceramic, and shell.

Table 2-2. Archaeological Sites within 1.6 Kilometers (1 Mile) of the Project Area

Site Number	Site Type	Cultural Period
44AC9	Shell Midden	Archaic
44AC77	Historic Artifact Scatter	Late 19th century
44AC78	Shell Midden	Undetermined Prehistoric
44AC79	Shell Midden	Undetermined Prehistoric
44AC80	Shell Midden	Undetermined Prehistoric
44AC81	Shell Midden	Undetermined Prehistoric
44AC89	Military Earthworks	Revolutionary War
44AC159	Shell Midden	Unknown
44AC459	Historic Coast Guard Site	Late 19th-20th century
44AC558	Artifact Scatter	Undetermined Prehistoric

2.2 ARCHITECTURAL INVESTIGATIONS

Two previously identified historic properties are located within a 1.6 kilometer (1 mile) radius of the project area (Table 2-3). Within the WFF itself are two historic properties that were found to be eligible for listing in the NRHP in the 2004 *Historic Resources Survey and Eligibility Report for Wallops Flight Facility, Accomack County, Virginia* (URS/EG&G 2004): the Wallops Exchange and Morale Association (WEMA) Recreational Facility/U.S. Coast Guard (USCG) Lifesaving Station (V-065, VDHR# 001-0027-0100), and the Observation Tower (V-070, VDHR#001-0027-0101). In a letter dated November 4, 2004, VDHR concurred with NASA's determination of eligibility for these two properties.

Table 2-3. Architectural Sites within a 1.6 kilometer (1 mile) of the Project Area

DHR ID #	Name	National Register Eligible
001-0027-0100	U.S. Coast Guard Lifesaving Station	Yes
001-0027-0101	Observation Tower	Yes

2.3 KNOWN SHIPWRECKS IN THE WALLOPS ISLAND AREA

Twelve shipwrecks have been recorded in the vicinity of Wallops Island, extending 20.9 kilometers (13 miles) off shore (Table 2-4). These wrecks were identified primarily using NOAA's Automated Wreck and Obstruction Information System (AWOIS), and Bruce Berman's *Encyclopedia of American Shipwrecks* (1972).

The proximity of Wallops Island to the Chincoteague Inlet, which serves as the entrance to Chincoteague Bay, resulted in extensive commercial and recreational vessel traffic along the Wallops Island coastline en route to Chincoteague and other barrier islands. Reported craft losses in the vicinity of Wallops Island are consistent with vessel classes commonly operated within the Chesapeake region. All craft were lost during the 20th century. A total of four wrecks were sailing schooners and three were barges. A single tug boat and fishing trawler were also lost, along with three unidentified vessels.

Table 2-4. Vessels Sunk within 20.9 kilometers (13 miles) of Wallops Island

Vessel Name	Vessel Type	Date of Loss	Date Built	Tonnage	Cause of Loss	Location
E.R. Smith	Unknown	1/25/1943	Unknown	Unknown	Sunk	Lat: 37.8167 Long: 75.3663
Florence and Lillian	Schooner	9/19/1921	1874	252	Foundered	SW of Chincoteague Lighthouse
Jennie N Huddell	Schooner	2/4/1910	1870	279	Stranded	Carter’s Shoal, Chincoteague
Lizzie Godfrey	Schooner	7/12/1914	1890	77	Stranded	Chincoteague Inlet
Nancy Jane	Fishing Trawler	3/2/1968	Unknown	Unknown	Sunk, broken up	Lat: 37.8667 Long: 75.4163
P. J Hooper	Tug	3/26/1971	Unknown	Unknown	Unknown	Lat: 37.8367 Long: 75.3399
Ruhama Shaw	Barge	12/8/1917	1915	473	Foundered	Blackfish Bank, Va.
Ruth	Barge	12/9/1917	1908	435	Foundered	Blackfish Bank, Va.
Steel Barge No. 2	Barge	1/23/1935	1889	2217	Foundered	Blackfish Bank Buoy, Va
Unknown	Sailing	Unknown	Unknown	Unknown	Unknown	Lat: 37.8646 Long: 75.4005
Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Lat: 37.8001 Long: 75.2463
Wm. Meekins	Schooner	12/22/1918	1874	79	Stranded	Chincoteague, Va.

Source: AWOIS, Berman 1972

3.0 CULTURAL CONTEXT

The Virginia Department of Historic Resources (VDHR) has developed a chronological framework for the prehistory and history of the Commonwealth. This framework provides the basis for understanding prehistoric and historic cultural development in the area, as well as providing a context for predicting the types and kinds of archaeological sites expected in the project area. Included in this background section are Prehistoric Context and Historic Contexts.

3.1 PREHISTORIC CONTEXT

VDHR has defined three major periods of prehistory. These are the Paleoindian Period (10,000 – 8000 BC), the Archaic Period (8000 – 1000 BC), and the Woodland Period (1000 BC – AD 1600). Table 3-1 summarizes the chronology of these periods. The Archaic and Woodland Periods are further subdivided into Early, Middle, and Late Periods, which are characterized by changes in material culture (e.g., projectile point styles), environmental adaptation, subsistence strategies (e.g., hunting and gathering, fishing, and horticulture), settlement patterns, technology, and socio-political configurations. Each major time period is discussed below, along with relevant data concerning settlement and subsistence patterns established by excavations and study of archaeological sites in the Coastal Plain.

Table 3-1. Prehistoric Culture Chronology

Culture Period	Sub-Period	Date Ranges
Paleoindian	n/a	10,000 – 8000 BC
Archaic	Early	8000 – 6500 BC
	Middle	6500 – 3000 BC
	Late	3000 – 1000 BC
Woodland	Early	1000 BC – AD 300
	Middle	AD 300 – AD 1000
	Late	AD 1000 – AD 1600
Contact	n/a	ca. AD 1600

3.1.1 Paleoindian Period (10,000 – 8000 BC)

The region was first inhabited approximately 12,000 years ago with an influx of people who practiced a hunting and foraging lifestyle. Although there is evidence of human occupation in western North America and South America before 10,000 – 12,000 BC, there is no conclusive evidence in the Middle Atlantic region for human occupation before the Paleoindian Period. There is a great deal of debate over the issue of a “pre-Clovis” culture in the Americas that predates the traditional “Clovis” culture of the Paleoindian Period. Archaeological sites such as Cactus Hill in Virginia (e.g., McAvoy and McAvoy 1997), Meadowcroft Rockshelter in southwestern Pennsylvania (e.g., Adovasio et al. 1978), and the Topper Site in South Carolina (e.g., Parfit 2000; Rose 1999) have provided tantalizing but inconclusive evidence for human occupations predating the Paleoindian Period. There is currently no evidence for pre-Paleoindian occupations on the Delmarva Peninsula although shifts in survey strategies in recent decades (e.g. Lowery 2001, 2003) have resulted in new discoveries that may change the focus of research in this area. There are also extensive aeolian soils on the coastal plain that may cover more ancient fluvial sediments (Foss et al. 1978). Some of the depositional contexts may eventually reveal buried Paleoindian or pre-Paleo occupations. The discussion below focuses on the widely accepted definition of the Paleoindian culture in the Middle Atlantic region.

The end of the Pleistocene epoch (ca. 12,000 – 10,000 years ago) represents the terminus of the Ice Age or at least the beginning of a long interglacial episode. The environment during this time was quite different from modern conditions. Moisture locked in glacial ice sheets resulted in lower sea levels and greater exposure of coastal lands. Areas exposed during this time were subsequently inundated by the global sea level rise that began at the end of Pleistocene, when climatic amelioration resulted in melting continental ice sheets. During this period of post-glacial warming, the climate was probably three to eight degrees Celsius colder than at present, and the vegetation consisted of an open spruce parkland forest composed of spruce, pine, fir and alder (Brush 1986:149; Owens et al. 1974; Sirkin et al. 1977).

The Paleoindian toolkit included fluted projectile points, which were typically manufactured from high-quality lithic materials chosen for their predictable and consistent flaking properties. Projectile point types include Clovis, Cumberland/Barnes, Crowfield, Hardaway-Dalton, and Hardaway Side-Notched (Dent 1995; Lowery 2001, 2003). Other tools in the Paleoindian toolkit include endscrapers, sidescrapers, gravers, burins, denticulates, knives, *pieces esquillées*, wedges, perforators, and generalized unifaces and bifaces (Dent 1995).

Preferred lithic materials for these projectile points were high-quality cryptocrystalline rock such as jasper and chert (Brown 1979; McCary 1984), though tools made from locally available quartz and quartzite cobbles have been documented at sites in the Middle Atlantic region (e.g., Ebright 1992; McAvoy and McAvoy 1997). Archaeologists have postulated that Paleoindian hunter-gatherers traveled long distances to obtain raw materials for tool production (e.g., Custer 1984a; Gardner 1977). Recent research, however, has documented the availability of high-quality cherts and jasper cobbles in the Coastal Plain (e.g., Lowery 2001, 2003), suggesting that Paleoindians did not necessarily travel long distances to obtain lithic raw materials.

Paleoindian Period settlements consisted of seasonally-occupied camps, from which forays were made to obtain specialized resources, such as stone for tool manufacture (Custer 1984a; Dent 1995; Gardner 1977). Site types postulated for the Paleoindian Period include base camps, quarry sites, quarry reduction stations, quarry-related base camps, base camp maintenance stations, outlying hunting stations, and isolated projectile point finds (Custer 1989; Gardner 1989). These site types are considered part of the “seasonal round” of Paleoindian settlement patterning.

The isolated point find is the most common of these manifestations and the distribution of such finds on the Delmarva Peninsula shows a concentration on the Mid-peninsular drainage divide where bay-basin features represent Pleistocene surface water sources (Custer 1989:29). This is not to say that other areas were not frequented; perhaps it simply reflects the availability of more exposed acreage for occupation in the Middle of the peninsula. These sites are in headwater areas where streams flow to the bay and the ocean. Davidson (1981) also notes the use of interior drainages during this period; a trend that continues though the Middle Archaic. A single fluted point site is recorded in Virginia on the lower Delmarva Peninsula, (Custer 1989:93), but this find is not noted in McCary's (1984) fluted point survey.

Custer (1984a, 1989) classifies upper Delmarva Paleoindian sites within the Delaware Chalcedony Complex, which focuses on outcrops of high quality cryptocrystalline lithic raw materials, specifically Delaware chalcedony. Settlement patterns focused on these high quality lithic resources and on environmental resource gathering zones such as upland or interior swamps, headwater zones and similar early Holocene environmental settings.

Paleoindian subsistence patterns are difficult to discuss for the Middle Atlantic region due to the paucity of recovered faunal and floral remains. Paleoindians in the western United States are considered to be "big game" hunters of extinct Pleistocene megafauna such as the mammoth, caribou, musk ox, and giant beaver. There is no concrete evidence for a similar subsistence pattern in the Middle Atlantic region, though megafaunal remains have been recorded in the area (Custer 1989; Dent 1995; Edwards and Merrill 1977; Lowery 2001, 2003). Paleoindians in this area likely subsisted on mammals such as white-tailed deer, caribou and moose, along with smaller mammals. While Paleoindian subsistence probably focused on hunted game, there is evidence to suggest that plant foods and fish were also important food resources (Dent 1995; McNett l985). It should also be noted that a rich array of megafauna (e.g., mammoth, mastodon, walrus, and ground sloth) recovered from the continental shelf of the east coast may represent some of the key species that were hunted at the end of the Pleistocene (Edwards and Merrill 1977). One of the mammoth finds, for example, comes from the outer edge of the coastal plain in the lower Delmarva Peninsula area of Virginia (Edwards and Merrill 1977:11).

Paleoindian sites are not widely known in the Virginia Coastal Plain. Much of what archaeologists know about Paleoindians comes from isolated finds of fluted projectile points. Few intact Paleoindian sites have been identified in the region (Dent 1995; Lowery 2001, 2003); however, dozens of isolated fluted point finds have been documented on the Delmarva Peninsula (e.g., Custer 1989; Dent 1995). The Paw Paw Cove site, located in the northern Chesapeake Bay area in Maryland, is currently the only excavated Paleoindian site on the Delmarva Peninsula (Dent 1995; Lowery 2001, 2003). One theory explaining the lack of documented Paleoindian sites is that they are located on the Continental Shelf of the Atlantic Ocean in areas that would have been dry land during the Paleoindian Period (e.g., Dent 1995; Lowery 2001, 2003).

3.1.2 Archaic Period (8000 – 1000 BC)

The Archaic Period dates to ca. 10,000 to 3,000 years ago, and is conventionally sub-divided into the Early (8000 – 6500 BC), Middle (6500 – 3000 BC), and Late (3000 – 1000 BC) Sub-Periods. In the Middle Atlantic area, Archaic sites are much more numerous, larger, and richer in artifacts than earlier Paleoindian sites. They represent a series of adaptations that engendered an increasingly sedentary existence, and focused on resources available along large rivers and major tributaries. Other, often smaller sites of this period located away from the main streams probably represent seasonal or other specialized activities. Increasing territoriality and regional diversity are reflected in numerous artifact varieties, especially projectile points, throughout the Archaic Period. Evidence from Paleoindian and Early Archaic sites suggests that the transition from the Paleoindian way of life was a gradual transition (Custer 1990).

This transition was associated with a major climatic change that marks the end of the Pleistocene and beginning of the Holocene. The cool and moist climate of the late Ice Age shifted to a warmer and drier climate that approximates that of today. Rising sea levels inundated the lower Susquehanna River Valley and began forming the Chesapeake Bay estuary and its large salt and brackish water marshes, habitats that provided a rich and diverse subsistence base (Kraft 1976). As temperatures increased during the early Holocene, vegetation in the region shifted from coniferous forests of spruce to mixed deciduous/coniferous forests of hemlock, birch, hickory, and oak (Brush 1986:149; Custer 1990:10; Owens et al. 1974; Sirkin et al. 1977). The spread of deciduous woodlands into upland areas after 7000 BC opened up new habitats to be exploited by animals and humans (Custer 1990).

3.1.3 Early Archaic Period (8000 – 6500 BC)

Environmental conditions during the Early Archaic Period were not drastically different from the Paleoindian Period. Glacial recession continued and deciduous forests expanded, possibly leading to a proliferation of temperate fauna. The most distinctive cultural characteristic of the Early Archaic was the appearance of notched projectile points, most notably the Palmer and Kirk varieties. There was a continuation of the Paleoindian tradition of using high quality cryptocrystalline lithic materials until the end of the Early Archaic Period, when lower quality quartz and quartzite materials were more frequently used. Archaeological investigations in the Patuxent River drainage showed that the majority of Kirk points found were made of rhyolite. This indicates that by the Kirk phase, people traveled long distances in order to obtain preferred lithic raw materials, or that by this time long-range trade networks had been established (Steponaitis 1980:68). Although rhyolite is certainly exploited as a lithic raw material by this time, it still does not represent the intensive use evident during the Late Archaic.

There was significant innovation in stone tool kits during the Early Archaic Period. Stemmed and side-notched serrated projectile points replaced fluted projectile point varieties. The variety of projectile points associated with these periods indicates possible changes in subsistence strategies and exchange networks, and a possible regionalization of cultural traditions. Projectile point styles characteristic of the period include: corner-notched, serrated point styles such as Kirk, Palmer, Charleston, Lost Lake, Decatur, Amos, Kessel, and Fort Nottoway/Thebes; and stemmed points such as the Kirk stemmed and Pequea types (Custer 1984a, 1989, 1996; Dent 1995; Lowery 2001, 2003). Other tool types characteristic of Early Archaic Period assemblages include grinding slabs, milling stones, nutting stones, chipped stone adzes, wedges, perforators, knives, and scrapers, as well as unifacial and bifacial tools (Dent 1995; Lowery 2001, 2003).

Early Archaic Period inhabitants continued to show a preference for high-quality lithic materials, either transported into the area through trade or travel, or obtained from cobble sources in river and stream beds. Some researchers (e.g., Lowery 2001, 2003) have noted that Early Archaic people appear to have a preference for non-local cherts, chalcedonies, and jaspers, and have also noted the increased use of rhyolite for tools during this period (e.g., Custer 1984a; Dent 1995; Lowery 2001, 2003).

Both Gardner (1974) and Custer (1980) have hypothesized that Early Archaic Period peoples banded together into macro-base camps, or groups of families, in the spring and summer, and dispersed into smaller micro-base camps in the fall and winter months. Larger base camps were located in the valley floodplains while the smaller autumn and winter encampments were located in upland regions.

There is little faunal evidence from archaeological sites dating to the Early Archaic period, though "it is assumed that this environment supported bear, deer, elk, and a variety of small game adapted to a northern climate" (Kavanagh 1982:9). One exception is the Cactus Hill site (44SX202) which contains the remains of species that are still common in the region today (Whyte 1995). Floral evidence from sites such as the Crane Point site, in Talbot County, Maryland, includes hickory nut, butternut, acorn, amaranth, and chenopodium (Lowery 2001, 2003). Other sites in the Chesapeake Bay region have produced similar results (Dent 1995). The floral remains recovered from Early Archaic contexts indicate that a variety of plants were used for food. Stone artifacts such as grinding slabs, milling stones, and nutting stones are also indicative of increased reliance on plant foods, while adzes indicate increased manufacture of items from wood (e.g., shelter). The changes in tool types have been interpreted as a shift in subsistence strategies towards a broad-spectrum adaptation, utilizing a variety of species of animals and plants, rather than focusing primarily on large animals.

Numerous Early Archaic Period sites are located throughout the Delmarva Peninsula (Custer 1989; Dent 1995), mostly from surface finds in estuarine and shore locations. Early Archaic Period base camps on the Eastern Shore may have been located on floodplains or river terraces that have since become submerged by sea level rise. Smaller procurement or temporary camps may be located on the high terrace areas (elevations above 25 feet amsl), though none have been recorded in Accomack County. The same terraces that produced fluted points have also produced numerous finds of Early Archaic points, recovered by artifact collectors who search shoreline surfaces at low tide. These submerged manifestations represent significant clusters of Early Holocene sites. Nearby upland areas may also contain a variety of procurement sites and lithic scatters.

3.1.4 Middle Archaic Period (6500 – 3000 BC)

The beginning of the Middle Archaic Period coincides with the on-set of the Atlantic climatic episode, which was a warm, humid period with a gradual rise in sea level that led to the development of inland swamps. It was a period marked by an increase in summer drought, sea level rise, grassland expansion into the Eastern Woodlands, and the appearance of new plant species (Carbone 1976:106; Hantman 1990:138). Human settlements consisted of small base camps located in or near inland swamps that were convenient to access seasonally available subsistence resources as well as small, temporary upland hunting sites. This adaptation, along with the use of a greater variety of plant resources, allowed for an increase in general foraging (Kavanagh 1982:50).

The Middle Archaic Period is characterized by a variety of projectile point styles, including bifurcated styles (e.g., St. Albans, LeCroy, and Kanawha) that were introduced at the end of the Early Archaic Period (Dent 1995). Other projectile point styles used during the Middle Archaic Period include Stanly Stemmed, Neville, Morrow Mountain I and II, Halifax, and Guilford types (Dent 1995; Lowery 2001, 2003). Morrow Mountain and Neville points are more rarely found in Virginia. The former are found principally in the Southeast whereas Neville points are a typical Northeast type. Brewerton and Otter Creek styles were introduced during the latter part of the Middle Archaic Period, and persist into the early Late Archaic Period. Other artifact types characteristic of the Middle Archaic Period include groundstone tools (e.g., adzes and gouges), as well as scrapers, perforators, spokeshaves, and expediently-made flake tools for a variety of functions (Dent 1995; Lowery 2001, 2003). Rhyolite became more commonly used for making tools, though other local resources such as quartz and quartzite were utilized as well. The tendency towards greater reliance on local lithic sources led to a marked increase in numbers of informal flake tools for short-term use.

Middle Archaic Period sites have been documented on the Delmarva Peninsula, and include isolated point finds as well as sites with buried components (Dent 1995; Lowery 2001, 2003). Community pattern and settlement data are somewhat limited due to the scarcity of Middle Archaic Period sites with good, interpretable depositional contexts. Surface sites are, however, located in a variety of settings including uplands, river terraces, and wetland areas. Middle Archaic Period sites on the Delmarva Peninsula have been documented along Carolina Bay features, spring-fed interior wetlands, upland terraces, and confluences of freshwater streams (Lowery 2001, 2003). Subsistence patterns appear to be very similar to the preceding Early Archaic Period, based on the limited data that are available (Dent 1995; Lowery 2001, 2003). Middle Archaic points in nearby areas of Maryland have been found on sites (e.g., 18SO75 and 18SO105) along Kings Creek and the Manokin River. Like earlier Holocene manifestations, most of sites are known through isolated point finds on river terraces and along eroding shorelines.

3.1.5 Late Archaic Period (3,000 – 1000 BC)

Modern vegetation had become established in the region by approximately 3,000 BC, and the climate was punctuated by alternating periods of dry and moist conditions (Brush 1986:150). The Late Archaic Period is characterized by a warmer and drier climate than today, with the development of xeric forests (e.g., oak and hickory) and open grasslands (Carbone 1976; Custer 1984b). Sea level continued to rise, but was relatively stable by the end of the Late Archaic Period (Dent 1995; Lowery 2001, 2003). The warmer and drier climate appears to have stabilized stream valleys and estuaries in the region, making such localities more attractive for settlement. These settings developed into rich habitats with a great diversity of exploitable resources, particularly shellfish and anadromous fish (Davidson 1981; Hughes 1980). This is reflected in the changes manifested in Late Archaic tool kits as well as in the number of site types and site locations utilized. For example, settlement data from the lower Eastern Shore show increased use of riverine and estuarine settings, and there is a concomitant use of ephemeral settings as well, including headwaters, and low and high order stream areas (Davidson 1981, Hughes 1980).

The Late Archaic Period is characterized by a large variety of projectile point styles, including Otter Creek, Vosburg, and Brewerton, Lackawaxen, Bare Island, Halifax Side-Notched, Vernon, Clagett, Piscataway (a type that persists into the Woodland Period), and Holmes (Dent 1995). The initial sequence for the Late Archaic was developed by Stephenson and Ferguson (1963) and referred to Piscataway, Otter Creek, Vernon, and Brewerton projectile point styles. Otter Creek points have been recovered from Middle and Late Archaic contexts including an Otter Creek component identified at the Higgins site (Ebright 1989). Other Otter Creek sites in the Middle Atlantic region and the Northeast in general are described by Steponaitis (1980) and Funk (1965).

Projectile point styles characteristic of the end of the Late Archaic (sometimes referred to as the Terminal Archaic Period) include “broadspears” such as the Savannah River, Susquehanna Broadspear, Koens-Crispin, Lehigh, and Perkiomen types (Dent 1995). Other projectile point types found during the Terminal Archaic that persist into the Early Woodland Period include the

Orient Fishtail and Dry Brook types. The Fishtail phase marks the end of the Archaic period and the beginning of the Early Woodland.

Besides the established formal projectile point styles, there appears to have been an increase in the production of informal tools made out of flakes (Klein and Klatka 1991:98). Other artifacts characteristic of the period include steatite (soapstone) bowls, groundstone tools (axes, adzes, celts, gouges), perforators and drills fashioned from broken projectile points, and scrapers (Dent 1995). Rhyolite was established during this period as a preferred lithic raw material for tool manufacturing. It was during the Terminal Archaic as well as the succeeding Early Woodland Period that large amounts of rhyolite were transported from sources in the Blue Ridge to the Coastal Plain. The network that facilitated trade in rhyolite is not well understood (Kavanagh 1982:99).

Surface collections in the Delmarva region show greater use of locally available lithic raw materials (e.g., quartz and quartzite) during the Late Archaic. Broadspears recovered from eastern shore sites, especially the Susquehanna broadspears, are almost exclusively made from South Mountain (Blue Ridge) rhyolite. In the lower eastern shore of Maryland, these have been recovered, along with bannerstones and gorgets, from sites (e.g., site 18WO32) along the Pocomoke River.

The Late Archaic was characterized in the eastern United States by evidence of population growth, patterns of regional differentiation, and increased technological specialization. Trade networks appear to have been established for the exchange of raw materials and finished goods. The first large, semi-sedentary (i.e., occupied for several months or seasons) base camps were established along rivers and streams, and along estuaries on the Delmarva Peninsula. Surface site data show increases in site size, which may simply represent multiple, repeated occupations rather than single, large group manifestations. Site types postulated for the area include base camps, temporary camps, and resource procurement stations (Dent 1995).

Subsistence was still largely based upon gathering and hunting, although there was an increased reliance on riverine resources toward the end of the period (Steponaitis 1980). Seasonal hunting and foraging continued, but exploitation of riverine resources rapidly became an important part of the subsistence base. This continues the earlier trend toward a broad spectrum adaptation in which a variety of resources were exploited in many different environmental settings. The result has been the identification of Late Archaic sites in just about every habitable setting in the region. This broad spectrum adaptation is another way of characterizing what Caldwell (1958) originally called *primary forest efficiency* in the Archaic of the Eastern Woodlands.

A number of indicators point to an intensification of certain subsistence strategies ca. 2000 BC, which represents a major change in lifeways. This intensification has been explained as a consequence of gradual change (Caldwell 1958) and as episodic change relating to a shift in the composition of the environment (Carbone 1976). Structures such as fish weirs, used to exploit anadromous fish runs, were constructed during this period, and reflect the intensive riverine focus of the latter part of this period. While riverine resources were certainly important, interior and upland areas continued to be utilized by Late Archaic peoples. Late Archaic subsistence economies may be described as diffuse, considering the use of upland areas for a broad range of resource procurement activities gathering foods such as acorns, hickory nuts, and butternuts as well as large and small game (Cleland 1976). Subterranean storage pits and steatite containers appear in the archaeological record by 1500 BC. These technological developments led to food surpluses and the subsequent preservation of these surpluses over an extended period. The appearance of large numbers of implements, useful in processing seed and fiber products, is further evidence of this emerging economic pattern.

3.1.6 Woodland Period (1000 BC – AD 1600)

The Woodland Period dates from 1000 BC – AD 1600, and is conventionally divided into the Early (1000 BC – AD 300), Middle (AD 300 – 1000), and Late (AD 1000 – 1600) sub-periods based on changes in ceramic types, lithic technologies, subsistence patterns, and social development. The climate during the Woodland Period is characterized by a return to cool, moist conditions and establishment of vegetation that is characteristic of the region today. The Woodland Period is marked by the introduction of ceramics, significant population growth, and an increasingly sedentary way of life. Hunting and gathering of wild floral and faunal resources remained important, but incipient horticulture, based on maize cultivation, eventually formed an important part of the subsistence base.

3.1.6.1 Early Woodland Period (1,000 BC – AD 300)

It was previously thought that the transition between the Late Archaic and Early Woodland Period represented the introduction of horticulture (e.g., Fritz 1993; Smith 1992, 1995). Although Early Woodland groups in the South and Midwest used cultivated plants, there is presently no evidence that cultivated foods played a role in the diet of Early Woodland people in the Chesapeake Bay area. Efficient hunting and gathering systems stemming from several millennia of development (e.g., Caldwell 1958), including the exploitation of riverine and marine species, apparently slowed the acceptance of viable cultigens. Cultivated foods begin to assume an important role after 800 to 900 AD, when varieties of tropical cultigens arrived in the Middle Atlantic area (Smith 1995). These complemented cultigens of the eastern agricultural complex (e.g. sunflower, goosefoot, sumpweed, and little barley) that had been developing for centuries.

The introduction of pottery around 1,000 BC marks the beginning of the Woodland Period. Potters’ innovations, as reflected in ceramic types, have become a significant basis for dating Woodland Period archaeological site components. The earliest ceramic types from the Eastern Shore are the steatite-tempered Marcey Creek ware and the crushed rock-tempered Dames Quarter ware. Both of these wares were later replaced by the sand or crushed quartz-tempered Accokeek wares, Wolfe Neck wares, and the grog-tempered (crushed clay) Coulbourn wares (Custer 1983, 1989; Dent 1995; Egloff and Potter 1982; Mouer 1991; Stephenson et al. 1963).

Stone artifacts characteristic of the Early Woodland Period include Calvert, Rossville, Potts, and Piscataway types, some of which are also found in Late Archaic contexts (Dent 1995; Lowery 2001, 2003; Hranicky 1991, 1993, 1994; Hranicky and Painter 1989). Other artifact types include drills, perforators, flake tools, scrapers, bifaces, anvil stones, net sinkers, mortars, pestles, manos, metates, groundstone tools (axes, adzes, celts), ground slate, gorgets, and tools made from animal bone and teeth (Dent 1995).

The Early Woodland Period is marked by an intensification of burial ceremonialism. Influences from the Ohio River Valley include the Adena culture, which is represented on a few key sites in the Middle Atlantic region during the Early Woodland Period. Artifacts associated with the Adena culture include Cresap stemmed points, large bifaces, blocked-end tubular pipes, effigy pipes, copper beads and other copper artifacts, gorgets, pendants, bird stones, bar stones, ground slate objects, and red ochre (Dent 1995; Lowery 2001, 2003). Although these artifacts are most typically found associated with cremation burials, Adena artifacts have been recovered from habitation sites in the region (Dent 1995; Lowery 2001, 2003). Evidence for Adena influence in the region has also been documented as surface finds of trade items (e.g., Adena blocked-end tubular pipes) along major streams and occasional finds of Adena projectile points (e.g., site 18WO144). The Nassawango site near Salisbury (Wise 1974) contained more substantial evidence of an Adena presence on the Coastal Plain in Maryland. Mortuary data have also come from Adena sites in nearby Delaware, such as Killens Pond (7K-E-3), Saint Jones (7K-D-1), and the Frederica site (7K-F-2) (Custer 1984a:121-2). On the western shore of Chesapeake Bay, a cremation site (West River Site) from which Adena artifacts were recovered is one of the few buried features dating to this time period in the region (Ford 1976).

Early Woodland settlement patterns were still predominantly riverine, with sites most often identified at the junction of freshwater and brackish water streams. Early Woodland sites are generally larger than those of previous times, and there seems to have been an increasing reliance on riverine and estuarine resource areas. The smaller camps were established seasonally in areas where ripening resources or concentrations of game could be found. Gardner (1982:60) notes that the settlement-subsistence system of this period was focused primarily on a series of base camps where people gathered together to exploit seasonally available resources. These base camps were used to harvest anadromous fish in the spring and early summer, and to exploit estuarine resources in the fall and early winter. Barber (1991) contends that an increase in sedentism was in part a result of a stabilized sea level that facilitated the establishment of resource-rich environments. Other than a trend toward sedentism and more focused hunting and gathering, subsistence patterns were similar to the preceding Late Archaic period with increasing reliance on marine resources (e.g., shellfish) and cultivated plants (Dent 1995; Lowery 2001, 2003).

3.1.6.2 Middle Woodland Period (AD 300 – 1000)

The Middle Woodland Period (AD 300 – 1000) generally is not well-defined, and researchers disagree about the exact boundaries of the period. Dent (1995:235) has referred to this period of “technological homogenization” where “ceramic and projectile point variability becomes limited to fewer types.” Despite the presence of fewer ceramic and projectile point styles, the Middle Woodland Period represents a continuation and further development of cultural complexity that culminates in the Late Woodland Period. The intensification in trade networks over a large region is one of the notable trends evident by the onset of the Middle Woodland Period. It is thought that warmer and drier conditions may have prevailed during this period (Kellogg and Custer 1994; Lowery 2001, 2003).

The major ceramic types for the period are Popes Creek and Mockley wares (Dent 1995). Popes Creek ceramics were first manufactured in the Early Woodland Period, and the style persisted through the early Middle Woodland Period in the region (Maryland Archaeological Conservation Laboratory 2002). Mockley shell-tempered ceramics are common in the latter half of the Middle Woodland Period.

Stone tool kits utilized by Middle Woodland peoples are basically the same as those used during the succeeding Late Woodland, but more exotic lithic materials are evident in Middle Woodland assemblages. The technology evident in many Middle Woodland sites seems to favor bifacial tool production rather than the prepared core and blade flake technology that typifies Ohio Valley cultures. Projectile points characteristic of the Middle Woodland Period include Selby

Bay/Fox Creek and the Jack's Reef types (Custer 1989; Dent 1995; Potter 1993; Stewart 1992). Other tool types found during the Middle Woodland Period are similar to those found during the Early Woodland Period, and include drills, perforators, flake tools, scrapers, bifaces, anvil stones, net sinkers, mortars, pestles, manos, metates, groundstone tools (e.g., axes, adzes, celts), ground slate, gorgets, and tools made from animal bone and teeth (Dent 1995). Dent (1995) notes that bone tools, such as awls and needles, appear to be more ubiquitous during the Middle Woodland than the Early Woodland Period. The presence of non-local rhyolite, argillite, and jasper at a few sites suggests that exchange networks may have been established between the Costal Plain and areas near western Maryland and the New Jersey Fall Line.

There are a few sites in the Chesapeake Bay region that evidence an elaboration of mortuary ceremonialism, with projectile points, ceramics, bone artifacts, shell beads, large pentagonal bifaces, platform pipes, bannerstones, and pendants (Lowery 2001, 2003). These sites appear later in Middle Woodland period, suggesting a reemergence of mortuary ceremonialism and continued selective influences from the Ohio River Valley/Great Lakes region (Lowery 2001, 2003).

Settlement patterns were largely similar to those of the Early Woodland Period, although base-camp settlements located at freshwater/brackish water junctions appear to have been abandoned in favor of broader floodplain sites where maximum resource exploitation of both non-tidal and tidal aquatic resources was possible. The large number of sites for this time period and the extensive size of some of the sites support the argument for possible seasonal aggregation and dispersal. There is some evidence for a significant shift toward settlement of coastal and estuarine areas (Davidson 1981) though Hughes (1980) notes that inland areas along swamps and small streams are still being utilized at that time. Hunting and gathering continued as the primary food sources, with increased reliance on riverine and domesticated plant resources. The presence of large, shell Midden sites during the Middle Woodland Period indicates the increased reliance on shellfish. There is also an intensification of horticultural practices, although hunting, fishing, and plant collecting are still important subsistence pursuits. The subsistence economy is also marked by the initiation of maize horticulture.

3.1.7 Late Woodland Period (AD 1000 – 1600)

Cultivated crops came to play an important role in subsistence for much of the region during the Late Woodland Period (AD 1000 – 1600 (Dent 1995). Some researchers (e.g., Lowery 2001, 2003) suggest, however, that agriculture did not play a big role on the Delmarva Peninsula, and that hunting, gathering, and fishing were the basis of the subsistence economy. The climate had stabilized by this period, and "environmental conditions were essentially modern in character" (Lowery 2001:87).

Chesapeake Bay region artifacts characteristic of the Late Woodland Period include a variety of ceramic types, including Cashie Currioman, Gaston, Killens, Minguannan, Moyaone, Potomac Creek, Rappahannock, Roanoke, Sullivan Cove, Townsend, and Yeocomico wares (Dent 1995; Maryland Archaeological Conservation Laboratory 2002). Only the Killens, Minguannan, Rappahannock, and Townsend wares appear on Delmarva Peninsula archaeological sites (Custer 1989; Dent 1995).

Projectile points characteristic of the Late Woodland Period include small triangular styles, such as the Madison and Levanna types and their variants (Custer 1989; Dent 1995; Lowery 2001, 2003). There is an apparent preference for locally available stone material for making points.

Other stone artifacts recovered from Late Woodland Period sites include scrapers, perforators, bifaces, hoes, choppers, net sinkers, groundstone axes, celts, adzes, mauls, grinding slabs, metates, manos, mortars, pestles, pendants, boatstones, bannerstones, and abraders (Dent 1995; Stephenson et al. 1963). Artifacts made from shell and bone are recovered from Late Woodland Period sites, including fish hooks, scraping implements, pendants, beads, awls, bodkins, beamers, needles, pins, and beads (Dent 1995). Clay tobacco pipes were manufactured during this period. Copper beads and pendants are also, but rarely, found (Dent 1995).

Unlike the rich mortuary traditions of the Early and Middle Woodland Periods, Late Woodland mortuary sites consist of large ossuaries containing human remains and few grave goods. Exotic items found in Early and Middle Woodland Period mortuary contexts are absent from Late Woodland ossuaries (Dent 1995; Lowery 2001, 2003). Smaller, single interments are found throughout the Chesapeake region. Late Woodland Period dog burials have also been recorded in Virginia (Dent 1995).

The establishment of stable agriculture during the Late Woodland Period led to the development of sedentary floodplain village communities. Villages were often located within palisades near agricultural fields. The reliance on agriculture, and the presence of village palisades, hearths, storage pits, Middens, and burials, is indicative of the greatest degree of sedentism seen until this time. Settlements were generally located on broad floodplains, often near the junction of a tributary stream and river. Small transient camps have been found in upland settings (Gardner et al. 1984:18-20). Hunting and gathering was conducted from larger estuarine camps surrounded by micro-band camps. Other trends include shifts in lithic raw material preferences, perhaps related to the development of more sedentary lifestyles. Smaller foraging and hunting ranges would have resulted in more limited exploration for lithic raw materials and greater dependence on resources found near the camps, as well as those regularly obtained through exchange with other groups.

Increased population density and competition for choice land and resources led to the rise of chiefdoms and a hierarchical type of political organization. Hunting, gathering, and fishing were still practiced, but to a lesser extent than earlier. Agriculture does not appear to have played a major role in the Late Woodland Period subsistence economy on the Delmarva Peninsula, though populations do seem to have adopted a more sedentary lifestyle. There was an increase in social and political interaction among native tribes in the region after AD 1500, and Potter (1993:151) has suggested that an alliance of coastal plain Algonquian groups was formed prior to European contact.

3.1.8 Potential to Encounter Prehistoric Sites within the Project Area

The most likely sites to be encountered in the project area are Paleoindian in nature, because the offshore landforms being evaluated may have been exposed during the Late Pleistocene. Paleoindian sites are rare on the Delmarva Peninsula, and usually consist of isolated projectile point finds. Large habitation sites that may be detectable with remote sensing technologies are not associated with early prehistory.

A sub bottom profiler array can, in theory, detect buried relict channels that may have been exposed during the Late Pleistocene. The margins and confluences of these buried channels represent locations where Paleoindian Period peoples may have frequented. The preservation potential within the survey areas, which will be discussed in the next section, is very low, and it is highly unlikely that any buried relict channels have survived intact to the present time. By extension, there is a very low possibility to find an intact prehistoric site where there are no intact buried relict channels.

3.2 MARITIME HISTORIC CONTEXT

Wallops Island is a barrier land mass located on the eastern shore of the Delmarva Peninsula in Accomack County, Virginia. The maritime history of this sparsely inhabited island is intimately related to the political, economic, and cultural background of Virginia's Eastern Shore, particularly Accomack County. This maritime context will focus on the history of this portion of Virginia for this reason. Details regarding the history of Wallops Island are included throughout.

3.2.9 Contact Period (1524-1606)

The Contact Period begins as European explorer's first venture into North America in search of a northwestern passage to Asia and Cathay. Early voyages to the Eastern Shore of Virginia began in the early 16th. The first documented landing took place in 1524, when French adventurer Giovanni da Verrazano landed approximately 16.1 kilometers (10 miles) north of Cape Charles. Contracted to explore the new world by Francis I of France, Verrazano hastily mapped the eastern shore of the Chesapeake Bay and daringly penetrated the headwaters of the Pocomoke River in his carrick, *La Dauphine*. He also documented lifeways of the indigenous Accomac peoples, including the construction and use of seaworthy dugout canoes. Verrazano dubbed the region Arcadia in a subsequent report to the French crown (Wise 1911, Lowery 2000). A second landing took place in 1525. Explorer Lucas Vasquez d' Ayllon cruised the interior of the Eastern Shore of Virginia in an effort to identify a northern passage out of the Chesapeake Bay. He surveyed numerous waterways during this venture and landed several times to provision his vessel (Wise 1911).

Other explorers who sailed Virginia's Eastern Shore between 1571 and 1606 were Englishman Bartholomew Gilbert and Dutch captain Richard Hakluyt (Wise 1911, Lowery 2000). Bartholomew Gilbert explored the southern coasts of Virginia, beginning in 1602, in search of the lost residents of Roanoke Island. Sailing a fifty ton bark with a small crew, Gilbert was caught in a storm off the Capes of Virginia during the summer of 1603. To escape the storm he sailed into the Chesapeake and anchored one mi (1.6 km) off the eastern shore. In need of provisions and water, Gilbert and a small well armed party went ashore. After travelling only a short distance on the beach they were attacked by the local Accawmack tribe, and Gilbert and a crew member were killed (Wise 1911).

Vessels employed by European explorers between 1525 and 1600 shared similar characteristics. The 16th century was the first period during which ship design was based on predetermined mathematical projections. Vessels developed from these projections maintained rounded hulls with a length to breadth ratio between 2.8 and 3.1 to 1. These characteristics resulted in slow, seaworthy ships with a massive tonnage or carrying capacity. Waterline length varied between 20 and 45 meters (65.6 and 147.6 feet) (Steffy 1994). Ships of this time were called carrick, galleon, nao, caravel, pinnace, bergaitin, and fluit (Unger 1994).

3.2.9.1 Settlement to Society (1607-1750)

Much like the rest of the Chesapeake Bay region, Virginia's eastern shore was primarily settled by English immigrant farmers. Explorer John Smith attracted his countrymen to the area in 1607 when he exclaimed that the area was a fertile, wooded land with many creeks, bays and inlets that permitted navigation into the interior. The first settlement in the area was a satellite community hailing from Jamestown. Governor Thomas Dale sent Lieutenant William Craddock and a score of men to Smith Island in 1614 to provide salt and fish for the struggling Virginia colony (Wise 1911, Ames 1940). The success of this small town, called Dale's Gift, generated interest among colonists, thus initiating the permanent settlement of the region. Salt production became the first industry of Virginia's Eastern Shore, and it remained a profitable one until the early 18th century (Ames 1940).

The southern portion of the Delmarva Peninsula was formally recognized by the English crown in 1634 when the House of Burgesses established Accomac Shire under the direction of England and King Charles I. It stood as one of the original eight shires of Virginia and was named for the local Accawmack tribe. This shire was divided into Accomack and Northampton Counties in 1671 (Wise 1911). The earliest permanent settlement on Virginia's eastern shore was located on the southwestern side of the peninsula along the Chesapeake Bay where it was more protected from the elements. This settlement, known as Accomack Plantation, was composed of three distinct settlements along Kings Creek, Old Plantation Creek, and Magothy Bay at Cape Charles (Turman 1964). The town of Accomac became the location of a county courthouse on the seaward side of the peninsula.

English and Dutch settlement on the eastern shore gradually increased throughout the 17th century, and land grants were routinely issued throughout Accomack County for parcels ranging from 200 to 2,000 acres. The grant for Wallops Island was awarded during this land rush. Englishman John Wallop was given 1,450 acres on then Kickotank Island in 1672 to reward his effort to seed Accomack with British colonists. This grant was later revised to 1,800 acres in 1682 and then 1,500 acres in 1692. The island, which was later dubbed Wallops Island, is shown on the 1693 map of the region done by Daniel of St. Thomas Jenifer (Figure 3-1) It was intended that all lands granted by the English crown be farmed speculatively by the owner for the benefit of mother England and the still isolated peninsula (Whitelaw 1968). After being granted to Wallop, the island became known as Wallops Island and was passed down to his children and grandchildren.

The colonial economy of the Delmarva Peninsula was more diverse than that of the tobacco dominated western shore. Salt making began on Smith Island in 1619, and became a luxury commodity throughout the colonies until the first quarter of the 18th century. Fertile fields throughout Accomack and Northampton Counties yielded excellent grain, corn, and tobacco. Industries associated with these crops, such as grain mills and tobacco cask manufacturing houses, dotted the landscape as additional plantations were established. Hemp and flax were also grown for the manufacture of cloth, and bricks were made for the construction of permanent structures on plantations and at Accomac Town. Fishing and boat manufacture were also growing industries at coastal settlements (Ames 1940). Vessel production was so vital to the success of the region that the Accomack assembly offered an incentive in 1661 of 50 pounds of tobacco for every vessel ton produced (Wise 1911). The diverse eastern shore economy established in the early 17th century continued with little change over the next 300 years.

Prospective buyers in Amsterdam, Boston, Baltimore, London, and the Greater Antilles clamored for eastern shore products, and maritime trade became key to the prosperity of this isolated community between 1630 and 1750. Dutch and English trading houses located throughout Accomack County owned seaworthy vessels that traveled between Boston, England, Baltimore, and the Greater Antilles with cargoes of grain, tobacco, flax, and salt. These moderately sized 20 to 40 ton ships returned laden with molasses, sugar, rum, and refined goods slated for re-distribution among prospering colonists (Ames 1940). These trading craft, called *Africa*, *Blessing of Virginia*, *Deliverance*, *Anne Clear*, *May Flower*, and *Artillery*, became the face of eastern shore commerce for 120 years, and generated fortunes for merchants such as Richard Scarburgh and William Claybourne (Wise 1911).

The success of merchant fleets throughout colonial America did not go unrecognized by the English Crown, and Parliament passed a series of acts that restricted the local trade of competing nations. The first of these navigation acts was passed in 1651, and it stated that goods shipped to England had to be carried by English vessels. This declaration infuriated foreign merchants, particularly the large Dutch population on the eastern shore. The resultant regional conflict between Dutch and English traders became known as the Dutch War, which raged between 1651 and 1653. The war was contested politically on land and between Dutch and English privateers at sea, and many merchant vessels were sunk or taken as prizes as a result (Wise 1911, Ames 1940). Dutch interests suffered terribly during the conflict, and they ceased to be a major economic factor in the region after the war.

Maritime prosperity on the eastern shore also enticed those motivated by quick profit, and piracy was a looming threat along the eastern seaboard throughout the seventeenth and early eighteenth centuries. The isolated barrier islands of the southern Delmarva Peninsula served as excellent havens for captured prizes and pirate vessels alike (Shomette 1985). John James of *Providence Frigate*, William Kidd of *Adventure Galley*, Edward Davis, and John Cook all harried merchant shipping in the region (Middleton 1953). Fear of piracy along the eastern shore prompted local officials to establish lookouts along the coast; Captain Gilbert Moore was commissioned to patrol the coast in search of possible culprits. Accomack assembly member John Custis also petitioned the Virginia governor for a royal frigate to discourage further predation. Captain Edward Teach, commonly known as Blackbeard of *Queen Anne's Revenge*, was born and raised in Accomack County (Wise 1911, Shomette 1985).

As the Eastern Shore is relatively isolated from the mainland of Virginia, the most expedient way to travel between the two locations was by boat. In order to facilitate travel, a ferry system was established. A ferry had been making two round trips per week from the port of Northampton to York and Hampton since 1705. John Masters was given rights to operate a ferry from the Eastern Shore to the ports of York and Hampton in 1724. During his operation of the ferry the main port was soon moved to Mattawoman Creek, the main branch of Hungars. He provided one transport for the passage of foot passengers and one for men and horses (Turman 1964).

The importance of shipping on Virginia's Eastern Shore in this period became evident in the increased restrictions placed on shipping. Towns that could become ports and attract shipping grew exponentially both in population and wealth. Virginia passed "An Act for Cohabitation and Encouragement of Trade and Manufacture" in 1680 (Henning 1819b). This act was designed to establish towns for storehouses in order to better control the moment of tobacco and other exports. All produce was to be carried to the designated towns before export and all goods brought into the colony including "servants, Negros, and other slaves" were to be landed only in these towns (Henning 1819b: 477). Only one such town was established for Accomack County, called Onancock, on the bay side of the peninsula. This town was the site of brisk trade with the western shore of Virginia and was one of the major ports of the colony. In an attempt to limit the number of ports to concentrate prosperity, customs began being collected. Each port from which boats entered and departed had a customs collector, and each ship captain was responsible for ensuring that goods loaded aboard his ship had been properly inspected and a certificate from the customs collector (Turman 1964).

In 1691, Virginia passed an act concerning the establishment, location, and operation of ports throughout Virginia (Henning 1819a). This designated where vessels could load and unload goods and where goods could be sold (Henning 1819a). It also decried the home of the Naval Officer who kept track of the vessels coming and going for each district. This port was located in Accomack County at Onancock, where by 1691 “the court house, several dwelling houses and warehouses are already built” (Henning 1819a). The court remained at Onancock until 1786 when it was moved to the sea ward side of Accomack, as this location was considered more convenient for the local population (Wise 1967:233). Ports at Accomack in Folly Creek (seaside) and Onancock (bayside) were designated official ports in the same year (Henning 1819c:321). The two towns are only 4.5 mi apart by land.

As ports became larger and supported greater volume of incoming and outgoing traffic, it became necessary to protect the channels leading to these ports. Sailing vessels brought in significant amounts of sand, gravel and ballast stone, which were often dumped in the channels and wharves surrounding these ports. The General Assembly passed a law requiring every county adjacent to a navigable stream to provide a place to deposit ballast on shore where it would not wash back into the waterway and obstruct navigation (Turman 1964). They were also required to provide an overseer to regulate this process. Ship captains were required to pay the overseer a fee for unloading ballast on shore, which prompted many vessel operators to load their vessels with paying ballast such as limestone, chalk, bricks, and stones to avoid paying the ballast fee while earning freight charges.

Virginia, as a colony of Great Britain, was discouraged from manufacturing finished goods, and the crown mandated importation of nearly all housekeeping materials. Colonial officials reported to the Lords of Trade in 1741 that “The colonial Virginias has all the necessities they wished for the adornment of their persons or for the furnishing of the homes just as if they lived in Great Britain” (Coulter 1945:296). The majority of manufactured goods came from Great Britain, but other goods arrived from all over the known world. Five British ports dominated trade with Virginia during the 18th century; these were (in order of importance) London, Bristol, Glasgow, Liverpool and Whitehaven. England’s center of shipping was London, and “Drawing into its markets the manufactures of Britain, continental Europe, and Asia, and having its own special products, 18th century London was the world emporium of trade” (Coulter 1945:297). Vessels destined for Virginia may have originated in Britain, but the cargo came from all over the world.

There was considerable trade between Virginia and the British West Indies during the colonial period. The islands of Barbados, Antigua, St. Kitts and Jamaica were producers of sugar and rum, and imported food and wood from the colonies in return. Vessels traveling to Virginia from the West Indies usually carried a cargo of sugar and a few slaves. The vessels were smaller sloops, not the larger African ships devoted to slaving (Kline 1975). Moreover, slaves that had spent time in the West Indies were considered “seasoned” or acclimated to the climate and culture of colonial America. These were preferred to slaves that came directly from Africa for reasons associated with disease, language, and conduct (Coulter 1945).

Accomack County and its district port of Accomack were a common destination for the smaller coastal vessels from northern American colonies and the West Indies (Kline 1975). Larger vessels, such as the slavers coming directly from Africa, would call on the larger ports of the South Potomac, Rappahannock, and York River districts (Klien 1975). Accomack, being small and removed from the rest of the colony, was not a favored destination of slave traders. Only 125 slaves were brought to the county (via the port at Accomack) during the 42 year period of 1727 to 1769. None of the voyages to Accomack came directly from Africa, but from the West Indies and other colonies. In contrast, the district of York River received 15,607 slaves during the same period, with 60 percent of the voyages coming directly from Africa (Kline 1975). There was a direct correlation between the size of the vessels and the size of the port it was able to enter.

Craft common to the southern eastern shore between 1607 and 1750 were varied. During both the 17th and 18th century, vessels operating in the Wallops Island area would have been small craft used to move small amounts of goods and produce up and down the seaside of the peninsula. Their capacity would have been that of livery, or transport, to the larger transatlantic vessels that would carry hundreds of large hogsheads of tobacco to London and beyond. One colonist described the Chesapeake Bay and the surrounding waterways in 1724 as “navigable for sloops, shallops, long-boats, flats, canoes and *Periaguas*” (Brewington 1953). Vessels used in the American colonies were very similar to their European counterparts, as locally constructed vessels were not typically built for a specific purpose, but could be used for anything befitting their size (Chapelle 1951). There were few distinctly colonial vessel types recorded during this period. Modifications of previously used vessels were made, but there are seldom detailed descriptions or terms for these regionally modified vessels. The major vessel types used during this period include the dugout/log canoe, the punt or flat boat, bateau, the sloop, and the shallop.

The dugout represents the earliest vessel type employed in the Chesapeake region. It originated from the local Native American population that inhabited Virginia’s Eastern Shore. These vessels were typically carved from a single log to form a trough-like vessel (Brewington 1963). This vessel type, which was embraced and modified by the colonists, ultimately resulted in a craft ranging from 12 to 40 feet in length that could be constructed of several logs shaped and mortised together. Adaptations of this general form included the addition of multiple logs, which allowed the vessels to be larger, more stable, and have a deeper draft. They were typically undecked, and sometimes had framed and planked topsides with sharp ends. These canoes were likely originally rowed and punted, but were adapted to be rigged with one or two spritsails and could have a jib set on raking, unstayed pole masts (Brewington 1966). Large dugout canoes fitted with sails were often referred to as *periaguas* (Chapelle 1951).

The punt and flat represent very similar vessel types; the distinction between the two was the presence or absence of sails. The flat was frequently employed as a ferryboat, and possessed curved ends with platforms at the bow and stern with the rest of the hull left open (Chapelle 1951). This vessel was typically flat bottomed, and double ended. The flat was commonly rowed or punted, and generally did not have a sail. The punt was constructed very similarly to the flat but it possessed a single forward mast and a boomless spritsail (Chapelle 1951). Both the flat and the punt were simple to construct and very efficient in the shallow, shoal waters of the Chesapeake. They were used as ferry boats and for transporting goods.

The *bateau*, which translates to boat in French, became a specialized vessel type in the Chesapeake during the 18th century. Regionally, the term bateau was applied to a chine built hull that averaged 40 to 45 feet long (Chapelle 1951). These vessels could be rowed or poled. They were occasionally fitted with sails and external keels to facilitate sailing close-hauled.

The sloop was the most popular vessel type used in the British colonial period. Sloops varied in capacity from 25 to 70 tons during the 18th century, and were typically rigged fore and aft (Chapelle 1951). These vessels would have a single mast with a gaff mainsail, two to three headsails, a square topsail and a square lower sail (Chapelle 1935). Sloops were designed with an external rudder, a flat transom, a slightly curved bow, and a single mast with no bowsprit (Chapelle 1935). They tended to be at least partially decked. Sloops were small in the beginning of this period, but were constructed larger as the 18th century progressed.

The shallop represents one of the many vessel types used during the colonial period for which the name can represent many vessel configurations. The authors of the 17th and 18th century were not overly familiar with nautical terminology, and used various terms to describe them. The shallop was often referred to as a ship's boat, longboat, or launch. These vessels were initially used to lighter crew from ship to shore, and were very popular in the Chesapeake due to a shallow draft and ease of handling. It was a versatile vessel that was easy and inexpensive to construct. Shallops could be used for fishing and transportation of goods and people in a region that favored water transport over road travel (Baker 1966). The shallop often acted as a farm and household boat to be used for everyday purposes. These vessels were typically two masted, open boats without a boom on the main mast which could range from 18 to 28 feet along the keel (Chapelle 1951). A less common variation included decking with a boomed mainsail.

3.2.10 Colony to Nation (1750-1789)

The second half of the 18th century along Virginia's Eastern Shore was fraught with conflict. The Seven Year's War, which began in 1755 and lasted nine years in Virginia, was a dispute between England and France. It had a notable influence upon Virginia. Fighting occurred throughout North America, including the Eastern Shore. The Virginia General Assembly met in 1755 to establish a quota of men to be recruited from each county (Turman 1964). The conflict was to establish British supremacy on the North American continent, but Eastern Shore residents were more concerned with preventing British occupation of their homes. Many local men were placed on guard duty or sent to occupy the frontier to such an extent that tobacco production diminished and overall trade declined. Militiamen were placed on guard in all navigable creeks and rivers. Several forts were also established (Turman 1964).

The war had a detrimental effect on tobacco production and trade on the Eastern Shore, but it also began to make the local population more self sufficient. With a limited ability to receive goods from British ships, Eastern Shore residents began making many of their own goods. Travelling weavers, tailors, and shoemakers also went from town to town making necessary items. Virginia-made linen sheets and pillow cases became more prevalent, and weaving equipment became a necessity on every plantation (Turman 1964).

King George III succeeded his grandfather as ruler of England after the Seven Year's War, and began exerting his authority over the colonies in ways that had never before been experienced. Parliament passed the Townshend duties in 1767, which taxed lead, paint, paper, tea, and glass (Turman 1964). This act had a dramatic impact on residents of the Eastern Shore, as the paper tax affected all legal documents as well as newspapers and almanacs. The paint tax represented a hardship to ship builders who were now unable to paint ship bottoms. It also challenged the residents who painted their homes in order to preserve the wood in the damp seaside climate. This act was repealed in 1770 following intense protest and the boycott of goods, with the exception of the tax on tea.

The boycotts of British made goods, as well as the difficulty in receiving imported goods during the Seven Years War, made Virginia's Eastern Shore largely self sufficient. They were capable of producing many necessities themselves, saving money typically used for imported products from England and other European nations. Tobacco remained the principal cash crop, but pork, beef, hides, shoes, corn, wheat, salt and sea food also became major exports. Records show that castor oil, which could be used for medicine, soap, axle grease, and paint, was also produced in quantities large enough for export (Turman 1964). Flax was also produced for domestic use and export. It could be used to produce linen, and its seeds were used in the production of house and boat paint.

When the war for independence broke out with England, the general sentiment on the Eastern Shore was in favor of colonial independence. The two Eastern Shore counties supplied seven companies of soldiers, one captain, two lieutenants, one ensign, four sergeants and a drummer to the Ninth Virginia Regiment (Turman 1964).

War soon touched the lives of residents of Accomack and Northampton Counties, as British warships took control of the mouth of the Chesapeake Bay. The ports of these two counties soon became a major part of the Colonial supply line. The 1751 Fry and Jefferson map illustrates many of the important creeks and islands which became vital cogs in supplying the Continental Army (Figure 3-2). Ports along the ocean side of the peninsula, including Metompkin and Chincoteague Creeks, were able to receive supplies from France and other neutral countries and transport them to the interior. Medicine, munitions, and other necessary supplies were received along the seaside, transported over land, and reloaded onto small vessels in the creeks and rivers of the Chesapeake, where they were transported to the head of the Bay and down the western side of Virginia and Maryland (Turman 1964). This round-about route was necessary to avoid blockading British vessels and raiding barges operating throughout the Chesapeake region.

A fort was established on Parramores Beach in order to prevent British raiding barges from entering the vital port of Metompkin Creek, and to protect incoming ships (Turman 1964). The fort and other defensive measures along the Eastern Shore peninsula did not prevent the British from seizing a portion of the shore in 1779. This action, and the establishment of a base on Hog Island under the command of Captain John Kidd, infuriated Virginians. This base allowed the British to send out small ships, tenders, and barges to raid surrounding farms and plantations to supply nearby warships. Raids typically took place at night when livestock were corralled and poultry were in their roosts. It was not uncommon for British raiding parties to burn the property of, and steal silver and valuables from, resistors (Turman 1964).

Ferry service between the Eastern Shore and the mainland was discontinued during the British occupation. Vessels that had been involved in the ferry service were leased to the fledgling American government and used to transport troops and goods along the Bay (Turman 1964). These ferries and similar privately owned transport vessels were used to transport Washington and his troops from the Head of the Chesapeake to just north of Yorktown in 1781 where the decisive battle of the war was fought.

Yorktown, which is commonly touted as the last battle of the American Revolution, was fought in 1781, but the last naval engagement of the war involving the Eastern Shore took place in November 1782. The Battle of the Barges occurred when Commodore Whaley of Maryland, who was charged with barges ordered to protect Maryland from British Commodore Kidd's marauding vessels, traveled into Onancock Creek to select volunteers for a skirmish with six enemy barges (Turman 1964). Buoyed by 25 new volunteers and a vessel to be commanded by Colonel John Dropper, Whaley and his fleet successfully discerned the size of the British fleet and their location at Cadger's Strait (Shomette 1985). After a quick, forceful attack by Whaley, the British vessels nearly fled. The battle would have been a victory for the Americans, but the powder magazine exploded on one of the colonial vessels, causing death, destruction, and general pandemonium. The ensuing chaos allowed the British to board and capture Whaley's fleet, rending the conflict an embarrassing loss (Shomette 1985).

A significant trade conflict arose on the Eastern Shore between the adoption of the Virginia Constitution in 1776 and the adoption of the United States Constitution. Virginia's right to charge a toll on ships travelling between the Virginia Capes and Maryland was disputed along with the right to build piers and fish on the south bank of the Potomac. The agreement that was reached allowed Maryland ships to travel through the entrance to the Chesapeake without being charged in exchange for use of the Potomac River by Virginia citizens for commerce and fishing (Turman 1964). This agreement remains in effect to the present and illustrates the importance of maritime commerce and navigation to the residents of Virginia and Maryland.

Vessels used during this era were the same as those of the previous period with few additions. General craft continue to be small to accommodate travel in the often shallow, shoal prone waters of the Chesapeake and the barrier islands. This period and the one prior continue to exhibit ambiguity in vessel and rig types. A vessel could be described by its hull form or its rigging. The major addition of this period was the schooner.

The schooner is mentioned at various times during the first quarter of the 18th century in reference to a rigging style that was largely un-standardized (Chapelle 1935). The term "schooner" supposedly arose in 1713 when upon the launch of a new vessel, a spectator commented "Oh, how she scoons!" The owner of the vessel was enamored with this comment, and declared that it should be called a schooner (MacGregor 1997). While this may or may not be the origin of the term, these vessels became standardized by the second half of the 18th century (Chapelle 1935). Howard Chapelle (1935) suggests that the schooner is one of the first distinctive American vessels. These vessels were the most common type found in colonial waters by the time of the American Revolution because they were fast and relatively simple to construct and sail. The schooner was quickly adopted for legal and illegal trade throughout the colonies.

Most schooners were sloop hulls with two fore and aft rigged masts, with the occasional topsail added (Chapelle 1935 and Brewington 1966). They were designed to be very sharp and fast with a large sail plan. Schooners tended to be relatively small, ocean going vessels that were often used by the Royal Navy as transports (Chapelle 1935). The schooner that became the workhorse of the Chesapeake Bay had a shorter sail plan, more upright spars, and a topmast on the main mast only. This adaptation contrasted with the schooners involved in the ocean trade (Brewington 1966). Schooners would increase in length over time and ultimately transformed into clipper ships.

3.2.11 Early National and Antebellum (1789-1860)

The end of the American Revolution and the establishment of the fledgling United States ushered in a period of peace and growth on the Eastern Shore. The Eastern Shore accounted for three percent of the Virginia population with a total of 20,848 people during the first United States census in 1790 (Turman 1964). The population of the two Virginia Eastern Shore counties had increased slightly by 1800 to 22,456 with 8,479 in Accomack County (Turman 1964). Wallops Island had 30 residents, 14 of them above the age of 16.

Industry on the Eastern Shore continued unchanged. Tobacco was still a major cash crop, with warehouses constructed near ferry landings to store the crop before transportation to market. Tobacco was placed in a “rolling house” before being transported via a “rolling road” constructed from the bayside to a warehouse along the seaside. The large hogsheads of tobacco could be attached to a frame which allowed it to roll and be pulled by a horse or ox (Turman 1964). Madison’s 1807 map of Virginia illustrates the major islands and creeks of the Eastern Shore that were vital for the tobacco trade (Figure 3-3).

The production of flax was also important, and was used in the production of linen cloth, boat sails, thread, fishing lines, nets, and rope. Flax seed was also a lucrative byproduct of flax production, for the seeds could be used for making medicine and linseed oil for paints. Wool had also become an important home industry on the Eastern Shore (Turman 1964).

Ferry service between the Eastern and Western shores resumed, with two trips per week made from the port of Hungars. The major change to the ferry service was the addition of a mail contract. The operators of the Hungars ferry were to pick up the mail from the Western Shore on each trip across the Bay to deliver it to the post office on the Eastern Shore (Turman 1964).

War was again declared between the United States and Great Britain in June 1812, and the Eastern Shore was vulnerable to attack and possible occupation. The militia continued to drill regularly, and men from both Accomack and Northampton counties were called to defend their homes. The militia rotated watches along the mouths of bayside creeks. The British did not bother landing on the seaward side of the peninsula, but instead concentrated on taking control of the Chesapeake Bay. The appearance of enemy ships at the mouth of the Chesapeake once again brought an end to ferry service between the Eastern and Western shores (Turman 1964).

The British soon turned their attention to preparing to attack the American capital, Washington, D.C. The British navy selected Accomack County as its base of operation. The attack was to be a naval campaign and the Navy needed a base out of reach of the Eastern Shore militia. They selected Tangier Island located on the Chesapeake Bay to this end. Tangier Island was occupied on April 5, 1814, under command of British Rear Admiral George Cockburn. They constructed a fort there and used it until the end of the war.

The first record of attack on Virginia from this base occurred near Pungoteague on May 30, 1814. Known as the Battle of Pungoteague, British barges and tenders fired cannon at the mouth of Onancock Creek in order to draw the American militia there. The British soon crossed the bar of Pungoteague Creek in 11 tenders and barges before landing on the north side of the creek and advancing more than one mile (1.6 km). The militia engaged them briefly with no notable results. The British soon retreated back to Tangier Island. This battle, however, marked the only battle on the Eastern Shore against a European nation (Turman 1964).

Trade during the war was impaired but not paralyzed. Eastern Shore residents found themselves experiencing great difficulty transporting and receiving goods from northern cities, but local industry had developed to such an extent that they were largely self sufficient. This self sufficiency produced most of the necessities and allowed them to purchase goods from New England, France, and other friendly European countries as vessels were able to evade the British and land at seaward ports.

The war ended with little damage to the Eastern Shore, and ferry service resumed in 1815 at Hungars Ferry. This ferry, which had operated since 1724, soon faced competition from the Port of Pungoteague. The new ferry also ran two trips per week from one shore to the other (Turman 1964). A steamboat ferry service was established by the early 1840s, and it ran between the Eastern Shore and Norfolk, Hampton, and Yorktown on the Western Shore. A steamboat company was able to obtain a franchise to operate in both Northampton and Accomack Counties, and the terminal was moved to Cherrystone Creek where two trips per week were made to the mainland (Turman 1964). Once per week a steamer was sent to Pungoteague. The vessels used on this route included steamboats *Star* and *Joseph E. Coffee.*

The end of the war ushered another period of growth on the Eastern Shore. The principal crops were wheat, rye, oats, beans, peas, Indian corn, cotton, and potatoes. Castor beans were also frequently produced to manufacture castor oil. Tobacco, while still produced, was slowly being replaced by other crops. The first agricultural figures were officially recorded in the 1840 census, and the transition from staple crops to production of commercial vegetables had begun (Turman 1964). The census reports that 10,254 pounds of cotton, 107 tons of flax, and 112 pounds of tobacco were produced along with 173 pounds of beeswax, 4,598 bushels of salt, and 3,372 cords of firewood (Turman 1964). Farm products produced here were in demand in Washington, D.C., Baltimore, Philadelphia, and New York. Completion of the Chesapeake and Delaware Canal across the 14 mi neck of the Delmarva Peninsula in 1829 aided the transport of goods to the northern markets. The eventual development of steam also allowed Eastern Shore produce to be transported to market with greater speed than sailing vessels.

The increase in commercial agricultural production, especially wheat and corn, prompted the construction of mills for grinding these crops. There were a total of 75 mills between both counties by 1840. There were also five lumber mills and one brick making plant (Turman 1964). The seafood industry was also becoming increasingly important. It had become such a booming industry that the legislature was required to prohibit the sale of oysters between the first of May and the first of September in order to conserve the supply.

The location of Virginia's Eastern Shore on a peninsula with numerous small creeks, shoals, and tributaries made vessel travel necessary and hazardous. The need for lighthouses had been clear since colonial times, but the first lighthouse was not started until the late 1820s. The Cape Charles Light on Smith Island was completed in 1832 at a cost of $7,398.82. Lighthouses were completed on Assateague Island and Watts Island in 1833. A study was conducted at this time regarding the placement of a lighthouse on Hog Island, but it was not until 1852 that Congress appropriated money for its construction. Dwellings for the light keeper and assistant keeper were also constructed. Smaller lighthouses also marked the entrances to Occohannock and Pungoteague Creeks. The lights were fueled by oil with reflectors, which required regular cleaning and daily care by the lighthouse keeper. The lighthouse keeper was a vital part of Eastern Shore life until the lights were electrified nearly a century later.

19th century vessel types were designed to meet demand. The main economic stimulus in the Chesapeake was the oyster harvest, and this encouraged vessel development. Vessels became larger but retained the sails, shallow drafts, and flat bottoms necessary for navigation in the marshes, cuts, and islands of both the seaward side and bay of the Eastern Shore. Centerboard, or drop keel vessels became popular in the Eastern Shore region after 1850 (Chapelle 1951). Vessel names varied by region, but were largely dependent on the type of rigging employed.

Craft used during this period included the earlier forms like the sloop and schooner, but also boasted the clipper, various regionalized watercraft, and steam powered vessels.

The heyday of the fast clipper ships, regionally known as Baltimore Clippers, was 1845 to 1860 (Crothers 1997). This vessel type is a result of the rising demand for fast ships. Their construction design often sacrificed cargo space and low operating costs in favor of speed (Chapelle 1935). It was this disregard for practical aspects of sailing and ship construction that led to a relatively short period of use. The clippers which have been greatly popularized and romanticized are not constructed with a single characteristic hull form but rather used three basic models. These consisted of the Baltimore Clipper, which was characterized by a very sharp deadrise and fine ends, the sharp ended clipper with a very full midrise and very small deadrise, and a compromise between the two extremes, which was characterized by a noticeable, but not extreme amount of deadrise (Chapelle 1967). None of these models became dominant, as all had advantages and disadvantages and were used for different purposes. The common clipper varied in length along the waterline from 105 feet to 228 feet (Crothers 1997). The bow and stern were extremely V-shaped and very sharp at the waterline. They were typically wide at midship to accommodate cargo. Most clipper ships were three masted, but four masted vessels were also common. Four masted variants were rigged with a spanker gaff and boom on a smaller mast set near the stern (Crothers 1997). Typical rigging plans had as many as 15 yards to support sails (Crothers 1997).

A number of more regional watercraft were also being used during this period. These include the scow and the pungy. The scow first appeared in the 1750s, but was most popular in the early 19th century. It was characterized by square raked ends, hard chines, and a flat bottomed hull (Brewington 1966). They were typically rigged as a sloop or a schooner, and were fitted with a leeboard rather than a keel or centerboard. Ranging from 30 to 50 feet in length, these watercraft were considered workhorses used to haul goods and crops (Brewington 1966).

The pungy was another regional craft operating along the Eastern Shore, and has been considered the best of all native Chesapeake watercraft. While very similar in configuration to the schooner, this vessel type was characterized by a much deeper stern than bow, with a greater deadrise. The beam was greatest further forward, the ends were more raking, and a log rail was employed rather than the bulwarks of the schooner (Brewington 1966). The transom was also hewn from a solid timber rather than built plank over frame. It employed a very similar sail plan to that of the schooner but tended to be taller with lighter spars and more sharply raked rigging (Brewington 1966). While lamenting its demise, one waterman noted “no pungy was ever lost except by bad management. A pungy is all keel and no hold. She can’t carry much more than a common freight car” (*Peninsula Enterprise*, July 20, 1907). A few variations on the pungy existed, including one fitted with a centerboard for navigating shoal waters. That same waterman also commented on the speed and maneuverability of the pungy saying “a deep model, what I call long-legged, with only one topsail, no jibboom and nothin’ but a standin’ jib is surely goin’ to be a little lazy in a calm. But the more it blows the faster a pungy is. In oyster weather, fall and winter, she’s a goer. She’s got the stern to be fast” (*Peninsula Enterprise,* July 20, 1907). One of the most obvious traits of the pungy was its distinctive paint scheme. They would be painted with “the bottom, copper; the boot-top, “flesh” pink the bends, bottle green; and the bead, scarlet” (Brewington 1966).

Schooner hulls were converted into steam vessels in the Chesapeake region by making room below decks for engines and equipment and installing exhaust piping on deck. When purpose built steam vessels were constructed, they had long, narrow hulls with a vertical single cylinder engine and side paddle wheels (Labaree et al. 1998). The boilers, like those on locomotives, were first wood burning, then coal and later diesel. Bay and river vessels employed a superstructure to prevent hogging and to stiffen the vessel (Labaree et al. 1998). They typically had two decks with the greater part of the vessel above the waterline. These vessels were ideal for carrying bulk cargo.

Steamboats in the Chesapeake region retained a shallow draft and stern paddle wheels that suited the calmer waters of the region. Ocean going steam vessels employed propellers and were constructed with a sharper hull (Labaree et al. 1998). There was great variation in hull form in steam powered vessels, but a majority of builders eventually moved both storage and cabins from below to above deck. One example of an early steamboat is the *Alabama.* This wooden hull, side wheeler was built in 1838 and was "210 feet in length, by 24.6 beam and 13.5 depth of hold" (Brown 1938:392). This vessel was owned by the Maryland and Virginia Steamboat Company and did the Baltimore to Norfolk run (Brown 1938). Vessels of this period boasted speeds of up to 10 to 14 miles-per-hour (Brown 1938).

The Chesapeake Bay was home to some of the earliest steam powered vessels, and by 1813 steam service began between Baltimore, Frenchtown and Philadelphia (Labaree et al. 1998:256). The first steamboat operating on the Eastern Shore was owned by the Floyd family and ran from Townfields to the Hampton Roads area (Whitelaw 1968). Steam vessels were employed as transport ships that offered regular service from cities such as New York and Baltimore to Norfolk and New Orleans; "In the year 1838 Maryland had nineteen registered steamboats and Virginia, sixteen" (Brown 1938:391). The railroads and steamships worked in tandem to move produce, goods and people up and down the bay by the 1850s.

Different types of work vessels evolved with the advent of steam. The steam tug boat was used to move sailing vessels through canals and rivers out to sea (Labaree et al. 1998). These hulls were both wood and metal. They set low in the water and were designed with a low, rounded stern to accommodate lines off the aft deck.

Civil War (1861-1865)

Virginia's Eastern Shore had become a vital farming and maritime region on the eve of the Civil War. Water transportation was far more expedient than road travel during this period. Steamboats were making scheduled stops on both the bayside and seaside ports to take on cargoes of produce, seafood, and other goods. While steam had gained a significant foothold in shipping commercial goods, the local people still relied upon sail transport (Turman 1964). Sailing vessels and rigging had improved to the point that more speed could be gained with smaller crews. Sail propelled vessels could also be locally produced while steam was more costly and complicated. Fleets of sailing vessels under the ownership and direction of local people were trading as far as Cuba and northern cities.

Delegates from Accomack and Northampton Counties traveled to Richmond in February of 1861 for a convention considering a referendum that allowed people to determine whether to join the Confederacy or remain in the Union. The convention chose to allow the referendum and it was scheduled for May 23, 1861 (Turman 1964). Union ships blockaded the lower Chesapeake before the referendum could take place. Lighthouses were darkened by Confederate forces and ferry service was once again halted between the Shore and the mainland. The only lighthouse that continued operation was the Assateague Light. Both counties, with the exception of the Chincoteague precinct, voted to join the Confederacy when the referendum took place.

The courts of both Accomack and Northampton Counties authorized funds for recruiting, arms, and ammunition after deciding to join the Confederate cause. This resulted in 800 men being organized into eight companies of infantry, two cavalry, and one light artillery. These men were later divided into three regiments, two from Accomack County and one from Northampton. This arrangement was a holdover from the War of 1812 (Turman 1964). Every capable man on the peninsula was already in the militia and was required to drill three times per year.

The Eastern Shore of Virginia was a prime location for smugglers due to the many miles of coastline and small inlets that made hiding a vessel from Union patrols a relatively simple task. Fake licenses to operate were being issued to Virginia boat owners that identified them as Maryland residents. These documents allowed them to fill up their small schooners and rowboats and take them down to the Eastern Shore to supply the Confederacy (Mills 1996). Supplies could also be smuggled from the North to Chincoteague on the ocean side, and then transported overland to waiting boats along the Bay (Mills 1996). The prevalence of smuggling led to a boat burning expedition led by the Union army. They ran from Fort Monroe up Back Creek and successfully captured or destroyed several vessels engaged in smuggling (Mills 1996).

Major General John Dix was put in command of the defense of Maryland to prevent goods and men from flowing through Maryland to the Confederacy and to intimidate rebel troops (Mills 1996). His major responsibilities including ensuring supplies did not flow into Accomack and Northampton Counties. To achieve this end he devised a plan to occupy the two Eastern Shore Counties.

Brigadier General Henry H. Lockwood was to head the occupying army. He received a report on Confederate activities in the region and requested an army large enough to convince them that resistance was unwise (Turman 1964). Dix sent a letter to the people of Virginia's Eastern Shore offering protection of private property if the people would not resist occupation. He also promised to restore trade with those counties and to restore the lights in the lighthouses (Mills 1996).

Confederate General Smith ordered his men and the militia to the northern part of Accomack County to mount a defense, but he had no choice but to retreat when he received the proclamation from Dix (Turman 1964). A total of 44 officers and 64 enlisted men were able to escape to the Western Shore by boat before the Union army completely occupied the Shore. Young men who were away in college also enlisted, and others ran the blockade to join the Confederate army (Turman 1964). A total of 197 men from Accomack County and 255 from Northampton County served in the Confederacy.

Several attempts were made to run the blockade during the Union occupation, so guards were placed at the mounts of 16 streams and landings including Cape Charles, Cherrystone Inlet, Hungars Creek, and Pungoteague Inlet. Strict orders were issued that no trade was to be permitted between locals and soldiers except under very strict regulations (Turman 1964). Penalty for violation of these orders was one month hard labor or one month's imprisonment with bread and water. Once occupied, the Eastern Shore was cut off both geographically and politically from the rest of Virginia. Smuggling and blockade running continued throughout the war, but it was not as flagrant or frequent as it was originally (Mills 1996).

Despite the fact that Virginia had seceded from the Union, there were those who lived on the Eastern Shore with no interest in the war. They were simply interested in selling their daily catch of oysters. Many on Chincoteague Island remained loyal to the Union and signed an oath of allegiance on October 15, 1862, which gained them Union protection and permission to sell their oysters as far north as New York and Philadelphia (Mills 1996).

The Eastern Shore had become an important link in communication between Washington D.C. and Fort Monroe in the Hampton Roads area. A telegraph line was quickly constructed through the Eastern Shore to Cherrystone Inlet and a cable was laid to Old Point. Troops could also be moved down the shore to reinforce Fort Monroe. Steamboat service was established by the army to more easily transport goods and soldiers (Turman 1964).

There were no new vessel types introduced on the Chesapeake during the Civil War, but local craft continued to be used, as well as steam powered vessels. Vessels employed during the period leading up to the Civil War continued in use. It was not uncommon for residents of the Eastern Shore to construct work vessels for their own use in blockade running or for everyday work. The oyster industry was disrupted during the war to such an extent that watermen found the freight and ferry business to be far more profitable than oystering (Wennersten 1978)

3.2.12 Reconstruction and Growth (1865-1914)

Virginia was designated a territory following the surrender at Appomattox in 1865, and was part of Military District Number 1 (Turman 1964). This included Accomack and Northampton Counties. A constitutional convention was held in 1867, and produced a constitution that was ratified by voters in 1869. Virginia was readmitted to the Union in 1870 (Turman 1964). After being under military rule for more than eight years, residents of the Eastern Shore were excited to have self government restored.

The Federal Government realized the need to establish lifesaving stations along the Shore in 1874. Congress created the Life Saving Service in 1871 but it took three years for stations to be authorized and funds appropriated for construction in Accomack and Northampton Counties (Turman 1964). Stations authorized in 1874 included Assateague Beach Station, Wachapreague Beach Station, Hog Island Station, Cobbs Island Station, and Smith Island Station. Four more stations were authorized in 1878 and 1882, including one on Wallops Island, which is visible in the 1892 Coast and Geodetic Survey Map (Figure 3-4, Turman 1964).

Prior to the authorization of life saving stations, volunteers stepped in whenever they found a ship in distress. The addition of formal life saving stations meant that trained men with the proper equipment were always on duty and ready to assist a vessel or sailor in distress. The stations were composed of two story frame houses constructed with rooms for lifeboats which were always ready for deployment, as well as living quarters for the men. Those serving at a station were on duty for one week with at least that much time off before the next shift (Turman 1964). The keeper of the station had the same status as a commissioned officer and was tasked with training and drilling the men and directing a rescue. The coastline from Delaware Bay to the Mouth of the Chesapeake Bay made up Life Saving District 6 (Turman 1964). This district was under command of Captain Benjamin Rich from 1875 until his death in 1901. While under his command more than 800 disasters involving 6300 people were addressed as well as $12 million in property of which more than $8 million was saved. During this 26 year period, only 45 lives were lost (Turman 1964).

The Eastern Shore and much of Virginia was forced to shift from a tobacco and slave based economy to one more diversified. This eastern coastal region of Virginia began to export produce, peanuts, fish, and oysters to the western part of the state and beyond (Surface 1907). Chincoteague Island and the Bay islands of the Chesapeake became known for oyster harvesting, tonging, dredging, and dragging. Chesapeake oysters were exported all over the world. Oysters were harvested in vessels including sloops, schooners, bugeyes and skipjacks, first via wind power, then steam.

In the late 19th century, truck farming—the cultivation of a few crops for shipment to localities in which such crops cannot be grown, became very important to the Eastern Shore of Virginia and Maryland (Gemmill 1926). Large farms producing a few main crops for sale to the open market, often at some distance from the farm, became the norm on the peninsula. This required seasonal labor and reliable transportation. The need for transportation was met by wagon, boat, and rail. Farmers brought their produce to local wholesale markets by wagon and boat, where it was then transported by rail to Baltimore, Philadelphia, and New York. Skipjacks and buyboats brought the produce from remote areas. Steam vessels would transport large loads of produce from areas without ready access to the railway. Remote areas were able to receive a wider range of goods due to new transportation routes.

A railroad line was initially proposed for the Eastern Shore of Virginia and Maryland as early as 1835 (US Senate 1937). It was considered again in 1855 when plans and maps were drawn but the project abandoned (Turman 1964). The oyster trade prompted the establishment of the first rail line on the Eastern Shore. "The railroad first touched the Eastern Shore seaside in 1876 when a line… laid southwestward of Snow Hill, Maryland reached its terminus just below the Maryland-Virginia boundary and next to the Chincoteague Bay oyster grounds at what became Franklin City" (Thomas, Barnes, and Szuba 2007). This area was not only famous for oysters but also for the outdoor sports of duck hunting and fishing. Advertisements highlighted the easy transportation to the Virginia Eastern Shore: "The upper portion of the peninsula can be reached daily by rail from Philadelphia, the terminus being Greenbackville, on the sea side opposite to Chincoteague Island, and distant from it about five miles. A steam ferryboat conveys passengers from the depot to the island" (Hallock 1877).

Ready access to the railroad, and the advent of refrigerated boxcars encouraged the growth of the seafood industry. It opened many new markets and increased the demand for Chesapeake Bay seafood. A rail line was established in 1884, serving the length of the peninsula (Turman 1964). The New York, Philadelphia and Norfolk Railroad, which also owned steamships, undertook the construction of the line, running north to connect with the existing rail line near the state boarder (General Assembly of Virginia 1884). This coincided with the construction of a harbor and wharf at Cape Charles that was deep and large enough to accommodate steamships (Turman 1964). "By 1889 more than one hundred vessels from 5 to 65 tons and about two hundred decked vessels of under five tons participated in the upper seaside oyster trade" (Thomas, Barnes, and Szuba 2007). These transportation advancements promoted both truck farming and the oyster trade as tomatoes, potatoes and oysters could be put on the train in the morning and served in a restaurant in Baltimore or New York that same evening.

There was a pleasure club on Wallops Island by 1891, complete with a steam powered pleasure boat for excursions (*Peninsula Enterprise*, May 16, 1891). Other sporting clubs soon opened as the news of the fine hunting and fishing spread; "There are three clubs located on the ocean side of Accomack, one on Wallops Beach, composed principally of Pennsylvanians; one on Revels

Island and one of Wachapreague" (Johnson 1899). This was all made possible by trains and motor powered boats operating in the region.

Many of the vessels used during this period were similar to those of the previous period, with developments and innovations most often focused on the oyster business. The Chesapeake Bay was known for producing regionalized vessels designed for the oyster harvest and to meet local needs. Many of these vessel types and the miniscule distinctions between them have been lost with the shipwrights who constructed them. The vessels which became prominent during this period included the flattie, the skipjack, the bugeye, and the buyboat.

The flattie was originally used to transport produce on the Virginia and Maryland tidewater streams, as well as for use in oystering, crabbing, and duck hunting (Chapelle 1951). These vessels likely first appeared prior to the Civil War, but were most prominent during the last portion of the 19th century and represent the smaller predecessor to the skipjack. They are characterized by a V-bottom with some deadrise aft. They ranged from 16 to 30 feet in length, and tended to be partially decked (Chapelle 1951). This vessel type was supposedly out of use by the 1890s, but Chapelle notes seeing a number on the Eastern Shore in 1940 (Chapelle 1951). This vessel is said to have been created to "produce a wide sharpie that would sail well" (Chapelle 1951:312). They were said to sail very well when properly canvassed and were commonly constructed by Eastern Shore mariners for their own use. Accomack County is said to have produced the greatest number of these vessels (Chapelle 1951).

The skipjack, which was a dead-rise skiff with a V-bottom, first appeared after 1860 but did not become popular until the 1880s (Chapelle 1951). The term skipjack is frequently associated with the rigging of the Chesapeake oyster boats rather than a specific hull form. The name is said to be after the bluefish that is known to "skip" across the surface of the Bay (Wennersten 1978). The characteristic rigging is a sprit sail and a jib, without the topsail which was characteristic of older, similar vessels (Chapelle 1951). Construction was done in a very plain, craftsman-like fashion. Skipjacks usually had one raking pole mast on the foredeck and an external rudder on a square transom. One author in 1880 comments that skipjacks are "very wide, with sharp rise of floor the full length of the bottom, jib-and-mainsail rigged, heavily canvassed, and with a reputation for being very fast and Weatherly (Chapelle 1951:306)." A very specialized type originated at Chincoteague Island with masts located fore and aft that could be operated single-handedly (Chapelle 1951:330).

The bugeye originated in the Chesapeake region in the second half of the 19th century when the demand for simple, inexpensive to construct oyster dredging vessels peaked. The bugeye persisted as a popular type until nearly 1920, and is noted as the preferred vessel for oyster dredging due to its simple operation and the ability to be operated by one man (Wennersten 1978). The bugeye was originally little more than an enlarged, decked log canoe with a fixed rig, but it gradually grew and was refined. Employed primarily in oyster dredging, this vessel has been described as a "flat-bottomed centerboard schooner of small size (3 to 15 tons) decked over and with a cabin aft" (Brewington 1964:35). These watercraft typically have two masts, one situated on the foredeck and one located aft of amidships with a leg-of-mutton foresail, a mainsail and jib with a single halyard and sheet (Brewington 1964:59). They tend to have a sharp bow with a stubby bowsprit. This vessel type ranged in size between three to fifteen tons, 30 to 80 feet in length, 10 to 23 feet in beam and 2.5 to 5.5 in draft. The average vessel measured 50 feet in length, 15 feet in beam with a 4 foot draft (Brewington 1966). Hull variations began appearing in the 1880s as a means of gaining deck space. These variations included round and square sterned vessels as well as the "patent stern" which developed in 1908 as an outboard projection of the deck. They are characterized by flat bottoms and hard bilges (Chapelle 1935).

One of the more notable vessels used in oystering, specifically tonging, was a round bottomed boat that was formed from three dug out logs that were joined together. This vessel type was used through the end of the 19th century and was rigged with a jib and one or two sails, and had no deck. They tended to be approximately eight to 25 feet in length and are noted to be especially seaworthy (Wennersten 1978).

The buyboat is synonymous in the modern Chesapeake Bay. The term "buy-boat" originated from their utility. These vessels met oyster boats, purchased their catch and transferred it on the water from boat to boat. The buyboat, though engine powered, continued to possess a main mast and limited rigging needed for a boom crane. It was developed at the dawn of the 20th century with the advent of the gas motor (Chowning 2003). It represents the end of sail power and the beginning of motor vessel ascendancy. Even though steam powered vessels were in use before gas or diesel engines, early bay vessels were too small for the boiler assembly (Chowning 2003).

The traditional schooner, skipjack or bugeye hulls would be fitted with an engine during the early years of motor adaptation, but appearance of the vessel was largely unchanged (Chowning 2003:34). Some early buyboats were bugeyes or skipjacks with cut masts, the bow sprit removed, and a small cabin on deck for shelter. The buyboat hull was designed and built to utilize both sail and motor propulsion. Buyboats were versatile and purpose designed for watermen as they could use sail power to harvest oysters (in Maryland waters power harvesting was restricted for preservation purposes) and could be used under power for hauling and other types of fishing (Chowning 2003). They ranged in length from 40 to 100 feet, with a stub mast and boom forward of the hold, a pilothouse aft, and a decked hull (Chowning 2003:3). They have three main hull configurations: frame-built, log built, and deadrise or box-built (Chowning 2003:3). The buyboat was used to haul grain, coal, log wood, produce, people, and sometimes vehicles in a time before bridges and extensive roadways (Chowning 2003). They continue to be used to the present.

Two shipwrecks from this time period are known to have been lost within 13 mi (21 km) of the Wallops Island area. Both vessels were schooners. The first, the *Jennie N. Huddel*, was a 279 ton vessel built in 1870 that was stranded at Carters Shoal in Chincoteague in 1910. The second vessel was the *Lizzie Godfrey*, a 77 ton schooner stranded at Chincoteague Inlet in 1914. These two vessels represent the first craft identified to have been lost in the vicinity. While there were likely many vessels lost here in the preceding periods, these are the first for which documentation exists.

3.2.13 World War I to the Present (1915-Present)

World War I was officially declared in 1917, and the US Coast Guard was the only armed protection available on the Eastern Shore (Turman 1964). Beaches were closely patrolled to prevent landing of enemy spies and submarines. Watch was also kept at the Cape Charles Station for enemy ships and submarine periscopes. The Life Saving Service had been combined with the Revenue Cutter Service to form the US Coast Guard in 1915. It remained under the Treasury Department, but the men serving in the Coast Guard became naval reserve units for use in time of war. The Eastern Shore became part of the Fifth Coast Guard District. Stations were linked by telephone so that in the event of a large disaster men and resources could be drawn upon from multiple stations (Turman 1964).

World War I did not have a dramatic influence upon life on the Eastern Shore of Virginia, but the end of the war and the return of troops brought remarkable changes and prosperity. Automobile use had grown so much that it had to be regulated, jobs were plentiful, and a college education was attainable (Turman 1964). Every steamboat returning to the Eastern Shore brought new cars from Baltimore. Trains also brought them on flat cars (Turman 1964). Filling stations and garages had to be erected to accommodate the flood of new automobiles. Land prices were also spiraling upward as people invested in stocks, bonds, or loans to others to grow more Irish potatoes, a major cash crop. Approximately 53,267 acres of Irish potatoes were grown in 1920 with amounts increasing yearly.

Prompted by rapid growth, the Chincoteague Toll Road and Bridge Company was organized in 1919 (Turman 1964). The road and bridge was a lifelong dream of John B. Whealton. He surveyed the land from the south of Chincoteague Island to Wallops Neck before convincing Company directors that the bridge should run into the business section of town (Turman 1964). The land was resurveyed and permission was granted by the Federal Government for a drawbridge spanning the Chincoteague Channel. The Virginia General Assembly then granted permission to build

> "A road from A.F. Jester's dock, next to the Atlantic Hotel Dock, leading across Chincoteague Channel to the marsh and then across Black Narrows Channel and marsh, then in a southwestern direction across Wide Narrows to Queen Sound at the mouth of Shell Bay, then in a westerly direction to W.H. Hickman's Farm in Wallops Neck" (Turman 1964:226).

The road was opened on November 15, 1922 with nearly 4,000 visitors arriving on the island to witness the ribbon cutting and hear the Governor speak. The newly constructed earthen causeway was eroded by rain during the speech, and many travelers became stranded on the causeway to be rescued by small boats (Turman 1964). The following day the stranded cars were rescued by ferry and renovations of the road began. The causeway reopened by Christmas of the same year.

The 1920s continued to bring changes to Accomack and Northampton Counties, including new buildings, changes to the school system, troopers appointed for highway safety, and increased public involvement by women who had been granted the right to vote. Farmers, watermen, and professionals associated with these two industries also experienced renewed success during this period (Turman 1964).

The prosperity of the 1920s was evident in the local recreational facilities. Hotels were built and visited by sportsmen during both hunting and fishing seasons. Local people also enjoyed these facilities which included three country clubs, each with a nine hole golf course (Turman 1964). Many residents also owned pleasure boats that were often raced.

The railroad was also prospering, and the railroad companies invested in several new ferries, including *Virginia Lee*, which was touted as the finest steamboat running between Norfolk, Old Point, and Cape Charles (Turman 1964). This steamer was 300 feet long with an auto deck capacity of 80 cars. *Virginia Lee* and *Maryland* made three round trips per day between Cape Charles, Norfolk, and Old Point. While *Maryland* was capable of ferrying cars on an improvised automobile deck, fares were high enough on all steamers to encourage travel by train rather than private automobile (Turman 1964).

A ferry franchise was granted to the Peninsula Ferry Company in 1930. They began operating between the north side of Cape Charles and Pine Beach (Turman 1964). They ran a large open steamer with a 100 car capacity. The Peninsula Ferry Company was able to charge fares lower than the Pennsylvania Railroad Steamers, which contributed to their success. The Virginia Ferry Company, partially owned by the Pennsylvania Railroad, superseded the Peninsula Ferry Company in 1933 with *Delmarva*, a streamlined steamer designed to carry cars and trucks (Turman 1964). The ferry terminal was moved that same year to the Pennsylvania Railroad Terminal, while the southern terminal was at Little Creek, where the railroad had built tracks for box car barges (Turman 1964).

The stock market crashed in October 1929, but the real impact of the Depression did not peak until 1934 (Turman 1964). The price of Irish potatoes fell dramatically, which brought hardship to farmers, merchants, and professionals due to the prevalence of the potato as a cash crop. When the price of potatoes fell below the cost to produce them, Virginia's Eastern Shore felt the effects of the Great Depression in earnest.

Canning and gardening began to increase in an attempt to recover from the effects of the potato failure, and thrift and industry again returned. The WPA stepped in to assist in the recovery by developing roads, mosquito control, and water systems, and opening sewing rooms for women to produce linen curtains (Turman 1964). Flax was once again produced for linen.

Farmers were harvesting crops that did not include potatoes when World War II broke out in 1939. Soybeans and vegetables that could be canned were being grown, and many of them were shipped by truck to canneries and a newly opened quick-frozen food plant (Turman 1964). Farmers were growing tomatoes, potatoes, sweet potatoes, corn, peas, string beans, lima beans, turnip greens, broccoli, spinach, and strawberries both for personal use and for sale to the military (Turman 1964). The war also expanded the poultry industry that had begun in the 1930s, and 5,745,420 chickens were fattened in Accomack County in 1945 (Turman 1964). Many other veterans were seeking employment in shipyards and war material plants by 1940.

The war brought recovery to the region, but it also brought uncertainty. The return of the draft and quotas made the war more of a reality. The Federal Government acquired land at the mouth of the Chesapeake Bay in 1940 to construct Fort John Custis (Turman 1964). This represented the first visible sign of war on the Eastern Shore.

Coastlines were being very closely monitored by 1942, especially the Atlantic side of the peninsula. Small army posts had been established at the towns of Chincoteague and Accomack, and were responsible for patrolling the shores with trained dogs from dusk to dawn (Turman 1964). These patrols were designed to locate submarines and to prevent enemy landings. While the number of submarines sunk in the Atlantic by the Civil Air Patrol operating out of Accomack and Northampton counties is unknown, there were at least 10 American ships recorded as torpedoed by enemy submarines (Turman 1964). It was not unusual for those living near the coast to hear explosions or feel their homes shake when the Civil Air Patrol was working (Turman 1964).

The government purchased land on Wallops Neck for a naval air station in 1942 and subsequently constructed a landing strip and buildings for officers and members of the unit. The Chincoteague Naval Air Station was commissioned in March of 1943 (Turman 1964). This was soon followed by the opening of a base on Wallops Island under the command of Langley Field Research Center of the National Advisory Committee for Aeronautics. They surveyed the island in 1945, which was then owned by a group of sportsmen using it for fishing and hunting, and a portion was owned by the U.S. Lifesaving Service (Figure 3-5, Turman 1964). A total of 80 acres at the south end of the island were purchased and 1000 acres leased. Construction of facilities for firing rockets started in May 1945 and the first test rocket was fired in June. The remaining portions of Wallops Island were purchased by the Federal Government in 1949 (Turman 1964).

The end of World War II brought another period of growth to Accomack and Northampton Counties. Crops were bringing in good prices and canneries were operating to full capacity (Turman 1964). Televisions, refrigerators, and new cars were popular post-war purchases.

The Virginia Ferry Company was taken over by the Chesapeake Bay Ferry Commission in 1954 by authorization of the General Assembly (Turman 1964). The fleet boasted five vessels, three of which would be enlarged, with two more joining the fleet. They began exploring the possibility of constructing a combination bridge and tunnel across the Bay not long after the Commission was formed. This would be completed in the 1960s.

The Chincoteague Naval Air Station closed in June 1959 and preliminary negotiations were underway to allow NASA to acquire the 1,000 acres of land west of Wallops Island (Turman 1964). It was ultimately decided that the NASA expansion would take place on the former Naval Air Station site. The administrative and technical support facilities on Wallops Island were moved to the mainland on July 1, 1959, which allowed NASA to occupy the location formerly used by the Langley Field Research Center (Turman 1964). NASA was now in control of Wallops Island, which was connected to the mainland by bridge in 1960.

The close of the 20th century and the beginning of the 21st century was marked by a period of declining numbers of farms, but the rise of large farms made it possible for fewer permanent workers (Turman 1964). The major crops included potatoes, both Irish and sweet, tomatoes, snap beans, strawberries, soybeans, and other assorted vegetables. The food packing and processing industry as well as the frozen food industry also became very profitable. The seafood industry remained important but was in decline. Clams, oysters, and crabs continued to be sold in large quantities, and a number of deep sea fishing fleets operate from Virginia's Eastern Shore (Turman 1964).

Lifeboat stations operate on the ocean islands including Smith, Cobb, Hog, Little Machipongo, Parramore, Metompkin, Assateague, and Popes Islands to provide protection for mariners. These stations are under the purview of the Fifth Coast Guard District. Each station continues to provide living quarters for men on duty as well as rescue equipment and boats. While employees live on the mainland and work in shifts, all personnel will be subject to duty around the clock in the event of a disaster (Turman 1964).

The 20th century is not characterized by any distinctive regional vessel types. The primary forms operating in the region were ferries, barges, fishing vessels, tugs, and pleasure craft. These vessel types were all associated with the various maritime activities of the region.

Numerous barges and ferries were operating in the Wallops Island region during the early 20th century. Barges were used as a means of transporting large objects along the coast. There are several reports of tug towed barges transporting cars or boxcars being lost in storms (Turman 1964). One 1906 newspaper remarked that, "there are some 100 barges, with 15 tugs to attend exclusively to bay towing" (Turman 1964: 237). Fishing boats were extremely prominent in this area and remain so to the present. The Chesapeake Bay produced nearly nine times more tons of fish per square mile (2.6 square km) than did the fishing grounds of New England in the late 1920s (Labaree et al. 1998).

A 1912 report from the United States Army to Congress to assess the necessity of dredging the Chincoteague Inlet produced the following list of vessels registered in the area during this period (United States Secretary of War 1912).

600 small boats, not registered, value each $250	$150,000
300 gasoline boats, value each $700	$210,000
100 boats between 5 and 20 tons, value each $800	$80,000
18 vessels over 20 tons, value each $2,000	$36,000
500 barges, scows, etc., value each $40	$20,000
1 steamer (ferryboat)	$10,000
1 steamer (tugboat)	$3,000

These vessels provide a snapshot of the types and importance of the vessels operating in the Wallops Island vicinity during the early 20th century. The emphasis is on practical, working vessels.

The majority of the documented wrecks in within 21 kilometers (13 miles) of the Wallops Island area occurred during this period. The eight vessels lost include two schooners, one fishing trawler, one tug, three barges, and one of unknown type. This likely does not represent the full range of vessels lost in the vicinity, but does provide a cross section of the types of vessels operating in the area during the post World War I era.

3.2.14 Shipwreck Potential within the Project Area

There was a moderate potential to encounter shipwrecks in the project area. This determination was based upon evaluation of known shipwrecks in the area and upon archival research. The likelihood of encountering vessels from the Contact Period through the late 18th century is slight because relatively few vessels traversed the Wallops Island coastline during this time period. Vessels common to this period, which include sloops, bateau, punts, flats, and shallops, were also small coastal vessels that rarely ranged that far from shore. They were also lightly constructed and less likely to have survived to the present.

Potential for encountering vessels from the 1840s to the present increases over the previous periods because the relative prosperity of Virginia's Eastern Shore generated a sharp rise in seagoing merchant vessel traffic and a general increase in seaworthy vessel forms. The most common seagoing craft operating near the project area were schooners, steamboats, barges, and assorted regional watercraft such as larger skipjacks and bugeyes.

A total of 12 known ships were reported wrecked in the project area vicinity (Table 2-4), and all were lost during the 20th century. The loss of four schooners constructed during the last quarter of the 19th century, along with three turn of the century barges, are illustrative of the vessel classes expected offshore of Wallops Island. The preponderance of these two forms on the list suggests that schooner type vessels and barges were common sights along the Wallops coastline, and that they were susceptible to loss in sea conditions endemic to that stretch of the sea. The overall potential to encounter shipwrecks in the project area is moderate, and those that may have been encountered would most likely date from 1840 to the present, and would represent schooners, barges, or other working vessels.

4.0 PROJECT LOCATION AND DESCRIPTION

The WFF is located on the Delmarva Peninsula in the northeastern portion of Accomack County, Virginia. The Delmarva Peninsula is bordered by the Atlantic Ocean to the east and the Chesapeake Bay to the west. The WFF is located approximately 8 kilometers (5 miles) west of Chincoteague Island. The WFF project area consists of three areas totaling approximately 2,428 hectares (6,000 acres): the Wallops Main Base (902.4 hectares [2,230 acres]); the Wallops Mainland (40.5 hectares [100 acres]); and Wallops Island (1699.7 hectares [4,200 acres]), which includes approximately 404.7 hectares (1,000 acres) of tidal marsh. The Main Base is located off Virginia Route 175 and approximately 3.2 kilometers (2 miles) east of U.S. Route 13 (NASA 2005). The entrance gate for the Wallops Mainland and Wallops Island is located approximately 11 kilometers (7 miles) south of the Main Base (NASA 2005). This section summarizes the topography, natural setting, and present land use of the project area. This summary will serve as an environmental context from which regional occupations can be interpreted.

4.1 PHYSICAL ENVIRONMENT

The project area lies "in the Tidewater region of the Embayed section of the Atlantic Coastal Plain" Physiographic Province (United States Department of Agriculture, Soil Conservation Service [USDA:SCS] 1994). Three major landforms are found in Accomack County: mainland, tidal marsh, and barrier island. All three are found in the WFF project area. The mainland includes low and high terraces separated by a discontinuous escarpment at 7.62 meters (25 feet) above mean sea level (amsl). Low terraces are found west of Route 13 (outside the project area) and on the extreme eastern edge of the mainland. The low terrace "consists of broad to narrow flats bordered by tidal marshes on the east and a discontinuous escarpment on the west" (USDA, SCS 1994). The high terrace ranges in elevation from 7.62 to 15.2 meters (25 to 50 ft) amsl. The high terrace topography is more complex than the low terrace, and "is generally characterized by broad, nearly level terraces that are broken by narrow elliptical ridges [Carolina Bay features], gentle escarpments, tidal creeks, and drainageways" (USDA, SCS 1994). Extensive tidal marshes are located between the mainland and barrier islands. The marshes flood regularly with the tides, are drained by an extensive system of meandering creeks, and have immature soils. Barrier islands are roughly parallel to the mainland and are generally less than 3 meters (10 feet) amsl. Topography varies from nearly level to steep, and soils are immature and vary widely from very poorly to excessively drained (USDA, SCS 1994).

The majority of the WFF Main Base is located on a high terrace landform (7.6 to 12.2 meters [25 to 40 feet] amsl) with the northern and eastern portions located on low terrace (0 to 7.6 meters [25 feet] amsl) and tidal marsh. The Wallops Mainland is primarily located on low terrace (0 to 7.6 meters [25 feet] amsl) and tidal marsh, and Wallops Island is a barrier island with extensive tidal marshes between the island and the Wallops Mainland.

The area is underlain by Quaternary Period (ca. two million years ago to present) sands, gravels, silts, and clays (United States Geological Survey [USGS] 1973). The surface geology of the project area varies somewhat according to landform. The Accomack Member of the Omar Formation is found on the mainland, and consists of sand, gravel, silt, clay, and peat deposits (USGS 1973). Tidal marsh areas are underlain by Joynes Neck Sand, a fine to coarse-grained sand that coarsens downward to gravel and sand. Tidal marsh areas also include organic-rich silts and clays. The barrier islands contain beaches and dunes that are composed of fine to coarse-grained quartz sands that are poorly to well-sorted (USGS 1973).

Soils in Accomack County were formed from parent material consisting of transported sediments moved and deposited by marine and stream action (USDA, SCS 1994). Within the project area, soils mapped for the terraces include Bojac, Nimmo, Molena, and Polowana series. These soils are sands and sandy loams that vary from fine to coarse in texture. Soils mapped for the tidal marshes within the project area include Chincoteague and Magotha series. Chincoteague soils are gleyed silt loams. Magotha soils are also gleyed silt loams, but are located in higher elevations within the marshes and have a mature soil profile. These areas were former uplands before they were transformed to tidal marsh by rising sea levels. Soils mapped for the barrier island in the project area (i.e., Wallops Island) include beaches, the Camocca series, and the Fisherman-Assateague complex. Beaches are unconsolidated sands with no soil development. The Camocca series and Fisherman-Assateague complex soils formed from sandy sediments and are immature soils as indicated by the absence of surface pedogenic horizons (i.e., there is no A Horizon overlying parent materials).

The lack of soil development on Wallops Island reflects the dynamic environment typical of barrier islands. On the Delmarva Peninsula, barrier island shorelines are constantly migrating inland. As the Atlantic Ocean-side is eroding, sand is deposited behind the active dunes on the landward-side of the island. This process leads to erosion of the former land surface on the Atlantic Ocean side of the island and burial of the former land surface by dune migration on the landward side of the island (Fehr et al. 1988). On Wallops Island, these soil disturbing processes have been slowed through recent human intervention (e.g., emplacement of seawall and facility construction on the island). In addition to the dynamics of barrier island formation, sea level rise during the Holocene has led to inundation of formerly dry land surfaces and extensive development of tidal marshes between the barrier islands and the mainland. The northern end of the island has been building towards Chincoteague Island over the past one hundred years. In addition, at the southern end of the island, Assawoman Inlet, which separates Assawoman Island from Wallops Island, was filled in 1986 due to a storm (NASA 2005). The inlet was temporarily reopened in 1987, but has since filled in again. These changes reflect the dynamic nature of barrier island environments. The Wallops Main Base and Mainland have been protected from tidal erosion due to the presence of the barrier islands and tidal marshes, and are not subject to the same dynamic forces that affect barrier islands.

4.2 NATURAL ENVIRONMENT

Vegetation for the area varies with landform association. On the Wallops Main Base and Wallops Mainland (mainland landform) areas include loblolly pine, black cherry, red maple, black willow, sassafras, and wax myrtle (NASA 2005). Wallops Island (barrier island landform) vegetation includes seabeach orach, common saltwort, sea rocket, American beachgrass, seaside goldenrod, northern bayberry, wax myrtle, groundsel-tree, phragmites, poison ivy, greenbriar, loblolly pine, cherry, and duckweed (NASA 2005). The tidal marsh areas between Wallops Island and the mainland are dominated by saltmarsh cordgrass and salt meadow cordgrass

(NASA 2005). Areas of marsh are also located along Mosquito Creek on the northern fringe of the Main Base area (NASA 2005). Areas of lawn are maintained in all three areas of the WFF.

Both terrestrial and aquatic faunal species are found throughout the WFF (NASA 2005). Invertebrate species include a variety of insects, snails, and crabs. In addition, sand shrimp, moon jelly, and squid are found. Fish species include sandshark, smooth dogfish, smooth butterfly ray, bluefish, pipefish, spot, croaker, sea trout, and flounder. Amphibian and reptile species include Fowler's toad, green tree frog, black rat snake, hognose snake, box turtle, and northern fence lizard. Several species of sea turtle and whales are also found in the waters of the area. Bird species include several species of sparrows and gulls, red-winged blackbird, boat-tailed grackle, fish crow, gray catbird, mourning dove, swallows, mockingbirds, robins, and starlings. Migratory birds include numerous species of ducks, geese, shorebirds, and songbirds. Predatory birds (raptors) include the osprey, bald eagle, and peregrine falcon. Mammalian species include white-tailed deer, raccoon, red fox, white-footed mouse, meadow vole, opossum, gray squirrels, and cottontail rabbit (NASA 2005).

4.3 PRESENT LAND USE

The Wallops Main Base was developed as a flight training center by the U.S. Navy in the 1940s (NASA 2002). NASA acquired the property in 1959, as well as the Mainland property, and continues to operate the runways. The Main Base also houses research facilities, operations centers, and permanent orbital and suborbital tracking centers. The Mainland provides access to Wallops Island (via a causeway across the tidal marshes), and contains Doppler radar and tracking facilities. The National Advisory Committee for Aeronautics (NACA) authorized the Langley Research Center in 1945 to proceed with development of Wallops Island as a site for rocket propelled models. This was an essential step in the nation's efforts to conduct aerodynamic research at high speeds, leading to advances in aeronautics and space science. NASA acquired the property in 1958 and continues to operate its runways. Launch sites are still located on the island, and are actively used today (NASA 2002). In addition to current use by NASA, through cooperative agreements the WFF is also used by the U.S. Navy, Virginia Commercial Space Flight Center, National Oceanic and Atmospheric Administration (NOAA), and the U.S. Coast Guard.

The majority of the WFF has been subject to continuous change and development since its founding in the 1940s. Changes to the property include frequent construction, upgrade, and removal of structures and facilities caused by technological developments and advances in rocket science and related fields. Few undeveloped areas remain on the WFF, and those areas are located along the fringes of the property, and for the most part, in the tidal marshes (though dredging activities have occurred in some areas adjacent to the Main Base and Mainland). Wooded areas are located in the southern and northern portions of the Main Base, as well as the northern portions of Wallops Island.

5.0 RESEARCH DESIGN

5.1 OBJECTIVES

The objectives of the four archaeological tasks conducted at WFF were to locate and identify potentially significant cultural resources, as shell middens or other prehistoric sites, shipwrecks, or historic maritime sites or structures. These objectives will be met by a series of archaeological tasks, including a remote sensing of the proposed breakwater location, a scientific diving survey of the proposed beach groin location, a pedestrian survey of the Wallops Island shoreline, and the archaeological monitoring of geotextile tube installation on the same shoreline.

The project area is composed of three separate survey parcels, which includes the proposed beach groin location, the proposed breakwater location, and the entire Wallops Island coastline contained within the bounds of WFF (Figure 1-2). The APE for the Wallops Island shoreline is 3.85 mi (6.2 km), or approximately 69 acres, of coastal beach in Accomack County, on Virginia's Eastern Shore. The pedestrian survey was undertaken from the waterline to the beach edge within this portion of WFF. Archaeological monitoring of the 4,600 ft (1,402 m) of shoreline that received geotextile tubes occurred within this study area, beginning at the southern terminus of the seawall and extending to the camera station at the southern end of NASA Property. The APE of the proposed beach groin is located in the Atlantic Ocean, directly opposite of the camera station at the southern end of NASA property. It measures approximately 500-ft long (152.4-m) by 100-ft wide (30.5-m), or 1.1 acres. The APE of the proposed breakwater is intended to address any ancillary impacts such as anchoring, or jack-up barges, and is located on the seaward edge of the proposed beach groin, and extends 400 ft (121.9 m) to either side of the groin. It measures approximately 1,200 ft long (365.9 m) by 800 ft wide (243.9 m), or 22 acres.

5.2 METHODS

5.2.1 Background Research

The purpose of background research is to develop cultural contexts for identifying and evaluating archaeological sites that may be encountered within the project area. Research was conducted at the National Archives in Washington, D.C. and at various online repositories. Reports of previous cultural resources investigations and previously recorded architectural and archaeological sites as well as known shipwrecks were obtained from the Virginia Department of Historic Resources. Historic maps and accounts of the development of Wallops Island were obtained from the National Archives and through books and periodicals.

5.2.2 Pedestrian Survey Methods

The area covered during the shoreline pedestrian survey spans 6.2 kilometers (3.85 miles) of Wallops Island shoreline, or approximately 27.9 hectares (69 acres Figure 5-1). The topography of the parcel was that of a flat barrier island beach and dune face that varied in width from approximately 91 meters (250 feet) to nothing at areas along the bare rock seawall. The beach in the central portion of the surveyed coastline (approximately 56.1 percent of the project area) was completely eroded to rock seawall (Plate 5-1) during recent storm events, and no systematic survey was possible in this area. Beaches to the northeast and southwest of this rock seawall (Plates 5-2 and 5-3) were the focus of the pedestrian survey.

Due to the flat topography and constantly shifting sediments of the Wallops Island beach, the northeast and southwest extremities of the survey area were subjected to a systematic pedestrian survey, in which three archaeologists traversed transects that extended along the existing beach from the surf line to the fringe of the marsh or seawall at 20 meter (65 feet) intervals. The position of any significant cultural resource discovered during the survey was to be plotted via a Global Positioning System (GPS) unit and photographed.

Previous research conducted on Wallops Island during the *Cultural Resource Assessment of Wallops Flight Facility*, which was completed by URS in 2003, indicated that three potentially significant cultural resources may exist on the northern half of the island, including the remnants of a U.S. Coast Guard Station established in 1883, a small civilian occupation that dated to the first half of the 20th century along the southern beach remnant, and prehistoric shell middens. Archaeologists targeted these areas, along with recent flotsam that may have been washed to the beach from previously buried shipwrecks located near the shoreline of Wallops Island.

5.2.3 Archaeological Monitoring Methods

Monitoring took place on a 1,402 meter (4,600 foot) stretch of shoreline where Geotextile tubes are to be installed, beginning at the southern terminus of the seawall, and extending to the camera station at the southern end of NASA property (Figure 5-2). Geotextile tubes are durable textile cylinders that are 4.3 meters (14 feet) wide, 1.7 meters (5.5 feet) high, and have a 10.4 meter (34 foot) circumference. These are filled with sand and serve as a temporary bulwark to further impede beach erosion. Ground disturbances associated with this action included the preparation of the project corridor and the excavation of two sand slurry pits to facilitate tube filling. Approximately 304.8 meters (1,000 feet) of the northern portion of the Geotextile tube corridor were graded. The monitor was responsible for the review and photo-documentation of these actions, and also ensured that historic properties were not damaged or destroyed.

5.2.4 Scientific Diver Survey Methods

Field examination of the proposed groin site was undertaken as a controlled scientific diver survey. The proposed beach groin survey area was located in the Atlantic Ocean, directly opposite of the camera station at the southern end of NASA property (Figure 5-3, Plate 5-4). It measured approximately 152.4 meters (500 feet) by 30.5 meters (100 feet), or 0.4 hectares (1.1 acres). This parcel was divided into 11 transects spaced at 3.1 meter (10 foot) intervals, which yielded 1676.8 linear meters (5,500 linear ft) or 1.676 linear kilometers (0.96 linear survey mi). Water depth ranged between 0.3 and 3 meters (1 and 10 feet) in this survey area. Divers established underwater transects spaced at 3 meters (10 feet) and running the length of the proposed groin, and will used an underwater metal detector to identify potentially significant cultural resources. The exact position and nature of the encountered metallic materials were noted based on the diver's position along a fixed baseline. Divers also visually inspected the sediments to insure that no prehistoric materials are in the proposed project area. The dive team consisted of three scientific divers working in tandem, a communications operator, and a dive supervisor. The safety divers and dive supervisor used a small inflatable boat (Zodiac) when dive operations were more than 76.2 meters (250 feet) away from the beach, or when water depths required a support vessel. The expected water depths within the survey area ranged between 0.3 and 3.7 meters (1 and 12 feet) in depth.

5.2.4.1 Dive Team Role Definitions

The URS scientific dive team consisted of five archaeologists, all of whom are certified divers trained in nautical archeology. There were three defined roles within the URS scientific dive team for the field examination of proposed groin site at Wallops Island; these roles were Dive Supervisor, Communications Operator, and Scientific Diver. These roles are described below. No safety divers were employed during this survey because three trained scientific divers were working in close proximity to one another at the same time.

Scientific Diver

The role of the scientific diver on this project was designed around three main tasks. The first task was to set up the survey area using marker buoys, anchors, and measuring tapes. The second task was to swim established survey transects while visually inspecting sediments for cultural resources, sweep the transect area with a survey grade underwater metal detector, and identify any potential targets. The third task was to establish new transects after the previous transect had been surveyed. There were three scientific divers operating in tandem to accomplish these tasks.

Communications Operator

The role of Communications Operator (CO) was designed to serve as the nerve center for each planned dive. The DSC was responsible for communicating with the Scientific Diver, for relaying and recording archaeological data, and for logging all dive related information on the Dive Log Form (DLF). Data recorded on the DLF by the CO includes diver name, dive time, the date, general dive objectives, and the current weather and water conditions. The dive records created by the DSC were curated as project data. The communications operator was stationed on a small inflatable survey boat (zodiac) positioned on the seaward edge of the survey area.

Dive Supervisor/Primary Archaeologist

The Dive Supervisor/Primary Archaeologist (DSA) was responsible for orchestrating the field survey in a safe, systematic manner. The supervisor continually monitored sea and general weather conditions, and will decided if operations can proceed based on these factors. The DSA was also responsible for ensuring that the survey was conducted in a systematic manner, ensuring that the entire survey area has been adequately surveyed for cultural resources. The final role of the DSA was to guarantee that the dive efforts conducted at Wallops Island conform to the Health and Safety Plan (HASP) designed for this project. The HASP was be reviewed and approved by certified Industrial Hygienists and the URS Dive Safety Control Board. The DSA was stationed on a small inflatable survey boat (Zodiac) positioned on the seaward edge of the survey area. He also served as the vessel operator.

5.2.4.2 Survey Area Setup

The survey area for the proposed beach groin extension extended perpendicular to the Wallops Island shoreline at the location of the current groin remnant. The rectangular parcel measured 30.5 meters (100 feet) wide and extended 152.4 meters (500 feet) into the Atlantic Ocean. The survey area was delineated on shore with a 30.5 meter (100 foot) measuring tape, the extremities of which (corners of the survey area) were clearly marked with red flags. The seaward extreme of the survey area was delineated by two large red buoys firmly fixed with anchors. The positioning of these buoys was established with a survey grade ranging device set up on the shoreline. Special care was taken to ensure that there was not excessive scope in the buoy line, thus ensuring that the buoys accurately represented the limits on the survey area. Two additional lines of five red buoys were placed at 30.5 meter (100 foot) increments between the shoreline flags and the seaward most buoys. These floats served as control points that effectively divided the survey area into five smaller 30.5 meter (100 foot) by 30.5 meter (100 foot) survey blocks. The positioning of these floats was also established with a survey grade ranging device set up on the shoreline. Survey tapes that measure 30.5 meter (100 foot) in length were aligned on the bottom between each 30.5 meter (100 foot) buoy pair to serve as a set of underwater control points. They were fixed to the sea bottom using carabineers and 0.6 meter (two foot) lengths of iron rebar.

5.2.4.3 Survey Design

The scientific diver survey of the proposed beach groin extension was designed to employ three scientific divers working in concert. Each diver was equipped with underwater communications that allow contact with the communications operator at the surface and with each other. The overall survey area was evaluated in smaller 30.5 meter (100 foot) by 30.5 meter (100 foot) survey blocks that were delineated with surface buoy markers and underwater measuring tapes. Each block was denoted as Block A through Block E. Transects within the blocks were spaced every 3 meters (10 feet) and were assigned the letter designation of the corresponding block along with a number designation beginning at 1 and continuing to 11.

There were two tasks required of the three scientific divers assigned to this survey. Two divers aligned and fixed a 30.5 meter (100 foot) transect tape between underwater control tapes at 3 meter (10 foot) increments, beginning at 0 ft and extending to 30.5 meters (100 feet). The third diver swam along this transect tape investigating the bottom for cultural resources and fanning five feet to either side of the transect tape with an underwater metal detector to identify any metal objects located beneath the sediments. The location of any finds were derived from its position along the transect tape and the perpendicular distance to the left or right of the transect tapes as measured by a 1.8 meter (6 foot) folding rule. These coordinates were reported to the communications operator, along with an identification of the anomaly or surface find. These data also were recorded by the diver on an underwater dive slate. A map of underwater debris and cultural resources was created with these data. Potentially significant cultural resources were assigned a Resource Number and were identified with secondary floats marked with the corresponding number. The control divers moved the transect tape 3 meters (10 feet) further down the control tapes after the transect procedure had been completed.

There were eleven 30.5 meter (100 foot) long transects surveyed in this manner per survey block, and a total of fifty- five (55) 30.5 meter (100 foot) transects for the entire survey area.

5.2.4.4 Dive Equipment Summary

Each diver was equipped with an OTC full face mask with an integrated underwater acoustic communications system. The primary stage array contained a buoyancy compensator (BC) whip, mask whip, drysuit whip, and an integrated depth/compass and air gauge console. The diver was also outfitted in a standard BC, wetsuit or drysuit, fins, dive knife and weight belt. Portions of the survey were snorkeled with standard snorkeling gear as depth and visibility permit.

5.2.5 Remote Sensing Methods

The proposed breakwater location was subject to an extensive cultural resources remote sensing survey. The survey area was located on the seaward edge of the proposed beach groin site, and extends 121.9 meters (400 feet) to either side of the groin (Figure 5-4). It measured approximately 365.9 meters (1,200 feet) long by 243.9 meters (800 feet) wide, or 22 acres. This parcel was divided into 17 transects spaced at 15.2 meters (50 foot) intervals, which yielded 4,390.2 linear meters (14,400 linear feet) or 4.39 linear survey kilometers (2.72 linear survey miles). Water depth ranges between 0.3 and 6.1 meters (10 and 20 feet). This survey was designed to identify magnetic and acoustic anomalies that may represent significant submerged cultural resources, including submerged watercraft and buried archaeological sites. A well designed survey conducted with sensitive, high resolution sensors can detect submerged habitation sites and shipwreck debris, and can reliably differentiate these finds from the earth’s ambient magnetic field and natural bottom topography.

A carefully defined set of criteria were used to distinguish naturally occurring magnetic and acoustic anomalies from significant cultural resources. Magnetic anomalies were evaluated based on data points that include anomaly duration (both time and distance), magnetic amplitude in nanoTesla (nT), and magnetic signature. Magnetic signatures were denoted as dipoles (D), monopoles (±M) or multi-components (MC) (Figure 5-5). Positive and negative monopoles refer to one half of a dipolar perturbation, and usually indicate an isolated magnetic source located some distance from the sensor. Monopoles produce either a positive or negative deflection from the ambient magnetic field. The polar signature depends on whether the positive or negative pole of the object is oriented toward the magnetometer sensor. Dipolar signatures display both a rise and a fall from the ambient field, and they are generally associated with single source anomalies located directly under the magnetic sensor. Multi-component magnetic perturbations represent several, randomly scattered ferrous objects with different magnetic orientations. Anomalies with these signatures are likely associated with man-made objects, possibly shipwrecks. The last two criteria are the location of the anomaly center, and the distribution and patterning of anomalies within the survey area.

Side scan sonar data were used to image the sea floor, to locate and identify culturally significant materials, and to map the geomorphic and bathymetric anomalies within each survey area. A sub bottom profiler was used to detect buried structures or geomorphic features, such as buried relict channels, shell middens, shipwrecks, or buried cables and pipelines.

Data acquired from these instruments were first evaluated separately, and then as an integrated data set. Potential cultural targets are often comprised of related magnetic and acoustic anomaly groups. Targets are identified as significant if the various anomaly groups reflect parameters established for shipwrecks and other significant cultural features.

The survey array used for the WFF Beach Replenishment survey consisted of the following: a Differential Global Positioning System (DGPS), a cesium vapor marine magnetometer, side scan sonar, a continuous transmission FM chirp sub bottom profiler and an echo sounder (Plates 5-5 and 5-6). Hydrographic and navigational controls were achieved by the use of Hypack's survey software.

5.2.5.1 Positioning

A Hemisphere Crescent R130 DGPS with inertial navigation corrections (for up to 45 minutes after loss of signal) was used for this survey. The Hemisphere system transmits information in NMEA 0183 code to a computer navigation system using the *Hypack 2009a* survey software. The *Hypack* software incorporates the NMEA 0183 data string and displays vessel position on a computer screen relative to pre-programmed track lines and each instrument sensor. It also performs instantaneous data translations between various geodetic projections, which combine all incoming data with accurate positions for seamless data integration and post acquisition processing. Navigation files within *Hypack 2009a* can be utilized to produce track line maps and derive X, Y, and Z data sets for analysis and contour plotting. Positioning control points were obtained every 100 ft (30.5 m) along survey transects. The Hemisphere Crescent 130 DGPS is considered to be accurate to within 8 inches Root Mean Square (RMS) values under optimal conditions.

5.2.5.2 Magnetometer

A Geometrics G882 marine magnetometer was used for the magnetic survey. The G882 magnetometer is a 0.01 nT (RMS) sensitivity cesium magnetometer that is linked to *Hypack 2009a*, which enables precise, real-time positions for recorded magnetic data. Survey was terminated if induced magnetic background noise exceeded +/-3 nanoTesla (nT). The magnetometer sensor was towed a sufficient distance from the transom of the survey vessel to avoid magnetic interference from the propulsion and electrical systems.

5.2.5.3 Side Scan Sonar

A MarineSonic 600 kHz side scan sonar system was used to collect acoustic data for this survey. The 600 kHz system produces high resolution images with moderate ranges of a few hundred feet. Navigation fixes are imbedded with the acoustic data in real time, which allows images to be geo-referenced and side scan mosaics created for analysis.

5.2.5.4 Sub Bottom Profiler

A Benthos Chirp III sub bottom profiler was used to record sediment structure and any cultural material deposited beneath sediments. The Benthos system uses a continuously transmitted acoustic pulse that begins at 2 kHz and continues to a maximum of 20 kHz. This swept frequency can image sediment structure with up to 2 cm (0.78 in) resolution. The DGPS system feeds positioning data to the sub bottom profiler receiver and is used to control recording speed and data point position.

5.2.5.5 Echo Sounder

An ODEM Hydrotrac digital echo sounder was used to record bathymetric data for each survey transects. *Hypack 2009a* recorded the position and bottom depth every tenth of a second and corrected for transducer layback and offset values. The bathymetric data is used to better understand the geomorphology of the survey area and how that affects the distribution of magnetic and acoustic anomalies, as well as to delineate any features sitting above the sediment surface.

5.2.5.6 Data Collection and Position Control

Hypack 2009a survey software was used for survey planning and data collection. Once the survey was designed and track lines planned, *Hypack* survey module was used to establish survey control and data collection and correction. While surveying, the planned transects were projected onto the navigation screen and the data being collected, which permits “real time” quality control and field data logging of anomalous data.

All remote sensing data were correlated with DGPS positioning data and time through *Hypack 2009a*. Positions for all data were then adjusted for sensor layback and offsets. Positioning was recorded using Virginia State Plane South, US Survey foot, referencing the North American Datum of 1983 (NAD-83), and U.S. survey feet were the units of measure.

5.2.6 Marine Data Analysis

Magnetic and acoustic data were reviewed for anomalies during data collection, and that data were reviewed again during post-processing using *Hypack* data review module, Chesapeake Technology’s *SonarWiz.Map* 4.04, and Golden Software’s *Surfer* (Version 8). These computer programs were used to assess the duration, amplitude, and complexity of individual magnetic disturbances, and to review side scan sonar (SSS) and sub bottom profiler (SBP) data for anomalies. The software was also used to plot anomaly positions within the project area to better understand their spatial distribution and association with other anomalies.

Nautical archeologists maintained field notes on the locations of modern sources of ferrous material, such as pipeline and cables corridors as well as fishing grounds and charted shipwrecks that would have altered regional magnetic field readings. Magnetic perturbation of 3 nT or greater with durations greater than 10 ft (3 m), were cataloged for further analysis. Acoustic imaging was reviewed for anomalous returns that could be associated with significant submerged cultural resources. SBP data were reviewed for buried shipwrecks, submerged prehistoric features and relict landforms that have potential to contain intact prehistoric deposits. All data sets were cross-checked for relevant correlations. Anomalies in clear association were identified as targets and underwent further analysis. The presence of known shipwrecks in the vicinity of Blackfish Bank suggests that the area has a moderate potential for containing shipwrecks and other maritime cultural resources.

5.3 EXPECTED RESULTS

Research and analysis presented in Sections Two and Three suggest that there was a moderate probability to encounter significant cultural resources within the survey areas. Evidence of historic and prehistoric activity along the Wallops Island shoreline might be encountered during the pedestrian survey of the coastline and the monitoring of geotextile tube installation. It was anticipated that archaeologists might encounter remains associated with the early Coast Guard Station of 1883, the civilian hunting activities of the early 20th century, or shell middens associated with prehistoric occupations. It was also anticipated that the results of the diving survey of the proposed beach groin and remote sensing survey of the proposed breakwater location would represent recent construction and dumping activities from the 1950-1960's associated with WFF shoreline protection projects.

6.0 RESULTS OF CULTURAL RESOURCES INVESTIGATIONS

Cultural resources tasks associated with SRIPP were undertaken to assist WFF with compliance under Section 106 of the National Historic Preservation Act of 1966, as amended; the Abandoned Shipwreck Act of 1987; and the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) of 1970. These efforts included the pedestrian survey of the Wallops shoreline, and scientific diving survey of a proposed groin location, the remote sensing survey of a proposed breakwater location, and the archaeological monitoring of Geotextile tube installation. A detailed review of the results of each effort in provided below.

6.1 RESULTS OF THE PEDESTRIAN SURVEY OF THE WALLOPS SHORELINE

A total of 6.2 km (3.85 mi) of beach line was traversed during the Wallops Island shoreline cultural resources survey on September 18, 2006. No significant cultural resources were identified during this evaluation. The north and south beaches were littered with modern materials thrown to shore during recent storm events. These materials included wooden pallets, portions of wooden decks, and fishing nets (Plate 6-1).

There was no evidence of the three potentially significant cultural resources that may have existed on the northern half of the island. These resources include remnants of a U.S. Coast Guard Station established in 1883, a small civilian occupation that dated to the first half of the 20th century along the southern beach remnant, and prehistoric shell middens. The southern portion of the beach contained evidence of structures at the surf line and in the sea itself, including caisson foundation posts (Plate 6-2) and pier remnants (Plate 6-3). Although these structural features relate to the previously discussed civilian occupation of Wallops Island, they were previously noted in the *Cultural Resource Assessment of Wallops Flight Facility* completed by URS in 2003 and will not be discussed further (Meyers 2003). None of the identified features appears to be eligible for listing in the National Register of Historic Places.

6.2 RESULTS OF CULTURAL RESOURCES MONITORING OF GEOTEXTILE TUBE INSTALLATION

A URS Senior Archaeologist inspected the Geotextile tube installation work on behalf of WFF on January 22, 2007. The APE for the cultural resource monitoring effort consisted of 4,600 ft (1,402 m) of shoreline that received geotextile tubes which began at the southern terminus of the seawall and extended to the camera station at the southern end of NASA property.

Ground disturbances during this action include the preparation of the 4,600 ft (1,402 m) corridor for the placement of Geotextile tube and the excavation of two sand slurry pits to facilitate filling. Approximately 1,000 ft (304.8 m) of the northern portion of the Geotextile tube corridor was also machine graded during monitoring. Machine grading was less than one ft in depth and did not extend below sand deposited by recent storm events (Plates 6-4). No artifacts or cultural features were observed during the grading effort.

Excavation of the northern sand slurry pit was not monitored because Geotextile tube filling was in progress, but fill material from this pit was inspected. No cultural materials were noted during the inspection of the backdirt surrounding the pit. Soils from this excavation were comprised of a dark yellowish brown loamy sand A-horizon, mixed with an equal amount of pale brown sands with seashell fragment inclusions (Plate 6-5). This sand deposit was consistent with natural, unconsolidated beach sediments. No cultural materials were noted in this area.

Review of the soil profile from the 1.8 meters (6 feet) deep southern sand slurry pit, which measured approximately 12.2 meters (40 feet) by 3.9 meters (13 feet), revealed extensive soil disturbance. A soil anomaly and associated lumber and trash deposit were visible in the southwestern pit wall (Plate 6-6). Several fragments of machine milled lumber were also seen in the nearby backdirt pile. Closer examination of the pit profile and backdirt revealed that the majority of trash consisted of modern aluminum and plastic soft drink containers, plastic electrical fittings and rubber cable sheathing. Personnel on site mentioned that the general area was recently used as a construction site for an asphalt pad used to support an electrical panel. The pad and electrical panel are still present to the south of the southern sand slurry pit. Reconnaissance of the general area revealed a wide scatter of similar material on the surface. None of the materials encountered in or near the southern slurry pit constitute a significant cultural resource.

Ground disturbances from Geotextile tube installation did not impact any significant cultural resources. WFF therefore concluded that no historic or prehistoric resources were affected by the emergency installation of these cylinders on the beachfront. VDHR concurred with this finding in a response letter dated January 27, 2007 (Appendix C).

6.3 RESULTS OF ARCHAEOLOGICAL DIVER SURVEY ON THE PROPOSED BEACH GROIN LOCATION

The proposed beach groin survey area is located in the Atlantic Ocean, directly opposite of the camera station at the southern end of NASA property. It measures approximately 152.4 meters (500 feet) long by 30.5 meters (100 feet) wide, or 1.1 acres. This parcel was divided into 11 transects spaced at 3.1 meters (10 foot) intervals, which yields 1,676.8 linear meters (5,500 feet) or 1.7 linear survey kilometers (0.96 miles). Water depth ranges between 0.3 and 3 meters (1 and 10 feet).

The archaeological survey of the proposed groin location was designed as a systematic scientific diving investigation. This investigation survey was intended to cover the footprint of the original groin structure and the proposed location of a rock jetty. Cursory visual inspection of the study area revealed that the proposed groin site was filled with concrete rubble and other construction waste (Plate 6-7). This waste may have been dumped and along the shoreline as a temporary repair to the old wooden groin. This rubble is intermixed with concrete pipe fragments and brick, all of which contain exposed iron rebar and re-wire (Plate 6-8). The corroded extremities of this rebar and re-wire represent a serious impalement and laceration hazard to divers operating in the near zero visibility water of the turbulent swash zone.

The survey plan for the proposed groin location was altered from a scientific diver survey to a systematic wading survey due to safety hazards inherent to that locale. Archeologists began carefully traversing transects at the proposed groin location at low tide, and inspected the sea bottom in the troughs of waves. Each transect was traversed to a depth of 1.4 to 1.5 meters (4.5 to 5 feet), which was the depth that could be safely reached in very low visibility water and a high surge. No significant cultural materials were identified during this portion of the proposed beach groin survey.

The final 60.9 meters (200 feet) of the 152.4 meters (500 foot) long survey area was not traversed due to the afore- mentioned safety concerns, and because this 60.9 meter (200 foot) by 30.5 meter (100 foot) section has the very low potential to contain significant historic resources. This assessment is based on the general ground disturbance that has occurred at this site. These disturbances include the construction of the original groin, and the disposal of concrete construction waste throughout the area, and the substantial erosion and sediment transport that has removed a large portion of the Wallops shoreline.

6.4 RESULTS OF CULTURAL RESOURCES REMOTE SENSING SURVEY OF A PROPOSED BREAKWATER LOCATION

Magnetic and acoustic (side scan sonar, sub bottom profiler and echo sounder) data detected during the survey were reviewed during data collection for anomalies, and reviewed a second time during post-processing efforts using the *Hypack* (version 2009a) data review module and Golden Software's *Surfer*® (Version 8). These software programs were used to assess the duration, amplitude, and complexity of individual magnetic disturbances, and to plot the positions of these anomalies within the survey areas to better understand spatial patterning and their association with acoustic and bathymetric anomalies.

Archeologists maintained field notes on the locations of modern sources of ferrous material such as underwater cables, pipelines, or beach engineering structures such as pilings, piers groins, or breakwaters as well as other jettisoned debris. Magnetic perturbations with an intensity of 3 nT or greater and a duration longer than 20 ft (6.1 m), were cataloged for further analysis. Acoustic imaging data were reviewed for anomalous returns that could be associated with significant submerged cultural resources. Acoustic images and magnetic contouring were checked against bathymetric data for potential correlation.

The proposed breakwater is situated on the seaward edge of the proposed beach groin site. It measures approximately 365.9 meters long (1,200 feet) by 243.9 meters wide (800 feet), or 22 acres. The survey area was divided into 17 transects spaced at 15.2 meter (50 foot) intervals, which yields 4390.2 linear meters (14,400 feet) or 4.39 linear survey kilometers (2.72 miles). A total of 12 transects were surveyed during this effort; the remaining five were not completed due to shoal water. Water depths decreased to 1.8 meters (6 feet) beneath the keel at Transect 12, and the sea height at that time was between 0.6 and 1.2 meters (2 and 4 feet). The potential to ground the survey vessel and magnetic sensor in wave troughs was very high, and the remaining transects were abandoned for the safety of the crew and survey sensors.

There are four side scan sonar anomalies (Figure 6-1, Table 6-1), twenty one magnetic anomalies (Figure 6-1, Table 6-2), and several bathymetric anomalies recorded in the proposed breakwater area. Each anomaly was assigned a number preceded by A (acoustic anomaly) or M (magnetic anomaly).

A Benthos Chirp III sub bottom profiler was selected for this survey to image buried cultural resources. These resources include historic properties, such as shipwrecks, and ancient landforms, such as relict river channel margins that may have been frequented by Paleolithic Period peoples. The Benthos Chirp III sensor requires a minimum of 1.8 meters (6 feet) of water above and 2.7 meters (9 feet) of water beneath the sensor to collect data at frequencies needed for high resolution images. It was apparent that water depths in the survey area were not deep enough to safely collect reliable data. To account for the loss of sub-bottom profiler data, magnetic data, which was collected from a sensor height of between two and four feet above the sea floor, were examined for very short duration, low amplitude anomalies. These small perturbations serve as reliable indicators of cultural artifacts and features such as ancient hearths or deeply buried shipwrecks.

6.4.1 Target Descriptions

A total of five targets were derived from these data for further analysis (Figure 6-1, Table 6-3). Each target cluster is comprised of associated acoustic or magnetic anomalies, or combinations of both. These data were grouped based on proximity, spatial patterning, and magnetic signature, amplitude, or duration. Targets were assigned the prefix T to aid in plotting and differentiation. A detailed description and analysis of each target is described in below.

6.4.2 Target 1

Target 1 is comprised of magnetic perturbations M5, M8, and A1 (Figure 6-1, Tables 6-1 and 6-2). Anomaly M5 is a positive monopolar anomaly with a low amplitude of 6.6 nT, a long duration of 68.3 meters (224 feet), and a calculated ferrous mass of approximately 0.31 kilograms (0.68 pounds) with the height of sensor at 3.3 meters (10 feet) off the bottom (Tables 6-2 and 6-3, Figure 6-1). Anomaly M8 is a dipolar anomaly with a low amplitude of 11.9nT, a medium duration of 78.65 meters (258 feet), and an estimated ferrous mass calculated to be 15.45 kilograms (2 pounds) with the height of sensor at 3.3 meters (10 feet) off the bottom. The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-1). A single side scan sonar anomaly (A1) was recorded in the vicinity of Target 1 (Table 6-1). Anomaly A1 is a 6.7 meters (22 foot) section of pipe or cable that protrudes just above the sea floor. Analysis indicates that this anomaly consists of a single small ferrous mass that extends onto an adjoining survey line. It likely represents a section of discarded wire rope, cable or pipe. Target 1 does not represent a significant submerged cultural resource and no further work is recommended.

6.4.3 Target 2

Target 2 is composed of magnetic perturbations M19 and M21 (Tables 6-2 and 6-3, Figure 6-1). Anomaly M19 is a dipole with a long duration of 113.4 meters (372 feet), a low amplitude of 16 nT, and a calculated ferrous mass of 7.6 kilograms (16.7 pounds). Anomaly M21 is a dipolar anomaly with a low amplitude of 15.5 nT, a long duration of 114.3 meters (375 feet), and a calculated ferrous mass of 7.3 kilograms (16.1 pounds). The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-1). The dipolar signature of all perturbations indicates that the magnetic sensor passed directly over or just next to the detected ferrous mass. Magnetic analysis indicates that Target 2 is a simple isolated ferrous object, such as a section of discarded wire rope or cable. There were no acoustic anomalies associated with Target 2. Target 2 does not represent a significant submerged cultural resource and no further work is recommended.

6.4.4 Target 3

Target 3 is comprised of magnetic anomalies M3 and M4 (Tables 6-2 and 6-3, Figure 6-1). Anomaly M3 is a dipolar anomaly with a low amplitude deflection of 13 nT, a medium duration of 51.2 meters (168 feet), and a calculated ferrous mass of 6.27 kilograms (13.8 pounds). Anomaly M4 is a dipole with a low amplitude deflection of 13.2 nT, a medium duration of 63.1 meters (207 feet), and a calculated ferrous mass of 6.24 kilograms (13.7 pounds). The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-1). The magnetic analysis of Target 3 indicates that it is a simple dipolar anomaly that lacks the complexities associated with submerged cultural resources. This target, much like Target 2, likely represents a section of wire rope or ferrous construction debris. Acoustic data recorded in this vicinity does not show any anomalous surface features. Target 3 is clearly not associated with any significant cultural resource; no further work is recommended.

6.4.5 Target 4

Target 4 consists of magnetic anomalies M16, M18, and M20 (Tables 6-2 and 6-3, Figure 6-1). Anomaly M16 is a dipolar perturbation with a low amplitude deflection of 10.6 nT, a long duration of 117 meters (383.8 feet), and a calculated ferrous mass of 5 kilograms (11 pounds). Anomaly M18 is a dipolar anomaly that has a low magnetic deflection of 11.3 nT, a long duration of 109.2 meters (358.3 feet), and a calculated ferrous mass of 5.36 kilograms (11.8 pounds). The data was reviewed for magnetic pattern analysis and magnetic contouring (Figure 6-1). Acoustic data recorded in this area did not record any anomalous objects on the seafloor. Analysis of this target indicates that it has a simple magnetic pattern indicative of construction debris likely associated with the material deposited on the old groin location. No further work is recommended for Target 4.

6.4.6 Target 5

Target 5 consists of magnetic anomaly M15 (Tables 6-2 and 6-3, Figure 6-1). Anomaly M15 is a multi-component perturbation with a low magnetic deflection of 8.5 nT, a medium duration of 63.4 meters (208 feet), and a calculated ferrous mass of 4.1 kilograms (9 pound). Multi-component anomalies are more frequently associated with submerged cultural resources and generally represent several ferrous objects oriented in different planes. Magnetic pattern analysis and magnetic contouring on adjacent survey lines indicate that there is no linkage with other anomalous data (Figure 6-1). The side scan sonar system did not record any anomalous surface features in this area other than low amplitude sand waves. Analysis of Target 5 indicates that anomaly M15 likely represents an isolated scatter of ferrous materials. Target 5 lacks the characteristics of a shipwreck or other significant submerged cultural resource. No further work is recommended for Target 5.

6.4.7 Discussion

Analysis of the five of the target clusters indicates that the inshore area in the vicinity of the demolished beach groin was scattered with concrete construction debris that contained rebar and re-wire. This material originated from the groins and piers that dotted the southern WFF shoreline. Other ferrous debris likely originated from erosion control structures that have been built across the WFF beach. The small calculated ferrous mass of the magnetic perturbations, and the random spatial patterning of all anomalies suggest that the seafloor of the proposed breakwater location is littered with construction debris that has been re-distributed by storm events and general wave action. None of the anomalies recorded during the survey display characteristics typical of significant cultural resources.

The final 61 meters (200 feet) of the survey area not covered during the survey (for safety reasons) have a very low potential to contain significant cultural resources. This determination is based on data recorded in the first 183 meters (600 feet) of the survey, on the construction, demolition, and dumping activities that have taken place in that area, and on the high energy surge endemic to the Wallops Island coastline.

Table 6-1. Acoustic Anomalies

Anomaly Number	Block/ Line	Magnetic Association	Dimensions L x W x H (Ft)	Shape	X NAD 83 VA South State Plane, US Srv Ft	Y NAD 83 VA South State Plane, US Srv Ft	Identification
A1	Breakwater L4_1	M5 and M8	22 ftx.6ft	Pipe	12351195.09	3836604.111	Pipe Segment
A2	Breakwater L9_1		70 ftx20ftx1.5	linear	12350818.8	3836153.72	Cable or Wire Rope
A3	Breakwater L9_2		5ftx1ftx1.2ft	Rectangle	12350826.28	3836448.456	Concrete Debris
A4	Breakwater L10_1		24ftx7ftx.75 ft 19ftx10ftx1.5ft	Scatter	12351047.37	3836811.322	Scatter of Two Buried Objects

Table 6-2. Magnetic Anomalies

Block	Line #	Anom #	X NAD 83 VA South State Plane, US Srv Ft	Y NAD 83 VA South State Plane, US Srv Ft	Amplitude (nT)	Sign	Duration (ft)	Height of Sensor (ft)
Breakwater	12	M1	12350673.13	3836287.962	10.2	D	323.221	10
Breakwater	10	M2	12350583.83	3836098.596	5.79	-M	139.759	10
Breakwater	9	M3	12350564.34	3835969.092	13.36	D	168.725	10
Breakwater	9	M4	12350525.09	3835928.96	13.26	D	207.76	10
Breakwater	8	M5	12351127.25	3836647.999	6.61	+M	224.268	10
Breakwater	8	M6	12351025.01	3836504.871	9.37	D	211.341	10
Breakwater	8	M7	12350623.54	3835959.099	10.03	D	313.419	10
Breakwater	7	M8	12351171.03	3836616.551	11.97	D	258.19	10
Breakwater	6	M9	12351159.77	3836516.738	13.45	D	411.063	10
Breakwater	6	M10	12350805.52	3836052.279	4.14	D	98.3974	10
Breakwater	6	M11	12350695.8	3835902.688	9.21	D	225.102	10
Breakwater	5	M12	12350778.14	3835929.702	8.94	D	193.59	10
Breakwater	5	M13	12351319.12	3836643.236	13.38	D	353.68	10
Breakwater	4	M14	12351327.49	3836556.754	9.17	+M	106.476	10
Breakwater	4	M15	12350734.25	3835785.791	8.75	MC	208.151	10
Breakwater	3	M16	12350919.96	3835946.283	10.65	D	382.866	10
Breakwater	3	M17	12351217.39	3836356.627	9.43	+M	319.62	10
Breakwater	2	M18	12350954.42	3835915.874	11.39	D	358.333	10
Breakwater	2	M19	12351316.35	3836400.545	16.12	D	372.08	10
Breakwater	1	M20	12350950.43	3835910.478	11	D	360.387	10
Breakwater	1	M21	12351311.5	3836395.509	15.51	D	375.209	10

Table 6-3. Targets Identified during the WFF Proposed Beach Groin Survey Project

Target No.	Magnetic Anomalies Associated with Each Target	Associated SSS/ SB
T1	M5, M8	A1
T2	M19, M21	
T3	M3, M4	
T4	M16, M18 and M20	
T5	M15	

7.0 SUMMARY AND RECOMMENDATIONS

This chapter presents recommendations for four archaeological efforts undertaken as part of the NASA WFF SRIPP, Wallops Island, Virginia. These efforts include a cultural resource remote sensing of the proposed breakwater location, a scientific diving survey of the proposed beach groin location, a cultural resources pedestrian survey of the Wallops Island shoreline, and the cultural resources monitoring of Geotextile tube installation on the same shoreline. Management recommendations and a summary of the results of each effort are provided below.

7.1 PEDESTRIAN SURVEY OF THE WALLOPS SHORELINE

A total of 6.2 kilometers (3.85 miles) of coast was traversed during the Wallops Island shoreline cultural resources pedestrian survey on September 18, 2006. The beach was littered with modern debris deposited by recent storm events, and no significant cultural resources were identified during this survey. No further work on this shoreline is merited or recommended.

7.2 CULTURAL RESOURCES MONITORING OF GEOTEXTILE TUBE INSTALLATION

A URS Senior Archaeologist inspected the installation of Geotextile tube on behalf of WFF on January 22, 2007. The APE for the cultural resource monitoring effort consisted of 1,402 meters (4,600 feet) of shoreline that received Geotextile tubes, which began at the southern terminus of the seawall and extended to the camera station at the southern end of NASA property.

No archaeological resources were identified within the APE during the cultural resources monitoring effort. Ground disturbances generated by this action revealed modern landform modifications and buried construction debris. Therefore, NASA concluded that no historic or prehistoric resources were affected by Geotextile tube installation on the beachfront. VDHR concurred with this finding in a response letter dated January 27, 2007 (Appendix C).

7.3 WADING SURVEY OF A PROPOSED BEACH GROIN LOCATION

The first 250 ft of the proposed beach groin location was undertaken as a wading survey area. Scientific diving was not possible at this location because the corroded rebar that littered the area represented a serious impalement and laceration hazard to divers operating in the near zero visibility water of the turbulent swash zone. The wading survey did not identify any significant cultural resources. The final 200 ft (60.9 m) of the survey area was not surveyed due to the afore mentioned safety concerns, and because this 200 ft (60.9 m) by 100 ft (30.5 m) section has the a very low potential to contain significant historic resources. This assessment is based on the general ground disturbance that has occurred at this site, which includes the construction of the original groin, and the disposal of concrete construction waste throughout the area, and the general erosion and sediment transport that routinely takes place in the first 500 to 600 ft (125.4 to 182.8 m) of the Wallops shoreline. No further work is recommended for the proposed beach groin location.

7.4 CULTURAL RESOURCES REMOTE SENSING SURVEY OF A PROPOSED BREAKWATER LOCATION

Comprehensive analysis of survey data was conducted using criteria that included magnetic complexity, amplitude, duration, and contouring, along with the spatial patterning of all anomalies. Analysis included review of all side scan sonar data to identify any structures or geomorphic features associated with submerged historic cultural materials.

The breakwater survey area measured approximately 365.7 meters by 243.8 meters (1200 feet by 800 feet; Figure 1-1) and consists of 17 transects spaced at 15.2 meters (50 foot) intervals. A total of 5 target clusters (Table 6-3) were identified from the four acoustic anomalies (Table 6-1) and 21 magnetic anomalies (Table 6-2) recorded during the breakwater survey.

Acoustic and magnetic signatures from the five targets and isolated anomalies are consistent with modern debris that has originated from two sources. The first source was the rubble and construction debris deposited on the eastern edge of beach groin. Other debris has likely emanated from early beach engineering efforts along the WFF shoreline. This may include refuse derived from piers, pilings, and other materials deposited by wave energy reflection. None of the detected anomalies have the potential to represent significant submerged cultural resources. The final 61 meters (200 feet) of the survey area were not surveyed because it has a very low potential to contain significant cultural resources and there was a serious safety risk to the crew and survey array. No further work is recommended within the proposed breakwater survey area.

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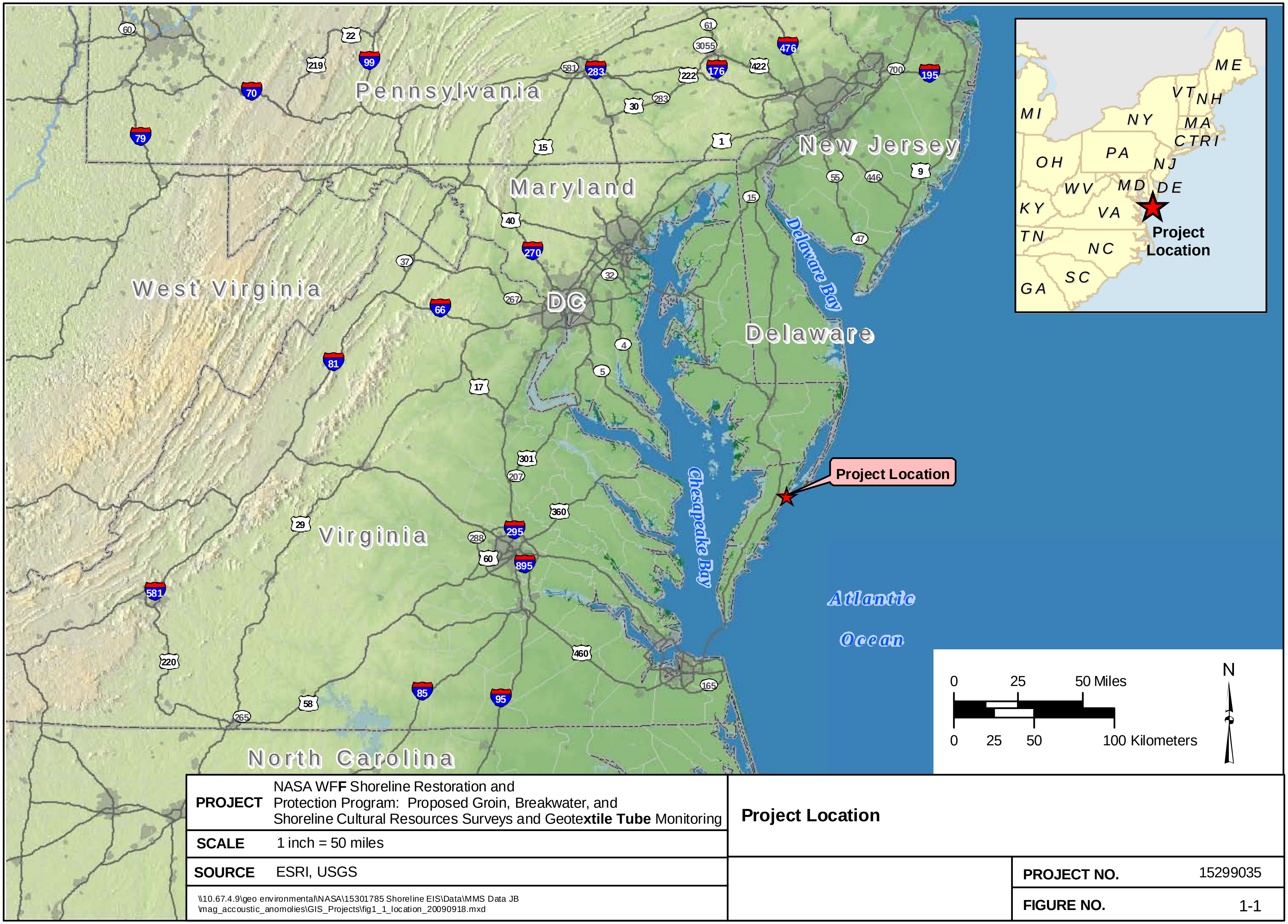
Addendum:

Report Figures and Plates



PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater, and Shoreline Cultural Resources Surveys and Geotextile Tube Monitoring
SCALE	1 inch = 50 miles
SOURCE	ESRI, USGS

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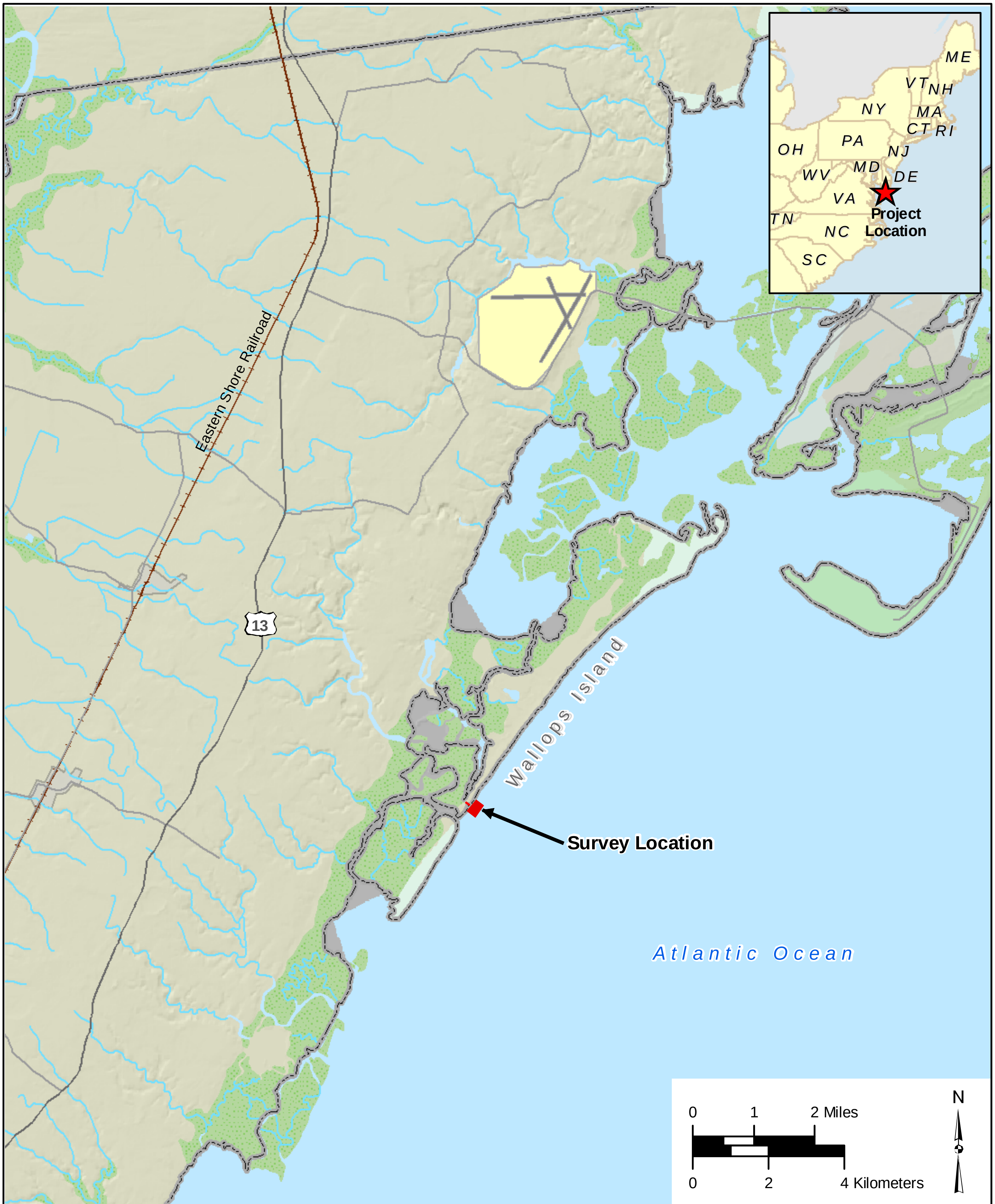
Project Location

PROJECT NO.	15299035
FIGURE NO.	1-1



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SCALE	1 inch = 2.3 miles
SOURCE	ESRI, USGS

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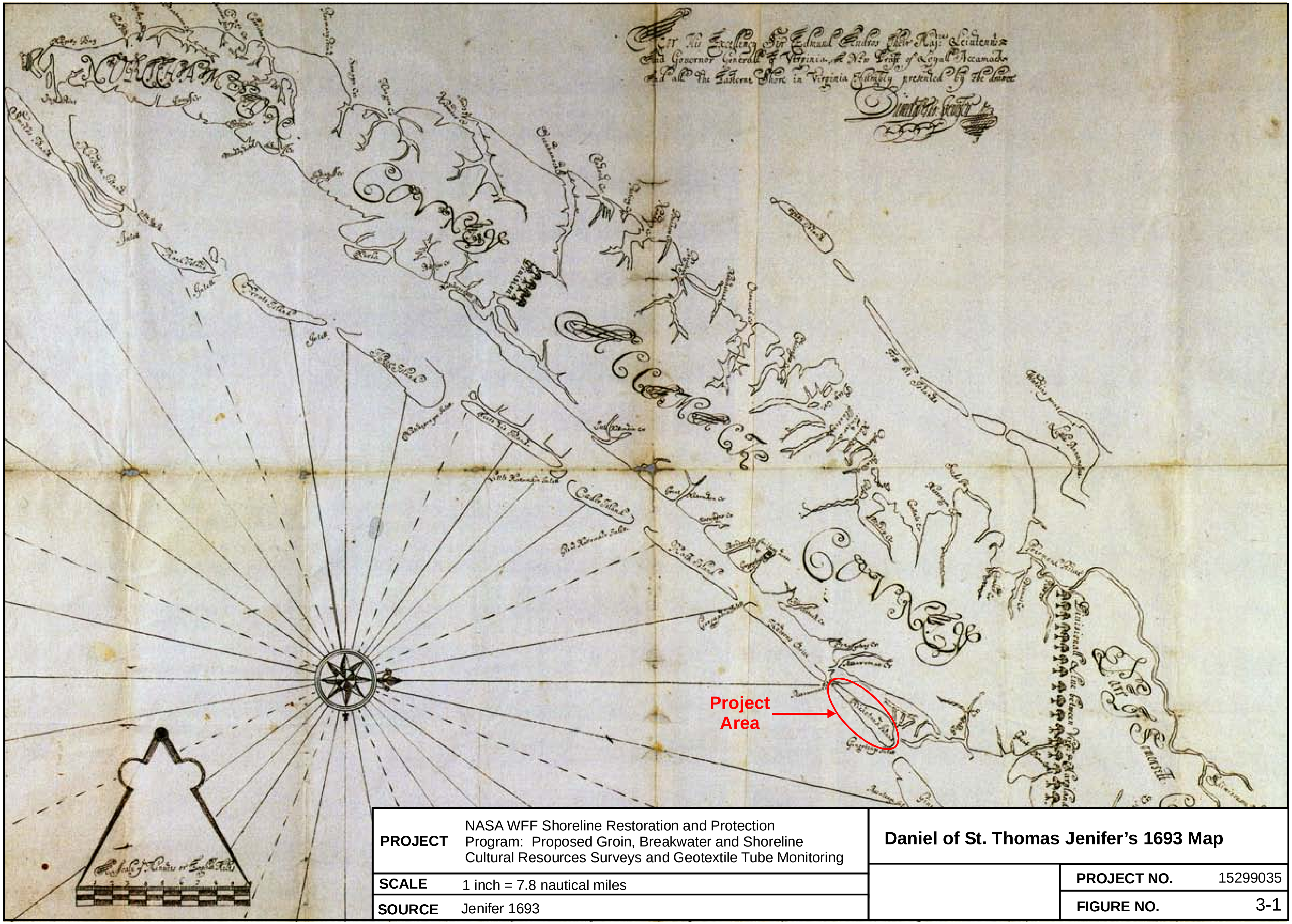
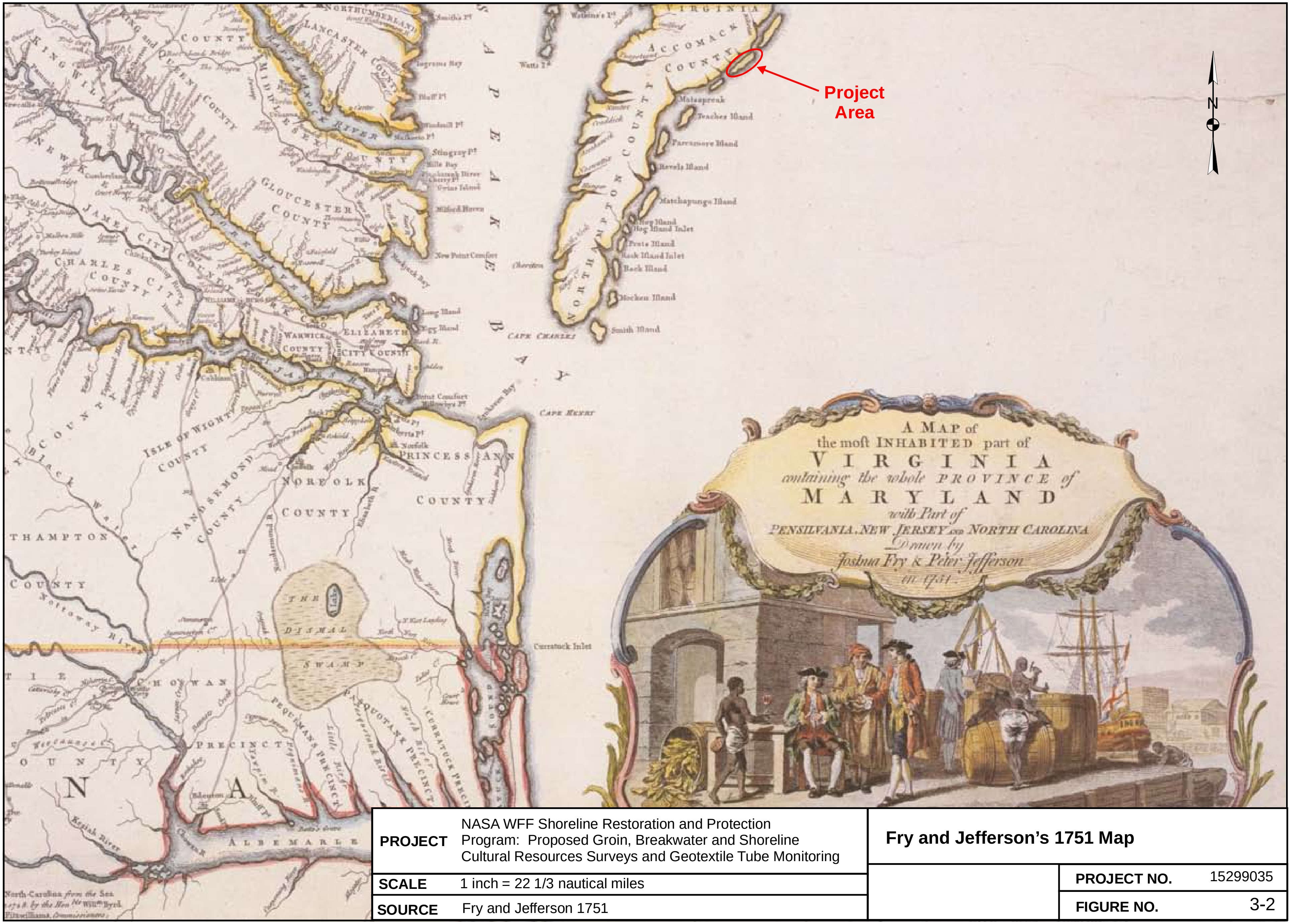
Groin and Breakwater Survey Locations on Wallops Island

PROJECT NO.	15299035
FIGURE NO.	1-2



PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resources Surveys and Geotextile Tube Monitoring	**Daniel of St. Thomas Jenifer's 1693 Map**	
SCALE	1 inch = 7.8 nautical miles	**PROJECT NO.**	15299035
SOURCE	Jenifer 1693	**FIGURE NO.**	3-1



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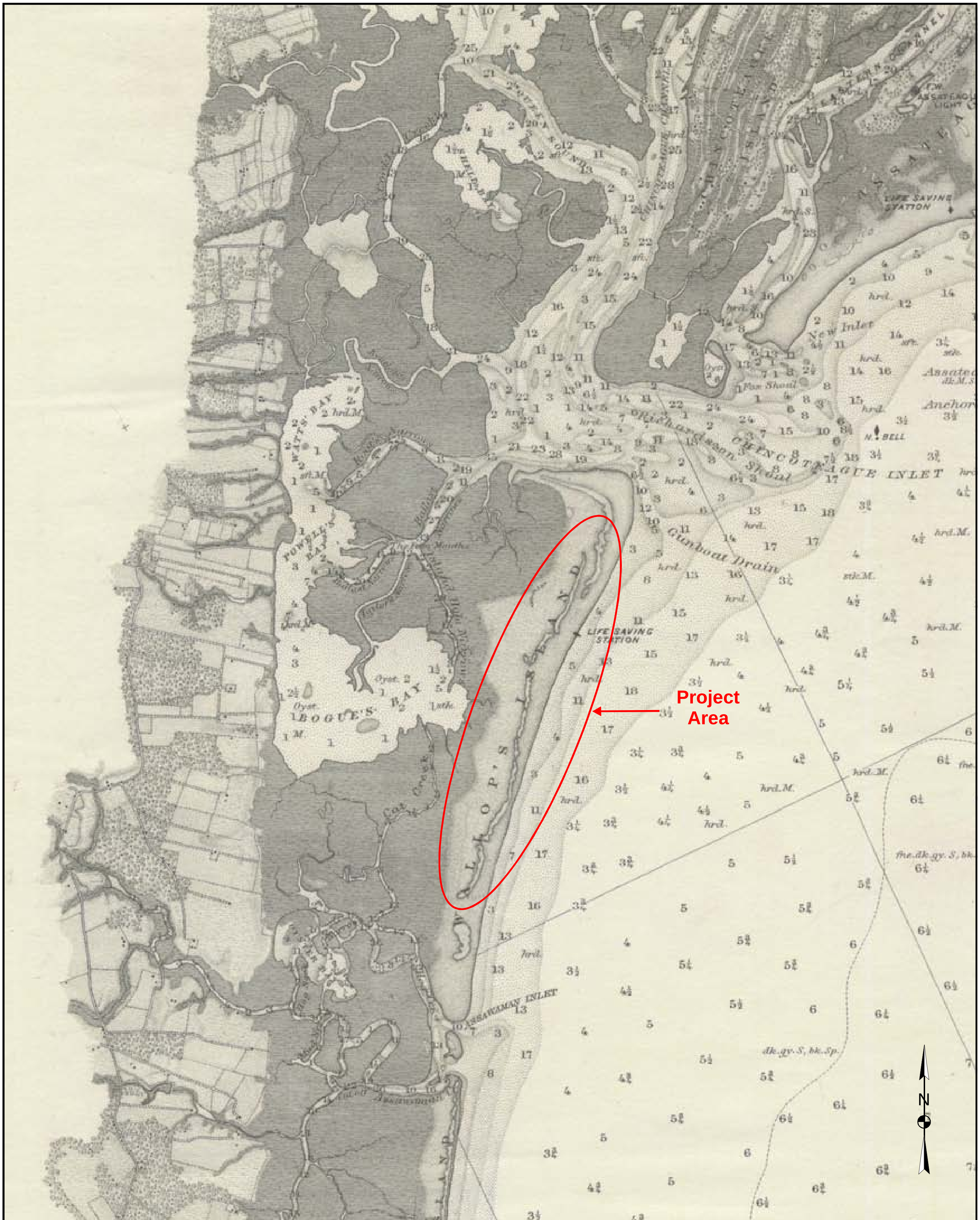
SCALE	1 inch = 22 1/3 nautical miles	**PROJECT NO.**	15299035
SOURCE	Fry and Jefferson 1751	**FIGURE NO.**	3-2

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resources Surveys and Geotextile Tube Monitoring	**Madison's 1807 Map of Virginia**	
SCALE	1 inch = 20 nautical miles	**PROJECT NO.**	15299035
SOURCE	Madison 1807	**FIGURE NO.**	3-3



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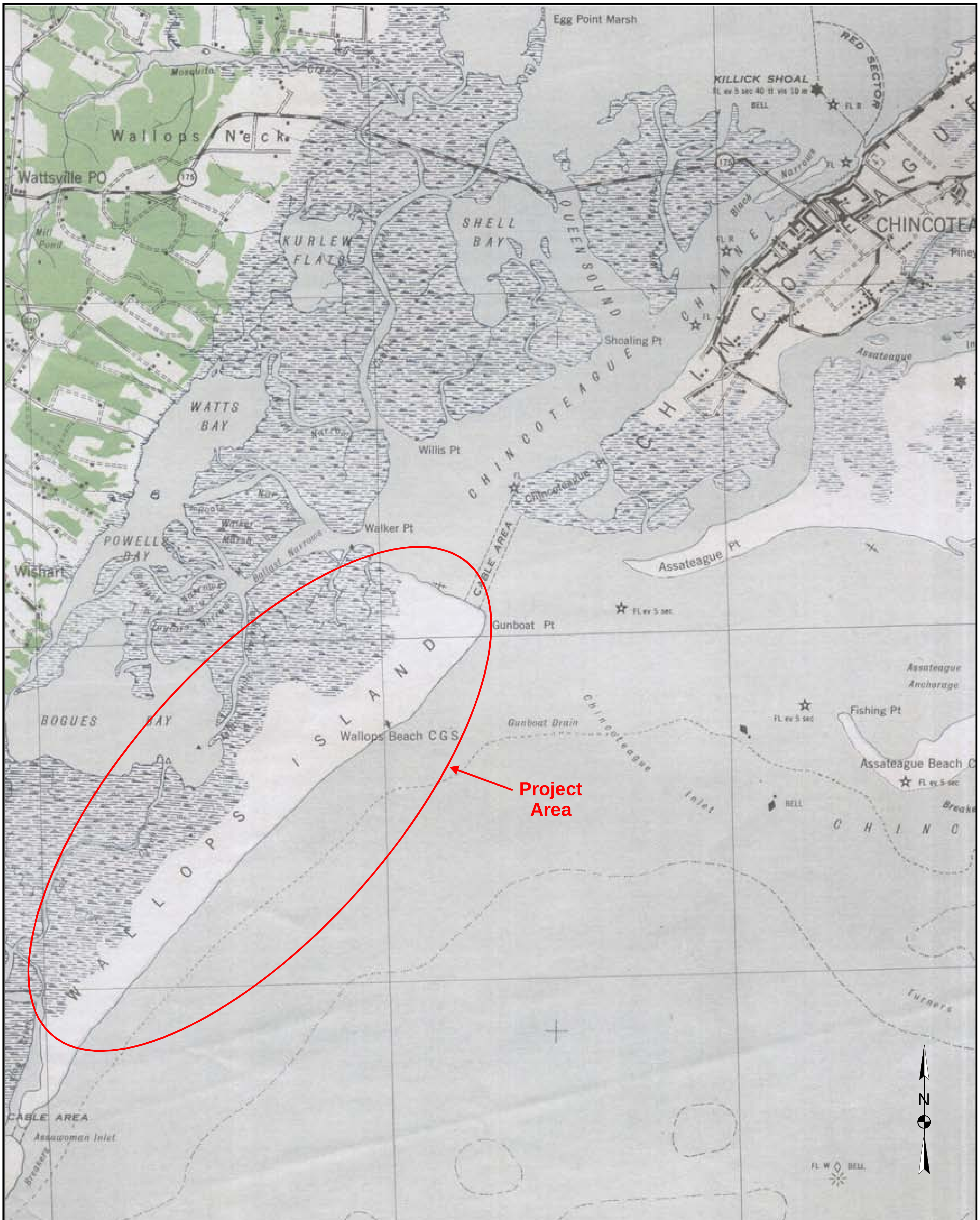
SCALE	3.5 inches = 5 nautical miles (1 to 80,000)	**PROJECT NO.**	15299035
SOURCE	USC&GS Coast Chart No.129, 1892	**FIGURE NO.**	3-4



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SCALE	1 inch = 1 mile		**PROJECT NO.**	15299035
SOURCE	USGS 15 Minute Series, 1937		**FIGURE NO.**	3-5

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater, and Shoreline Cultural Resources Surveys and Geotextile Tube Monitoring	**Wallops Island Shoreline Designated for Pedestrian Survey**
SCALE	1 inch = 1 mile	
SOURCE	USDA, NRCS	**PROJECT NO.** 15299035
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PROJECT	NASA WF**F** Shoreline Restoration and Protection Program: Proposed Groin, Breakwater, and Shoreline Cultural Resources Surveys and Geotextile Tube Monitoring	**Wallops Island Shoreline Designated for Geotubes Installation**	
SCALE	1 inch = 1 mile		
SOURCE	USDA, NRCS	**PROJECT NO.**	15299035
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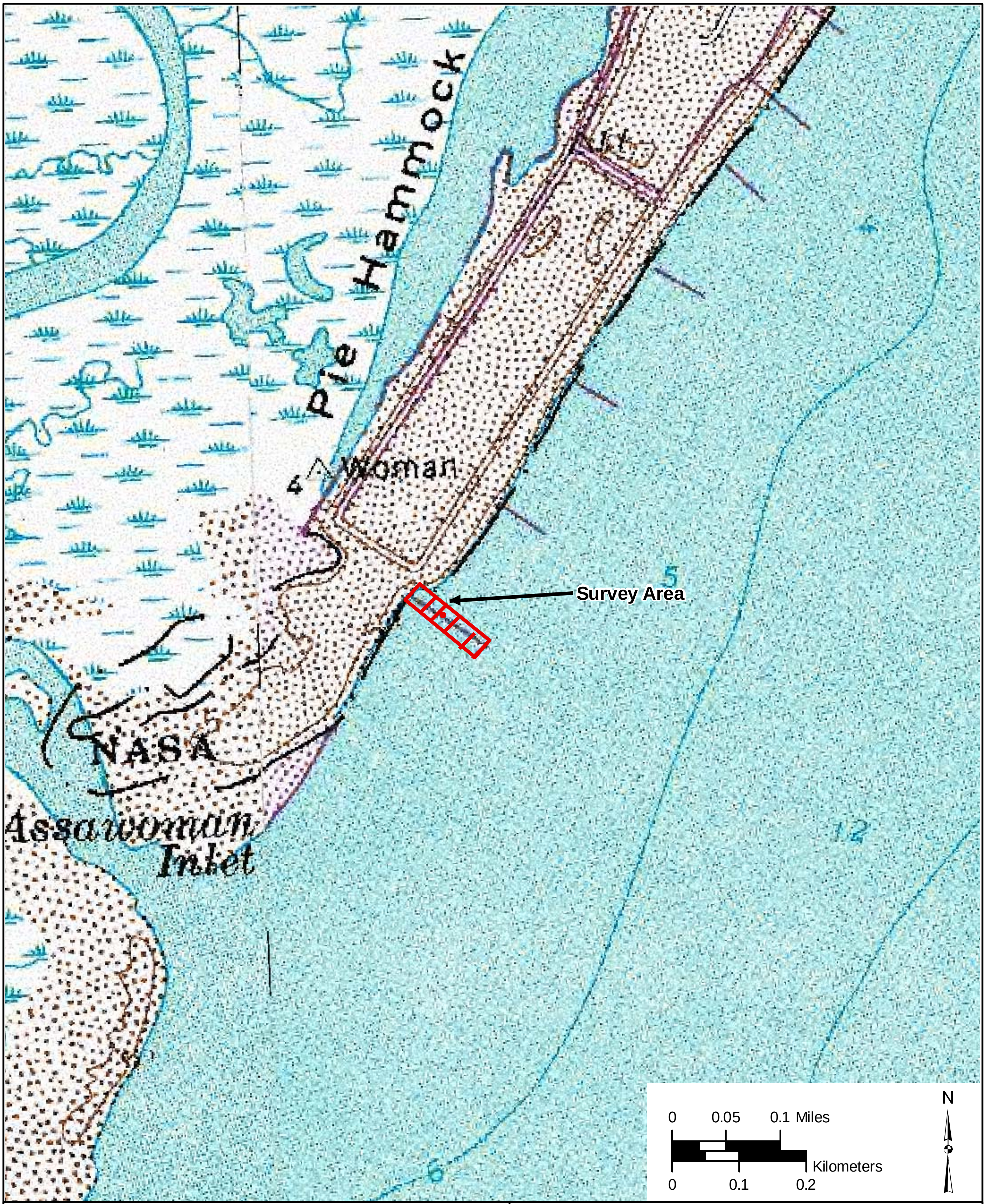

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater, and Shoreline Cultural Resources Surveys and Geotextile Tube Monitoring	**Location of the Proposed Beach Groin Survey Area**
SCALE	1 inch = 0.11 mile	
SOURCE	USDA, NRCS	**PROJECT NO.** 15299035
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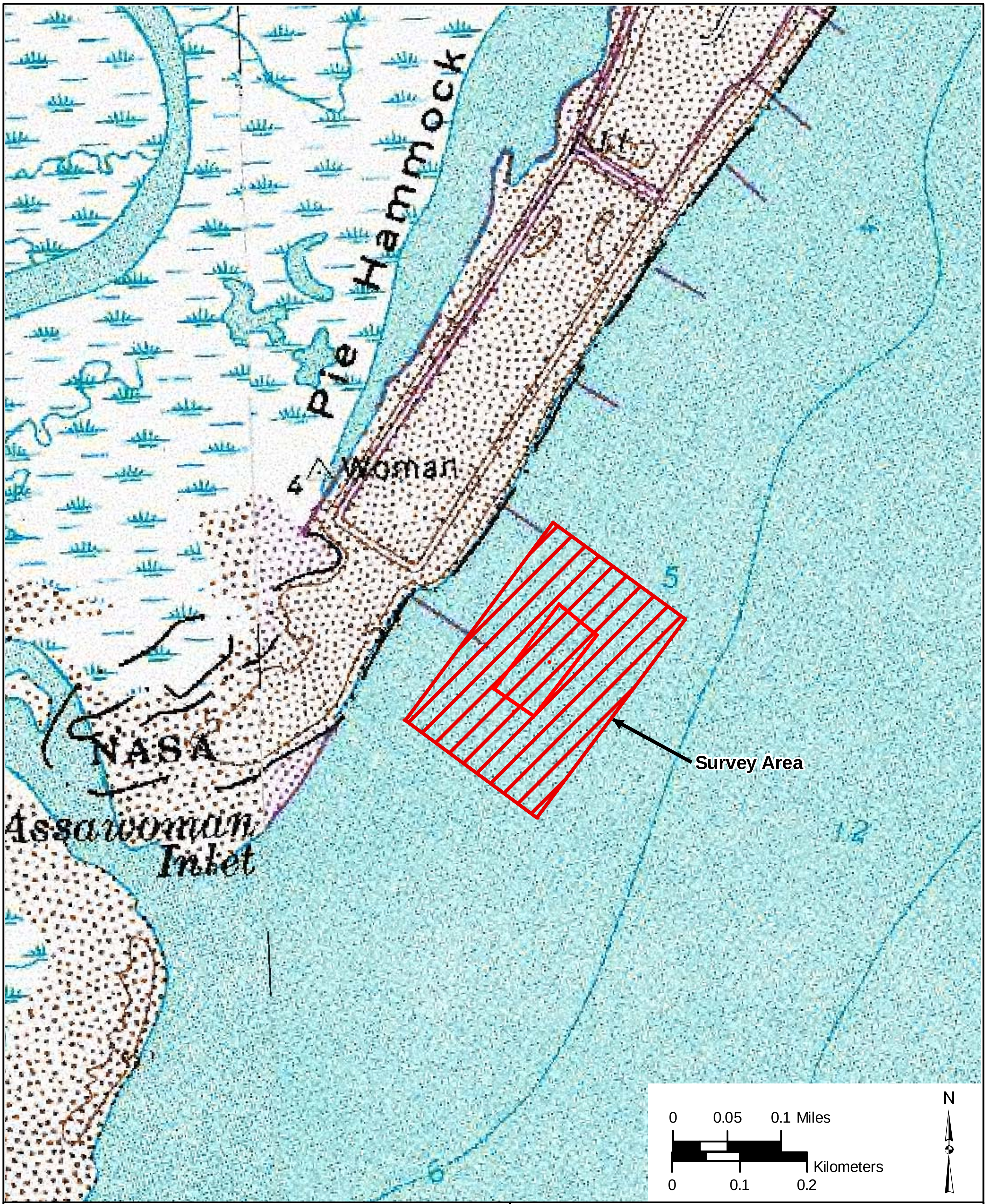

PROJECT NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater, and Shoreline Cultural Surveys and Geotextile Tube Monitoring	**Location of the Proposed Breakwater Survey Area**
SCALE 1 inch = 0.11 mile	
SOURCE USDA, NRCS	**PROJECT NO.** 15299035
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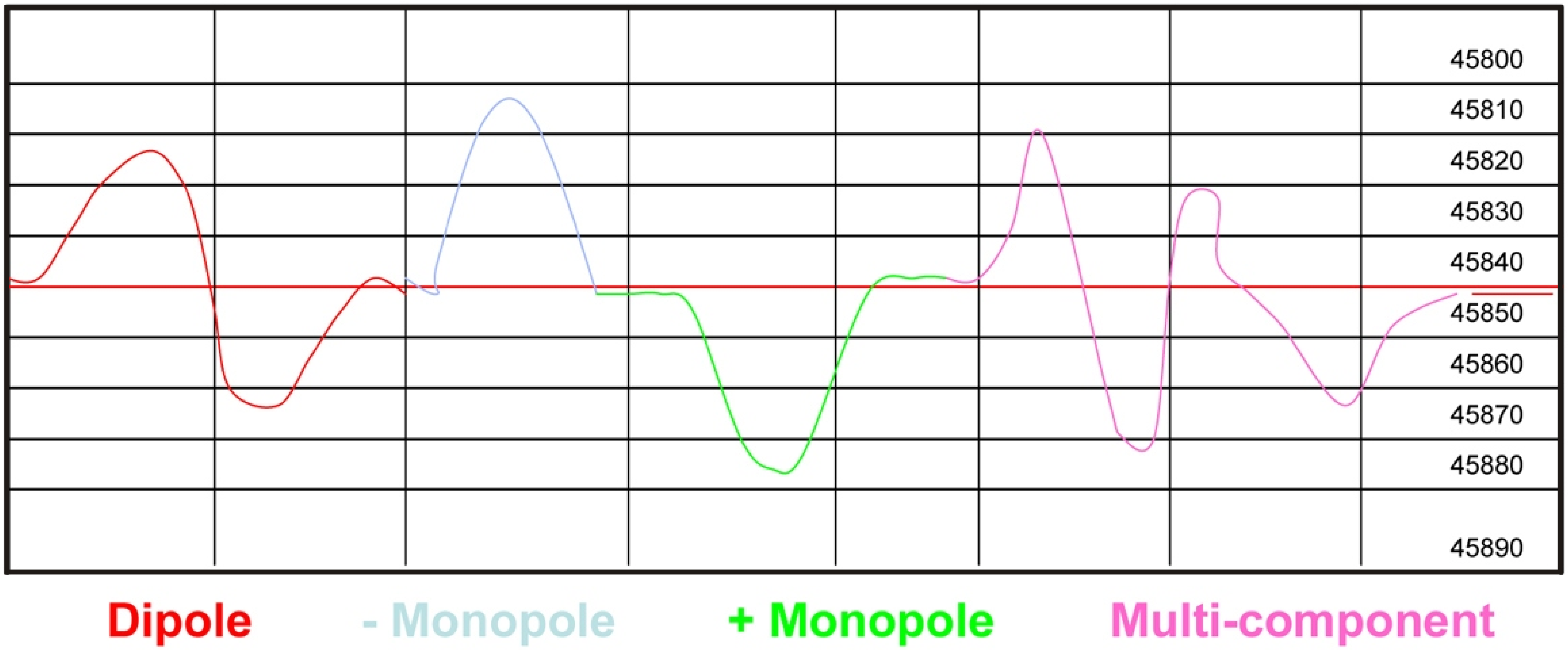
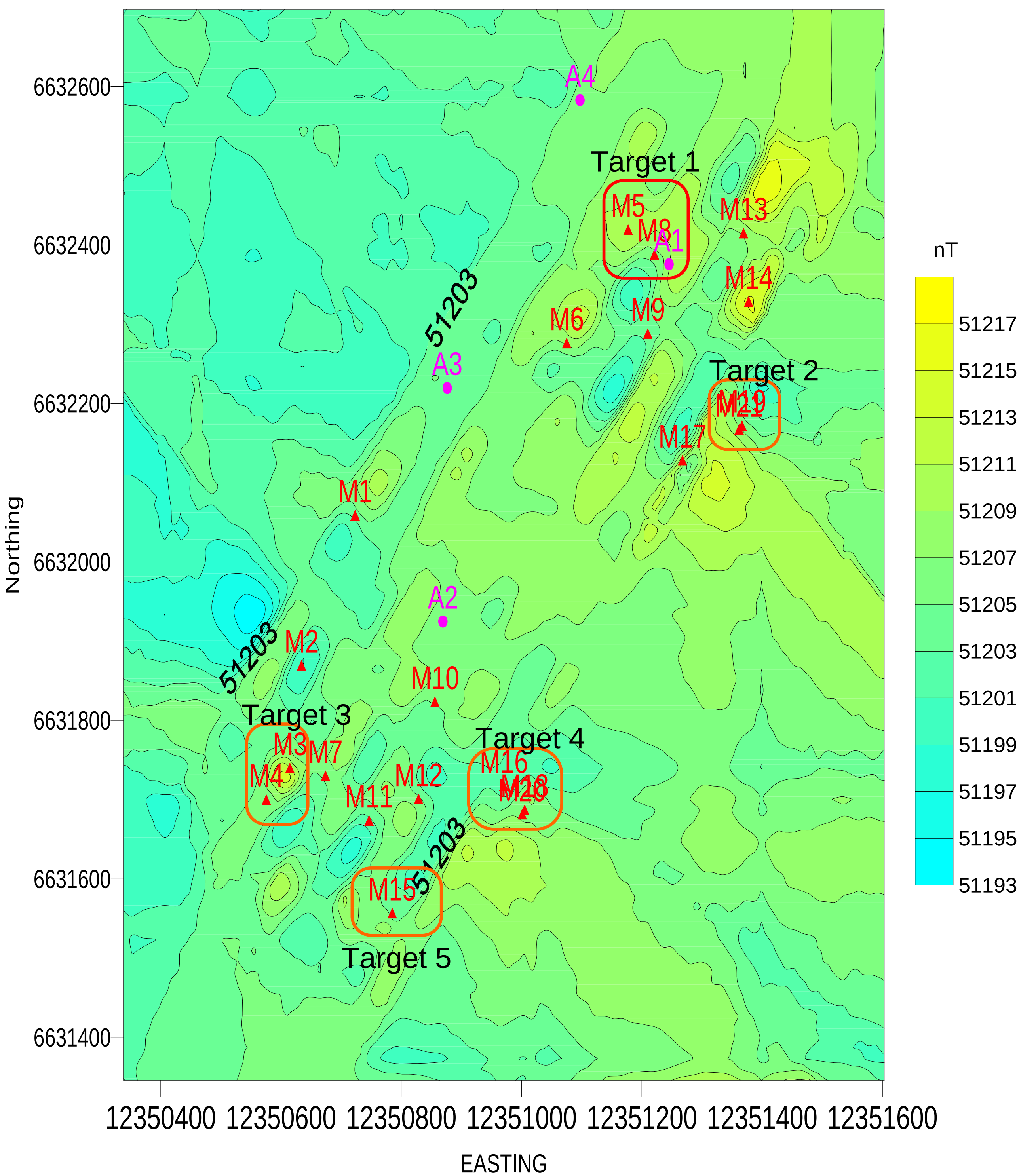
Magnetic Signatures



PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resources Surveys and Geotextile Tube Monitoring
SCALE	N/A
SOURCE	URS

Illustration Showing Four Magnetic Signature Types

PROJECT NO.	15299035
FIGURE NO.	5-5



Legend

- Acoustic Anomaly
- Magnetic Anomaly
- Target Cluster

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resources Surveys and Geotextile Tube Monitoring	**Breakwater Magnetic Contours, Anomalies and Target Plots**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**FIGURE NO.**	6-1

Plate 5-1. Rock Seawall Along Wallops Island Shoreline, Facing South

Plate 5-2. Wallops Island Beach Located Northeast of the Seawall, Facing South

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resource Surveys and Geotextile Tube Monitoring	**Project Photographs**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**PLATE NO.**	5-1 and 5-2

Plate 5-3. Wallops Island Beach Located Southeast of the Seawall, Facing South

Plate 5-4. View of Proposed Beach Groin Location, Facing SE

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resource Surveys and Geotextile Tube Monitoring	**Project Photographs**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**PLATE NO.**	5-3 and 5-4

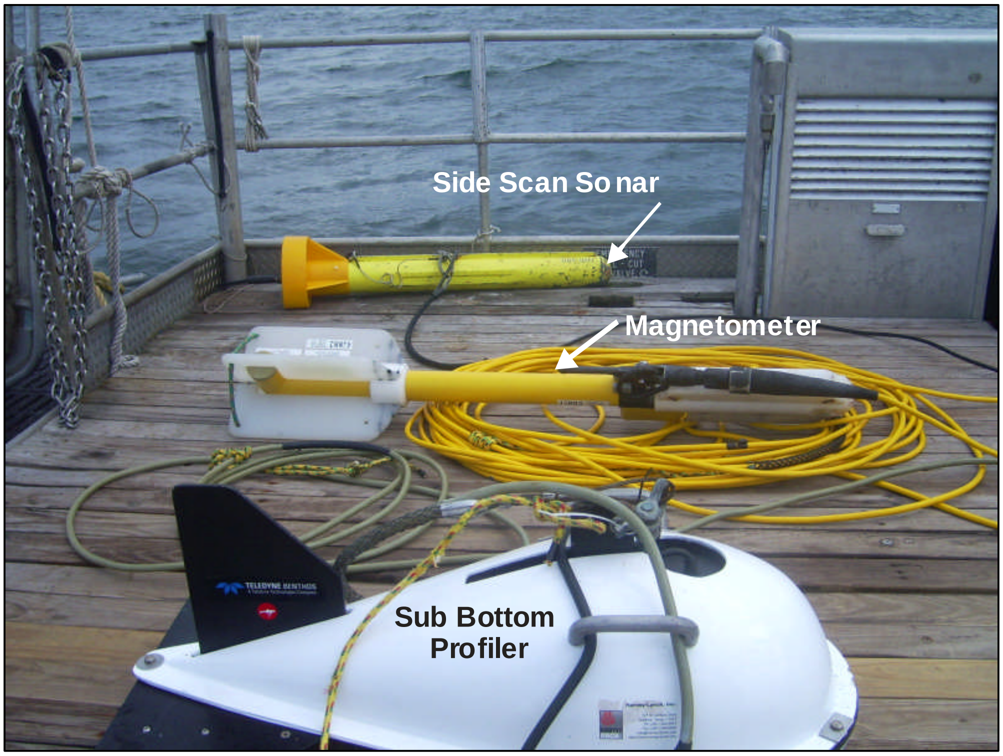


Plate 5-5. View of Survey Equipment

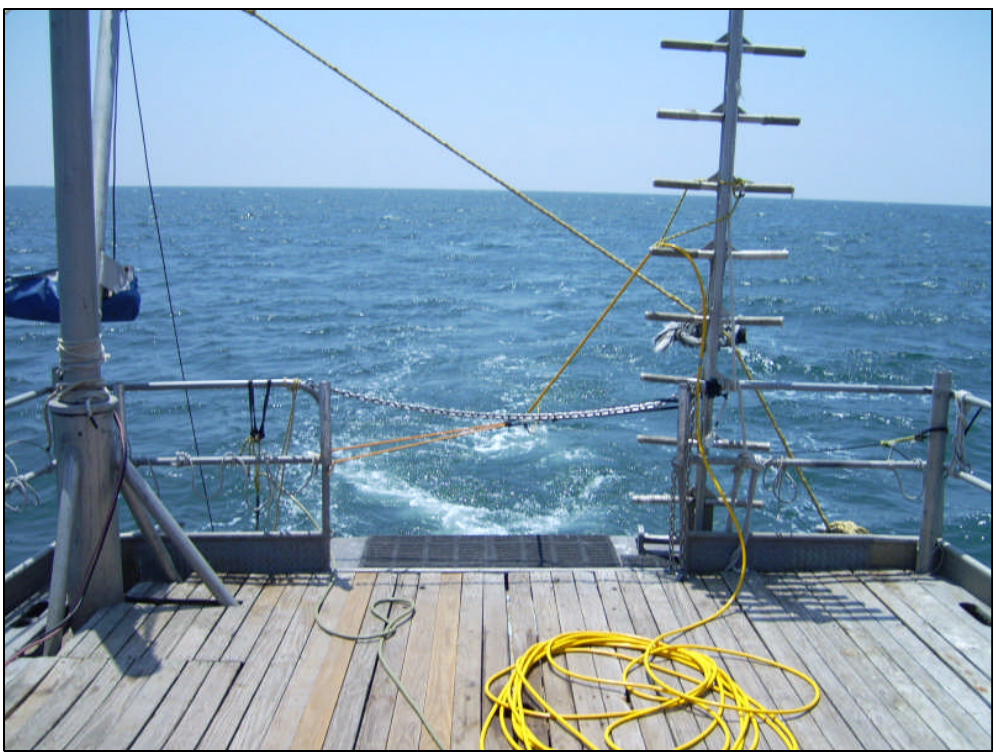


Plate 5-6. View of Survey Conditions

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resource Surveys and Geotextile Tube Monitoring	**Project Photographs**		
SCALE	N/A		**PROJECT NO.**	15299035
SOURCE	URS		**PLATE NO.**	5-5 and 5-6

Plate 6-1. Debris Noted During Pedestrian Survey of the Wallops Island Shoreline

Plate 6-2. Caisson Foundation Posts Noted During Pedestrian Shoreline Survey, Facing SE

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resource Surveys and Geotextile Tube Monitoring	**Project Photographs**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**PLATE NO.**	6-1 and 6-2

Plate 6-3. Pier Remnants Noted During Pedestrian Shoreline Survey, Facing SE

Plate 6-4. Geotextile Tube Corridor Grading, Facing South

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resource Surveys and Geotextile Tube Monitoring	**Project Photographs**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**PLATE NO.**	6-3 and 6-4

Plate 6-5. Northern Sand Slurry Pits and Backdirt Pile, Facing SW

Plate 6-6. Southern Sand Slurry Pit, Facing SE

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resource Surveys and Geotextile Tube Monitoring	**Project Photographs**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**PLATE NO.**	6-5 and 6-6

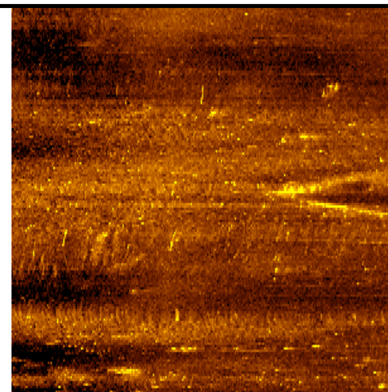
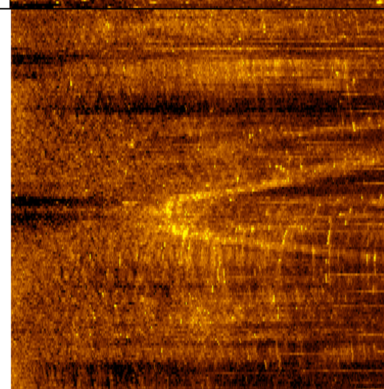
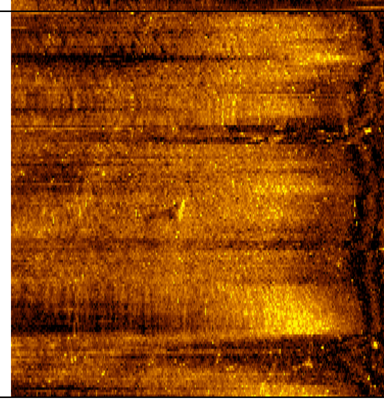
Plate 6-7. Construction Waste at the Western End of the Beach Groin Survey Area, Facing NW

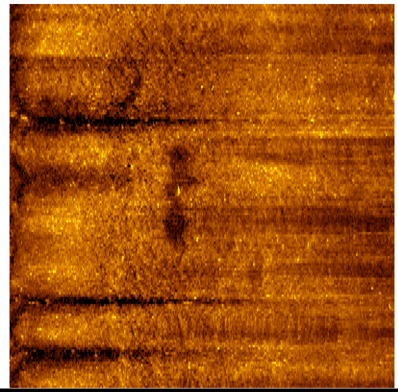
Plate 6-8. Concrete Rubble and Rebar Strewn Over the Beach Groin Survey Area, Facing East

PROJECT	NASA WFF Shoreline Restoration and Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resource Surveys and Geotextile Tube Monitoring	**Project Photographs**	
SCALE	N/A	**PROJECT NO.**	15299035
SOURCE	URS	**PLATE NO.**	6-7 and 6-8

Appendix A:

Side Scan Sonar Anomalies

Anomaly Number	Block/ Line	Magnetic Association	Dimensions L x W x H (Ft)	Identification	Image
A1	Breakwater L4_1	M5 and M8	22 ft x.6ft	Pipe Segment	
A2	Breakwater L9_1		70 ft x 20ft x 1.5	Cable or Wire Rope	
A3	Breakwater L9_2		5ft x 1ft x 1.2ft	Concrete Debris	

A4	Breakwater L10_1		24ft x 7ft x.75ft 19ft x 10ft x 1.5ft	Scatter of Two Buried Objects	

Appendix B:

Qualifications of Investigators

Jean Bernard (J.B.) Pelletier has over 20 years experience in marine geophysics, nautical archaeology, marine and terrestrial remote sensing, remotely operated vehicle operation and maintenance, underwater photography and video, technical diving, and diving safety. He is URS' Lead Nautical Archaeologist and Marine Remote Sensing Specialist. He exceeds the Secretary of the Interior's Professional Qualification Standards for Archaeology. Mr. Pelletier is an expert in the use of side-scan sonar, sub bottom profilers, single-beam echo sounders, and marine magnetometers and gradiometers. He also has extensive knowledge of Hypack Max software for data collection and interpretation. He has served a wide array of Federal, State, and private sector clients including the: USACE; U.S. Navy; MMS; National Oceanic and Atmospheric Administration; Delaware, Rhode Island, Florida, and Maryland DoTs; Maryland Department of Natural Resources; Maryland Port Authority; and BP. He received his M.A. in History and his B.A. in Geological Sciences from the University of Maine.

Anthony Randolph has 15 years of experience in cultural resources management, and exceeds the *Secretary of Interior Standards for Archaeology* (36CFR Part 61). Mr. Randolph has extensive experience in the management and execution of archaeological investigations. He has managed reconnaissance and investigations on prehistoric, historic and maritime sites throughout the eastern United States, Caribbean, and Europe. He also has extensive experience as an archaeological conservator through positions at Mariners Museum, and the government of Portugal. He received his Masters Degree in Anthropology from Texas A&M University in 2003 and his Bachelor's Degree in Neuroscience/Anthropology from the University of Pittsburgh in 1993.

Bridget Johnson has a broad background in historic and archaeological research. She has extensive experience in data collection and management for archaeological and historical projects. Ms. Johnson has extensive experience conducting historic research on a variety of topics and regions throughout the United States. Specialized experience includes the creation of three dimensional models of archaeological sites both terrestrial and underwater, as well as the management of archaeological collections. She received her Masters degree in Anthropology from Texas A&M University in 2008 and her Bachelors degree in History and Archaeology from St. Mary's College of Maryland in 2006.

Appendix C:

VDHR Response Letter to Archaeological Monitoring of Geotextile Tube Installation

Code 228 January 24, 2007

Ms. Kathleen Kilpatrick
Federal Review and Compliance Coordinator
Virginia Department of Historic Resources
2801 Kensington Avenue
Richmond, Virginia 23221

Subject: **Request for Project Review –** Geotextile Tubing Installation,
Goddard Space Flight Center's Wallops Flight Facility, Wallops Island, Virginia

Dear Ms. Kilpatrick:

The National Aeronautics and Space Administration (NASA) has recently initiated emergency measures to slow the current rate of erosion along the coast of Wallops Island. The ocean is encroaching substantially toward launch pads, infrastructure, and test and training facilities belonging to NASA, the U.S. Navy, and the Mid-Atlantic Regional Spaceport (MARS) at a rapid rate. Currently, assets on Wallops Island are valued at over $800 million and are increasingly at risk from larger than normal storm events, storm waves, and flooding damages. The risks to WFF could cause the interruption of missions supported by the facility and/or permanent loss of capabilities supported by the facility. At this time, NASA is installing geotextile tubes (GeoTubes®) along the southern portion of the beachfront (Photograph 1). Because this Undertaking has the potential to effect historic resources, NASA is initiating consultation with the Virginia Department of Historic Resources (VDHR) in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations as provided in 36 CFR Part 800.

Previous studies in this area included the creation of an archaeological predictive model for potential pre-historic and historic sites in the vicinity (which was approved by VDHR in a letter dated December 3, 2003). In December 2004, the *Historic Resources Survey and Eligibility Report for Wallops Flight Facility* (URS/EG&G) was submitted to VDHR and included an evaluation of structures in the area for National Register eligibility. The information gathered from these reports was the basis for the current evaluation of the affected beachfront.

Current plans consist of installing approximately 1,402 meters (4,600 feet) of GeoTubes® from the southern terminus of the seawall to the camera station at the southern end of NASA property (Figure 1). This project area falls within the moderate sensitivity zone for historic archaeology, a sensitivity model approved by VDHR in a letter dated December 4, 2003. The tubes are 14 feet wide, 5.5 feet high and have a 34 foot circumference (Figure 2). GeoTubes®

are composed of durable textile material formed into long cylinders that are filled with sand. The tubes, which are used instead of hard structures such as riprap, are normally placed in the backbeach parallel to the shore. Two temporary staging areas for sand and slurry have been created: one at the northernmost boundary of the GeoTube® line and the second midway down the beachfront. These two slurry pits will be restored after the project is complete. Water would be pumped through one temporary pipe extending from Hog Creek and one temporary pipe extending from the Atlantic Ocean.

On January 22, 2007 on behalf of NASA, a URS Senior Archaeologist and Architectural Historian inspected the current GeoTube® installation work in progress. An Area of Potential Effect (APE), taking into consideration viewsheds for adjacent structures and ground disturbing activities associated with the proposed work, was created (Figure 3). The topography of this portion of the beachfront prevents the visibility of the GeoTubes® from off the beach because of the severe level of erosion at the highwater mark (Photographs 2 and 3). Three buildings are located on the beach within the APE, one of which was surveyed for its National Register eligibility in *Historic Resources Survey and Eligibility Report for Wallops Flight Facility*, 2004 URS/EG&G (Table 1 and Figure 3). The two remaining buildings within the APE are not eligible for listing in the National Register. These buildings, an abandoned concrete block storage unit (Wallops # Z-42; Photographs 4 and 5) and operating Launch Control Center (Wallops # Z-40, Photograph 1), are ineligible for the National Register as they do not meet the 50-year criterion for listing nor do they embody the necessary exceptional importance to be listed under Criteria Consideration G.

Building Name	Date of Construction	National Register Eligibility Determination
Launch Control Center (WFF #Z-40)	1960	Ineligible for Listing on the National Register – less than 50 years of age.
Tracking Camera No. 2 (WFF #Z-35)	1951	Surveyed in 2004, *Historic Resources Survey and Eligibility Report for Wallops Flight Facility*, URS/EG&G, and found ineligible for listing on the National Register (VDHR # 001-0027-0122).
Vacant Storage Unit (WFF #Z-42)	1969	Ineligible for Listing on the National Register – less than 50 years of age.

Table 1 – Buildings within the Area of Potential Effects (APE)

Ground disturbances includes the preparation of the 4,600 ft corridor for the placement of GeoTubes® and the excavation of two sand slurry pits to facilitate GeoTube® filling. Approximately 1,000 ft of the northern portion of the GeoTube® corridor had been machine graded during the time of site visitation. Visual observations of this segment of the corridor revealed no artifacts or evidence of culturally derived features. In general, machine grading was shallow (< 1 ft below ground surface) and did not extend below the recent accumulation of storm related sand deposit on the beach (Photographs 7 and 8). Accordingly, the potential for the discovery of artifacts or intact cultural deposits was very low in the area of the GeoTube® corridor.

Monitoring of the northern sand slurry pit involved the inspection of fill material (i.e. backdirt). Actual excavation monitoring of the north pit was not possible as GeoTube® filling was already in progress (Photograph 9). However, an inspection of the backdirt pile surrounding the pit did not reveal any cultural material. In general, dark yellowish brown loamy sand representing A-horizon soils were observed at the base of backdirt pile, while pale brown sands with light to moderate shell fragments comprised the remaining bulk of the backdirt accumulation (Photograph 10). The sand deposits containing shell is consistent with natural unconsolidated beach deposits. No cultural materials were apparent in this area.

An examination of soil profile from the southern sand slurry pit was possible. The rectangular pit measured approximately 40 by 13 ft, with its long axis perpendicular to the adjacent roadway to the west. Maximum depth of the pit extended approximately 6 ft below ground surface. Upon initial inspection it was clear that an abrupt soil anomaly and an associated dense scatter of lumber and trash were present along the southwest portion of the profile (Photograph 11). Sections of 2 by 4 ft and 2 by 6 ft machine milled lumber were also present in the backdirt pile (Photograph 12). A closer examination of the pit profile and backdirt revealed that most of the associated trash consisted of modern aluminum and plastic soft drink containers, as well as what appeared to be plastic electrical fittings and rubber cable sheathing. Personal communication with Shari Silbert (WICC Team Member) indicated that this area was used to construct an asphalt pad for the operation of a modern electrical panel. A portion of the pad and electrical panel is still present immediately south of the southern sand slurry pit. A reconnaissance of the general area revealed a wide scatter of similar material on the surface, along with a number of other utility related material and cabling. As the materials encountered in the southern slurry pit do not constitute an archaeological resource, no impacts to any cultural resources have been sustained as a result of the ongoing construction activity in this area.

Because there were no historic structures identified within the APE and because the archaeological review of recent ground disturbance in the area found no archaeological resources NASA concludes that no historic or prehistoric resources are affected by the emergency measures on the beachfront. NASA is requesting that VDHR review this project and concur with the finding that no historic properties are affected by the emergency measures on the beachfront.

If you have any questions of comments regarding this portion of the project, please contact me, Kent Stover, at 757-824-1342 or Shari Silbert, at 757-824-2327.

Sincerely,

Kent Stover
Facility Historic Preservation Officer

Enclosures:
(1) VDHR Project Review Application Form
(1) VDHR DSS Map of Project Area
(2) Area of Potential Effect (APE) Map for GeoTube® Installation
(3) Photographic Log

Requesting a Project Review from the Department of Historic Resources

The Department of Historic Resources (DHR) is Virginia's State Historic Preservation Office (SHPO). Section 106 of the National Historic Preservation Act of 1966, as amended, requires federal agencies to consult with the SHPO and others who may have knowledge of historic properties in identifying known historic properties which may be affected by a federal undertaking, and in determining the need for further survey efforts to identify previously unrecorded historic properties. Information on Section 106 and the text of the Section 106 regulations are available on the web site of the Advisory Council on Historic Preservation (www.achp.gov).

THIS APPLICATION MUST BE COMPLETED FOR ALL FEDERAL UNDERTAKINGS AND SUBMITTED TO THE VIRGINIA DEPARTMENT OF HISTORIC RESOURCES FOR REVIEW. A federal undertaking is defined in the Section 106 regulations as "a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; those requiring a Federal permit, license or approval; and those subject to State or local regulation administered pursuant to a delegation or approval by a Federal agency." **This form may also be used to obtain the comments of DHR as part of a state review process**. Please provide a completed form even in cases where project information is included in a separate document, such as an Environmental Impact Report. Environmental documents may be submitted as attachments to the form if they provide an important part of the project description.

A program specific review application form for cell tower projects is available on DHR's website along with several other attachments to the project review application relating to the rehabilitation and demolition of historic structures which are intended to streamline the process.

Before You Complete the Project Review Application Form

1. Determine if your project constitutes an undertaking that has the potential to impact historic properties, assuming such historic properties were present (for the definition of an undertaking, go to the Section 106 Regulations, Definitions section, 36 CFR 800.16, on the web at www.achp.gov/regs.html).
2. Determine the Area(s) of Potential Effect (APE) for the project. For the purposes of Section 106, the area of potential effect (APE) is defined as the entire geographical area in which changes may occur to historic properties if any are present. The APE for archaeological resources may be different than for architectural resources. The viewshed of historic properties often extends well beyond their boundaries and is often an important contributing element to their historic significance. Therefore, projects which alter the landscape drastically - large scale subdivisions, highway construction - or those which insert a large, intrusive structure into the landscape – cell towers, water towers – must take into account the surrounding viewshed when determining the APE. A field inspection of the project area will help to establish the APE. Establishing the APE is the responsibility of the federal agency in consultation with DHR. When acting on the behalf of a federal agency, the APE that is presented to DHR must be the APE that is approved by that agency. The boundaries of the APE should be clearly described and indicated on a U.S.G.S. quad map (original or clear copy). If there are two different APEs – one where ground disturbance is going to occur and one where viewshed is the only concern, for instance, these should be clearly indicated.
3. Gather information to identify the historic properties within or adjacent to the APE that may be affected by your project. Information on recorded historic properties is available in the DHR Archives, and this information **must** be collected prior to submitting project review application. The Archives are open to the public, and the only charges for use are 15 cents per page for copies. If it is not possible to visit the DHR Archives, the archivist will provide information on recorded properties for a fee (telephone the Archives at 804-367-2323, extension 125 for more information). Please be aware that survey in Virginia is far from complete, and the absence of historic resources in DHR records does not necessarily mean that no historic

properties are present. Information that should be considered in the identification process may also be available in other repositories, such as county planning offices and historical societies. On-site inspections are an essential component of the identification process. Photographs of the subject property and any nearby properties that may be over 50 years old should be provided with your project review application. Please attach the available information on recorded historic properties within the APE and documentation resulting from field inspection to the project review application form. If no historic properties are recorded in the APE, and if no potentially historic properties were observed during field inspection, note this on the application form.

4. Following the identification process, you should complete the project review application form in its entirety by referring to the following instructions. Attach or enclose the required additional information, and submit your application packet to DHR. The Department of Historic Resources will respond to your request within 30 days.

How to Complete the Project Review Application Form

I. GENERAL PROJECT INFORMATION

1. Indicate if the project, or any part thereof, has been previously reviewed by DHR and if so, insert the file number. If we know that a project has been previously reviewed, we can often avoid asking for duplicate information.

2-3. Complete this section in its entirety providing the name and location (independent city or town and county) of the project. If your project involves work on a specific building, please include the street address of the building.

4. Refer to the attached list of agencies and their abbreviations and indicate the abbreviation(s) for the federal and/or state agencies involved in the project (permitting, licensing, funding, etc.). If more than one agency is involved, one must be designated the lead agency for Section 106 compliance. If the appropriate agency is not included on the list, please write the full agency name in the space provided.

5-6. It is important that complete mailing addresses be provided for both the lead federal or state agency contact and the applicant.

II. PROJECT LOCATION AND DESCRIPTION

7. Indicate the name of the USGS quadrangle on which your project area is located. An original or clear photocopy of the 7.5 minute USGS topographic quadrangle, or a **clearly labeled** portion thereof, showing the exact boundaries of the project location, and the project's Area(s) of Potential Effect (APE) **must** be attached to this application. Do **not** reduce or enlarge the map. Topographic maps may be downloaded free of charge from Topozone© (www.topozone.com).

8. Indicate the acreage of the project area.

9. Indicate if an architectural or archaeological survey has been conducted as part of the identification process or in a different context by consulting DHR's Archives. Indicate the author, title, and date of the report and if a copy of it is on file at DHR. If a survey has been completed and a copy is not on file, a copy should be included with the application materials.

10. During the identification stage of the Section 106 process you should determine the presence/absence of structures 50 years old or older. Indicate if the Archives search revealed any historic properties in the APE and if the site inspection revealed any properties over 50 years of age within or adjacent to the project area which may or may not be recorded at DHR. The date of construction for structures is often indicated in county or state tax records. Photographs of all structures over 50 years of age must be included with the application materials.

MAIL COMPLETED FORM AND ATTACHMENTS TO:

Virginia Department of Historic Resources
Attention: Project Review
2801 Kensington Avenue, Richmond, VA 23221
www.dhr.virginia.gov

11-12. These questions are designed to help DHR determine if your project needs to be reviewed by an architectural historian or an archaeologist or both. If the answer to either of these questions is *yes*, a complete explanation is required in the Description.

13. Description. Attach a detailed description of the project area and the proposed undertaking, making sure to include the following information:

a) Description of the existing land use. Include photographs of the project area.

b) Description of any recent modifications to the landscape. [Note: If the existing landscape appears to be markedly different from that shown on the attached quad map, please include information to that effect explaining what changes have occurred since the map was last updated.]

c) For projects involving the rehabilitation, alteration, or demolition of a structure over 50 years of age, a detailed description of the extent of the proposed alterations, along with photographs, architectural and engineering drawings, project specifications, and maps will be required.

d) Detailed project description that includes the precise location of all construction, destruction, and other proposed disturbance, the horizontal and vertical dimensions of all above and below ground construction, and the nature and extent of any previous disturbances – i.e. it is in a plowed field or disturbed VDOT right-of-way – within the APE.

Please Note: A complete project review application consists not only of the fully completed form, but also a completed Archives search, a USGS topographic map with the APE marked, a detailed project description, and all required photographs and project plans. A checklist is provided at the end of the application. Accurate and complete information will help in obtaining a timely response. If all required materials are not submitted, you will receive notification that your application is incomplete and the 30-day review period will not begin until all necessary materials are received.

MAIL COMPLETED FORM AND ATTACHMENTS TO:

Virginia Department of Historic Resources
Attention: Project Review
2801 Kensington Avenue, Richmond, VA 23221
www.dhr.virginia.gov

COMMONLY USED FEDERAL AND STATE AGENCIES AND ABBREVIATIONS

Federal Agencies

Advisory Council on Historic Preservation	ACHP
Department of the Interior, Bureau of Land Management	BLM
Central Intelligence Agency	CIA
Department of Defense, Army Corps of Engineers	COE
Drug Enforcement Administration	DEA
Department of Defense	DOD
Department of Defense, Army	Army
Department of Defense, Navy	Navy
Department of Defense, Marines	Marines
Department of Defense, Air Force	Air Force
Department of the Interior	DOI
Department of Justice	DOJ
Department of Labor	DOL
Defense Security Service	DSS
Department of Education	ED
Department of Commerce, Economic Development Administration	EDA
Environmental Protection Agency	EPA
Department of Transportation, Federal Aviation Administration	FAA
Federal Bureau of Investigation	FBI
Federal Communications Commission	FCC
Federal Deposit Insurance Corporation	FDIC
Federal Emergency Management Agency	FEMA
Department of Energy, Federal Energy Regulatory Commission	FERC
Federal Highway Administration	FHWA
Federal Railroad Administration	FRA
Department of Transportation, Federal Transit Administration	FTA
Department of Housing and Urban Development	HUD
General Services Administration	GSA
Department of Health and Human Services	HHS
Interstate Commerce Commission	ICC
Library of Congress	LC
Metropolitan Washington Airports Authority	MWAA
National Aeronautics and Space Administration	NASA
National Capital Planning Commission	NCPC
National Endowment for the Humanities	NEH
National Imagery and Mapping Center	NIMA
Nuclear Regulatory Commission	NRC
Department of Commerce, National Oceanic and Atmospheric Administration	NOAA
Department of the Interior, National Park Service	NPS
Department of Agriculture, Natural Resources Conservation Service	NRCS

Comptroller of the Currency	OCC
Department of the Interior, Office of Surface Mining	OSM
Department of Agriculture, Rural Development	RD
Rural Utilities Service	RUS
Small Business Administration	SBA
Smithsonian Institute	SI
Surface Transportation Board	STB
Technology Administration	TA
Tennessee Valley Authority	TVA
United States Coast Guard	USCG
United States Department of Agriculture	USDA
United States Department of Commerce	USDOC
United States Department of Energy	USDOE
Department of Agriculture, Forest Service	USFS
Department of the Interior, Fish and Wildlife Service	USFWS
United States Geological Survey	USGS
United States Postal Service	USPS
Department of Veterans Affairs	VA

State Agencies

Christopher Newport University	CNU
Central Virginia Community College	CVCC
College of William and Mary	CWM
Department of Criminal Justice Services	DCJS
Department of Conservation and Recreation	DCR
Department of Environmental Quality	DEQ
Department of Game and Inland Fisheries	DGIF
Department of General Services	DGS
Department of Housing and Community Development	DHCD
Department of Historic Resources	DHR
Department of Juvenile Justice	DJJ
Department of Mental Health, Mental Retardation and Substance Abuse Services	DMHMRSAS
Department of Mines, Minerals and Energy	DMME
Department of Motor Vehicles	DMV
Department of Accounts	DOA
Department of Corrections	DOC
Department of Education	DOE
Department of Forestry	DOF
Department of Veterans Affairs	DVA
Frontier Culture Museum of Virginia	FCM
Germanna Community College	GCC
Gunston Hall	GH
George Mason University	GMU
James Madison University	JMU

John Tyler Community College	JTCC
Jamestown-Yorktown Foundation	JYF
Medical College of Virginia	MCV
North Carolina Department of Transportation	NCDOT
Norfolk State University	NSU
Old Dominion University	ODU
Piedmont Virginia Community College	PVCC
Radford University	RU
State Corporation Commission	SCC
Science Museum of Virginia	SMV
Tidewater Community College	TCC
Thomas Nelson Community College	TNCC
University of Mary Washington	UMW
University of Virginia	UVA
Virginia Community College System	VCCS
Virginia Commonwealth University	VCU
Department of Agriculture and Consumer Services	VDACS
Department of Health	VDH
Department of Transportation	VDOT
Virginia Employment Commission	VEC
Virginia Institute of Marine Science	VIMS
Virginia Museum of Fine Arts	VMFA
Virginia Military Institute	VMI
Virginia Museum of Natural History	VMNH
Virginia Outdoors Foundation	VOF
Virginia Port Authority	VPA
Virginia Polytechnic Institute and State University	VPISU
Virginia Resources Authority	VRA
Virginia School for the Deaf and Blind	VSDB
Library of Virginia	VSLA
Department of State Police	VSP
Virginia State University	VSU
Virginia Western Community College	VWCC
Wytheville Community College	WCC
West Virginia Department of Transportation	WVDOT

MAIL COMPLETED FORM AND ATTACHMENTS TO:

Virginia Department of Historic Resources
Attention: Project Review
2801 Kensington Avenue, Richmond, VA 23221
www.dhr.virginia.gov

Project Review Application Form

This application must be completed for all projects that will be federally funded, licensed, or permitted, or that are subject to state review. Please allow 30 days from receipt for the review of a project. All information must be completed before review of a project can begin and incomplete forms will be returned for completion.

I. GENERAL PROJECT INFORMATION

1. **Has this project been previously reviewed by DHR?** **YES** ___ **NO** X **DHR File #** ________

2. **Project Name** **Geotube Installation Along Wallops Island, Wallops Flight Facility**

3. **Project Location**

Wallops Island		Accomack
City	Town	County

4. **Specify Federal and State agencies involved in project (providing funding, assistance, license or permit). Refer to the list of agencies and abbreviations in the instructions.**

Lead Federal Agency **NASA**

Other Federal Agency ________

State Agency ________

5. **Lead Agency Contact Information**

Contact Person **Kent Stover, Facility Historic Preservation Officer**

Mailing Address **NASA Wallops Flight Facility**
Wallops Island, VA 23337

Phone Number **757-824-1342** **Fax Number** **757-824-1831**

Email Address **Dalton.K.Stover@nasa.gov**

6. **Applicant Contact Information**

Contact Person **Shari Silbert, Environmental Scientist**

Mailing Address **EG&G**
NASA Wallops Flight Facility
Wallops Island, VA 23337

Phone Number **757-824-2327** **Fax Number** **757-824-1819**

Email Address **Shari.A.Silbert@nasa.gov**

II. PROJECT LOCATION AND DESCRIPTION

7. **USGS Quadrangle Name** **Wallops Island**

8. **Number of acres included in the project** **A length of 4,600 feet of shoreline approximately 14 feet in width running parallel to the ocean.**

MAIL COMPLETED FORM AND ATTACHMENTS TO:
Virginia Department of Historic Resources
Attention: Project Review
2801 Kensington Avenue, Richmond, VA 23221
www.dhr.virginia.gov

9. Have any architectural or archaeological surveys of the area been conducted? **YES_X_ NO___**

If yes, list author, title, and date of report here. Indicate if a copy is on file at DHR.
1. *Cultural Resources Assessment, NASA Wallops Flight Facility,* URS/EG&G, Nov 2003 – copy on file at DHR
2. *Historic Resources Survey and Eligibility Report, Wallops Flight Facility,* URS/EG&G, Dec. 2004 – copy on file at DHR
3. *Integrated Cultural Resource Management Plan for NASA Wallops Flight Facility,* URS/EG&G, Dec. 2006 – copy on file at DHR

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10. Are any structures 50 years old or older within or adjacent to the project area?
Three buildings are located within the APE. Two of these are less than 50 years of age. The third was constructed in 1951 and was previously evaluated for its National Register eligibility. It was found ineligible for listing in the National Register in *Historic Resources Survey and Eligibility Report, Wallops Flight Facility*, URS/EG&G, Dec. 2004 (VDHR # # 001-0027-0122). **YES_X_ NO___**
If yes, give date(s) of construction and provide photographs.
See attached photo log for photographs of the three buildings within the APE.

---

11. Does the project involve the rehabilitation, alteration, removal, or demolition of any structure, building, designed site (e.g. park, cemetery), or district that is 50 years or older? If *yes*, this must be explained fully in the project description. **YES___ NO_X_**

12. Does the project involve any ground disturbance (e.g. excavating for footings, installing sewer or water lines or utilities, grading roads, etc.)? If *yes*, this must be explained fully in the project description.
The project involved the excavation of two sand slurry pits and the preparation of a 4,600 ft corridor for placement of a geotextile tube as part of an ongoing beach restoration project. **YES_X_ NO___**

(Please see attached letter report.)

13. DESCRIPTION: Attach a complete description of the project. Refer to the instructions for the required information. See attached DOPAA and Reconnaissance Level Archaeology Survey for further information.

To the best of my knowledge, I have accurately described the proposed project and its likely impacts.

__Kristin Leahy, URS Corp. ____________________________ _____________1/23/07___
Signature of Applicant/Agent Date

The following information must be attached to this form:

X Completed DHR Archives search
X USGS map with APE shown
X Complete project description
X Any required photographs and plans

MAIL COMPLETED FORM AND ATTACHMENTS TO:
Virginia Department of Historic Resources
Attention: Project Review
2801 Kensington Avenue, Richmond, VA 23221
www.dhr.virginia.gov

____ No historic properties affected ______ No adverse effect
____ Additional information is needed in order to complete our review.
____ We have previously reviewed this project. A copy of our correspondence is attached.

Comments: ____
____
____
____

Signature____ Date ______________________

Phone number _______________________ DHR File # _________________________

This Space For Department Of Historic Resources Use Only

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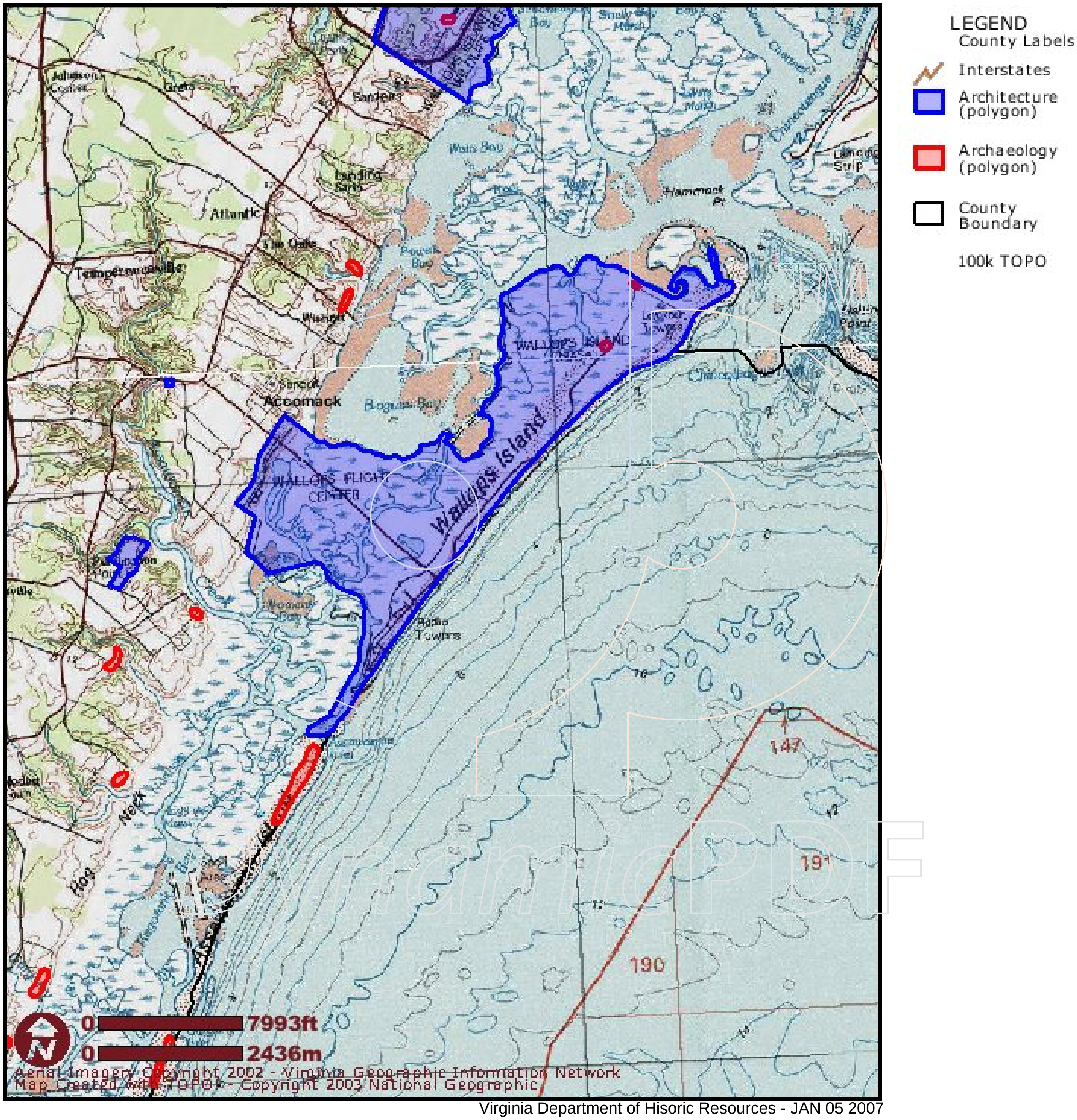
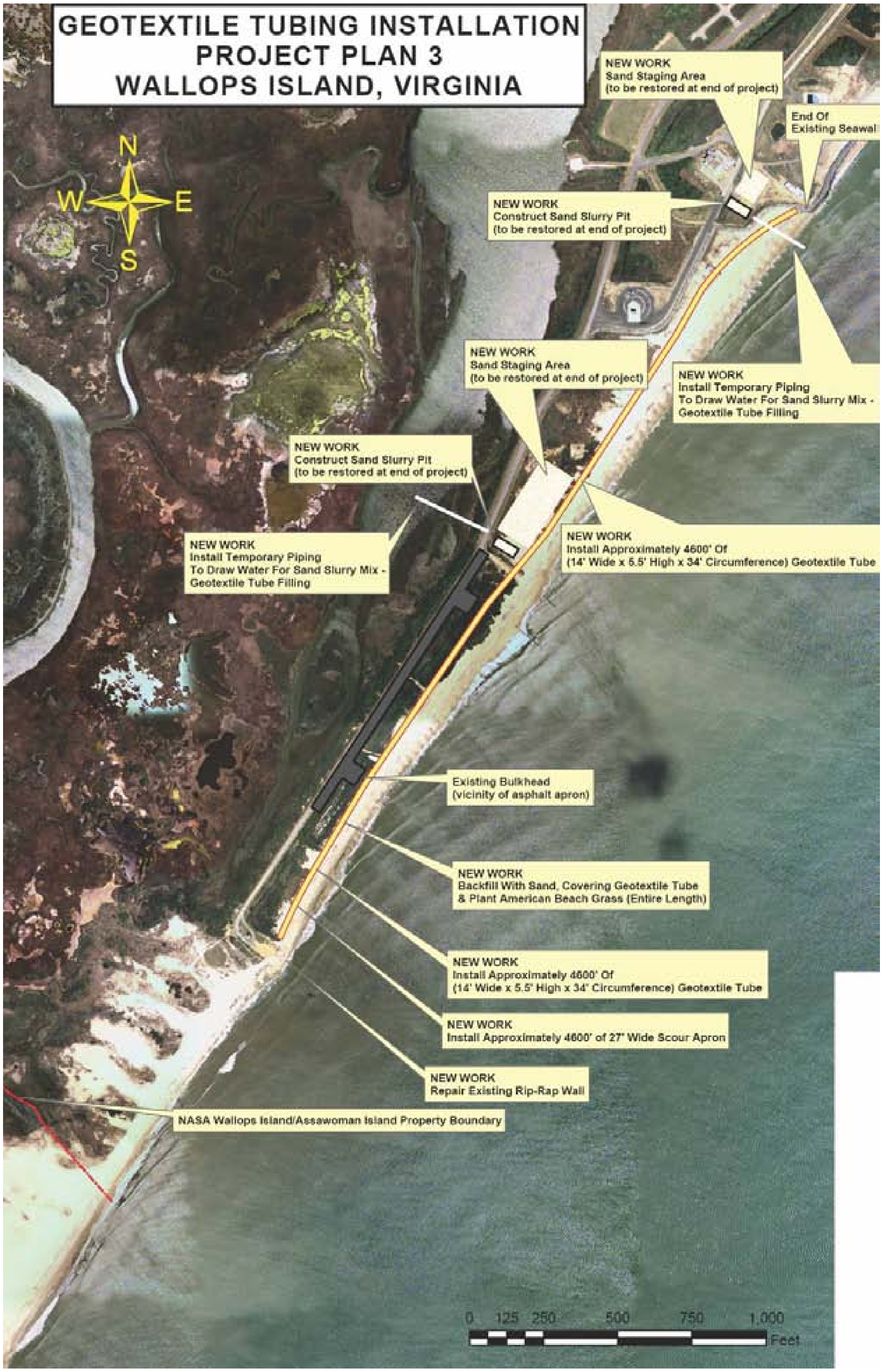
Virginia Department of Historic Resources Data Sharing System, 01/23/2007



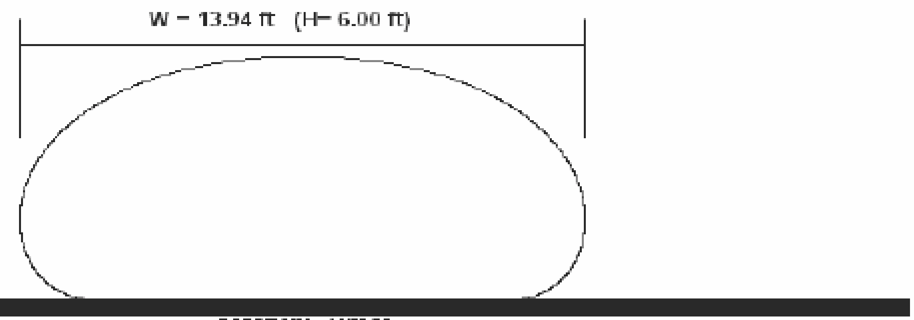
Virginia Department of Hisoric Resources - JAN 05 2007

Wallops Island

Geotube installation along beachfront of Wallops Island.



CLIENT NASA	TITLE **Geotube Installation**
PROJ Wallops Flight Facility Shoreline Restoration – Geotube Installation	URS — PROJ NO 15299035
	FIGURE **1**



Miratech

ver02s SOFFTWIN - 11/29/06

GIVEN C = 34.00 ft H = 6.00 ft SPG = 1.60 FS = 4.00

DENSITY OF SLURRY	=	99.84 pcf
TUBE CIRCUMFERENCE, C	=	33.99 ft
EX PRESS -TOP OF TUBE, P	=	1.323 ft (water) 0.5732 psi
WORKING CIRCUM FORCE, Tcir	=	95.57 lbs/in 1146.8 lbs/ft
WORKING AXIAL FORCE, Tax	=	71.33 lbs/in 855.91 lbs/ft
TOTAL HEIGHT OF TUBE, H	=	6.005 ft
TOTAL WIDTH OF TUBE, W	=	13.94 ft
BASE CONTACT WIDTH OF TUBE	=	10.37 ft
END AREA OF TUBE	=	70.76 sq ft 77.00 % FULL
TUBE VOLUME, V	=	2.621 cu yd/ft 529.3 gal/ft
FABRIC AREA TO VOL RATIO,R	=	1.441 sq yd/cu yd
BASE PRESSURE	=	4.737 psi 10.93 ft (water)
REQ'D CIRCUM STRENGTH T	=	382.3 lbs/in 4587.4 lbs/ft
REQ'D AXIAL STRENGTH	=	285.3 lbs/in 3423.6 lbs/ft

TenCate Geotube

NASA - Walllops Island

CLIENT NASA

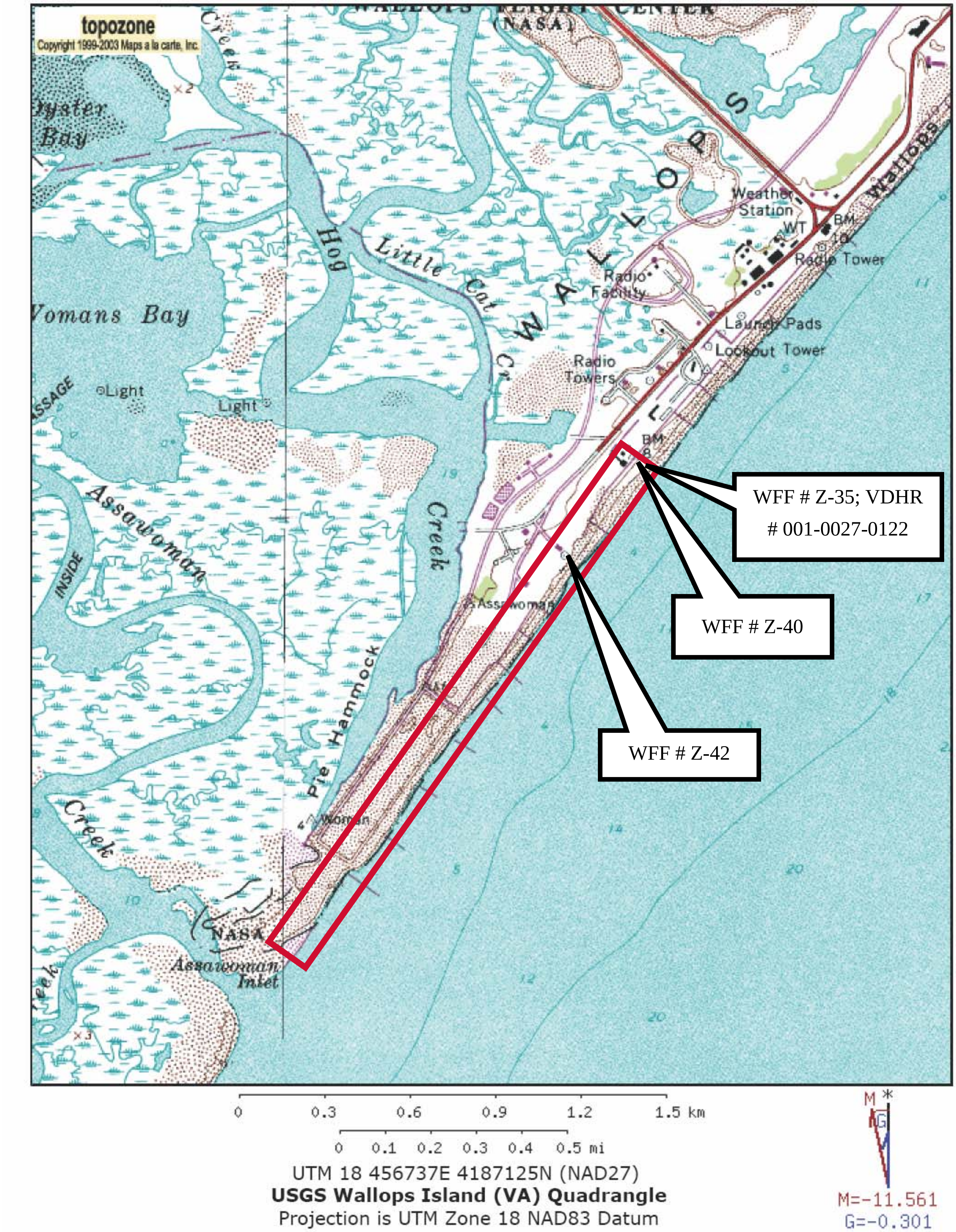
PROJ Wallops Flight Facility Shoreline Restoration Program

TITLE Geotube Dimensions – Wallops Flight Facility

URS

PROJ NO 15299035

FIGURE 2



CLIENT NASA	TITLE **Geotube Installation – Structures located within the Area of Potential Effects (APE)**
PROJ Wallops Flight Facility Shoreline Restoration – Geotube Installation	URS — PROJ NO 15299035 — FIGURE **3**

PHOTOGRAPHIC LOG

Client Name: NASA	Site Location: Wallops Flight Facility, Wallops Island, Accomack County, Virginia	Project No. 15299035

Photo No. 1	Date: 1/22/07

Direction Photo Taken:

Northeast

Description:

Photograph of Geotube Construction at Northernmost end of APE. Two of three buildings within identified APE in background - Launch Control Center (WFF #Z-40) and Tracking Camera No. 2 (WFF #Z-35; VDHR # 001-0027-0122).

Photo No. 2	Date: 1/22/07

Direction Photo Taken:

Southwest

Description:

Photograph of Beach Erosion to high water mark.

URS

PHOTOGRAPHIC LOG

Client Name: NASA	Site Location: Wallops Flight Facility, Wallops Island, Accomack County, Virginia	Project No. 15299035

Photo No. 3 | **Date:** 1/22/07

Direction Photo Taken:

Northeast

Description:

View of beachfront from southernmost end of anticipated Geotube construction. Note that no structures are found in the vicinity of the beachfront at the southernmost end of the project area APE.

Photo No. 4 | **Date:** 1/22/07

Direction Photo Taken:

Northeast

Description:

Photograph of vacant storage building (Z-42).

PHOTOGRAPHIC LOG

Client Name: NASA	Site Location: Wallops Flight Facility, Wallops Island, Accomack County, Virginia	Project No. 15299035

Photo No. 5	Date: 1/22/07

Direction Photo Taken:

Southwest

Description:

Photograph of vacant storage building (Z-42). Note level of sand deposited into vacant building during previous storm events.

Photo No. 6	Date: 1/22/07

Direction Photo Taken:

Southwest

Description:

Geotube construction from northern limit of APE. Note vacant storage building (Z-42) south of current construction along beachfront.

PHOTOGRAPHIC LOG

Client Name: NASA	Site Location: Wallops Flight Facility, Wallops Island, Accomack County, Virginia	Project No. 15299035

Photo No. 7	Date: 1/22/07
Direction Photo Taken: Southwest	
Description: Geotube Corridor Grading	

Photo No. 8	Date: 1/22/07
Direction Photo Taken: Northeast	
Description: Geotube grading showing present beach surface.	

	PHOTOGRAPHIC LOG

Client Name: NASA	**Site Location: Wallops Flight Facility, Wallops Island, Accomack County, Virginia**	**Project No.** 15299035

Photo No. 9	**Date:** 1/22/07	
Direction Photo Taken: North		
Description: Northern sand slurry pit.		

Photo No. 10	**Date:** 1/22/07	
Direction Photo Taken: West		
Description: Northern sand slurry pit and backdirt pile.		

PHOTOGRAPHIC LOG

Client Name: NASA	Site Location: Wallops Flight Facility, Wallops Island, Accomack County, Virginia	Project No. 15299035

Photo No. 11	Date: 1/22/07

Direction Photo Taken:

Northwest

Description:

Southern sand slurry pit.

Photo No. 12	Date: 1/22/07

Direction Photo Taken:

South

Description:

Southern sand slurry pit

____ No historic properties affected ✓ No adverse effect

____ Additional information is needed in order to complete our review

____ We have previously reviewed this project A copy of our correspondence is attached

Comments: ____

Signature ____________________ Date 25 Jan 07

Phone number 804-367-2323 x140 DHR File # 2007-0087

This Space For Department Of Historic Resources Use Only

MAIL COMPLETED FORM AND ATTACHMENTS TO:

Virginia Department of Historic Resources

Attention: Project Review

2801 Kensington Avenue, Richmond, VA 23221

www.dhr.virginia.gov

National Aeronautics and
Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Reply to Attn of: 250.W

February 12, 2010

Ms. Ellie Irons
Office of Environmental Impact Review
Virginia Department of Environmental Quality
629 East Main Street, Sixth Floor
Richmond, Virginia 23219

Dear Ms. Irons:

In accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, and Section 307 (c) (1) of the Coastal Zone Management Act of 1972, the National Aeronautics and Space Administration (NASA) has prepared a Draft Programmatic Environmental Impact Statement (DPEIS) and Federal Consistency Determination (FCD) for the proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP) at its Goddard Space Flight Center's Wallops Flight Facility (WFF) on Wallops Island, Virginia.

As the project sponsor, NASA is serving as the lead agency for both NEPA and Federal Consistency coordination with the Virginia Department of Environmental Quality. The U.S. Department of the Interior, Minerals Management Service (MMS) and the U.S. Army Corps of Engineers (USACE) would undertake actions connected to the SRIPP and are participating in NASA's NEPA process and Consistency coordination. The effects of their actions are considered in all project-related environmental documentation, including the enclosed DPEIS and FCD (Appendix G of the DPEIS). As such, please include all three action agencies in future correspondence regarding the SRIPP.

In cooperation with MMS and USACE, NASA has found that the proposed SRIPP would be consistent to the maximum extent practicable with the enforceable policies of the Virginia Coastal Resources Management Program. NASA respectfully requests that you review the enclosed DPEIS and FCD and provide comments within 60 days of receiving this letter. Four (4) hard copies and fourteen (14) compact discs are enclosed to facilitate the consolidated state agency review process.

If you have any questions or require any additional information please contact me at (757) 824-2319, or Ms. Shari Silbert at (757) 824-2327.

Sincerely,

Joshua A. Bundick
WFF NEPA Program Manager

Enclosure

cc:
MMS/Mr. D. Herkhof
USACE /Mr. R. Cole

FEDERAL CONSISTENCY DETERMINATION FOR THE SHORELINE RESTORATION AND INFRASTRUCTURE PROTECTION PROGRAM

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
WALLOPS FLIGHT FACILITY
WALLOPS ISLAND, VA 23337

Introduction

This document provides the Commonwealth of Virginia with the National Aeronautics and Space Administration's (NASA) Consistency Determination under Coastal Zone Management Act Section 307(c)(1) and Title 15 Code of Federal Regulations (CFR) Part 930, Subpart C, for implementation of the Shoreline Restoration and Infrastructure Protection Program (SRIPP) at NASA's Goddard Space Flight Center Wallops Flight Facility (WFF), Wallops Island, Virginia. The information in this Consistency Determination is provided pursuant to 15 CFR Section 930.39.

NASA has prepared a Programmatic Environmental Impact Statement (PEIS) to evaluate the potential environmental impacts from the proposed SRIPP in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S. Code 4321-4347), the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] 1500-1508), NASA's regulations for implementing NEPA (14 CFR Subpart 1216.3), and the *NASA Procedural Requirements (NPR) for Implementing NEPA* and *Executive Order (EO) 12114* (NPR 8580.1).

The U.S. Department of the Interior Minerals Management Service (MMS) and the U.S. Army Corps of Engineers (USACE), Norfolk District, have served as Cooperating Agencies in preparing the PEIS and this Consistency Determination, because they possess regulatory authority and specialized expertise pertaining to the Proposed Action. The PEIS is being developed to fulfill all three Federal agencies' obligations under NEPA. NASA, as the WFF property owner and project proponent, is the Lead Agency and responsible for ensuring overall compliance with applicable environmental statutes, including NEPA.

The SRIPP encompasses a 50-year planning horizon and is intended to reduce storm-induced physical damage to Federal and State infrastructure on Wallops Island. The Preferred Alternative would involve extending Wallops Island's existing rock seawall a maximum of 1,400 meters (m) (4,600 feet [ft]) south of its southernmost point and placing sand dredged from Federal waters on Wallops Island along 6.0 kilometers (3.7 miles) of the shoreline. An initial sand placement of approximately 2.4 million cubic meters (m^3) (3.2 million cubic yards [yd^3]) of would occur, followed by periodic renourishments anticipated to occur every 5 years, with a total of 9 renourishment cycles over the 50-year life of the SRIPP. Each renourishment event would involve placement of approximately 616,000 m^3 (806,000 yd^3) of sand on the shoreline. The topography and bathymetry of the beach would be monitored on a regular basis to determine sand movement patterns and plan when renourishment is needed. The initial fill plus the total fill volume over 9 renourishment events would result in approximately 8 million m^3 (10.5 million yd^3) of sand being placed on the shoreline.

The SRIPP would help reduce the risk to infrastructure on Wallops Island from storm-induced damages by restoring the beach profile in front of the present shoreline.

Effects to Resources

NASA has determined that the SRIPP would affect the land or water uses or natural resources of Virginia in the following manner:

Geology and Sediment – Beneficial long-term impacts on land use and the Wallops Island and northern Assawoman Island shorelines would occur due to creation of a beach. North Wallops Island sand removal would result in minor adverse impacts on sediments and topography. Placement of beach fill (initial and renourishment) would create and maintain a beach approximately 21 meters (70 feet) wide on Wallops Island, resulting in long-term direct beneficial impacts. The addition of sediment to the longshore transport system would offset some ongoing erosion that is occurring at the northern end of Assawoman Island. The northern end of Wallops Island would continue to accrete, and would likely accrete at a faster rate than under existing conditions due to the presence of additional sand in the longshore sediment transport system from the beach fill. The newly created beach profile would extend underwater for a maximum of 52 meters (170 feet), resulting in a new bathymetric profile within the subaqueous lands immediately east of Wallops Island.

To minimize impacts on sediments, beach nourishment would be done using a comparable sediment type (a similar percentage of sand, silt and clay), grain size and color as the existing beach material. The removal of sediments from north Wallops Island would be mitigated by the re-deposition of sediment that would come from the addition of new sand on the beach. A monitoring survey of the shoreline in the vicinity of Wallops Island would be conducted twice a year, with LiDAR (Light Acquisition, Detection, and Ranging) data obtained for the area approximately once a year. NASA would implement an adaptive management strategy to ensure that mitigation and monitoring are effective and appropriate.

Water Resources –Elevated turbidity in the nearshore marine water environment off Wallops Island would occur during and immediately after initial and renourishment beach fill. No impacts would occur on surface waters or wetlands.

Floodplains – Wallops Island is located entirely within the floodplain; therefore, all SRIPP activities on land would take place within the 100-year and 500-year floodplains. No practicable alternatives to work in the floodplain exist. The functionality of the floodplain on Wallops Island, provided both by the wetlands on the island and the area of the island itself, would not be reduced by the SRIPP.

Air Quality – Emissions from construction equipment (seawall extension, movement of sand on beach during placement, excavation of sediments on north Wallops Island beach) and barge activities (dredging and transport) are not anticipated to cause long-term adverse impacts on air quality or climate change.

Noise – Construction and transportation activities have the potential to generate temporary increases in noise levels from heavy equipment operations. Localized impacts would occur during construction of the seawall and sand placement activities, but no adverse impacts are anticipated. Temporary, localized impacts on marine mammals associated with noise related to vessel activities (dredging) and construction of the groin or breakwater.

Hazardous Materials and Hazardous Waste Management – Beneficial impacts would occur by restoring the Wallops Island shoreline and increasing the distance between breaking waves and hazardous materials storage areas and accumulation points. NASA has implemented various controls to prevent or minimize the effects of an accident involving hazardous materials on NASA property, including the following:

- Preparation of an Integrated Contingency Plan
- Preparation of emergency plans and procedures designed to minimize the effect an accident has on the environment
- Maintenance of an online database (MSDSPro) of hazardous materials and the associated buildings where they are stored or used, which would be updated to include the new facilities
- Annual training for all users of hazardous materials

Munitions and Explosives of Concern – MEC are not anticipated to be encountered in the area of seawall construction or beach fill. It is anticipated that shoreline erosion would increase to the south of the seawall extension in the first one to two years of the SRIPP; MEC may migrate to the ocean if further beach erosion occurs in this area. The beach fill (starting in year two) would reduce the potential of MEC migration into the ocean. There is a potential that MEC would be encountered during excavation of the north Wallops Island borrow site. To minimize the risk of adverse impacts from UXO in this area, an MEC Avoidance Plan that addresses the potential hazards would be prepared. A visual and magnetic survey of the area to locate MEC would be completed and potential hazards removed prior to excavation.

Vegetation – The addition of sand to the shoreline would result in beneficial impacts on existing vegetation. The presence of a beach is an important buffer for other vegetative zones on Wallops Island. The SRIPP would create beach and dune habitat along approximately 6.0 kilometers (3.7 miles) of shoreline where none currently exists, allowing grasses to repopulate the upper dune areas. Vegetative species associated with dune and swale systems would also benefit from the expanded beach habitat that would be created under the Preferred Alternative. The movement of dump trucks carrying the seawall components would likely disturb some vegetation in the upper beach zone. During renourishment cycles from the northern part of Wallops Island, vegetation is not expected to be disturbed because the equipment would travel along the unvegetated beach to reach the upland borrow site. Overall, it is anticipated that Alternative One would result in beneficial impacts on Wallops Island vegetation.

Benthic Resources –Placement of the initial fill would bury existing intertidal benthic community along an approximate 4,300-meter (14,000-foot) length of the seawall. The mean tidal range is approximately 1.1 m (3.6 ft); therefore approximately 0.5 hectare (1.2 ac) of hard-bottom, intertidal habitat would be permanently buried. In addition, approximately 91 hectares (225 acres) of the subtidal benthic community along the existing seawall would be buried during the initial fill placement. A new beach would be formed in front of the seawall and a beach benthic community would become established.

Terrestrial Wildlife and Migratory Birds – Impacts on migratory birds are anticipated during construction of the seawall extension due to temporary noise disturbances, especially during spring and fall migrations; however, noise disturbances would be similar to existing noise from daily operations, including airplane and launch operations on Wallops Island. Temporary minor adverse impacts on beach invertebrates on existing portions of the beach like ghost crabs may occur during sand placement. Terrestrial species found inland may become startled by construction-related noises, but this would be temporary and would only last the duration of the construction.

Threatened and Endangered Species – The SRIPP may affect, but is not likely to adversely affect vegetation, whales, sea turtles (except for loggerhead), and the candidate Red Knot. The SRIPP may affect, and is likely to adversely affect the loggerhead and Kemp's ridley sea turtles, and may affect, but is not likely to adversely affect the leatherback or Atlantic green sea turtles. The SRIPP is likely to adversely affect the Piping Plover. No adverse affect to other bird species. A qualified biologist would conduct surveys and monitor the project area to ensure Red Knots and Piping Plovers are not directly affected during construction activities. Turtle deflectors would be installed on the drag heads during dredging to reduce the risk of entrainment. In addition, NASA would implement a number of other measures to minimize impacts of incidental take of sea turtles. A NMFS-approved observer would be present on board the dredging vessel for any dredging occurring between April 1 and November 30.

Marine Mammals, Fisheries, Essential Fish Habitat – NASA has determined that the proposed SRIPP would have site-specific adverse effects on Essential Fish Habitat, but the impacts would not be significant within a regional context. There would be short-term site-specific adverse effects on fish habitat within the fill placement area due to temporary burial of existing benthic habitat and increased levels of turbidity during and immediately after sand placement. Benthic habitats would recover post-project. Temporary, localized potential impacts associated with physical disturbance to habitats during dredging and fill, vessel strike, and increased noise from vessel activities (dredging). Although placement of sand on the Wallops Island shoreline might disrupt foraging habitat, no adverse impacts are anticipated to marine mammals. Because vessel activity in the project area is common, noise impacts are not expected to be significant. As suggested by NMFS in a memorandum dated June 18, 2009, the potential of marine mammal strikes would be mitigated by operating the dredge vessel at speeds below 14 knots.

Socioeconomics – Beneficial impacts on the socioeconomic environment would occur from reducing damages to infrastructure and from job creation. Minor adverse effects on commercial and recreational fisheries. Disproportionately high or adverse impacts to low-income or minority populations are not anticipated.

Commercial and Recreational Fishing - There could be temporary impacts on commercial and recreational fishing resources during the placement of beach fill material on Wallops Island due to elevated turbidity levels in the nearshore environment and disruption of the benthos, which would cause fish to avoid the disturbed areas. No impacts to commercial and recreational fishing are anticipated from construction of the seawall or use of the north Wallops Island borrow site for renourishment.

Cultural Resources – No archaeological (below ground or underwater) resources or above-ground historic properties are present within the project area; therefore no archeological resources or above-ground historic properties would be affected. In a letter dated January 5, 2009, VDHR concurred with NASA's determination "that there are no historic properties location within the project area and that no further work is needed within the area studied," and that the SRIPP "will not adversely affect any historic properties." In the event that previously unrecorded historic properties are discovered during project activities, NASA would stop work in the area and contact VDHR immediately.

Transportation – Minor construction traffic is anticipated to be associated with the SRIPP on Wallops Island and also on the ocean between the proposed offshore shoals and the pump-out station located 3 kilometers (1.9 miles) off of Wallops Island. Employees would drive to the docked dredging barges to load them with any needed equipment. However, this amount of traffic would not be a significant increase from the usual daily landside traffic on Wallops Island.

Cumulative Impacts – The area for the cumulative effects analysis covered the nearshore areas from approximately Ocean City, MD to Sandbridge, VA. The only resources that have been identified as having the potential to be adversely impacted by the cumulative effects of the SRIPP in combination with other local projects and activities are the geomorphic integrity of the offshore sand shoal environment, the loggerhead sea turtle, and the Piping Plover. Beneficial cumulative impacts are anticipated on socio-economics. No cumulative impacts are anticipated on other resources.

Consistency Determination

The Virginia Coastal Resources Management Program contains the following applicable enforceable policies:

- **Fisheries Management**. Administered by VMRC, this program stresses the conservation and enhancement of shellfish and finfish resources and the promotion of commercial and recreational fisheries.
- **Subaqueous Lands Management.** Administered by VMRC, this program establishes conditions for granting permits to use State-owned bottomlands.
- **Wetlands Management.** Administered by VMRC and VDEQ, the wetlands management program preserves and protects tidal wetlands.
- **Dunes Management.** Administered by VMRC, the purpose of this program is to prevent the destruction and/or alteration of primary dunes.

- **Non-point Source Pollution Control.** Administered by the Virginia Department of Conservation and Recreation, the Virginia Erosion and Sediment Control Law is intended to minimize non-point source pollution entering Virginia's waterways.
- **Point Source Pollution Control.** Administered by the State Water Control Board, the National Pollutant Discharge Elimination System permit program regulates point source discharges to Virginia's waterways.
- **Shoreline Sanitation.** Administered by the Department of Health, this program regulates the installation of septic tanks to protect public health and the environment.
- **Air Pollution Control.** Administered by the State Air Pollution Control Board, this program implements the Federal Clean Air Act through a legally enforceable State Implementation Plan.
- **Coastal Lands Management.** Administered by the Chesapeake Bay Local Assistance Department, the Chesapeake Bay Preservation Act guides land development in coastal areas to protect the Chesapeake Bay and its tributaries.

Based upon the following information, data, and analysis, NASA finds that the proposed SRIPP activities are consistent to the maximum extent practicable with the enforceable policies of the Virginia Coastal Resources Management Program. The table below summarizes NASA's analysis supporting this determination:

Virginia Policy	Consistent?	Analysis
Fisheries Management	Yes	There would be short-term site-specific adverse effects on fish habitat within the fill placement area due to temporary burial of existing benthic habitat and increased levels of turbidity during and immediately after sand placement. Benthic habitats would recover post-project. Minor impacts on commercial or recreational fishing are anticipated. The proposed action would not violate the provisions outlined in Code of Virginia § 28.2-200 through 28.2-713 and Code of Virginia § 29.1-100 through 29.1-570.
Subaqueous Lands Management	Yes	The creation of a beach along Wallops Island would affect existing subaqueous areas in the nearshore ocean environment. Elevated turbidity in marine waters would occur during and immediately after beach fill. The newly created beach profile would extend approximately 21 meters (70 feet) above water from the existing shoreline and continue for a maximum of 52 meters (170 feet) underwater, resulting in a new bathymetric profile in the

Virginia Policy	Consistent?	Analysis
		subaqueous lands immediately east of Wallops Island. Any necessary VMRC permits required for work involving maintenance, repair, or emergency actions in subaqueous bottom land would be obtained by NASA prior to implementation of the SRIPP.
Wetlands Management	Yes	Project activities would not impact wetlands.
Dunes Management	Yes	Project activities would involve the creation of a beach and dunes along 6 kilometers (3 miles) of the Wallops Island shoreline over the top of the existing seawall. No destruction of existing dunes would occur. Any necessary VMRC permits would be obtained by NASA prior to implementation of the SRIPP.
Non-point Source Pollution Control	Yes	Construction activities could temporarily increase non-point source runoff to the Atlantic Ocean during the duration of the project. NASA would implement appropriate best management practices to minimize the impact. All land-disturbing activities would be conducted on the existing beach (seawall construction and use of north Wallops Island for beach renourishment) and newly created beach.
Point Source Pollution Control	Yes	The project would not involve a new point source discharge to Virginia waters.
Shoreline Sanitation	Yes	The project would not involve the construction of septic tanks.
Air Pollution Control	Yes	Use of equipment for construction of the seawall extension, movement of sand placed on the newly created beach, and excavation of sand at the north end of Wallops Island along with barge operations for dredging and transport of sand would result in emissions. NASA would minimize adverse impacts to air quality by implementing best management practices. The project would not violate Federal or Virginia air quality standards.
Coastal Lands Management	Yes	The proposed project would not include land development activities that would impact the Chesapeake Bay or its tributaries.

Pursuant to 15 CFR section 930.41, the Virginia Coastal Resources Management Program has 60 days from the receipt of this letter in which to concur with or object to this Consistency Determination, or to request an extension under 15 CFR Section 930.41(b). Virginia's concurrence will be presumed if its response is not received by NASA on the 60th day from receipt of this determination. The State's response should be sent to:

Joshua A. Bundick
WFF NEPA Manager
Environmental Office
NASA Wallops Flight Facility
Wallops Island, VA 23337
(757) 824-2319

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Douglas W. Domenech
Secretary of Natural Resources

Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
TDD (804) 698-4021
www.deq.virginia.gov

David K. Paylor
Director

(804) 698-4020
1-800-592-5482

April 14, 2010

Mr. Joshua A. Bundick
NEPA Program Manager
Code 250.W
Goddard Space Flight Center, Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, Virginia23337

RE: Draft Programmatic Environmental Impact Statement and Federal Consistency Determination for the Shoreline Restoration and Infrastructure Protection Program at Wallops Island, Accomack County, Virginia (DEQ# 10-019F)

Dear Mr. Bundick:

The Commonwealth of Virginia has completed its review of the above-referenced draft Programmatic Environmental Impact Statement (PEIS) which includes a federal consistency determination (FCD). The Department of Environmental Quality (DEQ) is responsible for coordinating Virginia's review of federal environmental documents prepared pursuant to the National Environmental Policy Act and responding to appropriate federal officials on behalf of the Commonwealth. DEQ is also responsible for coordinating state reviews of federal consistency determinations submitted under the Coastal Zone Management Act of 1972, as amended. The following agencies joined in this review:

Department of Environmental Quality
Marine Resources Commission
Department of Game and Inland Fisheries
Department of Conservation and Recreation
Virginia Institute of Marine Science
Department of Historic Resources
Department of Health

The Department of Agriculture and Consumer Services, the Department of Mines, Minerals and Energy, the Accomack-Northampton Planning District Commission and Accomack County were also invited to comment.

PROJECT DESCRIPTION

The National Aeronautics and Space Administration (NASA) prepared a Draft Programmatic Environmental Impact Statement for the Shoreline Restoration and Infrastructure Protection Program (SRIPP) at Wallops Flight Facility (WFF) on Wallops Island, Virginia. The U.S. Minerals Management Service (MMS) and U.S. Army Corps of Engineers (Corps) are cooperating agencies for the PEIS.

The purpose of the SRIPP is to reduce the potential for damage to, or loss of, existing NASA, U.S. Department of the Navy (Navy), and Mid-Atlantic Regional Spaceport assets on Wallops Island from wave impacts associated with storm events. Four alternatives were evaluated in the draft PEIS.

Alternative One. The preferred alternative involves an initial construction phase with follow-on renourishment cycles. The initial phase would include two distinct elements:

- Extending Wallops Island's existing rock seawall a maximum of 4,600 feet (ft) south of its southernmost point.
- Placing sand dredged from Unnamed Shoal A, located offshore in Federal waters, on the Wallops Island shoreline. An estimated 3,199,000 cubic yards (yd^3) of fill would be placed along the shoreline starting at camera stand Z-100, which is located approximately 1,500 ft north of the Wallops Island-Assawoman Island property boundary and extending north for 3.7 miles.

Each renourishment fill volume is anticipated to be approximately 806,000 yd^3. The renourishment cycles would include placing sand on the Wallops Island shoreline taken from either of three sources: the beach on the northern end of Wallops Island (Wallops Island borrow site), or from one of two sand shoals (Unnamed Shoal A or Unnamed Shoal B) located in Federal waters. The renourishment cycle is anticipated to occur every 5 years, with a total of 9 renourishment cycles over the 50-year lifespan of the SRIPP. The initial fill plus the total fill volume over nine renourishment events would result in approximately 10,453,000 yd^3 of sand being placed on the shoreline.

Alternative Two. Under Alternative Two, the seawall extension would be the same as described under the preferred alternative. In addition, a groin would be constructed at the south end of the Wallops Island shoreline and would involve the placement of rocks in a linear structure perpendicular to the shoreline at approximately 1,460 ft north of the Wallops Island-Assawoman Island border. The structure would be approximately 430 ft long and 50 ft wide. Construction of the groin would result in more sand being retained along the Wallops Island beach, so less fill would be required for both the initial nourishment and renourishment volumes as compared to the preferred alternative.

Alternative Three. Under Alternative Three, the seawall extension would be the same as described under the preferred alternative. In addition, a single nearshore breakwater would be constructed at the south end of the Wallops Island shoreline and would involve the placement of rocks in a linear structure parallel to the shoreline. The breakwater structure would be constructed approximately 750 ft offshore. The breakwater would be approximately 90,300 ft long and 110 ft wide. Construction of the breakwater would result in more sand being retained along the Wallops Island beach, so less fill would be required for both the initial nourishment and renourishment volumes compared to the preferred alternative.

No Action Alternative. This alternative serves as a baseline against which the impacts of the three proposed action alternatives were compared. Under this alternative, the SRIPP would not be conducted on Wallops Island, but maintenance and emergency repairs to existing structures would continue. Buildings and infrastructure on the Island would continue to be at increasing risk from storm damage.

SUMMARY

Several agencies indicate that the relocation of vulnerable infrastructure to the mainland would be the best long-term solution to protect the infrastructure on Wallops Island. Some agencies also agree that irregular and unscheduled emergency protective actions have not been (and would continue not to be) an effective shoreline management strategy. However, since all of the action alternatives propose some type of permanent erosion and storm protection along the Wallops Island shoreline, adverse impacts on coastal resources, including protected species and wildlife and the resources upon which they depend, will occur.

In general, the reviewing agencies agree that Alternative One, the preferred alternative, would have the least impacts of all the action alternatives since it no longer includes the installation of a permeable groin, and provided that sand is not taken from the Wallops Island borrow site for beach replenishment and the proposed seawall extension is limited to the minimum length absolutely necessary for the protection of the facilities. The agencies believe that the construction of a groin would disrupt the southerly longshore transport of sand thereby adversely affecting the islands south of Wallops. In addition, there are several Federal Facilities Restoration Program formerly used defense sites (FUDS) located along or immediately adjacent to the shoreline and/or the Wallops Island borrow site. Therefore, use of sand from the Wallops Island borrow site could adversely affect the FUDS sites, which are currently under investigation by the Corps. Essentially, all potential sources of sand identified in the draft PEIS could contain munitions and explosives of concern (MECs).

Although each of the proposed action alternatives will have significant impacts to the environment, each alternative includes multiple mitigation measures to minimize these impacts. Monitoring project activities will be essential to validate project performance assumptions and to adapt the management strategies as needed over the life of the project. Reviewers also indicated that there are information gaps and deficiencies in the draft PEIS, which should be remedied in the final PEIS.

GENERAL COMMENTS BY AGENCY

Virginia Institute of Marine Science (VIMS).

The Virginia Institute of Marine Science has been involved with the proposed project since 2008 as one of many stakeholders. VIMS provided the following comments on the draft PEIS:

- The main findings of the draft PEIS are well supported with various models, current scientific reference data and professional expert advice. The future effects of sea level rise were accounted for within the 50-year project life. Also, proposed offshore sand mining was thoroughly evaluated and appears to be consistent with the current scientific understanding of potential impacts. Several mitigation measures are included to minimize adverse environmental effects during the dredging and transport process. However, regardless of which alternative is selected, the proposed activities will have reasonably foreseeable effects on coastal resources.

- If relocation of vulnerable infrastructure to the mainland is not a viable option, then some type of permanent erosion and storm protection is necessary for the protection of infrastructure at this facility. Irregular and unscheduled emergency protective actions would not be effective.

- Given that some type of action is necessary, VIMS generally agrees that the three shoreline restoration alternatives are appropriate and consistent with current guidelines for projects on ocean coasts, even though the proposed project will have significant impacts to the environment. However, each proposed alternative includes multiple mitigation measures to minimize these impacts.

- Monitoring programs will be essential to validate project performance assumptions and to adapt the management strategies as needed over the life of the project. Beach profiles and biological surveys at the Wallops Island borrow area will be particularly important to support using this sand source.

For more information on these comments, contact Karen Duhring of VIMS at (804) 684-7159 or karend@vims.edu.

Department of Game and Inland Fisheries (DGIF).

In general, the management of Virginia's barrier island chain is minimal and typically allows nature to take its course. This management scheme has proven, over time, to benefit the fish and wildlife that inhabit the islands. However, shoreline stabilization efforts at Wallops Island have been ongoing since the 1940's; but these efforts have not abated the shoreline retreat of the island. DGIF believes that, even with intervention, the Wallops Island shoreline is likely to continue to retreat landward and any attempts to delay or alter the shoreline retreat may be futile over the long term. Oertel *et al.* (2008) refers to the area between the southern end of Assateague Island to the northern tip of

Parramore Island as the Chincoteague Bight and proposes that the extremely rapid retreat of the barrier islands within this area is due to natural processes driven by topographic features that existed during previous ice ages. Moreover, the "Storm Damage Reduction Project Design" study (Appendix A) suggests that the growing cape of Fishing Point, located at the southern end of Assateague Island, is capturing sand that would otherwise be available to the neighboring islands to the south. This sand capture is a further indication that Wallops Island will continue to retreat, thereby necessitating continual and costly efforts to slow the natural movement of the island over the long term.

Therefore, DGIF does not fully support any of the alternatives presented in the draft PEIS. Aggressive shoreline management coupled with the scope and location of the proposed shoreline stabilization activities directly counters the minimal management typical of Virginia's barrier island shoreline. DGIF believes that all of the alternatives are likely to result in adverse impacts upon wildlife and/or the resources upon which they depend (see DGIF's attached letter for more information). However, DGIF agrees with the selection of Alternative One as the Preferred Alternative, since it no longer includes the installation of a permeable groin. The groin would reduce the southerly longshore transport of sand thereby adversely affecting the islands south of Wallops.

DGIF's concerns about the proposed activities are outlined below:

- *Alternative One.* DGIF is concerned that the extension and increase in height of the existing seawall will prevent natural island overwash processes from occurring over a large area of the island. The draft PEIS (page 195) states that the seawall extension would likely result in a greater loss of surface area on the landward side of the seawall and enhance island narrowing as sea level rises. Over the long term (i.e., beyond the 50-year life span of the project), a reduction in land mass may seriously affect the island's natural function as the first line of protection against storm surge and other weather-related events for the marshes and mainland that lie west of the island. Moreover, it will reduce the island's value to beach and marsh-dependent wildlife through the loss of beach seaward of the seawall if renourishment efforts are not able to keep up with erosion rates, and the loss of marshes behind the island should significant island narrowing occur. Lastly, the results from the models presented in Appendix A of the draft PEIS suggest that the seawall extension will have less of an impact on Assawoman Island's shoreline over the long term than the current changes in shoreline incurred by yearly variation in wave climate and storms.

  Alternative One also proposes that a portion of the renourishment fill volumes would be excavated from the Wallops Island borrow site on the northern side of the island. DGIF is strongly opposed to using the northern end of Wallops Island as a borrow site for beach fill during renourishment cycles due to the presence of the federally-listed threatened Piping Plover.

  In addition, the draft PEIS (page 48) states that the sand at the Wallops Island borrow area is not an optimal grain size for use as beach fill, but that it offers potential renourishment material without the mobilization and operational costs associated with offshore dredging. DGIF states that the sacrifice of important and unique wildlife habitat along the only section of undeveloped beach on Wallops Island to acquire fill material at the lowest cost possible is not appropriate. Moreover, the use of sand which is not the optimal grain size is in opposition to the mitigation criteria developed by NASA for sand placement activities (page 300). The criteria states that beach nourishment will be accomplished so that the beach is restored to a comparable sediment type (a similar percentage of sand, silt and clay), grain size and color as the existing beach material.

- *Alternative Two.* DGIF is concerned about the adverse effects of Alternative Two on islands located south of Wallops Island. Alternative Two includes the placement of a groin at the southern end of Wallops Island, which could reduce the transport of sand to the areas south of Wallops Island. Although DGIF understands NASA's need to protect its assets, DGIF does not support any action that could adversely affect other barrier islands, which provide important habitat for shorebirds, sea turtle nesting areas and other wildlife.

- *Alternative Three.* This alternative includes the construction of a nearshore breakwater structure parallel to the south end of the Wallops Island shoreline. DGIF is concerned that the reduction in beach erosion resulting from wave attenuation performed by the breakwaters will be negated by the newly constructed seawall extension and that this structure may also result in shoreline erosion to its south.

In addition, DGIF has the following concerns:

- *Benthic communities.* The draft PEIS acknowledges that repeated dredging activities at intervals of three years or less, may not allow sufficient time for benthic communities to recover between dredging cycles. Studies examining the effects of sand mining on infaunal communities found that levels of abundance and diversity may recover within 1 to 3 years, but recovery of species composition may take longer (Byrnes *et al.* 2004).

- *Offshore Dredging Activities.* DGIF is concerned that the proposed project could impact sea turtles and other mammals.

- *Beach Profile Monitoring Program.* DGIF states that the beach profile monitoring program is too limited in its geographic scope and should be broadened to include islands south of Assawoman Island. Currently, NASA proposes that these efforts are to be confined to Wallops and Assawoman islands.

For more information on these comments, contact Amy Ewing at (804) 367-2211 or amy.ewing@dgif.virginia.gov.

Department of Conservation and Recreation (DCR).

- The Department of Conservation and Recreation continues to be concerned about the effects of the shoreline hardening on the islands downdrift of the project area, which includes properties owned by The Nature Conservancy and DCR.

For more information on these comments, contact Rene Hypes at (804) 371-2708 or rene.hypes@dcr.virginia.gov.

GENERAL RECOMMENDATIONS. DGIF recommends that NASA consider the following general recommendations:

- Develop a contingency plan detailing the steps to be taken if the proposed project is not undertaken. The contingency plan should be provided to all natural resource agencies for review so that agencies will have a better understanding of the long-term environmental impacts of the proposed project.

- Conduct beach profile monitoring on Metompkin and Cedar islands at a frequency that allows for an accurate assessment to be made regarding project impacts further south along the barrier island chain. Given that shoreline behavior on Wallops, Metompkin and Cedar islands is driven by the similar geologic processes (Oertel *et al.* 2008) and therefore may behave more as a unit than as independent landmasses, DGIF believes this is a necessary component of the beach profile monitoring program.

- Discuss in the final PEIS the assertion that any negative impacts from the seawall would be mitigated following beach fill placement. This statement implies that without renournishment, negative impacts are possible. The discussion should include the possible adverse impacts resulting from any of the proposed activities and how such impacts may be mitigated.

- Conduct a cost/benefit analysis which includes a threshold at which NASA considers the environmental costs of the project to outweigh the benefits to its mission and goals (for more information, see DGIF's attached letter) due to the potential impacts this project may have on wildlife resources beyond the project area. The cost/benefit analysis should not only examine monetary costs, but also take into account costs to fish and wildlife resources, the physical integrity of the barrier island chain, and other stakeholder interests. DGIF's letter also requested that the PEIS include a discussion on the availability of funding for continuous beach renourishment since it is being presented as a key element to the project's success. DGIF does not believe that either request was adequately addressed, making it far more difficult to assess the project's risk to the broader environment over the life time of the project.

- Perform studies prior to dredging to determine how the unnamed shoals are used by sea ducks. This data should then be used to analyze potential impacts that the removal of the shoal material will have on these species. Based on the results of the studies, a plan to mitigate any impacts upon sea ducks should be developed.

- Coordinate with the National Marine Fisheries Service (NMFS) regarding the protection of sea turtles and sea mammals during offshore dredging operations.
- Conduct a minimum of three aerial offshore transect surveys before beginning dredging activities over the course of at least one winter season (one in mid-December, one in mid-January, and one in mid-February) along the entire barrier island chain and out to 15 nautical miles. This would establish the relative use of the two unnamed shoals by sea ducks, which would assist DGIF in assessing the impact of dredging activities on these avian species.
- Provide a more detailed explanation of the types of wildlife habitats at the northern end of the island that would be avoided during excavation activities.
- Consider conducting an analysis of the actual recovery time and the sustainability of beaches at the northern end of Wallops Island.

In addition, VIMS recommends that NASA provide a better explanation as to why multiple containment structures with less frequent and intensive beach nourishment cycles are not acceptable and why alternatives with only one structure at the southern end are acceptable.

ENVIRONMENTAL IMPACTS AND MITIGATION

1. Water Quality and Wetlands. The draft PEIS (page 220) states that the proposed construction activities would not impact wetlands.

1(a) Agency Jurisdiction. The State Water Control Board (SWCB) promulgates Virginia's water regulations, covering a variety of permits to include Virginia Pollutant Discharge Elimination System (VPDES) permit, Virginia Pollution Abatement (VPA) permit, Surface and Groundwater Withdrawal Permit, and the Virginia Water Protection (VWP) permit. The VWP permit is a State permit which governs wetlands, surface water, and surface water withdrawals/impoundments. It also serves as § 401 certification of the federal Clean Water Act § 404 permits for dredge and fill activities in waters of the U.S. The VWP Permit Program is under the Office of Wetlands and Water Protection/Compliance, within the DEQ Division of Water Quality Programs. In addition to central office staff who review and issue VWP permits for transportation and water withdrawal projects, the six DEQ regional offices perform permit application reviews and issue permits for the covered activities.

1(b) Findings. DEQ's Tidewater Regional Office (TRO) states that the proposed project will require a VWP permit from DEQ.

1(c) Recommendation. DEQ recommends that all efforts should be taken to ensure that surface waters, including wetlands, are not adversely affected by the proposed activities. In general, NASA must comply with Section 404(b)(1) guidelines of the Clean Water Act and with the Commonwealth's wetland mitigation policies, if applicable. Both Federal and State guidelines recommend avoidance and minimization of wetland impacts as the first steps in the mitigation process. Any unavoidable impacts to State waters may require compensation such as wetland creation, restoration or other acceptable forms of wetland compensatory mitigation.

In general, DEQ recommends that impacts to surface waters, including wetlands, be avoided to the maximum extent practicable and encourages the following practices to minimize impacts:

- operate machinery and construction vehicles outside of wetlands and streams as no machinery may enter surface waters, unless authorized by a VWP permit;
- any temporary impacts to surface waters associated with this project shall require restoration to pre-existing conditions;
- erosion and sedimentation controls shall be designed in accordance with the Virginia Erosion and Sediment Control Handbook, Third Edition, 1992. These controls shall be placed prior to clearing and grading and maintained in good working order to minimize impacts to state waters. These controls shall remain in place until the area is stabilized and shall then be removed. All denuded areas shall be properly stabilized in accordance with the Virginia Erosion and Sediment Control Handbook, Third Edition, 1992;
- heavy equipment in temporarily impacted surface waters shall be placed on mats, geotextile fabric or other suitable material, to minimize soil disturbance to the maximum extent practicable. Equipment and materials shall be removed immediately upon completion of work;
- all construction, construction access, and demolition activities associated with this project shall be accomplished in a manner that minimizes construction materials or waste materials from entering surface waters, unless authorized by a permit; and
- herbicides used in or around any surface water shall be approved for aquatic use by the United States Environmental Protection Agency (EPA) or the U.S. Fish and Wildlife Service (FWS). These herbicides should be applied according to the label directions by a licensed herbicide applicator. A non-petroleum based surfactant shall be used in or around any surface waters.

For more information on VWP permitting, contact DEQ's Tidewater Regional Office.

1(d) Requirements. NASA should submit a Joint Permit Application (JPA) to the Virginia Marine Resources Commission (VMRC) for distribution and review by the permitting agencies.

1(e) Conclusions. Provided that all applicable VWP permits are obtained and complied with, the project will be consistent with the wetlands management and point source pollution control enforceable policies of the Virginia Coastal Zone Management

Program (VCP) (previously called the Virginia Coastal Resources Management Program).

2. Subaqueous Lands Management. The draft PEIS (page 219) states that the purpose of the proposed project is to create a new bathymetric profile along the east coast of Wallops Island. The new profile would be created by the placement of sand, which would extend approximately 70 feet above water from the existing shoreline and continue for a maximum of 170 feet underwater. Permits from the VMRC would be obtained to ensure compliance with the VCP.

2(a) Agency Jurisdiction. The Virginia Marine Resource Commission, pursuant to Virginia Code *§ 28.2-1200* through *1400*, regulates encroachments in, on or over state-owned subaqueous beds as well as tidal wetlands throughout the Commonwealth. Also, the VMRC serves as the clearinghouse for the Joint Permit Application used by the:

- U.S. Army Corps of Engineers for issuing permits pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act;
- DEQ for issuance of a Virginia Water Protection permit;
- VMRC for encroachments on or over state-owned subaqueous beds as well as tidal wetlands; and
- local wetlands board for impacts to wetlands.

2(b) Comments. Pursuant to Section 28.2-1200 *et seq.* of the Code of Virginia, the VMRC has jurisdiction over any encroachments in, on, or over the beds of the bays, ocean, rivers, streams, or creeks which are the property of the Commonwealth. Also, VMRC supports Alternative One, as this alternative would have less impact to the existing longshore transport of sand to Assawoman Island in the event that funding for the proposed 5-year beach nourishment cycles cannot be secured.

2(c) Findings. The VMRC states that it appears that the project would require authorization from the VMRC. However, any dredging that occurs more than 3 miles offshore will not require authorization from the VMRC.

2(d) Conclusion. Provided that all VMRC regulations are complied with, the project will be consistent with the subaqueous lands management enforceable policy of the VCP.

3. Dunes Management. The draft PEIS (page 220) states that the proposed project activities are designed to create approximately 3 miles of beach and dunes along the Wallops Island shoreline. Permits from the VMRC would be obtained to ensure compliance with the VCP.

3(a) Agency Jurisdiction. The Virginia Marine Resources Commission issues permits for encroachments to coastal primary sand dunes. VMRC's authority and responsibilities emanate from Subtitle III of Title 28.2 of the Code of Virginia and specifically regulates physical encroachment into this valuable resource area. In accordance with the commonwealth's Coastal Primary Sand Dune/Reaches Guidelines:

Barrier Island Policy (4 VAC 20-440-10 B. 1), no construction or any other activity which has the potential for encroaching on or otherwise damaging coastal primary sand dunes or state-owned beaches shall occur without review and approval by VMRC or a local wetland board, or both. For any development that involves encroachments on primary sand dunes, a JPA must be submitted to VMRC for review and approval.

3(b) Comments. Since Accomack County has not yet adopted the model Coastal Primary Sand Dune Zoning Ordinance, the Commission is charged with reviewing the impacts associated with any project that may fall within the Coastal Primary Sand Dunes/Beaches of Accomack County.

VIMS states that while it recognizes the attractiveness of using a local, upland sand source for beach replenishment, it is VIMS' opinion that mining sand from the Wallops Island borrow site could adversely impact beach and dune processes in this natural area. However, VIMS' concerns have been somewhat alleviated by the following:

- the sand from the Wallops Island borrow site would not be used for the initial beach fill;
- any material excavated from the borrow site would likely originate from the initial beach fill due to the predicted sand transport pattern;
- no temporary construction access roads or other improvements will be needed to transfer the material;
- sand from the northern end of the Island would only be use as source material for a portion of renourishment events; and
- sand from the northern end of the Island would only be use if threatened and endangered species will not be adversely impacted.

VIMS defers to the DGIF and FWS to further assess the potential plant and wildlife impacts associated with mining sand from the northern end of Wallops Island.

3(c) Conclusion. Provided that NASA obtains all applicable approvals from the VMRC, the project will be consistent with the dunes management enforceable policy of the VCP.

4. Fisheries Management. The draft PEIS (page 219) states that NASA does not anticipate that the proposed project will impact commercial or recreational fisheries. There would be short-term, adverse effects on fish habitat within the fill placement area due to the temporary burial of existing benthic habitat and increased turbidity levels during and immediately after sand placement.

4(a) Jurisdiction. The Department of Game and Inland Fisheries (DGIF) and the Virginia Marine Resources Commission administer the fisheries management enforceable policy of the VCP.

4(b) Comments. According to DGIF, the project is located within a marine environment. Therefore, DGIF defers to the VMRC regarding the project's consistency with the fisheries management enforceable policy of the VCP. The VMRC Fisheries Management Division has no comment on the proposed project.

4(c) Conclusion. Provided that NASA obtains all applicable approvals from the VMRC, the project will be consistent with the fisheries management enforceable policy of the VCP.

5. Nonpoint Source Pollution Control. The draft PEIS (page 220) states that construction activities will temporarily increase non-point source pollution. However, NASA would implement best management practices (BMPs) to minimize impacts.

5(a) Agency Jurisdiction. The Department of Conservation and Recreation's (DCR) Division of Soil and Water Conservation (DSWC) administers the Virginia Erosion and Sediment Control Law and Regulations (VESCL&R), Virginia Stormwater Management Law and Regulations (VSWML&R).

5(b) Erosion & Sediment Control and Stormwater Management Project-Specific Plans. According to the Department of Conservation and Recreation's, Division of Soil and Water Conservation, NASA and their authorized agents conducting regulated land disturbing activities on private and public lands in the state must comply with the Virginia Erosion and Sediment Control Law and Regulations (VESCL&R), Virginia Stormwater Management Law and Regulations including coverage under the general permit for stormwater discharge from construction activities, and other applicable federal nonpoint source pollution mandates (e.g. Clean Water Act-Section 313, Federal Consistency under the Coastal Zone Management Act). Clearing and grading activities, installation of staging areas, parking lots, roads, buildings, utilities, borrow areas, soil stockpiles, and related land-disturbance activities that result in the land-disturbance of greater than 10,000 square feet would be regulated by VESCL&R. Accordingly, NASA must prepare and implement erosion and sediment control (ESC) plan to ensure compliance with state law and regulations. The ESC plan is submitted to DCR's Suffolk Regional Office for review for compliance. NASA is ultimately responsible for achieving project compliance through oversight of on-site contractors, regular field inspection, prompt action against non-compliant sites, and other mechanisms consistent with agency policy.

5(c) VSMP General Permit for Construction Activities. The operator or owner of construction activities involving land disturbing activities equal to or greater than 1 acre are required to register for coverage under the General Permit for Discharges of Stormwater from Construction Activities and develop a project specific stormwater pollution prevention plan (SWPPP). The SWPPP must be prepared prior to submission of the registration statement for coverage under the general permit and the SWPPP must address water quality and quantity in accordance with the Virginia Stormwater Management Program (VSMP) Permit Regulations. General information and forms are available at http://www.dcr.virginia.gov/soil_and_water/index.shtml.

5(d) Conclusion. For consistency with the nonpoint source pollution control enforceable policy of the VCP, the project must comply with erosion and sediment control and stormwater management laws and regulations.

6. Chesapeake Bay Preservation Areas. According to the draft PEIS (page 220) the proposed project does not include any land development within the Chesapeake Bay or its tributaries. Therefore, the proposed project is consistent with the coastal lands management enforceable policy of the VCP.

6(a) Agency Jurisdiction. The Department of Conservation and Recreation's Division of Chesapeake Bay Local Assistance (DCBLA) administers the coastal lands management enforceable policy of the Virginia Coastal Program which is governed by the Chesapeake Bay Preservation Act (Virginia Code §10.1-2100-10.1-2114) and Chesapeake Bay Preservation Area Designation and Management Regulations (9 VAC 10-20 *et seq.*).

6(b) Findings. DCR's Division of Chesapeake Bay Local Assistance states that DCBLA recently determined that Wallops Island is in a portion of Accomack County that has not been designated as a Chesapeake Bay Preservation Area (CBPA). When Accomack County amended its ordinance to expand its CBPAs to the ocean side of the County in February 2009, the definition of these areas in the County ordinance references the official zoning map. That map, specifically excludes federal lands on the ocean side of the County, including Wallops Island.

Generally, when a locality does not map CBPAs on federal lands, they are still subject to the requirements of the Bay Act Regulations as they contain lands analogous to Resource Protection Areas and/or Resource Management Areas. However, Wallops Island is located in a part of Accomack County outside the Bay watershed and therefore, Wallops Island is not required to be included as part of a Chesapeake Bay Preservation Area and is not subject to the requirements of the Regulations.

6(c) Conclusion. Since the proposed project is not located within a CBPA, there are no CBPA requirements. Therefore, the project is consistent with the coastal lands management enforceable policy of the VCP.

7. Air Pollution Control. The draft PEIS (page 220) states that construction equipment will result in air emissions, but NASA would implement BMPs to minimize impacts. The project would not violate Federal or state air quality standards.

7(a) Agency Jurisdiction. DEQ's Air Quality Division, on behalf of the State Air Pollution Control Board, is responsible for developing regulations that become Virginia's Air Pollution Control Law. The DEQ is charged with carrying out mandates of the state law and related regulations as well as Virginia's federal obligations under the Clean Air Act as amended in 1990. The objective is to protect and enhance public health and quality of life through control and mitigation of air pollution. The Division ensures the safety and quality of air in Virginia by monitoring and analyzing air quality data, regulating sources of air pollution, and working with local, state and federal agencies to plan and implement strategies to protect Virginia's air quality. The appropriate regional office is directly responsible for the issuance of necessary permits to construct and operate all stationary sources in the region as well as monitoring emissions from these sources for compliance. As a part of this mandate, Environmental Impact Reports of projects to be undertaken in the State are also reviewed. In the case of certain projects, additional evaluation and demonstration must be made under the general conformity provisions of state and federal law.

7(b) Comments. The DEQ Air Division states that the proposed project is located in an ozone attainment area.

7(c) Fugitive Dust Control. During project activities, fugitive dust must be kept to a minimum by using control methods outlined in 9 VAC 5-50-60 *et seq.* of the Regulations for the Control and Abatement of Air Pollution. These precautions include, but are not limited to, the following:

- Use, where possible, of water or chemicals for dust control;
- Installation and use of hoods, fans, and fabric filters to enclose and vent the handling of dusty materials;
- Covering of open equipment for conveying materials; and
- Prompt removal of spilled or tracked dirt or other materials from paved streets and removal of dried sediments resulting from soil erosion.

7(d) Open Burning. If project activities include the open burning of materials on- or off-site, this activity must meet the requirements under 9 VAC 5-130 *et seq.* of the *Regulations* for open burning and it may require a permit. The *Regulations* provide for, but do not require, the local adoption of a model ordinance concerning open burning. NASA should contact Accomack County officials to determine what local requirements, if any, exist.

7(e) Fuel-Burning Equipment. Fuel-burning equipment may be subject to air permitting requirements. For more information or questions concerning requirements, contact DEQ's Tidewater Regional Office.

7(f) Conclusion. Provided that NASA complies with all applicable air regulations, the proposed project would be consistent with the air pollution control enforceable policy of the VCP.

8. Solid and Hazardous Wastes and Hazardous Materials. The draft PEIS (page 234) states that munitions and explosives of concern (MECs) are not anticipated to be encountered in the dredging of Unnamed Shoal A or B. Also, no MECs are anticipated to be encountered on the Wallops Island shoreline in the area of seawall construction or beach fill. However, it is anticipated that as shoreline erosion to the south of the seawall extension increases, MECs in this area may migrate to the ocean. NASA believes that the proposed beach fill along the southern portion of the island should reduce potential MEC migration.

8(a) Agency Jurisdiction. Solid and hazardous wastes in Virginia are regulated by the Virginia Department of Environmental Quality, the Virginia Waste Management Board (VWMB) and the U.S. Environmental Protection Agency. They administer programs created by the federal Resource Conservation and Recovery Act, Comprehensive Environmental Response Compensation and Liability Act (CERCLA), commonly called Superfund, and the Virginia Waste Management Act. DEQ administers regulations established by the VWMB and reviews permit applications for completeness and conformance with facility standards and financial assurance requirements. All Virginia localities are required, under the Solid Waste Management Planning Regulations, to identify the strategies they will follow on the management of their solid wastes to include items such as facility siting, long-term (20-year) use, and alternative programs such as materials recycling and composting.

8(b) Comments. DEQ's Federal Facilities Restoration (FFR) Program staff states that the proposed project is the latest in many beach replenishment projects that have occurred on Wallops Island. The history of beach replenishment at Wallops Island was provided in the draft PEIS. One potential consequence of relocating sand from borrow areas on Wallops Island or offshore dredge areas became evident during the winter storms of 2009. Wave action during those storms created breaches in the seawall. Within some of the breaches old munitions were found intermixed with seawall boulders and concrete debris (see attached Figures 1 and 2). It is believed that the munitions were transported to these areas during earlier replenishment projects as the locations where the munitions were discovered did not coincide with areas where munitions were used historically. Also, some of the munitions still contained explosive material.

The potential for munitions to be encountered during excavation of sand from other areas of Wallops Island as part of this project is clearly acknowledged within the draft PEIS. However, the draft PEIS does not address the potential for munitions to be encountered during offshore dredging activities at the Unnamed Shoal. Essentially, all potential sources for sand identified in the draft PEIS could contain MECs.

DEQ's Office of Waste Permitting and Compliance in the Tidewater Regional Office states that although the proposed project appears to enhance protection of the hazardous waste open burn/open detonation (OB/OD) Resource Conservation and Recovery Act (RCRA) permitted unit, the draft PEIS does not discuss potential alteration of and/or impacts to the existing groundwater monitoring network and potential changes to groundwater flow.

The DEQ-Waste Division states that the draft PEIS addresses both solid and hazardous waste issues, but does not include a search of waste-related databases.

8(c) Findings. The Waste Division staff reviewed its data files and conducted a search of its Geographic Information System database and determined that two hazardous sites and one formerly used defense site (FUDS) are located within the same zip code as the proposed project; however their proximities to the subject site are unknown. These sites are as follows.

Hazardous waste

- NASA GSFC Wallops Flight Facility, VA8800010763 LQG (Active), VA7800020888 LQG (Active), VA7800020888 TSD (Active)

FUDS

- C03VA0301, VA9799F1697, Wallops Island

The following websites may prove helpful in locating additional information for these identification numbers: http://www.epa.gov/superfund/sites/cursites/index.htm or http://www.epa.gov/enviro/html/rcris/rcris_query_java.html.

8(d) Federal Facilities Program. DEQ's FFR Program staff states that the Preferred Alternative may impact several Federal Facilities Restoration Program FUDS currently under investigation by the Corps. The sites in question are situated in the northern portion of Wallops Island along or immediately adjacent to the shoreline and/or the Wallops Island borrow site. Each site is in the early phases of investigation. To date only archive searches have been conducted which identified historic activities that warrant further investigation. These sites are as follows:

- Gunboat Point. This northern-most site contains a bombing area, strafing target, and explosive ordnance disposal (EOD) area. The bombing area was used by the Naval Aviation Ordnance Test Station (NAOTS) to test live high explosive bombs, aircraft parachute flares, and napalm-filled fire bombs. The strafing target was used to train naval aviators on the use of aircraft .50 caliber machine guns. The EOD area was used to dispose of ammunition and is expected to contain munitions and explosives of concern. Latitude and longitude coordinates for each area are available.

- Machine Gun and Rocket Firing Area. This site, located to the south of Gunboat Point, is an area where NAOTS statically tested aircraft machine guns and cannons at 3 ranges; a 750 yard, a 500 yard, and a 175 yard ground range each of which fired toward the dunes/ocean. Latitude and longitude coordinates are available for the firing points and target areas.

- Grebe Range, Target Center, and Facilities. This southern-most area is where a 20mm gun was used (fired out to sea) to calibrate the radar and fire control components. Kingfisher missiles, Grebe missiles, and 3.25 inch rockets were fired from this site. The Target Center is where the range was instrumented and used to various aspects of aviation ordnance. The Explosive Ammunition Test Facility established a controlled environment where aircraft guns and munitions could be test fired. Targets were located on the shoreline and guns were fired seaward from the test facility. Latitude and longitude coordinates are available for these facilities.

8(e) Recommendations. DEQ has the following recommendations:

- DEQ's FFR Program staff recommends that during removal, all borrow and dredge material should be thoroughly screened for munitions. Explosive ordnance disposal (EOD) personnel should be present at each sand removal point and each removal area should be field located (latitude and longitude) to allow for identification of areas where munitions were encountered. All munitions encountered should be managed in accordance with NASA's established munitions avoidance and disposal procedures. Under no circumstance should munitions be removed from borrow or dredge areas and disposed of in the project area.

- Prior to initiating any project activities on Wallops Island or offshore, DEQ's FFR Program recommends that the SRIPP Project Manager contact NASA's WFF Manager of Environmental Restoration for information concerning any CERCLA obligations and the Corps Remediation Project Manager for Wallops FUDS areas for information concerning CERCLA obligations at or near Wallops FUDS sites.

- All construction and demolition debris, including excess soil, must be characterized in accordance with the Virginia Hazardous Waste Management Regulations prior to disposal at an appropriate facility. Also, DEQ encourages all construction projects to implement pollution prevention principles, including:
    - the reduction, reuse, and recycling of all solid wastes generated; and
    - the minimization and proper handling of generated hazardous wastes.

For further information, contact Paul Kohler, DEQ-Waste Division (telephone, (804) 698-4208).

9. Petroleum Storage Tanks. The draft PEIS (page 233) states that there are no underground storage tanks (USTs) or aboveground storage tanks (ASTs) in the proposed project area. However, in the event of a petroleum release occurs during construction activities, NASA would notify DEQ.

9(a) Petroleum Storage Tank Cleanups. According to the DEQ-TRO, there have been multiple releases reported at the WFF. One of the closed cases (PC #1993-0913) is adjacent to the proposed shoreline restoration. Therefore, if evidence of a petroleum release is discovered during project activities, it must be reported to DEQ, as authorized by Virginia Code §62.1-44.34.8 through 9 and by the Virginia Administrate Code 9 VAC 25-580-10 *et seq*. Also, all petroleum contaminated soils and groundwater generated during construction must be characterized and disposed of properly. For more information, contact DEQ's Tidewater Regional Office.

***9(b)* Petroleum Storage Tank Compliance/Inspections.** The removal, relocation or closure of any regulated petroleum storage tank(s), including ASTs and USTs, must be conducted in accordance with the requirements of Virginia Regulations 9 VAC 25-91-10 *et seq*. and/or 9 VAC 25-580-10 *et seq*. Notification should be made to the DEQ Tidewater Regional Office.

10. Natural Heritage Resources. The draft PEIS does not address natural heritage resources.

10(a) Agency Jurisdiction. The mission of the Virginia Department of Conservation and Recreation is to conserve Virginia's natural and recreational resources. DCR supports a variety of environmental programs organized within seven divisions including the Division of Natural Heritage (DNH). The Natural Heritage Program's (DCR-DNH) mission is conserving Virginia's biodiversity through inventory, protection, and stewardship. The Virginia Natural Area Preserves Act, 10.1-209 through 217 of the Code of Virginia, was passed in 1989 and codified DCR's powers and duties related to statewide biological inventory: maintaining a statewide database for conservation planning and project review, land protection for the conservation of biodiversity, and the protection and ecological management of natural heritage resources.

10(b) Overall Recommendation. DCR supports Alternative One as the Preferred Alternative, provided that sand is not taken from the Wallops Island borrow site and the proposed seawall extension is limited to the minimum length absolutely necessary for the protection of the facilities. DCR's selection of Alternative One as the best alternative is based on the belief that sand transport to the south of the project area will be less likely to be disrupted without the construction of a groin or breakwater. However, DCR continues to recommend exploring the feasibility of inland relocation of existing facilities.

10(c) Agency Findings. According to the information currently in DCR's files, this site is located within the North Wallops Island and the North Assawoman, South Wallops Island Conservation Site.

The North Wallops Island Conservation Site has been given a biodiversity significance ranking of B2, which represents a site of very high significance. The natural heritage resource of concern at this site is:

- Piping Plover *Charadrius melodus* G3/S2B, S1N/LT/LT

The North Assawoman; South Wallops Island Conservation Site has been given a biodiversity significance ranking of B2, which represents a site of very high significance. The natural heritage resources of concern at this site are:

- Piping Plover *Charadrius melodus* G3/S2B, S1N/LT/LT
- Least Tern *Sterna antillarum* G4/S2B/NL/SC
- Wilson's Plover *Charadrius wilsonia* G5/S1B/NL/LE

10(d) Additional Information on Natural Heritage Resources. Information concerning natural heritage resources is as follows:

- Conservation Sites. Conservation sites are tools for representing key areas of the landscape that warrant further review for possible conservation action because of the natural heritage resources and habitat they support. Conservation sites are polygons built around one or more rare plant, animal, or natural community designed to include the element and, where possible, its associated habitat, and buffer or other adjacent land thought necessary for the element's conservation. Conservation sites are given a biodiversity significance ranking based on the rarity, quality, and number of element occurrences they contain; on a scale of 1-5, 1 being most significant.

- Piping Plover. This species inhabits coastal areas, using flat, sandy beaches of barrier islands for breeding (Cross, 1991). Threats to this species include predation of eggs and young and the development and disturbance of barrier island breeding sites (Cross, 1991). The Piping Plover is listed as threatened by the FWS and DGIF.

- Wilson's Plover. This species is a rare, short-term summer visitor along the lower Chesapeake Bay and the Atlantic Coast south of Cape Henry. The summer males have a thick black bill and a white breast with a single band while the females, young, and winter males are grayish brown to reddish brown (Bergstrom, 1991).

  Wilson's Plover habitat consists of the upper portions of sandy beaches on barrier islands, usually within 30 m of dune vegetation. Requirements for nesting include suitable foraging sites nearby for chicks, usually mud or sand flats. Predatory threats include foxes, herring gulls, great black gulls, and fish crows who eat the eggs and young. Nesting habitats are lost to both natural processes such as erosion and coastal development, as well as human disturbance during the nesting season. Since the eggs are a pale tan or buff with irregular black specks, they blend easily into the sand which allows for them to be overlooked by unsuspecting beach visitors who crush them. Recommendations for protecting these birds consist of predator control measures involving protection from predators for nests and discouraging development on the nesting islands. Wilson's Plover is protected under the Migratory Bird Treaty Act (Bergstrom, 1991).

- Least Tern. The Least Tern nests on broad, flat beaches with minimal vegetation and forages in saltwater near the shore. Threats to this species include loss of nesting habitat due to development and disturbance of breeding colonies by human activities and high numbers of predators (Beck, 1991). The Least Tern is listed as a special concern species by the DGIF.

10(e) Threatened and Endangered Plant and Insect Species. The Endangered Plant and Insect Species Act of 1979, Chapter 39, §3.1-102- through 1030 of the Code of Virginia, as amended, authorizes the Virginia Department of Agriculture and Consumer Services (VDACS) to conserve, protect and manage endangered species of plants and insects. VDACS Virginia Endangered Plant and Insect Species Program personnel cooperates with the U.S. Fish and Wildlife Service (FWS), DCR-DNH and other agencies and organizations on the recovery, protection or conservation of listed threatened or endangered species and designated plant and insect species that are rare throughout their worldwide ranges. In those instances where recovery plans, developed by FWS, are available, adherence to the order and tasks outlined in the plans should be followed to the extent possible.

VDACS has regulatory authority to conserve rare and endangered plant and insect species through the Virginia Endangered Plant and Insect Species Act. Under a Memorandum of Agreement established between the VDACS and DCR, DCR has the authority to report for VDACS on state-listed plant and insect species. DCR found that the current activity will not affect any documented state-listed plant and insect species.

10(f) Natural Area Preserves. DCR found that there are no State Natural Area Preserves under its jurisdiction in the project vicinity.

10(g) Recommendations. DCR has the following recommendations:

- Coordinate with DGIF and the FWS to ensure compliance with protected species legislation due to the legal status of the Piping and Wilson's Plovers.
- Protect habitat for the Least tern, Wilson's Plover, and Piping Plover during the nesting season from April 15th to August 15th.
- Limit the source for beach nourishment to the sand shoals (Unnamed Shoal A or Unnamed Shoal B) located offshore in Federal waters and not from the Piping Plover habitat at the Wallops Island borrow site.
- Coordinate with DCR's Division of Natural Heritage (telephone, (804) 371-2708) if a significant amount of time passes before the project is implemented, since new and updated information is continually added to Biotics Data System.

11. Wildlife Resources. The draft PEIS (pages 235-263) addresses impacts to state- and federally-listed protected species and other wildlife species known to inhabit the proposed project areas. Protected species that could be adversely affected by the proposed project include the Piping Plover and Kemp's Ridley and Loggerhead sea turtles.

11(a) Agency Jurisdiction. DGIF, as the Commonwealth's wildlife and freshwater fish management agency, exercises enforcement and regulatory jurisdiction over wildlife and freshwater fish, including state or federally listed endangered or threatened species, but excluding listed insects (*Virginia Code* Title 29.1). DGIF is a consulting agency under the U.S. Fish and Wildlife Coordination Act (16 U.S.C. sections 661 *et seq.*) and provides environmental analysis of projects or permit applications coordinated through DEQ and several other state and federal agencies. DGIF determines likely impacts upon fish and wildlife resources and habitat, and recommends appropriate measures to avoid, reduce, or compensate for those impacts. For more information, see the DGIF website at www.dgif.virginia.gov.

11(b) Comments. DGIF is strongly opposed to NASA's using the Wallops Island borrow site for beach fill during renourishment cycles due to the presence of the federally-listed threatened Piping Plover and sea turtle nesting sites.

11(c) Agency Findings. According to DGIF, the following wildlife species have been observed in the proposed project areas:

- Bald Eagle. A state-listed Threatened bald eagle nest has been documented at the northern end of Wallops Island. Eagles have high nest site fidelity and will typically return to the same nest each year to raise young, although eagle pairs also build alternate nest sites within their territory for use.
- Piping Plover. In 2009, four pairs of Piping Plovers nested in the area proposed for sand excavation. Collectively they fledged 10 young, which resulted in the highest reported fledge rate in Virginia last year, clearly indicating that the northern portion of the island provides suitable habitat for the species.
- Wilson's Plover. This plover is a state-listed threatened bird species, which is one of many avian beach nesting species in the project area.
- Red Knots. This species is a candidate for federal listing. In recent years, up to 25% of the Virginia's weekly Red Knot population occurred on Wallops Island during spring migration (Watts and Truitt, unpubl. data).
- Sea Turtles. The Loggerhead Sea Turtle is a federally-listed threatened species. Also, the Northwest Atlantic Loggerhead population, whose range includes Virginia, is currently being proposed as an endangered Distinct Population Segment (Federal Register, 2010). Also, DGIF supports the recommendations provided in the draft PEIS regarding the protection of sea turtles during offshore dredging operations.
- Sea Ducks. Various species of seaducks, including white-winged scoters, surf scoters, black scoters and long-tailed ducks, forage primarily on mollusks and crustaceans on marine wintering grounds (Bellrose 1978) in water depths ranging from 1-60 meters (Sea Duck Joint Venture, 2010). Also, Sea ducks occur in high densities within 12 nautical miles off of Virginia's coastline in areas with sandy shoals during the winter (Forsell 2003). Therefore, it is possible that the two unnamed shoals A and B are used by sea ducks as forging sites.

11(d) Recommendations. DGIF has the following recommendations to ensure protection of species under its jurisdiction:

- Bald Eagles. No large machinery should be used within 660 feet of any bald eagle nest from December 15 through July 15 of any year, to ensure protection of bald eagles during excavation activities. Also, DGIF recommends that prior to each excavation cycle, the Wallops Island borrow site should be surveyed to determine if any new nests are built within 660 feet of the excavation area and that the same excavation time-of-year restriction should be applied to any new or alternate nest sites.

- Shorebirds (Piping and Wilson's plovers and Red Knots). The removal of any sand from the Wallops Island borrow site should occur outside of the breeding and nesting seasons for shorebirds (work should occur from November-March of any year), to prevent potential adverse impacts upon these species as a result of habitat impacts and possible direct impacts associated with construction activities. Conducting construction activities, including extension of the seawall outside of the shorebird nesting season is the best way to minimize impacts and not through on-site monitoring as NASA has proposed. Also, NASA should consider indirect and cumulative impacts of project activities on these species.

- Sea Turtles. The removal of any sand from the Wallops Island borrow site should occur outside of the sea turtle nesting season (work should occur from November-March of any year). Although no species of sea turtles are currently known to nest along this section of beach, the placement of beach fill may attract sea turtles to the beach for nesting.

- Sea Ducks. A minimum of three aerial offshore transect surveys should be conducted over the course of at least one winter season (one in mid-December, one in mid-January, and one in mid-February) along the entire barrier island chain and out to 15 nautical miles, prior to commencing dredging activities. The survey will help to establish the relative use of the two unnamed shoals by sea ducks, which can be used by NASA to assess the impact of dredging activity on these species.

For more information on these comments, contact DGIF.

12. Historic Structures and Archaeological Resources. The draft PEIS (page 270) states that proposed construction activities will not affect aboveground historic properties within the project area. In addition, the additional of beach fill at Wallops Island would not impact archaeological resources as the fill activity is only a surface disturbance. Finally, the proposed Wallops Island borrow site was surveyed and no archaeological resources were discovered.

12(a) Agency Jurisdiction. The Department of Historic Resources (DHR) conducts reviews of projects to determine their effect on historic structures or cultural resources under its jurisdiction. DHR, as the designated State's Historic Preservation Office, ensures that federal actions comply with *Section 106 of the National Historic Preservation Act of 1966 (NHPA)*, as amended, and its implementing regulation at 36 CFR Part 800. The NHPA requires federal agencies to consider the effects of federal projects on properties that are listed or eligible for listing on the National Register of Historic Places. Section 106 also applies if there are any federal involvements, such as licenses, permits, approvals or funding. DHR also provides comments to DEQ through the state EIR review process.

12(b) Finding. The DHR concurs that none of the alternatives will adversely affect any historic properties.

12(c) Recommendation. If any previously unrecorded historic properties are discovered during construction activities, DHR recommends that NASA stop work immediately and contact DHR.

13. Public Water Supply.

13(a) Agency Jurisdiction. The Virginia Department of Health (VDH) Office of Drinking Water (ODW) reviews projects for the potential to impact public drinking water sources (groundwater wells and surface water intakes).

13(b) Agency Findings. The VDH-OWD states that there are no apparent impacts to public drinking water sources due to the proposed project. There are no groundwater wells within a 1-mile radius and no surface water intakes located within a 5-mile radius of the project site. The project site is not located within Zone 1 or Zone 2 of any public surface water sources.

13(c) Requirement. The VDH-OWD states that potential impacts to public water distribution systems or sanitary sewage collection systems must be verified by the local utility.

Contact Barry E. Matthews with VDH at (804) 864-7515 for additional information.

14. Pesticides and Herbicides. The use of herbicides or pesticides for landscape maintenance should be in accordance with the principles of integrated pest management. The least toxic pesticides that are effective in controlling the target species should be used. Please contact the Department of Agriculture and Consumer Services at (804) 786-3501 for more information.

15. Pollution Prevention.

15(a) Comments. DEQ advocates that principles of pollution prevention be used in all construction projects as well as in facility operations. Effective siting, planning, and on-site Best Management Practices (BMPs) will help to ensure that environmental impacts are minimized. However, pollution prevention techniques also include decisions related to construction materials, design, and operational procedures that will facilitate the reduction of wastes at the source.

15(b) Recommendations. We have several pollution prevention recommendations that may be helpful in constructing or operating this project:

- Consider development of an effective Environmental Management System (EMS). An effective EMS will ensure that the proposed facility is committed to minimizing its environmental impacts, setting environmental goals, and achieving improvements in its environmental performance. DEQ offers EMS development assistance and it recognizes facilities with effective Environmental Management Systems through its Virginia Environmental Excellence Program.

- Consider environmental attributes when purchasing materials. For example, the extent of recycled material content, toxicity level, and amount of packaging should be considered and can be specified in purchasing contracts.
- Consider contractors' commitment to the environment (such as an EMS) when choosing contractors. Specifications regarding raw materials and construction practices can be included in contract documents and requests for proposals.
- Choose sustainable materials and practices for infrastructure and building construction and design. These could include asphalt and concrete containing recycled materials, and integrated pest management in landscaping, among other things.
- Integrate pollution prevention techniques into the facility maintenance and operation. Maintenance facilities should be designed with sufficient and suitable space to allow for effective inventory control and preventative maintenance.

DEQ's Office of Pollution Prevention provides information and technical assistance relating to pollution prevention techniques and EMS. For more information, contact DEQ's Office of Pollution Prevention, Sharon Baxter at (804) 698-4344.

16. Regional and Local Comments. Accomack County and the Accomack-Northampton Planning District Commission were invited to comment on the proposed project.

16(a) Regional Planning Impacts. In accordance with the Code of Virginia, Section 15.2-4207, planning district commissions encourage and facilitate local government cooperation and state-local cooperation in addressing, on a regional basis, problems of greater than local significance. The cooperation resulting from this is intended to facilitate the recognition and analysis of regional opportunities and take account of regional influences in planning and implementing public policies and services. Planning district commissions promote the orderly and efficient development of the physical, social and economic elements of the districts by planning, and encouraging and assisting localities to plan, for the future.

16(b) Regional Comments. The Accomack-Northampton Planning District Commission did not respond to our request for comments.

16(c) Local Comments. Accomack County did not respond to our request for comments.

DOCUMENT DEFICIENCIES. Reviewing agencies indicated that the draft PEIS was deficient in its analysis concerning alternative selection, impacts to wildlife resources and physical processes in the project area. The final PEIS should address the following deficiencies:

- The draft PEIS (Section 2.3.3.4) is unclear why multiple off-shore breakwaters with beach fill is not an acceptable alternative at the southern end of the project area. During the planning stages of the proposed project, NASA and the Corps considered offshore containment structures and although not clearly explained in the draft PEIS, this alternative was discounted. VIMS wonders if the alternative was discounted due to excessive initial cost, the level of protection needed, a preference for the on-shore seawall extension, the expected downdrift impacts, a combination of these factors or other reasons.

- The draft PEIS is unclear as to why the selected alternatives with only one containment structure at the south end (either groin or breakwater) qualified for the secondary screening of alternatives.

- The draft PEIS does not include a plan of action should the SRIPP fail within the project's life time (i.e. it does not adequately protect the physical assets on the beach and/or it significantly interrupts the natural geologic processes on the islands to the south of the project area). According to the draft PEIS, the project's success is highly dependent on regular beach renourishment, which is expensive and its required frequency unpredictable. The draft PEIS does not explain what actions would be taken if future funding for renourishment activities are significantly reduced or withdrawn and/or if the availability of beach compatible sand from offshore sources becomes depleted. Without adequate renourishment, the seawall would serve as the last line of defense against storms, a strategy that has previously failed on Wallops Island.

- While the draft PEIS acknowledges that the shoreline at Wallops Island will certainly experience the effects of future sea level rise, sea level rise was not included as a variable in the models used to design SRIPP. Moreover, the Storm Damage Reduction Project Design for Wallops Island, Virginia report (Appendix A) offered a very limited discussion on climate change and sea level rise and the only concession it made to address the problem is to follow current Corps' policy. Current policy is to include an additional amount of material during each renourishment event that would raise the entire profile by an amount equal to the projected amount of sea level rise. However, there was no discussion about what steps would be taken to account for sea level rise within the project's lifetime if renourishment at the required volume and frequency is no longer possible due to lack of funding or availability of beach compatible sand. This omission in the draft PEIS makes it difficult to fully assess the scope and breadth of the project's risk to the environment over the next 50 years.

- The proposed mitigation measures for sand removal at the Wallops Island borrow site listed in Table 11 (PEIS, pages 73-74) state that a qualified biologist would closely monitor excavation activities to ensure that impacts to any listed species and their nests would be avoided or minimized. This statement appears to imply that the work would be conducted during the breeding season. However, the draft PEIS also states (page 302) that work in the proposed Wallops Island borrow site would be limited to the non-nesting season for the

Piping Plover (September-March). This contradiction in the draft PEIS needs to be addressed. Also, DGIF notes that if the work is timed to be completed outside of the nesting season, then an on-site biologist would not be necessary.

- The final PEIS should include a cost/benefit analysis. The analysis should examine both the monetary and natural resource costs, including the cost to fish and wildlife resources, the physical integrity of the barrier island chain, and other stakeholder interests (see section "Recommendations," pages 7-8 for more details).

- The draft PEIS states that the Wallops Island borrow area was developed in consideration of "wildlife habitat constraints," but this statement is not further explained. DGIF believes that any excavation at the northern end of the island will likely result in the direct loss of an appreciable amount of nesting habitat for Piping Plovers, Wilson's Plovers and other avian beach nesting species, many of which have been identified as Species of Greatest Conservation Need (SGCN) in Virginia's Wildlife Action Plan (DGIF 2005). Sand excavation activities may also result in the loss of nesting habitat for Diamondback Terrapins, a Tier II SGCN, as well as federally-listed threatened Loggerhead Sea Turtles (it should be noted that the Northwest Atlantic Loggerhead population, whose range includes Virginia, is currently being proposed as an endangered Distinct Population Segment (FR 2010)). Although this loss may not be permanent as indicated by the northern end's current accretion rates, the excavated areas will likely remain unsuitable for beach nesting species until the beach returns to its original elevation. The draft PEIS predicts the recovery period may range from a few months to a few years following excavation activities (PEIS, page 203).

  However, it appears that NASA did not consider the possibility that excavated sites may not have the opportunity to fully recover between renourishment cycles. The inability to recover stems from the fact that the 1 meter reduction in elevation will allow a greater volume of water to come ashore, which could hinder sand deposition through frequent flooding and scouring of artificially created low areas on the beach. Even if excavated areas on the north end are able to recover within several years, it is possible that adequate recovery time will not be provided if the renourishment cycle occurs every two to three years rather than every five years as currently predicted.

- DGIF states that the draft PEIS does not include any measurement of the density, abundance or species composition of benthic invertebrates in the proposed sand excavation area. The draft PEIS also does not address the potential effects that sand removal to a depth of 1 meter will have on the benthic community and the species that forage on these organisms, such as Piping Plovers, Red Knots (a candidate species for federal listing; in recent years, up to 25% of the Virginia's weekly Red Knot population occurred on Wallops Island during spring migration; Watts and Truitt, unpubl. data), and other migrant and breeding shorebirds. DGIF believes that the omission in analysis of environmental consequences represents a serious oversight and a discussion of such analysis should be included in future iterations of the document. The draft PEIS (pages 242-243) briefly discusses biological impacts to the benthic community from beach fill deposition, which may last as long as eight months or more (Bishop *et al.* 2006). DGIF believes that the combination of sand excavation on the northern end of the island and beach renourishment activities to the south may substantially reduce the benthic invertebrate prey base at Wallops Island for unknown periods of time, which will diminish the quality of the island's shorebird foraging (and breeding) habitat.

- While the draft PEIS mentions that reductions in benthic fauna could negatively affect the fish that forage on these organisms, no consideration was given to potential impacts on sea ducks that could result from reductions in the abundance and species composition of infaunal organisms. Based on the information included in the draft PEIS (Appendix B), it appears that no effort was made to measure the density, abundance and species composition of infaunal organisms at the two offshore borrow sites during the benthic habitat survey. Instead the final report for the benthic survey cites two studies conducted offshore of northern Maryland and southern Delaware (Cutter and Diaz 2000 and Diaz *et al.* 2004), which found that infaunal communities were dominated by annelid worms, followed by mollusks and crustaceans and that mollusks accounted for over 85 percent of the biomass. Various species of seaducks including white-winged scoters, surf scoters, black scoters and long-tailed ducks forage primarily on mollusks and crustaceans on marine wintering grounds (Bellrose 1978) in water depths ranging from 1-60 meters (Sea Duck Joint Venture, 2010). Sea ducks occur in high densities within 12 nautical miles off of Virginia's coastline in areas with sandy shoals during the winter (Forsell 2003). Therefore, it is possible that the two unnamed shoals A and B, proposed for sand mining, are used by sea ducks as forging sites.

- DGIF recommends that the 'Mitigation and Monitoring' section of the draft PEIS address mitigation measures for potential impacts to sea turtles.

- The draft PEIS should consider cumulative effects upon wildlife, not just direct effects resulting from specific construction activities.

- DEQ recommends that the final PEIS address the potential for munitions to be encountered during offshore dredging activities at the Unnamed Shoals as all potential sources for sand identified in the draft PEIS could contain MECs.

- The draft PEIS does not discuss potential alteration of and/or impacts to the existing groundwater monitoring network and potential changes to groundwater flow.

FEDERAL CONSISTENCY UNDER THE COASTAL ZONE MANAGEMENT ACT

Pursuant to the Coastal Zone Management Act of 1972, as amended, federal activities located inside or outside of Virginia's designated coastal management area that can have reasonably foreseeable effects on coastal resources or coastal uses must, to the maximum extent practicable, be implemented in a manner consistent to the maximum extent practicable with the VCP. The VCP consists of a network of programs administered by several agencies. The DEQ coordinates the review of federal consistency determinations with agencies administering the Enforceable and Advisory Policies of the VCP.

The draft PEIS includes a federal consistency determination and accompanying analysis of the enforceable policies of the VCP (page 219). The consistency determination states that the proposed project would have no effect on the wetlands management, point source pollution control, coastal lands management and shoreline sanitation management enforceable policies of the VCP. The reviewing agencies that are responsible for the administration of the enforceable policies generally agree with NASA's determination. However, NASA must ensure that the proposed action is also consistent with the aforementioned policies. Also, DEQ recommends that NASA consider the advisory policies of the VCP (see Attachment 2).

PUBLIC PARTICIPATION

In accordance with 15 CFR §930.2, the public was invited to participate in the Commonwealth's review of the FCD. A public notice of this proposal was published on the DEQ web site from February 19, 2010 to March 19, 2010. No comments were received in response to the public notice.

CONSISTENCY CONCURRENCE

Based on our review of the draft PEIS and the FCD and the comments submitted by agencies administering the enforceable policies of the VCP, DEQ concurs that the proposal is consistent to the maximum extent practicable with the VCP provided all applicable permits and approvals are obtained. However, other State approvals which may apply to this project are not included in this consistency concurrence. Therefore, NASA must ensure that this project is implemented in accordance with all applicable Federal, State, and local laws and regulations.

REGULATORY AND COORDINATION NEEDS

1. Water Quality and Wetlands. NASA must continue to coordinate with the DEQ to obtain a VWP permit prior to project commencement. For additional information regarding VWP permit regulations (9 VAC 25-210 *et seq.*), contact Bert Parolari of DEQ's Tidewater Regional Office at (757) 518-2166.

2. Subaqueous Lands Impacts. Pursuant to Section 28.2-1204 of the Code of Virginia the VMRC requires a permit for any activities that encroach on or over or take use of materials from the beds, bays, ocean, rivers and streams, or creeks, which are the property of the Commonwealth. NASA should work with the VMRC to obtain any applicable permits. For additional information, contact George Badger of the VMRC at (757) 414-0710.

3. Erosion and Sediment Control and Stormwater Management. Since the project disturbs more than 10,000 square feet, an erosion and sediment control (ESC) plan should be prepared and implemented to ensure compliance with state law and regulations (VESCL §10.1-560, §10.1-564; VESCR §4VAC50-30-30). The ESC plan should be submitted to DCR's Suffolk Regional Office at (757) 925-2468 for review for compliance.

As with the ESC Plan, NASA is required to prepare a project-specific Stormwater Management Plan for all projects involving a regulated activity. All specifications and plans must be prepared in accordance with the current versions of the Virginia Stormwater Management Law and the Virginia Stormwater Management Program (VSMP) Regulations (4 VAC 50-60 *et seq.*).

4. VSMP General Permit. NASA is required to apply to the Department of Conservation and Recreation for registration coverage under the Virginia Stormwater Management Program (VSMP) General Permit for Discharges of Stormwater from Construction Activities. This permit requires NASA to develop a project specific stormwater pollution prevention plan (SWPPP) (Virginia Stormwater Management Law Act §10.1-603.1 *et seq.*; VSMP Permit Regulations §4 VAC 40-50 *et seq.*). Specific questions regarding the VSMP General Permit for Construction Activities requirements should be directed to the Department of Conservation and Recreation's Division of Soil and Water Conservation (Holly Sepety, telephone, (804) 225-2613).

5. Air Quality Regulations. This project may be subject to air regulations administered by the Department of Environmental Quality. The following sections of Virginia Administrative Code are applicable:

- fugitive dust and emissions control (9 VAC 5-50-60 *et seq.*); and
- open burning (9 VAC 5-130 *et seq.*).

For information regarding air quality standards and air permits related to fuel burning equipment, contact Jane Workman of DEQ's Tidewater Regional Office at (757) 518-2112.

6. Solid and Hazardous Wastes. All solid waste, hazardous waste, and hazardous materials must be managed in accordance with all applicable federal, state, and local environmental regulations.

Some of the applicable state laws and regulations are:

- Virginia Waste Management Act (Code of Virginia Section 10.1-1400 *et seq.*);
- Virginia Hazardous Waste Management Regulations (VHWMR) (9VAC 20-60);
- Virginia Solid Waste Management Regulations (VSWMR) (9VAC 20-80); and

- Virginia Regulations for the Transportation of Hazardous Materials (9VAC 20-110).

Some of the applicable Federal laws and regulations are:
- Resource Conservation and Recovery Act (RCRA) (42 U.S.C. Section 6901 *et seq.*);
- Title 40 of the Code of Federal Regulations; and
- U.S. Department of Transportation Rules for Transportation of Hazardous materials (49 CFR Part 107).

For more information, contact DEQ-Tidewater Regional Office at (757) 518-2000.

7. Federal Facilities. DEQ's Federal Facilities Restoration Program recommends that prior to initiating any project activities, NASA should contact T.J. Meyer, NASA's WFF Manager of Environmental Restoration, at (757) 824-1987 for information concerning CERCLA obligations at or near areas adjacent to WFF's CERCLA sites. For information concerning CERCLA obligations at or near WFF's FUDS areas, NASA should contact Sher Zaman, Corps Remediation Project Manager, at (410) 962-3134. For questions concerning these comments, contact Paul Herman of DEQ's FFR Program at (804) 698-4464 or paul.herman@deq.virginia.gov.

8. Petroleum Storage Tanks. If evidence of a petroleum release is discovered during construction of this project, it must be reported to DEQ. For more information, contact the Lynne Smith of DEQ at (757) 518-2055 or Gene Siudyla of DEQ at (757) 518-2117.

Also, the removal, closure, or relocation of any underground or aboveground petroleum storage tank(s) must be must be conducted in accordance with the requirements of the Virginia Tank Regulations (9 VAC 25-91-10 *et seq.* (AST) and/or 9 VAC 25-580-10 *et seq.* (UST)). Questions should be directed to Tom Madigan of DEQ's Tidewater Regional Office at (757) 518-2115 or 5636 Southern Boulevard, Virginia Beach, Virginia 23462.

9. Protected Species. To ensure protection of bald eagles and to determine if any new bald eagle nests were detected during the 2009 survey season, NASA should contact the Center for Conservation Biology (telephone, (757) 221-2247). To ensure protection of all other wildlife species, contact Amy Ewing of DGIF at (804) 367-2211 or amy.ewing@dgif.virginia.gov.

10. Historic Resources. To ensure continued compliance with *Section 106 of the National Historic Preservation Act*, if any previously unrecorded historic properties are discovered during construction activities, NASA should stop work immediately and contact Roger Kirchen of DHR at (804) 367-2323, ext. 153.

Thank you for the opportunity to review the draft Programmatic Environmental Impact Statement and federal consistency determination. Detailed comments of reviewing agencies are attached for your review. Please contact me at (804) 698-4325 or Anne Pinion at (804) 698-4488 for clarification of these comments.

Sincerely,

Ellie JS

Ellie L. Irons, Manager
Office of Environmental Impact Review

Enclosures

cc: Elaine Meil, Accomack-Northampton PDC
Steven Miner, Accomack County

ec: Paul Kohler, DEQ-ORP
Kotur Narasimhan, DEQ
Laure McKay, DEQ
Tony Watkinson, VMRC
Cindy Keltner, DEQ-TRO
Amy Ewing, DGIF
Robbie Rhur, DCR
Keith Tignor, VDACS
Karen Duhring, VIMS
Roger Kirchen, DHR
David Spears, DMME
Barry Matthews, VDH

Attachment 2

Advisory Policies for Geographic Areas of Particular Concern

a. Coastal Natural Resource Areas - These areas are vital to estuarine and marine ecosystems and/or are of great importance to areas immediately inland of the shoreline. Such areas receive special attention from the Commonwealth because of their conservation, recreational, ecological, and aesthetic values. These areas are worthy of special consideration in any planning or resources management process and include the following resources:

a) Wetlands
b) Aquatic Spawning, Nursery, and Feeding Grounds
c) Coastal Primary Sand Dunes
d) Barrier Islands
e) Significant Wildlife Habitat Areas
f) Public Recreation Areas
g) Sand and Gravel Resources
h) Underwater Historic Sites.

b. Coastal Natural Hazard Areas - This policy covers areas vulnerable to continuing and severe erosion and areas susceptible to potential damage from wind, tidal, and storm related events including flooding. New buildings and other structures should be designed and sited to minimize the potential for property damage due to storms or shoreline erosion. The areas of concern are as follows:

i) Highly Erodible Areas
ii) Coastal High Hazard Areas, including flood plains.

c. Waterfront Development Areas - These areas are vital to the Commonwealth because of the limited number of areas suitable for waterfront activities. The areas of concern are as follows:

i) Commercial Ports
ii) Commercial Fishing Piers
iii) Community Waterfronts

Although the management of such areas is the responsibility of local government and some regional authorities, designation of these areas as Waterfront Development Areas of Particular Concern (APC) under the VCRMP is encouraged. Designation will allow the use of federal CZMA funds to be used to assist planning for such areas and the implementation of such plans. The VCRMP recognizes two broad classes of priority uses for waterfront development APC:

i) water access dependent activities;
ii) activities significantly enhanced by the waterfront location and complementary to other existing and/or planned activities in a given waterfront area.

Advisory Policies for Shorefront Access Planning and Protection

a. Virginia Public Beaches - Approximately 25 miles of public beaches are located in the cities, counties, and towns of Virginia exclusive of public beaches on state and federal land. These public shoreline areas will be maintained to allow public access to recreational resources.

b. Virginia Outdoors Plan - Planning for coastal access is provided by the Department of Conservation and Recreation in cooperation with other state and local government agencies. The Virginia Outdoors Plan (VOP), which is published by the Department, identifies recreational facilities in the Commonwealth that provide recreational access. The VOP also serves to identify future needs of the Commonwealth in relation to the provision of recreational opportunities and shoreline access. Prior to initiating any project, consideration should be given to the proximity of the project site to recreational resources identified in the VOP.

c. Parks, Natural Areas, and Wildlife Management Areas - Parks, Wildlife Management Areas, and Natural Areas are provided for the recreational pleasure of the citizens of the Commonwealth and the nation by local, state, and federal agencies. The recreational values of these areas should be protected and maintained.

d. Waterfront Recreational Land Acquisition - It is the policy of the Commonwealth to protect areas, properties, lands, or any estate or interest therein, of scenic beauty, recreational utility, historical interest, or unusual features which may be acquired, preserved, and maintained for the citizens of the Commonwealth.

e. Waterfront Recreational Facilities - This policy applies to the provision of boat ramps, public landings, and bridges which provide water access to the citizens of the Commonwealth. These facilities shall be designed, constructed, and maintained to provide points of water access when and where practicable.

f. Waterfront Historic Properties - The Commonwealth has a long history of settlement and development, and much of that history has involved both shorelines and near-shore areas. The protection and preservation of historic shorefront properties is primarily the responsibility of the Department of Historic Resources. Buildings, structures, and sites of historical, architectural, and/or archaeological interest are significant resources for the citizens of the Commonwealth. It is the policy of the Commonwealth and the VCRMP to enhance the protection of buildings, structures, and sites of historical, architectural, and archaeological significance from damage or destruction when practicable.

DEPARTMENT OF ENVIRONMENTAL QUALITY
TIDEWATER REGIONAL OFFICE
ENVIRONMENTAL IMPACT REVIEW COMMENTS

March 18, 2010

PROJECT NUMBER: 10-019F

PROJECT TITLE: NASA-Shoreline Restoration and Infrastructure Protection Program

As Requested, TRO staff has reviewed the supplied information and has the following comments:

Petroleum Storage Tank Cleanups:
My comments are similar to the review completed for this project on 6/13/07. There has been multiple petroleum releases reported at the Wallops Flight Facility. One of the closed cases is adjacent to the proposed shoreline restoration, PC# 1993-0913. This release, associated with regulated USTs and ASTs at Buildings X-5 and X-15, should not impact the proposed restoration project. If evidence of a petroleum release is discovered during construction of this project, it must be reported to DEQ. Contact Ms. Lynne Smith at (757) 518-2055 or Mr. Gene Siudyla at (757) 518-2117. Petroleum contaminated soils or ground water generated during construction of this project must be properly characterized and disposed of properly.

Petroleum Storage Tank Compliance/Inspections:
The removal, relocation or closure of any regulated petroleum storage tank – aboveground storage tank (AST); underground storage tank (UST) must be conducted in accordance with the requirements of the Virginia Storage Tank Regulations 9 VAC 25-91-10 et seq (AST) and / or 9 VAC 25-580-10 et seq (UST). Questions and / or documentation submittal may be directed to Tom Madigan – DEQ Tidewater Regional Office – 5636 Southern Blvd., Virginia Beach, VA 23462. Phone (757) 518-2115.

Virginia Water Protection Permit Program (VWPP):
This project will require a permit from the VWPP program. As such, a joint permit application should be submitted to VMRC for distribution and review by interested regulatory parties, including DEQ. Provided that all necessary permits are obtained and complied with, the project should be considered consistent with the requirements of the program.

Air Permit Program :
No comments.

Water Permit Program :
VPDES Permit Section - No Comment. The construction activities considered for this project do not involve permits under our purview.

Ground Water – No comment

DEPARTMENT OF ENVIRONMENTAL QUALITY
TIDEWATER REGIONAL OFFICE
ENVIRONMENTAL IMPACT REVIEW COMMENTS

March 18, 2010

PROJECT NUMBER: 10-019F

PROJECT TITLE: NASA-Shoreline Restoration and Infrastructure Protection Program

Waste Permit Program :
Although the proposed project appears to enhance protection of the hazardous waste open burn/open detonation (OB/OD) RCRA permitted unit the draft EIS does not discuss potential alteration/impacts to the existing groundwater monitoring network and potential changes to ground water flow. Prior to implementation coordination with DEQ's Office of Waste Permitting and Compliance is requested. All construction and demolition debris, including excess soil, must be characterized in accordance with the Virginia Hazardous Waste Management Regulations prior to disposal at an appropriate facility.

The staff from the Tidewater Regional Office thanks you for the opportunity to provide comments.

Sincerely,

Cindy Keltner
Environmental Specialist II
5636 Southern Blvd.
VA Beach, VA 23462
(757) 518-2146
Cindy.Keltner@deq.virginia.gov

DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF AIR PROGRAM COORDINATION

ENVIRONMENTAL REVIEW COMMENTS APPLICABLE TO AIR QUALITY

TO: Anne N. Pinion **DEQ - OEIA PROJECT NUMBER: 10 – 019F**

PROJECT TYPE: ☐ STATE EA / EIR **X FEDERAL EA / EIS** ☐ SCC

X CONSISTENCY DETERMINATION

PROJECT TITLE: SHORELINE RESTORATION AND INFRASTRUCTURE PROTECTION PROGRAM

PROJECT SPONSOR: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROJECT LOCATION: **X OZONE ATTAINMENT AREA**

REGULATORY REQUIREMENTS MAY BE APPLICABLE TO: **X CONSTRUCTION**
☐ OPERATION

STATE AIR POLLUTION CONTROL BOARD REGULATIONS THAT MAY APPLY:

1. ☐ 9 VAC 5-40-5200 C & 9 VAC 5-40-5220 E – STAGE I
2. ☐ 9 VAC 5-40-5200 C & 9 VAC 5-40-5220 F – STAGE II Vapor Recovery
3. ☐ 9 VAC 5-40-5490 et seq. – Asphalt Paving operations
4. **X 9 VAC 5-130 et seq. – Open Burning**
5. **X 9 VAC 5-50-60 et seq. Fugitive Dust Emissions**
6. ☐ 9 VAC 5-50-130 et seq. - Odorous Emissions; Applicable to__________________
7. ☐ 9 VAC 5-50-160 et seq. – Standards of Performance for Toxic Pollutants
8. ☐ 9 VAC 5-50-400 Subpart_____, Standards of Performance for New Stationary Sources, designates standards of performance for the______________________________
9. ☐ 9 VAC 5-80-10 et seq. of the regulations – Permits for Stationary Sources
10. ☐ 9 VAC 5-80-1700 et seq. Of the regulations – Major or Modified Sources located in PSD areas. This rule may be applicable to the ______________________________
11. ☐ 9 VAC 5-80-2000 et seq. of the regulations – New and modified sources located in non-attainment areas
12. ☐ 9 VAC 5-80-800 et seq. Of the regulations – Operating Permits and exemptions. This rule may be applicable to ____

COMMENTS SPECIFIC TO THE PROJECT:

K. S. Narasimhan

(Kotur S. Narasimhan)
Office of Air Data Analysis

Date: February 19, 2010

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

MEMORANDUM

TO: Anne Pinion, Environmental Program Planner

FROM: Paul Kohler, Waste Division Environmental Review Coordinator PWK

DATE: March 24, 2010

COPIES: Sanjay Thirunagari, Waste Division Environmental Review Manager; file

SUBJECT: Environmental Impact Report: Shoreline Restoration and Infrastructure Protection; 10-019F

The Waste Division has completed its review of the Environmental Impact report for the Shoreline Restoration and Infrastructure Protection project in Wallops Island, Virginia. We have the following comments concerning the waste issues associated with this project:

Both solid and hazardous waste issues were addressed in the report. The report did not include a search of waste-related data bases. A GIS database search did not reveal any waste sites within a half mile radius that would impact or be impacted by the subject site. The Waste Division staff performed a cursory review of its data files and determined that there are two hazardous waste sites (NASA GSFC Wallops Flight Facility, VA8800010763 LQG (Active) & VA7800020888 LQG (Active), VA7800020888 TSD (Active), and one formerly used defense site (C03VA0301, VA9799F1697, WALLOPS ISL) located within the same zip code, however their proximity to the subject site is unknown.

The following websites may prove helpful in locating additional information for these identification numbers: http://www.epa.gov/superfund/sites/cursites/index.htm or http://www.epa.gov/enviro/html/rcris/rcris_query_java.html. Paul Herman of DEQ's Federal Facilities Program has been contacted for his review of this determination and his response is attached.

Any soil that is suspected of contamination or wastes that are generated during construction-related activities must be tested and disposed of in accordance with applicable Federal, State, and local laws and regulations. Some of the applicable state laws and regulations are: Virginia Waste Management Act, Code of Virginia Section 10.1-1400 *et seq.*; Virginia Hazardous Waste Management Regulations (VHWMR) (9VAC 20-60); Virginia Solid Waste Management Regulations (VSWMR) (9VAC 20-80); Virginia Regulations for the Transportation of Hazardous Materials (9VAC 20-110). Some of the applicable Federal laws and regulations are: the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. Section 6901 *et seq.*, and the applicable regulations contained in Title 40 of the Code of Federal Regulations; and the U.S. Department of Transportation Rules for Transportation of Hazardous materials, 49 CFR Part 107.

Also, all structures being demolished/renovated/ removed should be checked for asbestos-containing materials (ACM) and lead-based paint prior to demolition. If ACM or LBP are found, in addition to the federal waste-related regulations mentioned above, State regulations 9VAC 20-80-640 for ACM and 9VAC 20-60-261 for LBP must be followed.

Please note that DEQ encourages all construction projects and facilities to implement pollution prevention principles, including the reduction, reuse, and recycling of all solid wastes generated. All generation of hazardous wastes should be minimized and handled appropriately.

If you have any questions or need further information, please contact Paul Kohler at (804) 698-4208.

MEMORANDUM

DEPARTMENT OF ENVIRONMENTAL QUALITY - WASTE DIVISION
Federal Facilities Restoration Program
629 E. Main Street P.O. Box 10009 Richmond, Virginia 23240

SUBJECT: Draft Programmatic Environmental Impact Statement - Wallops Flight Facility -Shoreline Restoration and Infrastructure Protection Program

TO: Anne Pinion, OEIR

FROM: Paul E. Herman, P.E., FFR

DATE: March 9, 2010

COPIES: Paul Kohler, File

The *Draft Programmatic Environmental Impact Statement - Wallops Flight Facility - Shoreline Restoration and Infrastructure Protection Program* dated February 2010 has been reviewed as requested by Paul Kohler, Waste Division Environmental Review Manager. The Draft PEIS identified several alternatives and the preferred alternative for addressing shoreline restoration/protection on Wallops Island. The restoration/protection project will have a direct impact on the shoreline, as intended, but also impacts the excavation and dredge areas from which sand will taken to replenish the shoreline.

Focusing on the Preferred Alternative, the proposed project may impact several Federal Facilities Restoration Program Formerly Used Defense Sites currently under investigation by the U.S. Army Corps of Engineers. The sites in question are situated in the northern potion of Wallops Island along or immediately adjacent to the shoreline and/or areas proposed for use as borrow pits for sand replenishment. Each site is in the early phases of investigation. To date only archive searches have been conducted which identified historic activities that warrant further investigation.

The northern-most site is Gunboat Point. The Gunboat Point site contains a bombing area, strafing target, and explosive ordnance disposal (EOD) area. The bombing area was used by the Naval Aviation Ordnance Test Station (NAOTS) to test live high explosive bombs, aircraft parachute flares, and napalm-filled fire bombs. The strafing target was used to train naval aviators on the use of aircraft .50 caliber machine guns. The EOD area was used to dispose of ammunition and is expected to contain munitions and explosives of concern. Latitude and longitude coordinates for each area are available.

Moving south along the shoreline, the next site is the Machine Gun and Rocket Firing Area. Here NAOTS statically tested aircraft machine guns and cannons at 3 ranges; a 750 yard, a 500 yard, and a 175 yard ground range each of which fired toward the dunes/ocean. Lat/long coordinates are available for the firing points and target areas.

The last site along the shoreline is the Grebe Range, Target Center, and Facilities. The Grebe Range is where a 20mm gun was used (fired out to sea) to calibrate the radar and fire control components. Kingfisher missiles, Grebe missiles, and 3.25 inch rockets were fired from this site. The Target Center is where the range was instrumented and used to various aspects of aviation ordnance. The Explosive Ammunition Test Facility established a controlled environment where aircraft guns and munitions could be test fired. Targets were located on the shoreline and guns were fired seaward from the test facility. Lat/long coordinates are available for these facilities as well.

The proposed project is the latest in many beach replenishment projects that Wallops Island has seen over the years the history of which was provided in the Draft PEIS. One potential consequence of relocating sand from borrow areas on Wallops Island or offshore dredge areas became evident during the storms of November and December 2009. Wave action during those storms created breaches in the seawall. Within some of the breaches old munitions were found intermixed with seawall boulders and concrete debris (Figure 1 and 2). It has been surmised the munitions were transported to these areas during earlier replenishment projects as the locations where the munitions were discovered did not coincide with areas where munitions were used historically. Some of the munitions still contained explosive material.

The potential for munitions to be encountered during excavation of sand from other areas of Wallops Island as part of this project is clearly acknowledged within the Draft PEIS. What is not addressed is the potential for munitions to be encountered during offshore dredging activities at the Unnamed Shoal. Essentially, all potential sources for replenishment sand identified in the Draft PEIS could contain munitions and explosives of concern. The borrow and dredge material should be thoroughly screened during removal. EOD personnel should be present at each sand removal point and each removal area should be GPS-ed to allow identification of areas where munitions were encountered. All munitions encountered should be managed in accordance with NASA's established munitions avoidance and disposal procedures. Under no circumstance should munitions be removed from a borrow or dredge area and disposed in the project area.

Prior to initiating any construction, excavation or dredging activities on Wallops Island or offshore, the Federal Facilities Restoration Program recommends the Shoreline Restoration and Infrastructure Protection Program Project Manager contact Mr. T.J. Meyer, NASA WFF Manager of Environmental Restoration at (757) 824-1987, for information concerning any CERCLA obligations at or near areas adjacent to Facility CERCLA sites and Mr. Sher Zaman, U.S. Army Corps of Engineers Remediation Project Manager, Wallops FUDS at (410) 962-3134 for information concerning CERCLA obligations at or near Wallops FUDS sites.

Figure 1

Figure 2

COMMONWEALTH of VIRGINIA

Marine Resources Commission
2600 Washington Avenue
Third Floor
Newport News, Virginia 23607

Douglas W. Domenech
Secretary of Natural Resources

Steven G. Bowman
Commissioner

February 17, 2010

Ms. Anne N. Pinion
c/o Department. Of Environmental Quality
Office of the Environmental Impact Review
629 East Main Street, Sixth Floor
Richmond, Virginia 23219

Re: 10-019F (Shoreline Restoration Wallops Island)

Dear Ms. Pinion:

You have inquired regarding the permitting requirements for Shoreline Restoration on Wallops Island. The Marine Resources Commission requires a permit for any activities that encroach upon or over, or take use of materials from the beds of the bays, ocean, rivers and streams, or creeks, which are the property of the Commonwealth.

In addition, since Accomack County has not yet adopted the model Coastal Primary Sand Dune Zoning Ordinance, the Commission is charged with reviewing the impacts associated with any project that may fall within the Coastal Primary Sand Dunes/Beaches of Accomack County.

Based upon my review of the reference maps and drawings, it appears that alternatives 1 through 3 will require authorization from the Marine Resources Commission. (The proposed dredged sits appear to be greater than 3 miles offshore, therefore, that portion of the project will not require a permit from our agency.)

<u>Alternative 1.</u> (NASA's Preferred Alternative) Proposes to extend the existing stone riprap an additional 4,600 feet south and place 3,199,000 cubic yard of sandy dredged material along the Wallops Island shoreline. **This alternative would help alleviate some of our concerns with the anticipated 5 year nourishment cycles long term funding. If funding was not secured the existing longshore transport of sand to Assawoman Island would have less impact than in the proposed Alternative 2 (jetty).**

If I may be of further assistance, please do not hesitate to contact me at (757) 414-0710.

Sincerely,

George H. Badger, III
Environmental Engineer

Pinion, Anne (DEQ)

From: O'Reilly, Rob (MRC)
Sent: Monday, April 12, 2010 9:24 AM
To: Pinion, Anne (DEQ); Badger, Hank (MRC); Travelstead, Jack (MRC)
Cc: Watkinson, Tony (MRC)
Subject: RE: Draft Programmatic EIS - NASA-Shoreline Restoration and Infrastructure Protection Program

Anne: Hope you are well, now. Hank Badger discussed the project with me. Fisheries Management does not have any comments. Thanks again. Rob

WILLIAM & MARY
VIMS
VIRGINIA INSTITUTE OF MARINE SCIENCE
SCHOOL OF MARINE SCIENCE

Center for Coastal Resources Management
Virginia Institute of Marine Science

March 25, 2010

Ms. Anne N. Pinion
Department of Environmental Quality
Office of Environmental Impact Review
629 East Main Street, Sixth Floor
Richmond, VA 23219

Subject: DEQ #10-019F
NASA Shoreline Restoration and Infrastructure Protection Program (SRIPP)

Dear Anne:

The preliminary Environmental Impact Statement for the NASA Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program was reviewed as requested. In addition to the review of the PEIS, VIMS has been involved with this project since 2008 as one of many state, federal and NGO stakeholders. The following comments are provided by VIMS:

1. This PEIS thoroughly examines potential shoreline protection alternatives and various environmental and other impacts associated with these alternatives. The main findings and selected alternatives are well supported with various models, current scientific reference data and professional expert advice.

2. If relocation of vulnerable infrastructure to the mainland is not a viable option, then we agree that the No Action Alternative is not acceptable. Irregular and unscheduled emergency protection actions are not effective. Some type of additional action is necessary to provide erosion and storm protection for the valuable infrastructure at this facility.

3. Even though the scope of the project will have significant impacts in federal offshore waters and along the coastline, we generally agree that the three selected shoreline restoration alternatives are appropriate. Each one includes multiple mitigation measures to minimize unavoidable impacts. The future effects of sea level rise were also accounted for within the 50-year project life.

4. It is not clearly explained in the Description and Comparison of Alternatives (Section 2.3.3.4) why multiple off-shore breakwaters with beach fill is not an acceptable alternative at the southern end of the project area. We know that offshore containment structures were seriously considered by NASA and the US Army Corps of Engineers. We also realize that several factors may have discounted this alternative, such as excessive initial cost, the level of protection needed, a preference for the on-shore seawall extension, the expected downdrift impacts, a combination of these factors or other reasons.

5. It is also not clear how the selected alternatives with only one containment structure at the south end (either groin or breakwater) qualified for the secondary screening of alternatives. We suggest a stronger explanation for the record why multiple containment structures are not acceptable and why alternatives with only one structure at the south end are acceptable.

6. The proposed offshore sand mining was thoroughly evaluated and appears to be consistent with the current scientific understanding of potential impacts. Several mitigation measures are included to minimize adverse environmental effects during the dredging and transport process.

7. While we recognize the attractiveness of a local, upland sand source, it is our opinion that mining sand from the north end of Wallops Island could have adverse impacts on the beach and dune processes in this natural area. Our concerns were alleviated somewhat by the supporting information that this source will not be used for the initial beach fill, the material to be excavated will likely originate from the initial beach fill due to the predicted sand transport pattern, and that no temporary construction access roads or other improvements will be needed to transfer the material. Other mitigating factors include only using this source material for a portion of the re-nourishment events and only if threatened and endangered species will not be adversely impacted. We defer to the VA Department of Game and Inland Fisheries and U.S. Fish and Wildlife Service to further assess the potential plant and wildlife impacts associated with mining sand from the north end of Wallops Island.

8. The proposed monitoring programs will be essential to validate project performance assumptions and to adapt the management strategies as needed over the life of the project. Beach profiles and biological surveys at the north island sand removal area will be particularly important to support using this sand source.

9. Regardless of which alternative is selected, the proposed activities will have reasonably foreseeable effects on coastal resources. It is our opinion that the proposed SRIPP activities are consistent to the maximum extent practicable with the enforceable policies of the Virginia Coastal Resources Management Program, as stated in Section 4.2.6, CZM Federal Consistency Determination. Additional and more specific avoidance, minimization, and mitigation measures will be addressed during the anticipated permit process for various stages of the project.

Please contact me if you have any questions about these comments (804-684-7159; karend@vims.edu).

Sincerely,

Karen A. Duhring

Karen A. Duhring
Marine Scientist

Center for Coastal Resources Management
Virginia Institute of Marine Science
College of William and Mary

Pinion, Anne (DEQ)

From: Ewing, Amy (DGIF)
Sent: Thursday, April 01, 2010 9:29 AM
To: Pinion, Anne (DEQ)
Cc: Boettcher, Ruth (DGIF)
Subject: ESSLog# 23888_ 10-019F_Wallops Flight Facility_Shoreline Restoration and Infrastructure Protection Program
Attachments: 23888_Wallops Island SRIPP_EIS Scoping_final_05072009.pdf

Good morning Anne,
As promised, our comments on the subject project are below. We also plan to follow up with NASA directly with a letter. Thanks and let me know if you have any questions. Amy

We have reviewed the Draft Programmatic Environmental Impact Statement (draft PEIS) for the Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP) that proposes three alternative projects to restore the shoreline along Wallops Island for the purpose of securing the flight facility's infrastructure. During scoping for the PEIS, we provided the attached letter to NASA and offer that here for reference.

Shoreline stabilization efforts have been ongoing at Wallops Island since the 1940's and yet the island continues to experience shoreline retreat; thus placing the increasing number of expensive assets on the beach at risk. Oertel *et al.* (2008) refers to the area between the southern end of Assateague Island to the north tip of Parramore Island as the Chincoteague Bight and proposes that the extremely rapid retreat of the barrier islands within this major offset along the barrier island chain is due to natural processes driven by topographic features that existed during previous ice ages. Moreover, the "Storm Damage Reduction Project Design" study (Appendix A) suggests the growing cape of Fishing Point, located at the southern end of Assateague Island is capturing sand that would otherwise be available to the neighboring islands to the south, a further indication that much of Wallops Island will continue to retreat thereby necessitating continual and costly efforts to slow the natural movement of the island over the long term. In light of this information, we caution that the shoreline along Wallops Island is likely to continue to shift under natural conditions and that attempts to delay or alter these natural fluctuations in shoreline may be futile over the long term.

Currently, management of Virginia's barrier island chain is minimal and basically allows nature to take its course. This management scheme has proven, over time, to benefit the fish and wildlife that inhabit these areas. All of the alternatives presented in the draft PEIS directly counter this management scheme. Based on this and the scope and location of the activities proposed to stabilize the shoreline at WFF, we cannot fully support any of the alternatives presented in the draft PEIS as they are all likely to result in adverse impacts upon wildlife under our jurisdiction and/or impact the resources upon which they depend (as described in the attached letter). However, of the alternatives presented in the draft PEIS, VDGIF agrees with the decision to designate Alternative 1 as the Preferred Alternative since it no longer includes the installation of a permeable groin, which would reduce the southerly longshore transport of sand thereby adversely affecting the islands south of Wallops. However, we do continue to have concerns about several aspects of the activities proposed in the Preferred Alternative. We offer the following comments and recommendations about the three alternatives presented in the draft PEIS.

Alternative 1 (Preferred Alternative): Full Beach Fill, Seawall Extension
Alternative 1, the Preferred Alternative, proposes to, during the initial construction phase, extend Wallops Island's existing rock seawall a maximum of 1,400 meters south of its currently existing southernmost point. We are concerned that extension and increase in height of the existing seawall will prevent natural island overwash processes from occurring over a large area of the island. As mentioned in the draft PEIS (chapter 4, page 195, third paragraph), this would likely result in a greater loss of surface area on the landward side of the seawall and enhance island narrowing with the rise of sea level. Over the long term (i.e., beyond the 50-year life span of the project), a reduction in land mass may seriously affect the island's natural function as the first line of protection against storm surge and other weather-related events for the marshes and mainland that lie west of the island. Moreover, it will reduce the island's value to beach and marsh-dependent wildlife through the loss of beach seaward to the seawall if renourishment efforts are not be able to keep up with beach fill erosion rates, and the loss of marshes behind the island should significant island narrowing occur. Lastly, the results from the models presented in Appendix A of the draft PEIS suggest that the seawall extension will have less of impact on Assawoman Island's shoreline over the long term than the current changes in shoreline incurred by yearly variation in wave climate and storms. The draft PEIS goes on to say that any negative impacts from the

seawall would be mitigated following beach fill placement, implying that without renourishment negative impacts are possible. We recommend further explanation of the possible adverse impacts resulting from any of the proposed activities and how such impacts may be mitigated.

Because of these and other potential impacts this project may have on wildlife resources beyond the project area, we requested that the PEIS present a threshold at which WFF considers the environmental cost of the project to outweigh the benefits to its mission and goals as detailed in the attached letter. We recommend that the cost/benefit analysis not only examine monetary costs, but also take into account costs to fish and wildlife resources, the physical integrity of the barrier island chain, and other stakeholder interests. We also requested that the PEIS include a discussion on the availability of funding for continuous beach renourishment since it is being presented as a key element to the project's success. We do not believe that either request was adequately addressed, making it far more difficult to assess the project's risk to the broader environment over the life time of the project.

The project's predicted success is the main theme presented throughout the draft PEIS. What it does not include is a plan of action should SRIPP fail within the project's life time (i.e., it does not adequately protect the physical assets on the beach and/or it significantly interrupts the natural geologic processes on the islands to the south of the project area). According to the draft PEIS, the project's success is highly dependent on regular beach renourishment, which is expensive and its required frequency unpredictable. The PEIS did not explain what actions would be taken should future funding for renourishment activities be significantly reduced or withdrawn and/or should the availability of beach compatible sand from offshore sources become depleted. Without adequate renourishment, the seawall would serve as the last line of defense against storms; a strategy that has been recently tried and failed on Wallops Island. We recommend that a contingency plan that details the steps to be taken if the proposed project fails be developed and provided to us for review so that we may better understand the long term environmental impacts of the proposed project.

The Preferred Alternative also proposes placing sand dredged from Unnamed Shoal A, located offshore in federal waters, on the Wallops Island shoreline from 460 meters north of the Wallops Island-Assawoman Island property boundary north for 6 kilometers. NASA proposes that sand for the initial fill be dredged from Unnamed Shoal A and that a portion of the renourishment fill volumes would be excavated from the north Wallops Island borrow site and the remaining portion would be dredged from either Unnamed Shoal A or Unnamed Shoal B. We are strongly opposed to using the north end of Wallops Island as a borrow site for beach fill during renourishment cycles. In 2009, four pairs of federally-threatened Piping Plovers nested in the area proposed for sand excavation. Collectively they fledged 10 young, which resulted in the highest reported fledge rate in Virginia last year, clearly indicating this portion of the island provides suitable habitat for the species.

The total potential area for sand excavation at the north end of Wallops Island encompasses 150 acres and the proposed excavation depth is 1 meter. The draft PEIS states that the area proposed for excavation was developed in consideration of "wildlife habitat constraints", but this is not further explained. We recommend a detailed explanation of what wildlife habitats at this end of the island are being avoided during excavation. While only a portion of the proposed area will be excavated during each renourishment cycle, this will likely result in the direct loss of an appreciable amount of nesting habitat for Piping Plovers, state-threatened Wilson's Plovers and other avian beach nesting species, many of which have been identified as Species of Greatest Conservation Need (SGCN) in Virginia's Wildlife Action Plan (VDGIF 2005). Sand excavation activities may also result in the loss nesting habitat for Diamondback Terrapins, a Tier II SGCN, as well as federally-threatened Loggerhead Sea Turtles (it should be noted that the Northwest Atlantic Loggerhead population, whose range includes Virginia, is currently being proposed as an endangered Distinct Population Segment (FR 2010)). Although this loss may not be permanent as indicated by the north end's current accretion rates, the excavated areas will likely remain unsuitable for beach nesting species they until build back up to their original elevations. The draft PEIS predicts the recovery period may range from a few months to a few years following excavation activities (page 203, last paragraph). What it appears the draft PEIS did not consider is the possibility that excavated sites may not have the opportunity to fully recover because the 1 meter reduction in elevation will allow a greater volume of water to come ashore, which may hinder sand deposition through frequent flooding and scouring of artificially created low areas on the beach. Even if excavated areas on the north end are able to recover within several years, it is possible that adequate recovery time will not be provided if renourishment occurs every two – three years rather than every five years as currently predicted. We recommend consideration of the actual recovery time and analysis of the sustainability of beaches at the north end of Wallops Island.

The draft PEIS does not include any measurement of the density, abundance or species composition of benthic invertebrates in the proposed sand excavation area. Nor does it address potential effects sand removal to a depth of 1 meter will have on the benthic community and the species that forage on these organisms, such as Piping Plovers, Red Knots, a candidate species for federal listing (in recent years, up to 25% of the Virginia's weekly Red Knot population occurred on Wallops Island during spring migration;Watts and Truitt, unpubl. data), and other migrant and breeding shorebirds. In our opinion, the omission in analysis of environmental consequences represents a serious oversight and a discussion of such analysis should be included in future iterations of the document. The draft PEIS does briefly discuss biological impacts to the benthic community from beach fill deposition (chapter 4, page 242 – 243), which may last as long as eight months or more (Bishop *et al.* 2006). We believe the combination of sand excavation on the north end and beach renourishment activities to the south may substantially reduce the benthic invertebrate prey base at Wallops Island for unknown periods of time, which will diminish the quality of the island's shorebird foraging (and breeding) habitat.

The draft PEIS reports that the sand on the north end of Wallops Island is not an optimal grain size for use as beach fill, but that it offers potential renourishment material without the mobilization and operational costs associated with offshore dredging (chapter 2, page 48, first paragraph). We are concerned that the sacrifice of important and unique wildlife habitat in the only section of undeveloped beach on Wallops Island to acquire fill material at the lowest cost possible is not appropriate. Moreover, this counters the mitigation measure developed for sand placement activities (chapter 5, page 300), which states that beach nourishment will be done so that the beach is restored to a comparable sediment type (a similar percentage of sand, silt and clay), grain size and color as the existing beach material.

The proposed mitigation measures for sand removal on the north end of Wallops Island listed in Table 11 (Chapter 2, page 73-74) state that a qualified biologist would closely monitor the area during excavation activities to ensure that impacts to any listed species and their nests would be avoided or minimized, thereby implying the work would be conducted during the breeding season. However, in Chapter 5, page 302, Section 5.1.5.2, it states that work in the proposed north Wallops Island borrow site area would be limited to the non-nesting season for the Piping Plover (September-March). This contradiction in the draft PEIS needs to be addressed. We want to re-iterate that we are opposed to using the north end of Wallops Island as a borrow site. However, if it is used for this purpose, we recommend that all excavation and related activities on the beach at the north end occur outside of the breeding and nesting seasons for Piping Plover and sea turtles. Therefore, we recommend that all work at the site occur from November – March of any year.

In addition, we note that a State Threatened bald eagle nest has been documented on the north end of Wallops Island. To ensure protection of this species from harm during excavation activities, we recommend that no large machinery be used within 660 feet of the bald eagle nest from December 15 through July 15 of any year. We note that eagles have high nest site fidelity and will typically return to the same nest each year to raise young. However, we do see eagle pairs also build alternate nest sites within their territory for use. We recommend that prior to each excavation cycle, the north end of Wallops be surveyed to determine if any new nests are built within 660 feet of the excavation area and that the same excavation time of year restriction be applied to any new or alternate nest sites.

Based on the information included in the draft PEIS, it appears that no effort was made to measure the density, abundance and species composition of infaunal organisms at the two offshore borrow sites during the benthic habitat survey (Appendix B). Instead the final report for the benthic survey cites two studies conducted offshore of northern Maryland and southern Delaware (Cutter and Diaz 2000 and Diaz *et al.* 2004) which found that infaunal communities were dominated by annelid worms, followed by mollusks and crustaceans and that mollusks accounted for over 85 percent of the biomass. Various species of seaducks including white-winged scoters, surf scoters, black scoters and long-tailed ducks forage primarily on mollusks and crustaceans on marine wintering grounds (Bellrose 1978) in water depths ranging from 1 – 60 meters (SDJV 2010). Sea ducks occur in high densities within 12 nautical miles off of Virginia's coastline in areas with sandy shoals during the winter (Forsell 2003). Therefore, it is possible that the two unnamed shoals A and B, proposed for sand mining, are utilized by these birds as forging sites.

The draft PEIS acknowledges that repeated dredging activities at intervals of three years or less, may not allow sufficient time for benthic communities to recover between dredging cycles. Studies examining the effects of sand mining on infaunal communities found that levels of abundance and diversity may recover within 1 to 3 years, but recovery of species composition may take longer (Byrnes *et al.* 2004). While the draft PEIS mentions that reductions in benthic fauna could negatively affect the fish that forage on these organisms, no consideration was given to potential impacts on sea ducks that could result from reductions in the abundance and species composition of infaunal organisms. We strongly recommend before the commencement of any dredging activities, that a minimum of three aerial offshore transect surveys be conducted over the course of at least one winter season (one in mid-December, one in mid-January, and one in mid-February) along the entire barrier island chain and out to 15 nautical miles to establish relative use of the two unnamed shoals by sea ducks. This information will assist efforts to assess the impact dredging activities will have on these avian species.

Alternative 2: Full Beach Fill, Groin, Seawall Extension
In addition to the extension of the seawall and beach fill as described in Alternative 1 (differences in beach fill amount between Alternatives 1 and 2), Alternative 2 includes the construction of a groin at the south end of the Wallops Island shoreline and perpendicular to the shoreline. We are concerned about the adverse affects placement of a groin at the south end of Wallops may have on islands south of Wallops as it may reduce the naturally occurring transport of sands to those areas. Although we recognize NASA's need to protect its assets, we do not support any action to do so that adversely affect other barrier islands that provide important shorebird and sea turtle nesting areas and other wildlife habitats.

Alternative 3: Dull Beach Fill, Breakwater, Seawall Extension
In addition to the extension of the seawall and beach fill as described in Alternative 1 (differences in beach fill amount between Alternatives 1 and 3), Alternative 3 includes the construction of a nearshore breakwater structure parallel to the south end of the Wallops Island shoreline. We are concerned that the reduction in beach erosion resulting from wave attenuation performed by the breakwaters will be negated by the newly constructed seawall extension. We are also concerned that this structure may also result in shoreline erosion to its south.

Sea Level Rise:

While the draft PEIS acknowledges that the shoreline at Wallops Island will certainly experience the effects of future sea level rise, it was not included as a variable in the models used to design SRIPP. Moreover, the Storm Damage Reduction Project Design for Wallops Island, VA report (Appendix A) offered a very limited discussion on climate change and sea level rise and the only concession it made to address the problem is to follow current US Army Corps of Engineers policy which is to include an additional amount of material during each renourishment event that would raise the entire profile by an amount equal to the projected amount of sea level rise. There was no discussion about what steps would be taken to account for sea level rise within the project's lifetime if renourishment at the required volume and frequency is no longer possible due to lack of funding or availability of beach compatible sand. This omission in the PEIS makes it difficult to fully assess the scope and breadth of the project's risk to the environment over the next 50 years.

Mitigation and Monitoring Plan:
Seawall Extension - According to the draft PEIS, impacts upon wildlife associated the extension of the seawall would be avoided through on site monitoring to ensure that Red Knots and Piping Plovers are not directly affected during the construction of the wall. We contend that avoidance could better be achieved by timing construction activities outside of shorebird nesting season. In addition, we recommend some mention in this section about mitigation for possible impacts upon sea turtles. Although none are known to nest along this section of beach, it is always possible, especially with the placement of beach fill. In addition, we recommend consideration of cumulative effects upon wildlife resulting from the project, not only direct affects resulting from specific construction activities.

Offshore Dredging Activities - We support the recommendations provided in this section regarding the protection of sea turtles and recommend continued coordination with the NMFS regarding their protection and the protection of sea mammals. As stated above, we recommend that studies be performed ahead of dredging to determine how the unnamed shoals are utilized by sea ducks and that those data be used to analyze what, if any, impacts upon sea ducks the removal of much of the shoal material will have on these species. We further recommend that based on the results of the studies, a plan to mitigate any impacts upon sea ducks be developed.

North Wallops Island Sediment Removal - As previously stated, we recommend that all sand removal, if performed, occur outside of the nesting season for Piping Plover and sea turtles. Statements that indicate that a biologist would be on site during excavation to ensure avoidance of direct impacts upon these species may not be necessary if the work is timed correctly. We recommend clarification of this point. Adverse impacts upon the listed species may occur as a result of habitat impacts in addition to possible direct impacts associated with construction activities. We recommend consideration of indirect and cumulative impacts.

Beach Profile Monitoring Program - The beach profile monitoring program discussed in Appendix A will be conducted throughout the lifetime of the project. Analysis of these data will also be used to determine when renourishment should take place and the amount of material needed from all three borrow sites. Moreover, the information collected will be the primary tool used to monitor the behavior of the project and identify any negative impacts. As this effort is currently proposed, it is confined to Wallops and Assawoman islands. We strongly recommend that the beach profile monitoring also be conducted on Metompkin and Cedar islands at a frequency that allows for an accurate assessment to be made regarding project impacts further south along the island chain. We feel this is a necessary component in the beach profile monitoring program given that shoreline behavior on Wallops, Metompkin and Cedar islands is driven by the similar geologic processes (Oertel *et al.* 2008) and therefore may behave more as a unit than as independent landmasses.

Coastal Consistency:
As this project is located within a marine environment, we defer to VMRC regarding whether this project is consistent with the Fisheries Management Section of the CZMA.

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Amy M. Ewing
Environmental Services Biologist
Virginia Dept. of Game and Inland Fisheries
4010 West Broad Street
Richmond, VA 23230
804-367-2211
amy.ewing@dgif.virginia.gov

COMMONWEALTH of VIRGINIA

L. Preston Bryant, Jr.
Secretary of Natural Resources

Department of Game and Inland Fisheries

Robert W. Duncan
Executive Director

May 7, 2009

Mr. Joshua A. Bundick
Wallops Flight Facility NEPA Program Manager
c/o National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337

RE: EIS Scoping – NASA Wallops
Flight Facility SRIPP
ESSLog # 23888

Dear Mr. Bundick:

This letter is in response to your notice of scoping for the Environmental Impact Statement (EIS) for the Shoreline Restoration and Infrastructure Protection Program (SRIPP) at NASA Wallops Flight Facility (WFF). The Virginia Department of Game and Inland Fisheries (VDGIF), as the Commonwealth's wildlife and freshwater fish management agency, exercises full law enforcement and regulatory jurisdiction over those resources, inclusive of State or Federally *Endangered* or *Threatened* species, but excluding listed insects. We are a consulting agency under the U. S. Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et *seq.*), and we provide environmental analysis of projects or permit applications coordinated through the Virginia Department of Environmental Quality, the Virginia Marine Resources Commission, the Virginia Department of Transportation, the U. S. Army Corps of Engineers, and other state or federal agencies. Our role in these procedures is to determine likely impacts upon fish and wildlife resources and habitats, and to recommend appropriate measures to avoid, reduce, or compensate for those impacts.

Virginia's Barrier Islands

Virginia's barrier islands represent a critically important breeding area for a number of beach nesting shorebirds and seabirds that are of high conservation concern, including the federally Threatened piping plover *(Charadrius melodus)*, the state Endangered Wilson's plover (*C. wilsonia*), the American oystercatcher (*Haematopus palliatus*), which is ranked nationally as a high conservation priority species in the US Shorebird Conservation Plan (Brown *et al.* 2001), the state Threatened gull-billed tern (*Sterna nilotica*), and the least tern (*S. antillarum*), which is a state species of special concern. The Commonwealth's northern barrier islands that extend from Assateague Island south to Cedar Island typically support over 75% of Virginia's piping plover breeding population and in some years over 90% of the Commonwealth's breeding pairs have occurred on the northern islands (Boettcher *et al.* 2007). Since 2000, Virginia's Wilson's plover breeding population has been confined to Assawoman, Metompkin and Cedar islands with the exception of 2008 when one pair was discovered nesting on Assateague Island (Wilke *et al.* 2009). The barrier islands support over 50% of Virginia's American oystercatcher breeding population with a significant proportion occurring on Metompkin and Cedar islands (Wilke *et al.* 2005; Wilke *et al.* 2009). Moreover, oystercatcher productivity rates along the barrier island chain are some of the highest reported on the US the Atlantic coast, suggesting that the islands may serve as important population sources for the east coast population (Wilke 2008). The barrier islands also provide critical breeding habitat for least terns; since 1975 35% – 67% of the Commonwealth's population has been documented on the barrier island chain (VDGIF, unpubl. data). Virginia's statewide gull-billed tern breeding population has declined from approximately 2,000 pairs in the mid-1970's (Erwin *et al.* 1998) to fewer than 300 pairs in the last three years with the majority of nesting occurring on Virginia's seaside marshes and barrier islands (VDGIF, unpubl. data). While gull-billed terns are able to exploit barrier island and marsh habitats with equal success in response to rapidly changing conditions (Boettcher and Wilke 2009), the barrier islands remain important habitat for the declining species in Virginia. Other barrier island nesting species of greatest conservation need (as defined in Virginia's Wildlife Action Plan, available at www.bewildva.com) include black skimmer (*Rynchops niger*), common tern (*S. hirundo*), royal tern (*S. maxima*) and sandwich tern (*S. sandvicensis*) (VDGIF 2005).

Collectively, the aforementioned avian species' habitat requirements include broad beaches with low discontinuous dunes and expansive sand-shell flats. In addition, piping plover broods require unimpeded access from beach nest sites to the moist-soil ecotones of backside marshes and mudflats for forage and cover (Boettcher *et al.* 2007). These areas are highly susceptible to storm-generated disturbances, which serve to maintain the open active sand zones favored by these species. Any beach restoration activities that attempt to stop the natural movement of an island, counter storm-generated disturbances, or disrupt the longshore transport of sand may result in widespread loss of suitable nesting habitat for avian beach nesting species.

Over the past 20 years, the red knot (*Calidris canutus rufa*) population has declined by over 80% (Morrison *et al.* 2004) and this species is currently a candidate for federal listing under the Endangered Species Act. A significant portion of the population that migrates north along the US Atlantic coast in the spring uses the barrier islands as stopover sites (Smith *et al.* 2008). This includes Wallops Island where more than 1,000 birds have been recorded during a single survey (Center for Conservation Biology, The Nature Conservancy, and VDGIF, unpubl. data). Typical beach renourishment may impact long-distance migrant shorebirds that forage on sand-dwelling invertebrates, such as red knot, by reducing the availability of prey within reach of the birds' bills for a period of time following sand deposition (Bishop *et al.* 2006). Moreover, beach armouring and the installation of groins may result in significant loss of suitable shorebird foraging habitat in the intertidal zone seaward and south of these structures, respectively. These effects are likely to become even more pronounced in the face of sea level rise (Galbraith *et al.* 2002).

Virginia is the northern extreme of the federally Threatened loggerhead sea turtle (*Caretta caretta*) nesting range. While the majority of the Commonwealth's nesting activity has been confined to southern mainland beaches (Fort Story - NC/VA border), nesting activity on the northern barrier islands, including Wallops Island, has increased slightly in recent years (VDGIF, unpubl. data). Nesting sea turtles typically nest on dynamic ocean beaches that have a wide berm and a relatively intact natural dune system. This species typically avoids or has poor nesting success on armoured beaches, which over time, become devoid of dry beaches and natural primary dune systems. Moreover, there is concern that beach renourishment may affect the quality of turtle nesting habitat (Crain *et al.* 1995). For example, the deposition of sand could change beach sand color thereby affecting sand temperature. Because the sex of sea turtles is determined by the temperature of sand surrounding the nest cavity, beach renourishment could alter sex ratios. Beach renourishment also may influence other physical characteristics of beaches such as sand-grain size and shape, silt-clay content, sand compaction, moisture content, porosity/water retention and gas diffusion rates. The altering of one or more of these physical characteristics may not necessarily impact beach selection by nesting females (Crain *et al.* 1995), but may reduce reproductive success of nests laid in these renourished areas (Ackerman 1996).

Alternatives Analysis

- Alternative 1 (the preferred alternative) proposes to extend the existing seawall an additional 4,500 feet south, enlarge the beach with offshore dredged sand, and construct a rock jetty near the southern WFF property line. The proposed groin would allow some fill to pass through and, according to the description of the SRIPP, the net sand transport to Assawoman Island would be equal to or exceed pre-construction conditions. We are concerned that the proposed jetty may impede existing longshore transport of sand to Assawoman, Metompkin and Cedar islands, especially if funding can not be secured for the anticipated 5 – 7 year renourishment cycle. In addition, we are concerned that the extension of the seawall will further accelerate sand loss seaward of the seawall, particularly during periods of frequent storm events. Lastly, regular beach renourishment is very costly and may negatively affect local wildlife habitats in the short term, especially if non-compatible sand is used. This practice also may threaten the biological integrity of the two shoals from where sand will be obtained and may reduce the overall sand budget in the nearshore system, accelerating erosion of nearby beaches.

- We have similar concerns with Alternative 4 as we do with Alternative 1 because it involves the same actions, only less beach fill will be used. The reduced beach fill will likely require more frequent beach renourishment; therefore Alternative 4 does not appear to offer any cost benefits or reduce barrier island ecosystem impacts over the long term.

- We have concerns with Alternatives 2 and 5, which involve beach fill, detached breakwaters, and seawall extension mainly due to issues surrounding the seawall extension as discussed above. While the breakwaters may attenuate wave action and thereby reduce beach erosion to some degree, the stable seawall, which will inhibit the natural movement of sand and water, will likely negate any benefits the breakwaters may provide.

- We do not consider Alternatives 3 and 6, which are limited to beach fill, to be viable options since both will likely result in the rapid loss of sand placed on the beach.

- We recommend a thorough analysis and discussion of a seventh alternative that involves the installation of detached breakwaters to attenuate wave action, but excludes the seawall extension and beach fill options, and considers limited retreat or removal of infrastructure that does not require a beachfront location.

Recommended items for discussion in the EIS:

- The impacts of sand mining at Blackfish Bank Shoal and unnamed shoal on erosion rates at Assateague Island and islands to the south including results from studies on this topic.

- All potential sand mining impacts on the aforementioned shoals' avifauna and to fishes and other wildlife species that forage on the shoals' benthos.

- Results from a compatibility analysis that examine how well the sand on the two offshore shoals matches the existing sand on the barrier islands (i.e., grain size, color, etc.).

- What level of protection each alternative will realistically offer and a full presentation of the analyses conducted to determine these protection levels. We recommend the analyses take into account sea level rise and the potential for future increases in storm activity and intensity.

- A detailed description of the beach fill design (i.e., targeted beach slope, elevation and width to be maintained over the long term).

- A thorough analysis and discussion of potential impacts each alternative poses on the islands to the south of the project area, with a special focus on Assawoman, Metompkin and Cedar islands.

- A detailed description of a post-construction beach monitoring plan. This plan should present methods for measuring changes to island shorelines over time. We strongly recommend that the monitoring plan not be confined to Assawoman Island, but that it also include, at a minimum, Metompkin and Cedar islands.

- A threshold at which NASA considers the cost of the project to outweigh the benefits to NASA's mission and goals. The cost/benefit analysis should not only examine monetary costs, but should also take into account costs to fish and wildlife resources, the physical integrity of the barrier island chain, and other stakeholder interests.

- The availability of funding for typical renourishment in the long term since, according to the SRIPP scoping document, beach renourishment is key to the project's success.

- Consultations with National Marine Fisheries Service regarding potential impacts of hopper dredging on sea turtles.

We appreciate the opportunity to provide comments regarding the development of the EIS for the SRPP at NASA Wallops Flight Facility. Please contact me or Amy Ewing at 804-367-6913 if we can be of further assistance.

Sincerely,

Raymond Fernald, Manager
Nongame and Environmental Programs

Encl: Literature Cited

Cc: David Whitehurst, VDGIF Wildlife Bureau Director

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COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street, Suite 326
Richmond, Virginia 23219-2010
(804) 786-2556 FAX (804) 371-7899

MEMORANDUM

DATE: March 19, 2010

TO: Anne Pinion, DEQ

FROM: Roberta Rhur, Environmental Impact Review Coordinator *for*
John Davy, Division Director, Planning and Recreational Resources

SUBJECT: DEQ 10-019F Wallops Island Shoreline Protection, Accomack CO

Division of Natural Heritage

The Department of Conservation and Recreation's Division of Natural Heritage (DCR) has searched its Biotics Data System for occurrences of natural heritage resources from the area outlined on the submitted map. Natural heritage resources are defined as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations.

According to the information currently in our files, this site is located within the North Wallops Island Conservation Site. Conservation sites are tools for representing key areas of the landscape that warrant further review for possible conservation action because of the natural heritage resources and habitat they support. Conservation sites are polygons built around one or more rare plant, animal, or natural community designed to include the element and, where possible, its associated habitat, and buffer or other adjacent land thought necessary for the element's conservation. Conservation sites are given a biodiversity significance ranking based on the rarity, quality, and number of element occurrences they contain; on a scale of 1-5, 1 being most significant. North Wallops Island Conservation Site has been given a biodiversity significance ranking of B2, which represents a site of very high significance. The natural heritage resources of concern at this site is:

Piping Plover	Charadrius melodus	G3/S2B, S1N/LT/LT

The Piping Plover inhabits coastal areas, utilizing the flat, sandy beaches of barrier islands for breeding (Cross, 1991). Threats to this species include predation of eggs and young and the development and disturbance of barrier island breeding sites (Cross, 1991). Please note that this species is listed as threatened by the United States Fish and Wildlife Service (USFWS) and the Virginia Department of Game and Inland Fisheries (VDGIF).

Additionally the site is also within the North Assawoman; South Wallops Island Conservation Site. The North Assawoman; South Wallops Island Conservation Site has been given a biodiversity significance ranking of B2, which represents a site of very high significance. The natural heritage resources of concern at this site are:

Piping Plover	Charadrius melodus	G3/S2B, S1N/LT/LT
Least Tern	Sterna antillarum	G4/S2B/NL/SC
Wilson's Plover	Charadrius wilsonia	G5/S1B/NL/LE

Wilson's Plover is a rare, short-term summer visitor along the lower Chesapeake Bay and the Atlantic Coast south of Cape Henry. The summer males have a thick black bill and a white breast with a single band while the females, young, and winter males are grayish brown to reddish brown (Bergstrom, 1991).

Wilson's Plover habitat consists of the upper portions of sandy beaches on barrier islands, usually within 30 m of dune vegetation. Requirements for nesting include suitable foraging sites nearby for chicks, usually mud or sand flats. Predatory threats include foxes, herring gulls, great black gulls, and fish crows who eat the eggs and young. Nesting habitats are lost to both natural processes such as erosion and coastal development, as well as human disturbance during the nesting season. Since the eggs are a pale tan or buff with irregular black specks, they blend easily into the sand which allows for them to be overlooked by unsuspecting beach visitors who crush them. Recommendations for protecting these birds consist of predator control measures involving protection from predators for nests and discouraging development on the nesting islands. Wilson's Plover is protected under the Migratory Bird Treaty Act (Bergstrom, 1991).

The Least Tern nests on broad, flat beaches with minimal vegetation and forages in saltwater near the shore. Threats to this species include loss of nesting habitat due to development and disturbance of breeding colonies by human activities and high numbers of predators (Beck, 1991). Please note that the Least Tern is listed as a special concern species by the Virginia Department of Game and Inland Fisheries (VDGIF).

Due to the legal status of the Piping Plover and Wilson's Plover,DCR recommends coordination with the VDGIF and USFWS to ensure compliance with protected species legislation. DCR also recommends the protection of rare bird habitat (Least tern, Wilson's plover, and Piping plover) during the nesting season from April 15th to August 15th. Additionally, the source for beach nourishment should be limited to the sand shoals (Unnamed Shoal A or Unnamed Shoal B) located offshore in Federal waters and not from the Piping plover habitat on the north end of Wallops Island. Please note, DCR continues to be concerned in regards to the effects of the shoreline hardening on the islands downdrift of the project area including The Nature Conservancy and DCR properties.

Alternative One (Preferred Alternative) would be DCR's preferred alternative provided sand is not taken from the beach on the north end of Wallops Island and the proposed seawall extension is limited to the minimum length absolutely necessary for the protection of the facility. The absence of groin or breakwater for this alternative makes it less likely to disrupt sand transport for resources located to the south of the project area. DCR continues to recommend exploring the feasibility of inland relocation of existing facilities.

Our files do not indicate the presence of any State Natural Area Preserves under DCR's jurisdiction in the project vicinity.

Under a Memorandum of Agreement established between the Virginia Department of Agriculture and Consumer Services (VDACS) and the Virginia Department of Conservation and Recreation (DCR), DCR represents VDACS in comments regarding potential impacts on state-listed threatened and endangered plant and insect species. The current activity will not affect any documented state-listed plants or insects.

New and updated information is continually added to Biotics. Please contact DCR for an update on this natural heritage information if a significant amount of time passes before it is utilized.

The Virginia Department of Game and Inland Fisheries maintains a database of wildlife locations, including threatened and endangered species, trout streams, and anadromous fish waters that may contain information not documented in this letter. Their database may be accessed from http://vafwis.org/fwis/ or contact Shirl Dressler at (804) 367-6913.

Division of Chesapeake Bay Local Assistance

Federal actions on installations located within Tidewater Virginia are required to be consistent with the performance criteria of the Regulations on lands analogous to locally designated Chesapeake Bay Preservation Areas. CBPAs are comprised of a Resource Protection Area (RPA) and Resource Management Area (RMA). RPAs include tidal shores, tidal wetlands, non-tidal wetlands connected by surface flow and contiguous to tidal wetlands or water bodies with perennial flow, and a 100-foot buffer located landward of these features. RMAs include land types that, if improperly used or developed, have a potential for causing significant water quality degradation or for diminishing the functional value of the RPA. The project's preferred alternative would consist of the installation of about 4600 feet of additional seawall along with beach fill along the shoreline of the Atlantic Ocean on Wallops Island in northern Accomack County. The installation of some of the sand fill would likely occur in areas that appear to be below mean low water, and outside of the jurisdiction of the Chesapeake Bay Preservation Act. The Bay Act applies to areas landward of mean low water. However, the placement of some of the fill and the extension of the seawall would be located above mean low water which results in impacts to areas analogous to RPAs. Shoreline erosion control is a permitted activity in RPAs, provided it conforms to erosion and sediment control for any land disturbances that exceed 2,500 square feet and occurs with the appropriate state and federal permits. As long as these requirements are met, we concur that the preferred proposed activity would be consistent with the *Chesapeake Bay Preservation Act & Regulations.*

Division of Soil and Water Conservation

The applicant and their authorized agents conducting regulated land disturbing activities on private and public lands in the state must comply with the Virginia Erosion and Sediment Control Law and Regulations (VESCL&R), Virginia Stormwater Management Law and Regulations including coverage under the general permit for stormwater discharge from construction activities, and other applicable federal nonpoint source pollution mandates (e.g. Clean Water Act-Section 313, Federal Consistency under the Coastal Zone Management Act). Clearing and grading activities, installation of staging areas, parking lots, roads, buildings, utilities, borrow areas, soil stockpiles, and related land-disturbance activities that result in the land-disturbance of greater than 2,500 square feet would be regulated by VESCL&R. Accordingly, the applicant must prepare and implement erosion and sediment control (ESC) plan to ensure compliance with state law and regulations. The ESC plan is submitted to the DCR Regional Office that serves the area where the project is located for review for compliance. The applicant is ultimately responsible for achieving project compliance through oversight of on site contractors, regular field inspection, prompt action against non-compliant sites, and other mechanisms consistent with agency policy. [Reference: VESCL §10.1-567;].

General Permit for Discharges of Stormwater from Construction Activities in CBPA:
The operator or owner of construction activities involving land disturbing activities equal to or greater than 2,500 square feet in areas designated as subject to the Chesapeake Bay Preservation Area Designation and Management Regulations adopted pursuant to the Chesapeake Bay Preservation Act are required to register for coverage under the General Permit for Discharges of Stormwater from Construction Activities and develop a project specific stormwater pollution prevention plan (SWPPP). The SWPPP must be prepared prior to submission of the registration statement for coverage under the general permit and the SWPPP must address water quality and quantity in accordance with the Virginia Stormwater Management Program (VSMP) Permit Regulations. General information and registration forms for the General Permit are available on DCR's website at
http://www.dcr.virginia.gov/soil_and_water/index.shtml
[Reference: Virginia Stormwater Management Law Act §10.1-603.1 et seq.; VSMP Permit Regulations §4VAC-50 et seq.]

The remaining DCR divisions have no comments regarding the scope of this project. Thank you for the opportunity to comment.

Cc: Amy Ewing, VDGIF
Tylan Dean, USFWS

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Pinion, Anne (DEQ)

From: Sacks, David (DCR)
Sent: Tuesday, April 13, 2010 3:04 PM
To: Pinion, Anne (DEQ); Rhur, Robbie (DCR)
Cc: Smith, Shawn (DCR)
Subject: RE: 10-019F SRIPP at Wallops Island

Anne and Robbie:

As a follow-up to a discussion between Anne, Julia, Ellie and myself earlier this afternoon, I would like to modify the comments this Division submitted to Robbie on February 24, 2010 regarding the above referenced project.

We recently determined that Wallops Island is in a portion of Accomack County that has not been designated as a Chesapeake Bay Preservation Area. When the County amended its ordinance to expand its Chesapeake Bay Preservation Area (CBPA) to the ocean side of the County in February 2009, the definition of these areas in the County ordinance references the official zoning map. That map, specifically excludes federal lands on the ocean side of the County, including Wallops Island.

Generally, when a locality does not map CBPAs on federal lands, they are still subject to the requirements of the Bay Act Regulations as they contain lands analogous to RPAs and/or RMAs. However, In the case of Wallops Island because these lands are located in a part of a county not required to be included as part of a Chesapeake Bay Preservation Area (outside the Bay watershed) they are not subject to the requirements of the regulations.

Consequently, regarding DEQ 10-019F, we have no comments

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street, Suite 326
Richmond, Virginia 23219-2010
(804) 786-2556 FAX (804) 371-7899

Revised April 14

MEMORANDUM

DATE: ~~March 19~~, 2010

TO: Anne Pinion, DEQ

FROM: Roberta Rhur, Environmental Impact Review Coordinator *for*
John Davy, Division Director, Planning and Recreational Resources

SUBJECT: DEQ 10-019F Wallops Island Shoreline Protection, Accomack CO

Division of Natural Heritage

The Department of Conservation and Recreation's Division of Natural Heritage (DCR) has searched its Biotics Data System for occurrences of natural heritage resources from the area outlined on the submitted map. Natural heritage resources are defined as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations.

According to the information currently in our files, this site is located within the North Wallops Island Conservation Site. Conservation sites are tools for representing key areas of the landscape that warrant further review for possible conservation action because of the natural heritage resources and habitat they support. Conservation sites are polygons built around one or more rare plant, animal, or natural community designed to include the element and, where possible, its associated habitat, and buffer or other adjacent land thought necessary for the element's conservation. Conservation sites are given a biodiversity significance ranking based on the rarity, quality, and number of element occurrences they contain; on a scale of 1-5, 1 being most significant. North Wallops Island Conservation Site has been given a biodiversity significance ranking of B2, which represents a site of very high significance. The natural heritage resources of concern at this site is:

Piping Plover	Charadrius melodus	G3/S2B, S1N/LT/LT

The Piping Plover inhabits coastal areas, utilizing the flat, sandy beaches of barrier islands for breeding (Cross, 1991). Threats to this species include predation of eggs and young and the development and disturbance of barrier island breeding sites (Cross, 1991). Please note that this species is listed as threatened by the United States Fish and Wildlife Service (USFWS) and the Virginia Department of Game and Inland Fisheries (VDGIF).

Additionally the site is also within the North Assawoman; South Wallops Island Conservation Site. The North Assawoman; South Wallops Island Conservation Site has been given a biodiversity significance ranking of B2, which represents a site of very high significance. The natural heritage resources of concern at this site are:

Piping Plover	Charadrius melodus	G3/S2B, S1N/LT/LT
Least Tern	Sterna antillarum	G4/S2B/NL/SC
Wilson's Plover	Charadrius wilsonia	G5/S1B/NL/LE

Wilson's Plover is a rare, short-term summer visitor along the lower Chesapeake Bay and the Atlantic Coast south of Cape Henry. The summer males have a thick black bill and a white breast with a single band while the females, young, and winter males are grayish brown to reddish brown (Bergstrom, 1991).

Wilson's Plover habitat consists of the upper portions of sandy beaches on barrier islands, usually within 30 m of dune vegetation. Requirements for nesting include suitable foraging sites nearby for chicks, usually mud or sand flats. Predatory threats include foxes, herring gulls, great black gulls, and fish crows who eat the eggs and young. Nesting habitats are lost to both natural processes such as erosion and coastal development, as well as human disturbance during the nesting season. Since the eggs are a pale tan or buff with irregular black specks, they blend easily into the sand which allows for them to be overlooked by unsuspecting beach visitors who crush them. Recommendations for protecting these birds consist of predator control measures involving protection from predators for nests and discouraging development on the nesting islands. Wilson's Plover is protected under the Migratory Bird Treaty Act (Bergstrom, 1991).

The Least Tern nests on broad, flat beaches with minimal vegetation and forages in saltwater near the shore. Threats to this species include loss of nesting habitat due to development and disturbance of breeding colonies by human activities and high numbers of predators (Beck, 1991). Please note that the Least Tern is listed as a special concern species by the Virginia Department of Game and Inland Fisheries (VDGIF).

Due to the legal status of the Piping Plover and Wilson's Plover,DCR recommends coordination with the VDGIF and USFWS to ensure compliance with protected species legislation. DCR also recommends the protection of rare bird habitat (Least tern, Wilson's plover, and Piping plover) during the nesting season from April 15th to August 15th. Additionally, the source for beach nourishment should be limited to the sand shoals (Unnamed Shoal A or Unnamed Shoal B) located offshore in Federal waters and not from the Piping plover habitat on the north end of Wallops Island. Please note, DCR continues to be concerned in regards to the effects of the shoreline hardening on the islands downdrift of the project area including The Nature Conservancy and DCR properties.

Alternative One (Preferred Alternative) would be DCR's preferred alternative provided sand is not taken from the beach on the north end of Wallops Island and the proposed seawall extension is limited to the minimum length absolutely necessary for the protection of the facility. The absence of groin or breakwater for this alternative makes it less likely to disrupt sand transport for resources located to the south of the project area. DCR continues to recommend exploring the feasibility of inland relocation of existing facilities.

Our files do not indicate the presence of any State Natural Area Preserves under DCR's jurisdiction in the project vicinity.

Under a Memorandum of Agreement established between the Virginia Department of Agriculture and Consumer Services (VDACS) and the Virginia Department of Conservation and Recreation (DCR), DCR represents VDACS in comments regarding potential impacts on state-listed threatened and endangered plant and insect species. The current activity will not affect any documented state-listed plants or insects.

New and updated information is continually added to Biotics. Please contact DCR for an update on this natural heritage information if a significant amount of time passes before it is utilized.

The Virginia Department of Game and Inland Fisheries maintains a database of wildlife locations, including threatened and endangered species, trout streams, and anadromous fish waters that may contain information not documented in this letter. Their database may be accessed from http://vafwis.org/fwis/ or contact Shirl Dressler at (804) 367-6913.

Division of Soil and Water Conservation

The applicant and their authorized agents conducting regulated land disturbing activities on private and public lands in the state must comply with the Virginia Erosion and Sediment Control Law and Regulations (VESCL&R), Virginia Stormwater Management Law and Regulations including coverage under the general permit for stormwater discharge from construction activities, and other applicable federal nonpoint source pollution mandates (e.g. Clean Water Act-Section 313, Federal Consistency under the Coastal Zone Management Act). Clearing and grading activities, installation of staging areas, parking lots, roads, buildings, utilities, borrow areas, soil stockpiles, and related land-disturbance activities that result in the land-disturbance of equal to or greater than 10,000 square feet would be regulated by VESCL&R. Accordingly, the applicant must prepare and implement erosion and sediment control (ESC) plan to ensure compliance with state law and regulations. The ESC plan is submitted to the DCR Regional Office that serves the area where the project is located for review for compliance. The applicant is ultimately responsible for achieving project compliance through oversight of on site contractors, regular field inspection, prompt action against non-compliant sites, and other mechanisms consistent with agency policy. [Reference: VESCL §10.1-567;].

The operator or owner of construction activities involving land disturbing activities equal to or greater than one acre are required to register for coverage under the General Permit for Discharges of Stormwater from Construction Activities and develop a project specific stormwater pollution prevention plan (SWPPP). Construction activities requiring registration also includes the land-disturbance of less than one acre of total land area that is part of a larger common plan of development or sale if the larger common plan of development will ultimately disturb equal to or greater than one acre. The SWPPP must be prepared prior to submission of the registration statement for coverage under the general permit and the SWPPP must address water quality and quantity in accordance with the Virginia Stormwater Management Program (VSMP) Permit Regulations. General information and registration forms for the General Permit are available on DCR's website at
http://www.dcr.virginia.gov/soil_and_water/index.shtml
[Reference: Virginia Stormwater Management Law Act §10.1-603.1 et seq.; VSMP Permit Regulations §4VAC-50 et seq.]

The remaining DCR divisions have no comments regarding the scope of this project. Thank you for the opportunity to comment.

Cc: Amy Ewing, VDGIF
Tylan Dean, USFWS

Literature Cited:

Bergstrom, P.W. 1991. Wilson's Plover. In Virginia's Endangered Species: Proceedings of a Symposium. K. Terwilliger ed. The McDonald and Woodward Publishing Company, Blacksburg, Virginia. pp.502-503.

Beck, R. A. 1991. Least Tern. In Virginia's Endangered Species: Proceedings of a Symposium. K. Terwilliger ed. The McDonald and Woodward Publishing Company, Blacksburg, Virginia. pp. 505-506.

Cross, R.R. 1991. Piping Plover. In Virginia's Endangered Species: Proceedings of a Symposium. K. Terwilliger ed. The McDonald and Woodward Publishing Company, Blacksburg, Virginia. pp. 501-502.

U.S. Fish and Wildlife, Northern Florida Office. Loggerhead sea turtle. Decemeber 29, 2005. http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/loggerhead-sea-turtle.htm

COMMONWEALTH of VIRGINIA

L. Preston Bryant, Jr.
Secretary of Natural Resources

Department of Historic Resources
2801 Kensington Avenue, Richmond, Virginia 23221-0311

Kathleen S. Kilpatrick
Director

Tel: (804) 367-2323
Fax: (804) 367-2391
TDD: (804) 367-2386
www.dhr.virginia.gov

March 16, 2010

Mr. Josh Bundick
NEPA Manager
NASA Goddard Space Flight Center, Wallops Flight Facility
Wallops Island, VA 23337

Re: Proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP)
Wallops Island, Accomack County
DHR File #: 2007-0087
Date Received: February 17, 2010

Dear Mr. Bundick:

We have received information regarding our review of the above referenced undertaking, including a copy of the report DRAFT *Programmatic Environmental Impact Statement, Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program* (URS: 2010).

Based upon the information provided, we concur with your determination that the Proposed Alternatives 1, 2, and 3 will *not adversely affect any historic properties*. In the event that previously unrecorded historic properties are discovered during project activities, stop work in the area and contact DHR immediately.

If you have any questions about our comments, please contact me at:
ron.grayson@dhr.virginia.gov or (804) 367-2323, Ext. 105.

Sincerely,

Ronald Grayson, RPA, Archaeologist
Office of Review and Compliance

Pinion, Anne (DEQ)

From: Forsgren, Diedre (VDH)
Sent: Friday, March 19, 2010 10:50 AM
To: Pinion, Anne (DEQ); Joshua.A.Bundick@nasa.gov
Cc: Matthews, Barry (VDH)
Subject: (10-019F) EIS/CD: Shoreline Restoration and Infrastructure Protection Program, NASA

DEQ Project #:	10-019F
Name:	Shoreline Restoration and Infrastructure Protection Program
Sponsor:	National Aeronautics and Space Administration
Location:	Accomack County

VDH – Office of Drinking Water has reviewed DEQ Project Number 10-019F. Below are our comments as they relate to proximity to **public drinking water** sources (groundwater wells, springs and surface water intakes). Potential impacts to public water distribution systems or sanitary sewage collection systems must be verified by the local utility.

No groundwater wells are within 1 mile radius of the project site.

No surface water intakes are located within 5 miles radius of the project site.

Project does not fall within Zone 1 or Zone 2 of any public surface water sources.

There are no apparent impacts to public drinking water sources due to this project.

Diedre Forsgren
Office Services Specialist
VIRGINIA DEPARTMENT OF HEALTH
Office of Drinking Water, Room 622-A
109 Governor Street
Richmond, VA 23219
Phone: (804) 864-7241
email: diedre.forsgren@vdh.virginia.gov

ESSENTIAL FISH HABITAT ASSESSMENT

WALLOPS FLIGHT FACILITY SHORELINE RESTORATION AND INFRASTRUCTURE PROTECTION PROGRAM

Prepared for

National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

In cooperation with

U.S. Department of the Interior, Minerals Management Service and
U.S. Army Corps of Engineers

February 2010

Prepared by

URS Group, Inc.
200 Orchard Ridge Drive, Suite 101
Gaithersburg, MD 20878
15301785

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Figures

Tables

Photos

Attachments

CFR	Code of Federal Regulations
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ELMR	Estuarine Living Marine Resources
FMP	fishery management plan
km	kilometer
MAB	Mid-Atlantic Bight
MARS	Mid-Atlantic Regional Spaceport
mm	millimeters
m^3	cubic meters
NASA	National Aeronautics and Space Administration
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NMFS	National Marine Fisheries Service
PEA	Programmatic Environmental Assessment
ppt	parts per thousand
SRIPP	Shoreline Restoration and Infrastructure Protection Program
USACE	U.S. Army Corps of Engineers
VIMS	Virginia Institute of Marine Science
WFF	Wallops Flight Facility
yd^3	cubic yards

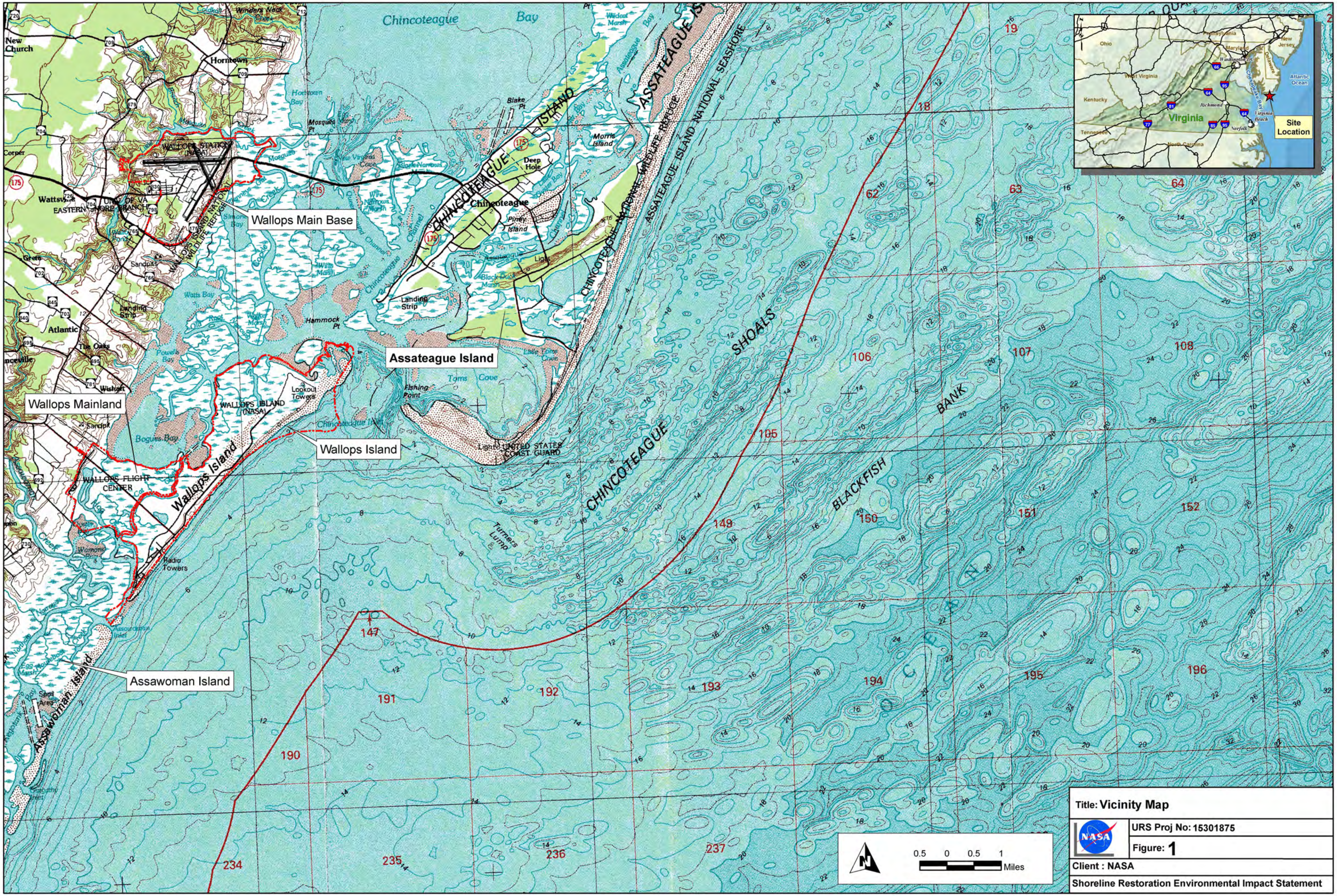
SECTION ONE: INTRODUCTION AND BACKGROUND

The National Aeronautics and Space Administration's (NASA's) Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP) is proposed for Wallops Island, a barrier island located in the northeastern portion of Accomack County, Virginia, on the Delmarva Peninsula (Figure 1). Wallops Island is bounded by Chincoteague Inlet to the north, Assawoman Inlet (which is presently filled in) to the south, the Atlantic Ocean to the east, and estuaries to the west.

Wallops Island has been subject to the effects of shoreline retreat well before NASA's presence on the island was established in the 1940s. Shoreline retreat has been caused by both natural and man-induced processes. The ocean has encroached substantially toward launch pads, infrastructure, and test and training facilities belonging to NASA, the U.S. Navy, and the Mid-Atlantic Regional Spaceport (MARS). Between 1857 and 1994, the southern part of Wallops Island has retreated about 3.7 meters (12 feet) per year on average from 1857 to the present (NASA, 2007). Assawoman Island to the south has been impacted even more, with a shoreline retreat rate between 4.9 and 5.2 meters (16 and 17 feet) per year.

NASA made several attempts since the 1960s to retain sand on the Wallops Island beach and prevent shoreline erosion. Various measures such as the construction of wooden groins and a stone seawall, placement of temporary geotextile tubes (long cylinders composed of durable textile material that are filled with sand), and other structures have been installed along the shoreline to slow down the erosion of sand from the beach, and to help protect onshore assets from wave action. The existing seawall is being undermined because there is little or no protective sand beach remaining and storm waves break directly on the rocks. Currently, the south end of the island is unprotected except for a low revetment around the MARS launch pad and temporary geotextile tubes.

Despite these past efforts, the ocean has continued to encroach substantially toward the valuable infrastructure on Wallops Island and threaten the daily operations of NASA and their tenants, the U.S. Navy and MARS. The U.S. Navy Surface Combat Systems Center is WFF's largest partner. Wallops Island is home to the unique replica of an AEGIS cruiser and its destroyer combat systems as well as the experimental radar deck of the DDG 1000 class destroyer. The Virginia Commercial Space Flight Authority is responsible for the development and operation of MARS, a Federal Aviation Administration-licensed commercial spaceport, which is also at risk from the eroding shoreline.



Chincoteague Bay
Wallops Main Base
Assateague Island
Wallops Mainland
Wallops Island
Assawoman Island
CHINCOTEAGUE ISLAND
ASSATEAGUE ISLAND NATIONAL SEASHORE
CHINCOTEAGUE NATIONAL WILDLIFE REFUGE
CHINCOTEAGUE SHOALS
BLACKFISH BANK
OCEAN
WALLOPS STATION (NASA)
WALLOPS ISLAND (NASA)
WALLOPS FLIGHT CENTER
UNITED STATES COAST GUARD
Virginia
Site Location
Atlantic Ocean
0.5 0 0.5 1
Miles
Title: Vicinity Map
URS Proj No: 15301875
Figure: 1
Client : NASA
Shoreline Restoration Environmental Impact Statement

SECTION TWO: PURPOSE

In accordance with provisions of the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSA) and the 1996 Sustainable Fisheries Act, federal agencies are required to consult with the National Marine Fisheries Service (NMFS) regarding actions that may adversely affect Essential Fish Habitat (EFH).

EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” *Waters* consist of aquatic areas and their associated physical, chemical, and biological properties that are currently utilized by fishes and may include areas historically used by fish. *Substrate* is defined as sediment, hardbottom, structures beneath the waters, and any associated biological communities. *Necessary* means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem. *Spawning, breeding, feeding*, or *growth to maturity* includes all habitat types used by a species throughout its life cycle. Only species managed under a Federal Fishery Management Plan (FMP) are protected under MSA (50 Code of Federal Regulations [CFR] 600). The act requires federal agencies to consult on activities that may adversely influence EFH designated in the FMPs.

As part of the EFH consultation process, federal agencies must develop and submit an EFH assessment to NMFS. The purpose of this assessment is to describe and evaluate activities that may have direct (e.g., physical disruption) or indirect (e.g., loss of prey species) effects on EFH and may be site-specific or habitat-wide. Potential adverse impacts are evaluated individually and cumulatively.

As defined in the MSA, a federal action is one that is authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a federal agency. The Federal action considered in this EFH assessment is the funding and authorization of the Shoreline Restoration and Infrastructure Protection Program (SRIPP) at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center’s (GSFC) Wallops Flight Facility (WFF) on Wallops Island, Virginia. As the project sponsor, NASA is serving as lead agency in the EFH consultation with NMFS. In connected actions, the U. S. Department of Interior, Minerals Management Service (MMS) and U.S Army Corps of Engineers (USACE) would provide authorizations for the project. The MMS would issue a negotiated agreement with NASA for the use of sand from Federal waters on the Outer Continental Shelf. The USACE would provide permit approval for the dredging and placement of fill material in waters of the U.S. under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbor Act of 1899. As such, both agencies are participating in NASA’s SRIPP EFH consultation and the effects of their actions are considered in this document.

SECTION THREE: PROPOSED PROJECT

The objective of the SRIPP is to reduce physical damage to Wallops Island infrastructure incurred during normal coastal storms and nor'easters by moving the zone of breaking waves away from vulnerable infrastructure. The SRIPP Proposed Action would include beach nourishment using sand dredged from one of two shoals offshore in Federal waters, and the extension of Wallops Island's existing rock seawall.

In 2007 and 2008, the USACE conducted sediment sampling to identify potential offshore borrow sites with compatible grain size and adequate volume for use as beach fill (Figure 2). Three offshore shoals in Federal waters, referred to as Unnamed Shoals A and B, and Blackfish Bank Shoal were identified as potential borrow sites (Figure 3). The evaluation of the sediment grain size and bathymetry, conducted by the USACE, concluded that Shoals A and B would provide adequate sand volumes and appropriately-sized sediment (grain size coarser that the median 0.20 mm grain size of the existing beach) for nourishment of the beach throughout the SRIPP's 50-year design life. Blackfish Bank Shoal, initially identified as a potential sand source, was eliminated as a potential borrow site for the SRIPP due to; (1) potential adverse impacts to Assateague Island due to increased wave energy from lowering of the shoal, and (2) concerns expressed during scoping over potential impacts to commercial and recreational fishing.

Borrow Sites

<u>Offshore Shoals</u>

The southwest end of Unnamed Shoal A is located approximately 11 kilometers (km) (7 miles) east of Assateague Island and approximately 18 km (11 miles) northeast of the north tip of Wallops Island. The total predicted volume of Unnamed Shoal A is approximately 31 million m^3 (40 million yd^3). This shoal covers an area of approximately 700 hectares (1,800 acres).

The southwest end of Unnamed Shoal B is located approximately 19 km (12 miles) east of Assateague Island and approximately 26 km (16 miles) northeast of the north tip of Wallops Island. The total predicted volume of Unnamed Shoal B is approximately 57 million m^3 (75 million yd^3). This shoal covers an area of approximately 1,600 hectares (3,900 acres).

<u>North Wallops Island</u>

The north Wallops Island borrow site is a beach area where sand has accreted as a result of the longshore transport system. Based on habitat constraints, the total potential area for sand removal is approximately 60 hectares (150 acres).

Initial Beach Nourishment

Under the SRIPP Proposed Action, 2.4 million m^3 (3.2 million yd^3) of sand would be placed along 6.0 km (3.7 miles) of shoreline during the initial nourishment. The beach fill would extend 21 meters (70 feet) from the present shoreline in a 1.8-meter-high (6-foot-high) berm, and then would slope underwater for an additional 52 meters (170 feet) seaward; the total distance of the fill profile from the current shoreline would be 73 meters (240 feet). During storm events, the new beach would provide a surface to dissipate wave energy and provide additional sediment in the nearshore system. In addition, Wallops Island's existing rock seawall would be extended up to 1,400 meters (4,600 feet) to the south.

Placement of the initial fill would bury existing intertidal benthic community along an approximate 4,300 m (14,000 ft) length of the seawall. The mean tidal range is approximately 1.1 m (3.6 ft); therefore approximately 0.5 ha (1.2 ac) of hard-bottom, intertidal habitat would be permanently buried. In addition, approximately 91 ha (225 ac) the subtidal benthic community along the existing seawall would be buried during the initial fill placement.

A new beach would be formed in front the seawall and a beach benthic community would become established. Sand for the initial beach nourishment would be dredged from an approximate 520 hectare (1,280 acre) area of Unnamed Shoal A. Assuming sand would be dredged from the entire 1,280 acre area, approximately two feet of material would be removed to obtain the required volume for the initial placement.

Renourishment Events

Under the SRIPP Proposed Action, subsequent beach re-nourishment cycles would vary throughout the expected 50-year life of the SRIPP as determined by the proposed monitoring program. The exact locations and magnitude of renourishment cycles may fluctuate due to the frequency and severity of storm activity and subsequent shoreline erosion. The renourishment cycle is anticipated to require approximately 616,000 m^3 (806,000 yd^3) of sand approximately every 5 years.

During each nourishment cycle, approximately 140 ha (347 ac) of benthic habitat on Shoal A or Shoal B would be adversely impacted assuming a uniform dredging depth of approximately 0.6 m (2 ft). Nine renourishment cycles are anticipated under Alternative One.

The length of a beach fill is a key parameter in determining how long the fill will last. A “full” beach fill loses much less of a percentage of its volume in a given time interval than a shorter, or “reduced” fill (USACE, 2006). At Wallops Island, a rectangle-shaped fill’s half-life (the time it would take for the fill to lose 50 percent of its volume) is estimated to be 8.7 years for the full 6.0 km (3.7 mi) fill. The topography and bathymetry of the beach would be monitored on a regular basis to determine sand movement patterns and to plan when renourishment is needed.

Renourishment fill volumes could be dredged from Unnamed Shoal A, Unnamed Shoal B, or a combination of one of these two shoals and the north Wallops Island borrow site. It is anticipated that approximately half of the fill volume for each renourishment cycle could be provided by the north Wallops Island borrow site.

Sand Removal Methods – North Wallops Island

Excavation depth for sand removal in the north Wallops Island proposed borrow site area is expected to be limited to about 1 meter (3.5 feet) below the ground surface due to tidal fluctuations and the high permeability of the soil (USACE, 2009b). Based on target depth of sediment removal, the area to be excavated would vary. For example, excavating to a depth of 1 meter (3.5 feet) would require a 70-acre area to provide a renourishment volume of 308,000 m^3 (403,000 yd^3).

Sand from north Wallops Island would be removed from land using a pan excavator. Because this excavator runs on several rubber tires with a low tire pressure, it can work in areas of the beach where typical equipment may be bogged down in unstable sand. The pan excavators would stockpile the sand, which would be loaded onto dump trucks that would transport the fill material up and down the beach. Bulldozers would then be used to spread the fill material once it is placed on the beach. All heavy equipment would access the beach from existing roads and established access points. No new temporary or permanent roads would be constructed to access the beach or to transport the fill material to renourishment areas.

Offshore Dredging Operations

Dredging of Unnamed Shoals A and B would be accomplished using a trailer suction hopper dredge (equipped with a turtle deflector), which is a ship capable of dredging material, storing it onboard, transporting it to the placement area, and pumping it on-shore. The hopper dredge fills its hoppers by employing large pumps to create suction in pipes that are lowered into the water to remove sediment from the shoal bottom (the process very closely resembles that of a typical vacuum cleaner). The hopper dredges likely to be used typically remove material from the bottom of the sea floor in layers up to 0.3 meters (1 foot) in depth (Williams, USACE, personal comm.).

Once the dredge hopper is filled, the dredge would transport the material to a pump-out station which would be temporarily anchored in the nearshore environment to deliver the sand and water slurry contained in the hopper dredge to the beach. The distance from Unnamed Shoal A to a theoretical average location for a pump-out station placed at a water depth of 9 meters (30 feet), which is reached approximately 1,830 meters (10,000 feet) offshore, is approximately 22 km (14 miles). The corresponding transit distance from Unnamed Shoal B and the theoretical pump-out station is approximately 30 km (19 miles).

The dredge would then mix the sand with water to form a slurry and pump the slurry from its discharge manifold through a submerged or floating pipeline. Discharge at the beach would occur at a fixed point in tandem with contouring of the deposited sand by bulldozers. Based on previous offshore dredging operations along the east coast, it is assumed that dredgers with a hopper capacity of approximately 3,000 m^3 (4,000 yd^3) would be used; however, because this volume is a slurry and not all sand, it is assumed that the actual volume of sand that each dredge would transport during each trip would be approximately 2,300 m^3 (3,000 yd^3).

Because of overflow from the hopper dredge at the offshore borrow site(s) during dredging and losses during pump-out and placement, a larger volume of material would need to be dredged to meet the targeted fill volume. Based on information from other shoreline restoration projects, sediment losses during dredging and placement operations may be up to 25 percent. Based on a conservative 25% loss during operations, dredge volumes for the offshore borrow sites are shown below in Table 1.

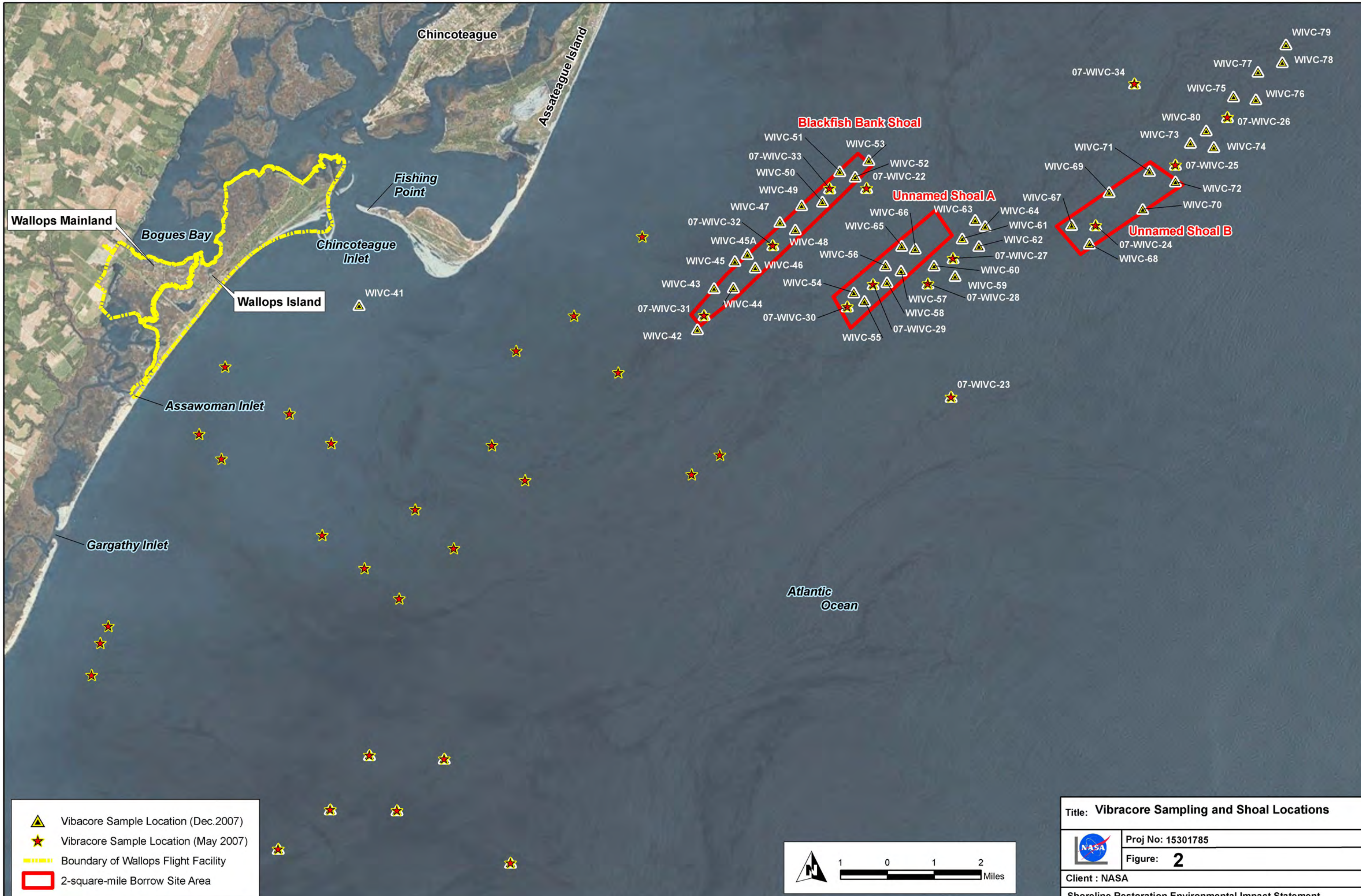
Table 1: Maximum Sand Removal Volumes

Nourishment Event	Possible Sources of Fill[1]	Volume of Sand Removed m^3 (yd^3)
Initial Nourishment	Shoal A	3,057,500 (3,998,750)
Single Renourishment Event	Shoal A or Shoal B	770,000 (1,007,500)
	North Wallops Island	308,000 (403,000)
Project Lifetime	Shoal A	9,990,000(13,066,250)

Nourishment Event	Possible Sources of Fill[1]	Volume of Sand Removed m^3 (yd^3)
	Shoal B	6,933,000 (9,067,500)
	North Wallops Island	2,773,000 (3,627,000)

[1]The north Wallops Island Borrow Site could provide up to about half of the renourishment fill per cycle
Source: USACE, 2009

The dredges would operate for 12 to 24 hour stretches. There would be approximately 1,000 to 1,100 dredge trips from the offshore borrow sites to the Wallops Island shoreline for the initial beach fill and approximately 240 to 270 dredge trips for each renourishment fill. Two dredges would be in use at the same time and would accomplish about 3 round trips per day. Assuming 10 percent downtime for the dredges due to weather, equipment failure, etc., the initial fill activities would take approximately 216 days, or about 7 months. Renourishment activities (assuming all fill is dredged from one of the proposed offshore shoals) would take approximately 50 days, or about 2 months. Under the Proposed Action, the initial fill plus the total fill volume over nine renourishment events would result in approximately 7,992,000 m^3 (10,453,000 yd^3) of sand being placed on the shoreline. The topography and bathymetry of the beach would be monitored on a regular basis to determine sand movement patterns and plan when renourishment is needed.



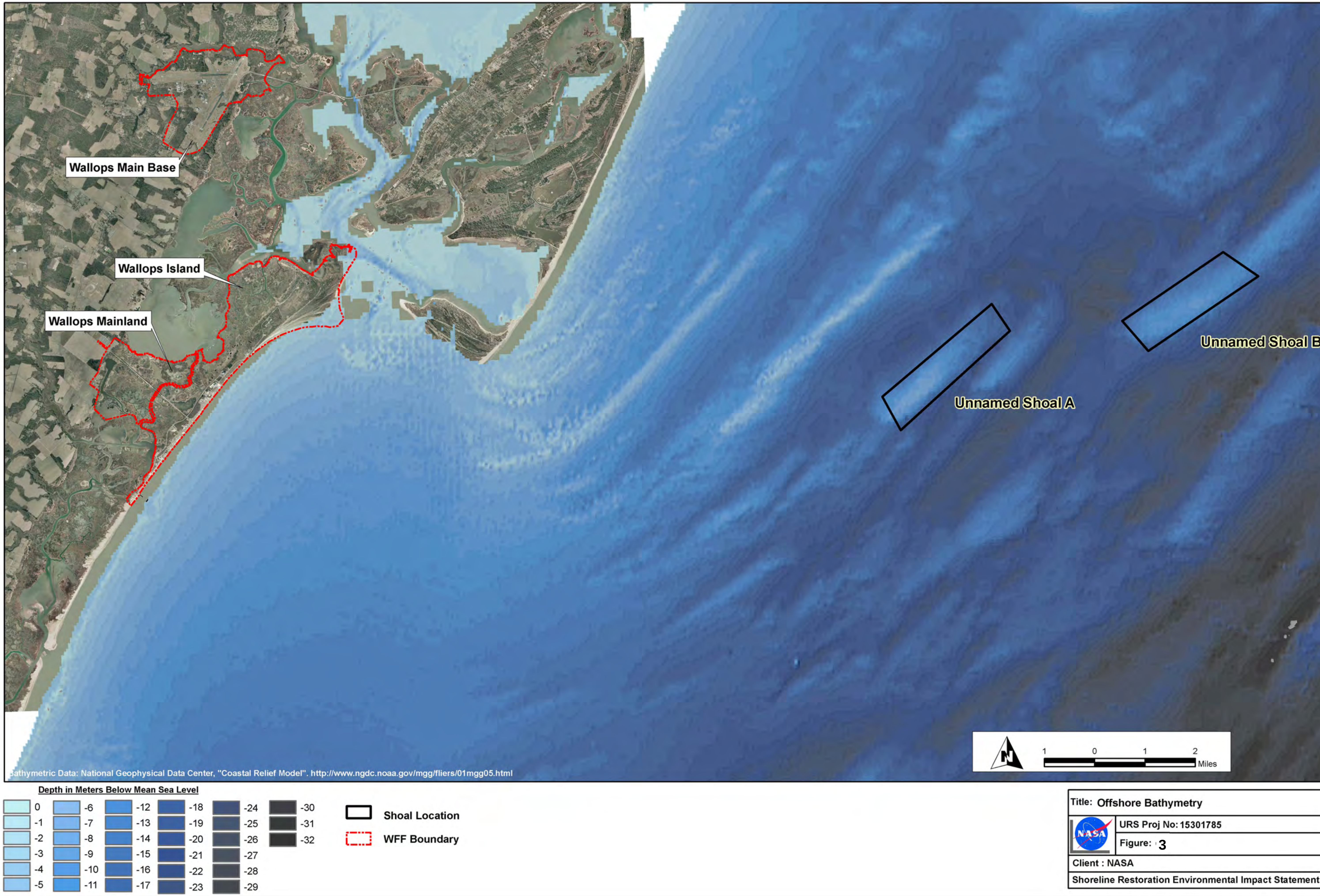
Title: Vibracore Sampling and Shoal Locations

Proj No: 15301785

Figure: 2

Client : NASA

Shoreline Restoration Environmental Impact Statement



Title: Offshore Bathymetry

URS Proj No: 15301785

Figure: 3

Client : NASA

Shoreline Restoration Environmental Impact Statement

SECTION FOUR: EFH CONSULTATION HISTORY

In 2006 and 2007, NASA prepared a Draft SRIPP Programmatic Environmental Assessment (PEA) to assess a wide variety of shoreline protection and sediment management alternatives at WFF. On April 17, 2007, NASA submitted an EFH assessment that considered the potential effects of offshore dredging and beach nourishment on Wallops Island. In response to the 2007 EFH assessment, the NMFS provided EFH conservation recommendations in a memorandum (NMFS, 2007) (Attachment A). The Draft PEA was never finalized but is serving as a basis for the development of the current SRIPP Programmatic Environmental Impact Statement (PEIS).

In March 2009, during the preparation of the SRIPP EIS, NASA submitted an updated Description of Proposed Action and Alternatives to NMFS for review. In a letter dated June 18, 2009, NMFS responded with comments on the SRIPP (Attachment B). NMFS suggested that EFH consultation be re-initiated and the initial EFH assessment under the PEA be updated because the proposed alternatives had changed substantially and 2 years had passed since the initial EFH assessment was submitted for the SRIPP.

SECTION FIVE: BENTHIC HABITATS OF THE OFFSHORE SHOALS

The nearshore Atlantic Ocean seafloor east of Wallops Island is relatively uniform and flat and does not contain large shoals that would provide suitable quantities of sand for beach fill (Hobbs et al., nd). Figure 4 shows the nearshore bathymetry of the seafloor east of Wallops Island adjacent to the shoreline.

The bathymetry of the seafloor in the region east of Assateague Island extending southward to the area east of northern Assawoman Island is extremely complex with many ridges running diagonal to the shore (Figure 5). Fishing Point extends from the southern end of Assateague Island approximately 6 km (4 miles) east of the northern end Wallops Island shoreline. Shallow shoals extend several miles further seaward. The area east of Wallops Island and south of the Chincoteague shoals is characterized by a slow and steady increase in depth seaward from the shoreline. In contrast, the bathymetry in the sand ridge complex area east of Assateague Island, including the Chincoteague Shoal, Blackfish Bank Shoal and Unnamed Shoals A and B has a wider range in depth. These sand ridges trend from northeast to southwest, and the shoal crests generally get deeper further offshore. The potential offshore borrow sites are located on separate sand ridges.

Depth in the sand ridge complex area ranges from an average of about 1 meter (4 feet) near the shoreline to about 30 meters (100 feet) deep about 21 km (13 miles) off shore in the vicinity of Unnamed Shoal B (Figure 20). The top of the Chincoteague Shoal ranges from 6.5 meters (21 feet) to about 2 meters (7 feet) below sea level. Depth between Chincoteague Shoal and Blackfish Bank Shoal drops to about 15 meters (50 feet). Blackfish Bank Shoal ranges in depth from 9 to 4 meters (30 to 13 feet). Moving eastward, depth drops to about 21 meters (70 feet) between Blackfish Bank and Unnamed Shoal A; Unnamed Shoal A has a depth of 12 to 7.5 meters (40 feet to 25 feet). Between Unnamed Shoals A and B, the depth ranges from to 23 to 12 meters (75 to 40 feet). Unnamed Shoal B ranges in depth from about 15 meters (50 feet) up to a high point of 9 meters (29 feet).

Beach Fill Extent
6000 meters
South end of existing seawall
Existing Geotextile Tubes
Proposed 1,400 meter Seawall Extension
UAS Runway
Camera Stand Z-100
Assawoman Inlet
Southern Boundary of WFF
1,500 0 1,500 3,000 Feet
Title: Seawall Extension and Beach Fill Overview
URS Proj No:15301785
Figure: 4
Client : NASA
Shoreline Restoration Environmental Impact Statement

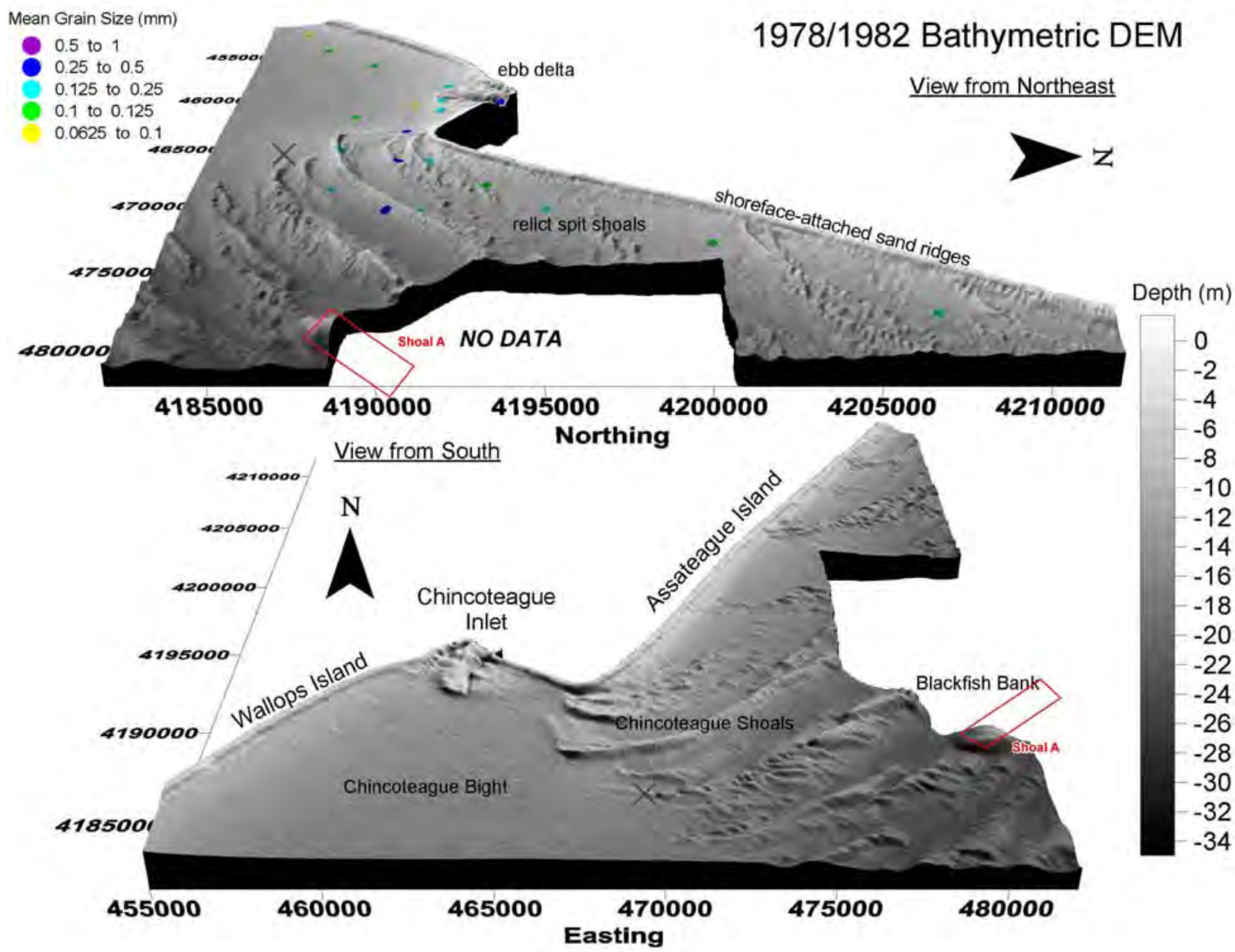


Figure 5: Bathymetry off Assateague Island

Source: Wikel, 2008. Bathymetric Digital Elevation Model (DEM) was created from 1978 and 1982 hydrographic surveys from the National Oceanic and Atmospheric Administration – National Geophysical Data Center.

Recent relevant studies which have been conducted include an assessment of the fauna on the sand shoals offshore of Ocean City, Maryland (Slacum et al. 2006), which is located approximately 64 km (40 miles) north of the SRIPP project area. Fifty-seven taxa of finfish were collected using a combination of small otter trawls, large commercial trawls, and gill net sets. Cutter and Diaz (2000) conducted beam trawls to characterize demersal, juvenile fish on shoals offshore of Ocean City, Maryland.

A video survey was conducted in July (NASA, 2009a) of the benthic habitat of the two unnamed sand shoals as part of baseline data collection for the PEIS. Video was collected at 40 stations at each of the shoals (80 stations total). The stations were established along 8 transects aligned across the approximate crest of each shoal with 5 stations per transect. The survey concluded that the proposed dredge area and the immediate area surrounding it are comprised of unconsolidated sand with no hard substrate present. In addition, a sub-bottom profile survey conducted in June and July (NASA, 2009b) for the offshore cultural resource investigation reached the same conclusion.

In general, results of the video survey indicated that sediment on the crests and topographically higher portions of the shoals were dominated by physical features such as ripple marks (Photos 1 and 2). The deeper portions of the shoals were dominated by shell fragments and hash as well as biological features such as tubes and feeding cones created by benthic organisms (Photo 3). Dominant epifaunal benthos included sand dollars (*Echinarachinus parma*) (Photo 4), hermit crabs (*Pagurus* spp.), crabs (*Libinia* spp., *Cancer* spp.) (Photo 5), moon shell (*Polinices* spp.) (Photo 6) and whelk (*Busycon* spp.). Fish were rarely seen at any of the stations; those that were observed were primarily (*Prionotus* spp.) (Photo 7).

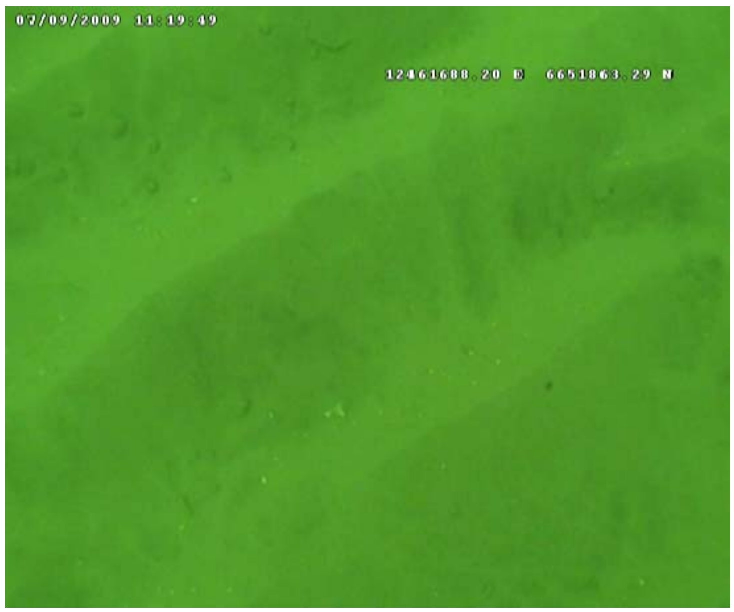


Photo 1: Station #20 from Unnamed Shoal B at a depth of approximately 45 ft depicting well-defined ripple marks and low shell content.

Photo 2: Station #39 from Unnamed Shoal B at a depth of approximately 56 ft with defined bedforms and low shell content.

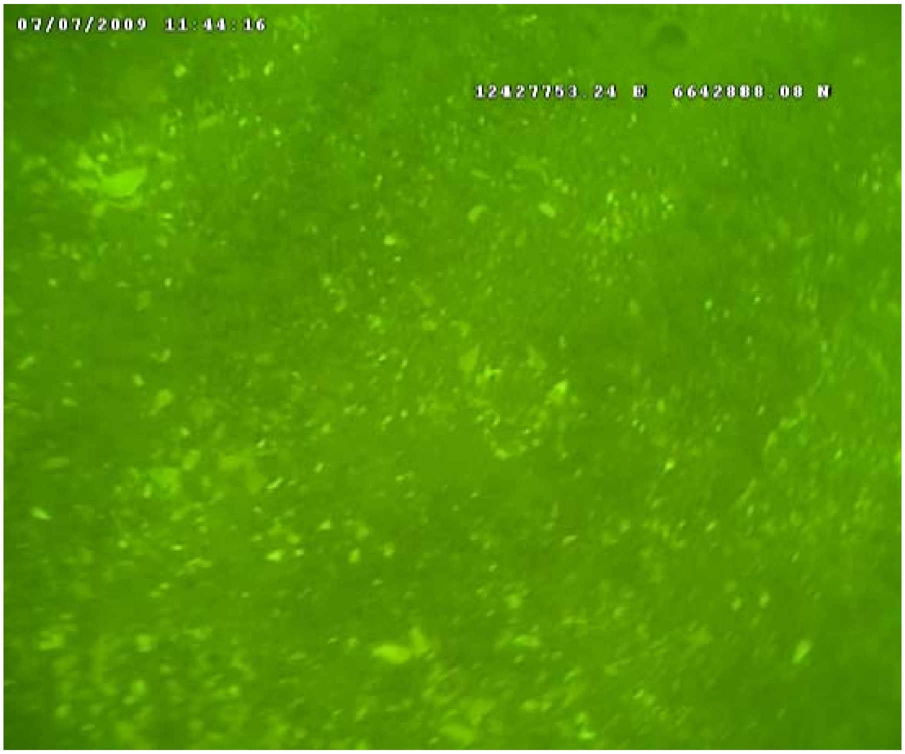


Photo 3: Station #2 from Unnamed Shoal A at a depth of 55 ft with high shell content and lack of surface bedforms

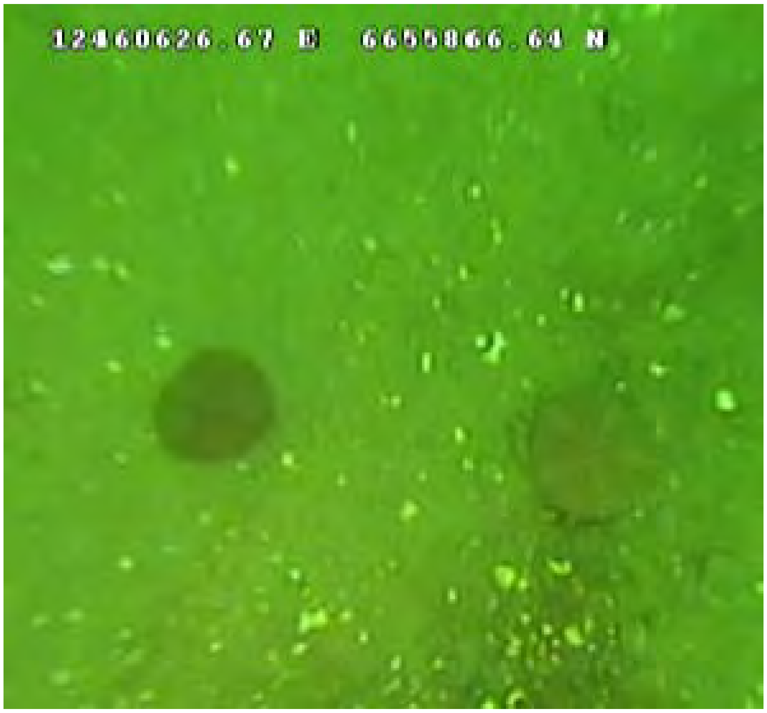


Photo 4: Sand dollars (*Echinarachinus parma*) from Station #14 Unnamed Shoal B at a depth of 48 ft.

Photo 5: Station #10 Unnamed Shoal B at a depth of 55 ft. Portly spider crab (*Libinia emarginata*) in lower right quadrant.

Photo 6: Station #10 Unnamed Shoal B at a depth of 55 ft. Moon snail (*Polinices* spp.) sand collars in upper right quadrant and moon snail in upper left quadrant.

Photo 7: Sea robin (*Prionotus* spp.) in lower right quadrant from Station #39 Unnamed Shoal B at a depth of 56 ft.

SECTION SIX: IDENTIFICATION OF MANAGED SPECIES

The National Marine Fisheries Guide to Essential Fish Habitat Designations in the Northeastern United States (http://www.nero.noaa.gov/hcd/) was used to determine potential species that have designated EFH in the project area. The species and life stages of EFH in the project area were determined by using the quick reference 10-minute x 10-minute (10' x 10') squares that are representative of the geographic area where project activities are proposed to occur.

The project area includes three 10' x 10' squares that are described below.

Square I:

Square I Coordinates

Boundary	**North**	**East**	**South**	**West**
Coordinate	38°00.0'	75°20.0'	37°50.0'	75°30.0'

Waters within Chincoteague Bay and the following areas: on the main coast of Virginia, from Powell Creek southwest of Greenbackville, VA; past Cockle Point, Swans Gut Creek, Sinnickson, VA; Horntown Ledge, Mosquito Creek, Cockle Creek, Shelley Bay, Shoaling Point, Willis Point, Gunboat Point, Kendell Narrows, Walker Marshes, Walker Point, Old Root Narrows, Gunboat Island, Balfast Narrows, all the way south to Wallops Island, Taylors Narrows, and Island Hole Narrows. Also, within the waters east of the above, within Simoneaston Bay, Watts Bay, Powells Bay, and Bogues Bay, the following features are included: almost all of Chincoteague Island, except for the northeast portion, the western part of Morris Island, Queen Sound Channel, Wire Narrows, Black Narrows, Chincoteague Channel Point, Chincoteague, Virginia, Piney Island, Assateague Channel, and southern Assateague Island, including around Assateague Point, Fishing Point, Assateague Beach, Tom's Cove, and Little Tom's Cove, as well as waters over southwestern Chincoteague Shoals, Turner's Lump, and Chincoteague Inlet.

Square II:

Square II Coordinates

Boundary	**North**	**East**	**South**	**West**
Coordinate	38°00.0'	75°10.0'	37°50.0'	75°20.0'

Atlantic Ocean waters, waters within Chincoteague Bay affecting the following: east of southern Assateague Island in Virginia, from Ragged Point Marshes on the north, south and west within Assateague Bay, around the Coardes Marshes, around Wild Cat Point on the northeast tip of Chincoteague Island, and Morris Island. Also affected are Blackfish Bank, and northern Chincoteague Shoals.

Square III:

Square III Coordinates

Boundary	North	East	South	West
Coordinate	37°50.0'	75°20.0'	37°40.0'	75°30.0'

Waters within the Atlantic Ocean, south one square of the square affecting Chincoteague Inlet in Virginia (Square I). The waters touch the coast near Hog Creek just north of Assawoman Inlet. They also affect Porpoise Banks and southwestern Wallops Island.

Managed Species Within The SRIPP Project Area

Species and their life stages within Squares I, II, and III are listed below.

Compiled Species List: Squares I, II and III

Species Common Name (*Scientific Name*)	Eggs	Larvae	Juveniles	Adults
Atlantic angel shark *(Squatina dumerili)*	---	X	X	X
Atlantic butterfish (*Peprilus triacanthus*)	---	---	X	X
Atlantic sea herring *(Clupea harengus)*	---	---	---	X
Atlantic sharpnose shark (*Rhizopriondon terraenovae)*	---	---	---	X
black sea bass (*Centropristus striata*)	n/a	X	X	X
bluefish (*Pomatomus saltatrix*)	---	X	X	X
clearnose skate *(Raja eglanteria)*			X	X
cobia (*Rachycentron canadum*)	X	X	X	X
dusky shark (*Charcharinus obscurus*)	---	X	X	---
king mackerel (*Scomberomorus cavalla*)	X	X	X	X
little skate *(Leucoraja erinacea)*			X	
monkfish *(Lophius americanus)*	X	X	---	---
red drum (*Sciaenops occelatus*)	X	X	X	X
red hake (*Urophycis chuss*)	X	X	X	---
sand tiger shark (*Odontaspis taurus*)	---	X	---	X
sandbar shark (*Charcharinus plumbeus*)	---	X	X	X
scalloped hammerhead shark *(Sphyrna lewini)*	---	---	X	X
scup (*Stenotomus chrysops*)	n/a	n/a	X	X
Spanish mackerel (*Scomberomorus maculatus)*	X	X	X	X
spiny dogfish *(Squalus acanthias)*	n/a	n/a	---	X

Species Common Name (*Scientific Name*)	**Eggs**	**Larvae**	**Juveniles**	**Adults**
summer flounder (*Paralicthys dentatus*)	---	---	X	X
surf clam (*Spisula solidissima*)	n/a	n/a	X	X
tiger shark (*Galeocerdo cuvieri*)		X		
windowpane flounder (*Scopthalmus aquosus*)	X	X	X	X
winter flounder (*Pleuronectes americanus*)	X	X	X	X
winter skate *(Leucoraja ocellata)*			X	X
witch flounder (*Glyptocephalus cynoglossus*)	X	---	---	---

Source: NMFS, No date, http://www.nero.noaa.gov/hcd/webintro.html. The notation "X" in the above table indicates that EFH has been designated within the project area for a given species and life stage. The notation "n/a" in the table indicates that the species either has no data available for the designated stage, or the particular stage is not present in the species' reproductive cycle. These species are: spiny dogfish, surf clam, which are referred to as pre-recruits and recruits (this corresponds with juveniles and adults in the table); scup and black sea bass, for which there is insufficient data for the life stages listed, and no EFH designation has been made as of yet for certain life stages, although data is available to describe the applicable life stages for these species.

Description of SRIPP Project Area

The SRIPP project area is found within the Mid-Atlantic Bight (MAB), one of the four subregions of The Northeast Continental Shelf ecosystem. Each subregions reflects different underlying oceanographic conditions and fishery management boundaries. There is also variation in marine water temperature, salinity, chlorophyll, and zooplankton biomass within each of these subregions.

The temperature and salinity within the MAB are two important factors influencing which managed fish species are present, and the time of year at which they are present in the SRIPP project area. In the MAB, temperature stratification varies greatly between summer and winter in. The water column is vertically well-mixed, with surface water temperatures of 14°C (57°F) at the surface and 11°C (52°F) at depth in the winter. During the summer, the water is generally 25°C (77°F) near the surface and 10°C (50°F) at depths greater than 656 feet (Paquette *et al*., 1995). The pH of the marine seawater is relatively stable due to the presence of the CO2-carbonate equilibrium system which maintains a pH between 7.5 and 8.5. The major chemical parameters of marine water quality include pH, dissolved oxygen, and nutrient concentrations. Salinity in the MAB generally ranges from 28 to 36 parts per thousand (ppt) over the continental shelf. Lower salinities are found near the coast and the highest salinities found near the continental shelf break. Marine seawater salinity is generally highest during the winter and lowest in the spring. The intrusion of saltier water (greater than 35 ppt) from the continental slope waters and freshwater input from coastal sources causes the variability in this area. A fairly uniform salinity range (32 to 36 ppt) is maintained throughout the year in continental slope waters of the MAB, with pockets of high-salinity water (38 ppt) near the Gulf Stream in the fall (DoN, 2008).

SECTION SEVEN: EVALUATION OF IMPACTS ON EFH SPECIES

7.1 ATLANTIC ANGEL SHARK (*Squatina dumerili*)

7.1.1 EFH for Atlantic Angel Shark

EFH for larvae (known as neonates), juveniles, and adults is off the coast of southern New Jersey, Delaware, and Maryland in shallow coastal waters out to the 25-meter (82-foot) isobath, including the mouth of Delaware Bay.

7.1.2 Background

The Atlantic angel shark is a bottom-dwelling species found in coastal waters of the Atlantic, generally at depths between 40 and 250 meters (131 and 820 feet). The flattened body and sandy-brown or gray color cause the shark to be frequently mistaken for a ray. The angel shark preys on demersal fish like flounder and skate, mollusks, crustaceans, and stingrays, such as the southern stingray (*Dasyatis americana)*. The shark is ovoviviparous, meaning that the female produces eggs, but they remain inside her body until they hatch, so that “live” birth occurs. The litter generally consists of 16 pups, which are born in the spring and summer. The angel shark is highly migratory, moving north during the summer and wintering in warmer southern waters (Florida Museum of Natural History, 2009).

7.1.3 Project Impacts

EFH may be adversely affected, as Atlantic angel sharks are known to frequent coastal areas. Although they may be present when dredging begins at the offshore shoals and during sand placement on the Wallops Island shoreline, they would have the ability to vacate the area once the disturbance begins. The disturbance of bottom sediments associated with dredging could interfere with feeding, predation, and avoidance patterns of this shark species. However, adverse impacts are expected to be temporary and highly localized.

7.2 ATLANTIC BUTTERFISH (*Peprilus triacanthus*)

7.2.1 EFH for Atlantic Butterfish

For juveniles and adults, offshore EFH is the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine through Cape Hatteras, North Carolina. Inshore, EFH is the "mixing" and/or "seawater" portions of all the estuaries where juvenile butterfish are "common," "abundant," or "highly abundant" on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia. Generally, juvenile butterfish are present in depths between 10 meters (33 feet) and 366 meters (1,200 feet) and temperatures between approximately 3°C (37°F) and 28°C (82°F).

7.2.2 Background

Both juveniles and adults are found over the shelf during the winter months, and spend the spring and fall in the estuaries. Schools of adults and larger juveniles form over sandy, sandy-silt, and muddy substrates. During summer, butterfish move toward the north and inshore to feed and spawn. Spawning occurs from June to August, and peaks progressively later at higher latitudes. During winter, butterfish move southward and offshore to avoid cool waters. Butterfish are primarily pelagic, and form loose schools that feed upon small fish, squid, and crustaceans. Smaller juveniles evade predation by associating with floating objects and organisms such as jellyfish. Inshore and in the surf-zone, butterfish prey on plankton, thaliaceans, squid, and copepods (Overholtz, 2000).

7.2.3 Project Impacts

Juvenile and adult butterfish may be present at the dredging area, but would likely temporarily vacate the shoal areas once dredging begins. No indirect impacts to juveniles or adults are expected due to dredging because butterfish are pelagic and their prey is largely found in the water column. The dredging area would be confined to portions of the two shoals and butterfish prey species are present throughout the surrounding areas. Dredging operations should not cause significant adverse impacts to the EFH for this species. Any adverse impacts, such as increased turbidity and loss of benthic prey would be highly localized and temporary.

7.3 ATLANTIC SEA HERRING (*Clupea harengus*)

7.3.1 EFH for Atlantic Herring

For adults, EFH consists of pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where Atlantic herring adults are found: water temperatures below 10° C (50° F), water depths from 20 to 130 meters (66 to 427 feet), and salinities above 28 ppt.

7.3.2 Background

Adult herring are found in pelagic waters and bottom habitats of the Mid-Atlantic Bight at water depths from 20 to 130 meters (65 to 426 feet). They primarily feed on zooplankton, krill, and fish larvae. Adult herring prefer temperatures below 10° C (50° F), and salinities above 28 ppt. Spawning occurs at depths of 15 to 46 meters (50 to 150 feet), at temperatures below 15°C, and salinities from 32 to 33 ppt. The bottom substrates on which they spawn consist of gravel, sand, and shell fragments, and eggs are occasionally found on aquatic macrophytes. The eggs are spawned in areas of well-mixed water, with tidal currents between 1.5 and 3.0 knots, with the majority of spawning in and adjacent to the project area occurring between July and November.

7.3.3 Project Impacts

Adult Atlantic herring may be present in the water column at the dredging areas. Atlantic herring are highly motile and would be able to vacate the shoal areas during dredging operations. Adult Atlantic herring are not generally associated with bottom habitats and are unlikely to be affected by activities in the proposed project area. No indirect impacts to adults are expected due to dredging because the area to be dredged is confined to portions of the two shoals and typical herring prey species are present throughout the surrounding areas.

7.4 ATLANTIC SHARPNOSE SHARK (*Rhizopriondon terraenovae*)

7.4.1 EFH for Atlantic Sharpnose Shark

EFH for adults is from Cape May, New Jersey, south to the North Carolina-South Carolina border; shallow coastal areas north of Cape Hatteras, North Carolina to the 25–meter (82-foot) isobath (USACE, 2009).

7.4.2 Background

Adult sharpnose sharks are found in estuaries, the surf zone of sandy beaches, and deeper offshore waters. This small shark only attains a maximum length of 85-90 cm (36 inches) when it is approximately 2.5 years old. Primary prey items of the sharpnose shark include small bony fish, worms, shrimp, crabs, and mollusks. Mating occurs in spring and early summer, followed by a 10 to 11 month gestation period. Litters of 4 to 7 pups are born in June in shallow coastal waters or estuaries.

7.4.3 Project Impacts

EFH may be adversely affected, as Atlantic sharpnose sharks are know to frequent coastal areas. Although they may be present when dredging begins at the offshore shoals and during sand placement on Wallops Island shoreline, they would have the ability to vacate the area once the disturbance begins. The disturbance of bottom sediments associated with dredging could interfere with feeding, predation, and avoidance patterns of this shark species. However, these adverse impacts are expected to be temporary and highly localized.

7.5 BLACK SEA BASS *(Centropristus striata)*

7.5.1 EFH for Black Sea Bass

For larvae, EFH consists of: 1) north of Cape Hatteras, the pelagic waters found over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina; and 2) estuaries where black sea bass were identified as common, abundant, or highly abundant in the Estuarine Living Marine Resources (ELMR) database, NOAA’s program to develop a consistent database of economically important fishes in the Nation’s estuaries, for the "mixing" and "seawater" salinity zones. Generally, the habitats for the transforming (to juveniles) larvae are near the coastal areas and into marine parts of estuaries between Virginia and New York. When larvae become demersal, they are generally found on structured inshore habitat such as sponge beds.

For juveniles, EFH consists of: 1) offshore, the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina; and 2) inshore, the estuaries where black sea bass are identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Juveniles are found in the estuaries in the summer and spring. Generally, juvenile black sea bass are found in waters warmer than 6 ^{o} C (43^{o} F) with salinities greater than 18 ppt and coastal areas between Virginia and Massachusetts. In winter, they are present offshore from New Jersey and south. Juvenile black sea bass are usually found in association with rough bottom, such as shellfish and eelgrass beds, and man-made structures in sandy-shelly areas; offshore clam beds and shell patches may also be used during the wintering.

For adults, EFH consists of: 1) offshore, the demersal waters over the Continental Shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina; and 2) inshore, the estuaries where adult black sea bass were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Black sea bass are generally found in estuaries from May through October. Wintering adults (November through April) are generally offshore, south of New York to North Carolina. Temperatures above 6° C (43^{o} F) seem to be the minimum requirements. Structured habitats (natural and man-made), and sand and shell substrate are preferred.

7.5.2 Background

Black sea bass is a demersal species found in temperate and subtropical waters all along the Atlantic coast, from the Gulf of Maine to the Gulf of Mexico. In the Mid-Atlantic, black sea bass migrate to inshore coastal areas and bays in the springtime and offshore areas in the fall as the temperatures change. The species is strongly associated with structured habitats including jetties, piers, shipwrecks, submerged aquatic vegetation, and shell bottoms.

7.5.3 Project Impacts

Potential impacts to the black sea bass EFH within both the offshore dredging site and the nearshore sand placement area are expected to be minimal and limited to temporary disturbance of bottom sediments. Significant displacement is not expected, as much of the underwater habitat (i.e., structures) that the species is strongly associated with is not prevalent in the proposed project area.

7.6 BLUEFISH *(Pomatomus saltatrix)*

7.6.1 EFH for Bluefish

For larvae, EFH consists of: 1) North of Cape Hatteras, pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) most commonly above 49 feet (15 meters), from Montauk Point, New York, south to Cape Hatteras; 2) south of Cape Hatteras, 100% of the pelagic waters greater than 45 feet over the continental shelf (from the coast out to the eastern edge of the Gulf Stream) through Key West, Florida; and 3) the "slope sea" and Gulf Stream between latitudes 29^{o} 00' N and 40^{o} 00' N. Bluefish larvae are not generally found inshore so there is no EFH designation inshore for larvae. Generally, bluefish larvae are present April through September in temperatures greater than 18^{o} C (64^{o} F) in shelf salinities greater than 30 ppt.

For juveniles, EFH consists of: 1) north of Cape Hatteras, pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ) from Nantucket Island, Massachusetts south to Cape Hatteras; 2) south of Cape Hatteras, 100% of the pelagic waters over the continental shelf (from the coast out to the eastern edge of the Gulf Stream) through Key West, Florida; 3) the "slope sea" and Gulf Stream; and 4) inshore, EFH is all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Generally juvenile bluefish occur in North Atlantic estuaries from June through October, Mid-Atlantic estuaries from May through

October, and South Atlantic estuaries March through December, within the "mixing" and "seawater" zones (Nelson et al., 1991; Jury et al., 1994; Stone et al., 1994). Distribution of juveniles by temperature, salinity, and depth over the continental shelf is undescribed (Fahay, 1998).

For adults, EFH consists of: 1) north of Cape Hatteras, the pelagic waters found over the continental shelf (from the coast out to the limits of the EEZ), from Cape Cod Bay, Massachusetts south to Cape Hatteras; 2) south of Cape Hatteras, 100% of the pelagic waters over the continental shelf (from the coast out to the eastern edge of the Gulf Stream) through Key West, Florida; and 3) inshore, all major estuaries between Penobscot Bay, Maine and St. Johns River, Florida. Adult bluefish are present in Mid-Atlantic estuaries from April through October in the "mixing" and "seawater" zones (Nelson et al., 1991; Jury et al., 1994; Stone et al., 1994). Bluefish adults are highly migratory and distribution varies seasonally and according to the size of the individuals comprising the schools. Bluefish are generally found in shelf salinities greater than 25 ppt.

7.6.2 Background

EFH is defined within the project area for larval, juvenile, and adult bluefish. Eggs of this species are pelagic and highly buoyant; with hatching and early larval development occurring in oceanic waters in the MAB, a coastal region running from Massachusetts to North Carolina. The young move inshore to estuaries, which serve as chief habitat for juveniles. Adults travel northward in spring and summer and to the south in fall and winter. Southerly migration may be closer to shore than northerly movement, although movement in both directions is characterized by inshore-offshore movement. It is believed that estuarine and nearshore waters are important habitats for juveniles and adults from Maine to Florida (NMFS, 2006). Adult bluefish prey on squid and other fish such as silverside.

7.6.3 Project Impacts

Bluefish are a schooling, pelagic species not associated with bottom habitats; therefore dredging operations should not significantly impact preferred habitat. Since bluefish are sight feeders, increased turbidity in the proposed project area may affect their ability to locate prey. Being highly mobile, however, bluefish should be able to avoid and/or quickly exit areas impacted by dredging operations. Wilber et al. (2003) reported in a study of the response of surf zone fish to beach nourishment in northern New Jersey that bluefish avoided areas of active beach fill operations. Any adverse impacts, such as increased turbidity and loss of benthic prey would be highly localized and temporary

7.7 CLEARNOSE SKATE (*Raja eglanteria*)

7.7.1 EFH for Clearnose Skate

For juveniles, EFH consists of bottom habitats with a substrate of soft bottom along the continental shelf and rocky or gravelly bottom, ranging from the Gulf of Maine south along the continental shelf to Cape Hatteras, North Carolina (the southern boundary of the New England Fishery Management Council [NEFMC] management unit). Generally, their full range is from the shore to 500 meters (1,640 feet), but they are most abundant at depths less than 111 meters

(364 feet). The juvenile skate prefers temperatures in the range of 9° to 30° C (48° to 86° F), but are most abundant from 9° to 21° C (48° to 70° F) in the northern part of its range and 19 to 30° C (66° to 86° F) around North Carolina.

For adults, EFH includes bottom habitats with a substrate of soft bottom along the continental shelf and rocky or gravelly bottom, ranging from the Gulf of Maine south along the continental shelf to Cape Hatteras, North Carolina (the southern boundary of the NEFMC management unit). Their full range is from the shore to 400 meters (1,312 feet), but they are most abundant at depths less than 111 meters (364 feet). The adult skate prefers temperature in the range of 9° to 30° C (48 to 86° F), but are most abundant from 9° to 21° C (48° to 70° F) in the northern part of its range and 19° to 30° C (66° to 86° F) around North Carolina.

7.7.2 Background

This skate species occurs along the eastern coast from the Nova Scotian Shelf to northeastern Florida, as well as in the northern Gulf of Mexico from northwestern Florida to Texas. North of Cape Hatteras, skate move inshore and northward along the Outer Continental Shelf during the spring and early summer, and offshore and southward during the autumn and early winter. In winter, the juveniles are most densely concentrated on the continental shelf from the Delmarva Peninsula to Cape Hatteras out to the 20 meter (66 foot) contour. In spring, skates concentrate inshore in the same region. In winter, adults are concentrated inshore out to 200 meters (656 feet) from near the Hudson Canyon to Cape Hatteras. In spring, small numbers of adults are found inshore out to 200 meters (656 feet) from Delaware to south of Cape Hatteras. In summer, small concentrations of adults are found from Cape May to Cape Hatteras, and during the fall, they are located from Long Island to Cape Hatteras. The clearnose skate is found on soft bottoms along the continental shelf but may also occur on rocky or gravelly bottoms. The species is abundant from the sublittoral zone out to about 55 meters (180 feet) (NOAA, 2003c).

7.7.3 Project Impacts

Disturbance of bottom habitat by dredging operations could negatively impact the clearnose skate, which favors soft bottom habitat which is prevalent throughout the project area. Additionally, turbidity associated with dredging could interfere with skate feeding, predation, and avoidance patterns. It is expected that these adverse impacts, however, would be temporary and highly localized. The benthic species that the skates feed would be expected to repopulate the dredged areas of sand bottom within a few years (Diaz et al., 2004). The skate is a highly mobile species, and would be capable of foraging in other locations near the shoal while the benthic community recovers.

7.8 COBIA *(Rachycentron canadum)*

7.8.1 EFH for Cobia

EFH for all stages of cobia includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone. For cobia, EFH also includes high salinity bays, estuaries, and seagrass habitat. In addition the Gulf Stream is an EFH because it provides a mechanism to disperse coastal migratory pelagic larvae. For cobia, EFH occurs in the South Atlantic and Mid-Atlantic Bights.

7.8.2 Background

Cobia is a pelagic species found in small schools near piers, buoys, boats, and platforms, sandy shoals, and offshore sandbars. Cobia are also associated with large marine animals such as sea turtles, rays, and sharks; in fact, they are often mistaken for remora (suckerfish). While usually found in the coastal areas, they occasionally inhabit inshore bays and inlets. Females form large aggregations and spawn during the day in the inshore area just outside coastal bays, inside bays, and in other areas within estuaries from June to mid-August. Spawning occurs once every 9 to 12 days, often up to 15 times per season (Florida Museum of Natural History, 2009). Cobia eggs are planktonic, and float freely in the water column. In the spring, the adults migrate north from the warmer waters of the Florida Keys to the coastal waters of Virginia. Cobia feed on crustaceans, invertebrates, and occasionally other pelagic fish (NOAA, 2009).

7.8.3 Project Impacts

This coastal migratory pelagic species may be impacted by proposed project activities, especially juveniles and adults which tend to feed on crabs and inhabit inshore environments. Disturbance to bottom habitat by dredging may affect prey availability in the project area. However, these adverse impacts are likely to be highly localized and temporary.

7.9 DUSKY SHARK *(Charcharinus obscurus)*

7.9.1 EFH for Dusky Shark

For neonate/early juveniles, EFH consists of shallow coastal waters, inlets and estuaries to the 25-meter (82-foot) isobath from the eastern end of Long Island, New York, to Cape Lookout, North Carolina; from Cape Lookout south to West Palm Beach, Florida, in shallow coastal waters, inlets and estuaries and offshore areas to the 100-meter (328-foot) isobath.

For late juveniles/subadults, EFH includes off the coast of southern New England, coastal and pelagic waters between the 25- and 200-meter (82- and 656-foot) isobaths; shallow coastal waters, inlets and estuaries to the 200-meter (656-foot) isobath from Assateague Island at the Virginia/Maryland border to Jacksonville, Florida (NOAA, 2008).

7.9.2 Background

Dusky shark habitat ranges from shallow inshore waters to beyond the continental shelf. Although the shark feeds near the bottom, it can also be found anywhere in the water column up to 378 meters (1,240 feet) deep. Mating occurs in the spring, followed by a gestational period of either 8 or 16 months, depending on the number of birth seasons in a given year. While juveniles inhabit estuaries and shallow coastal waters, adults are not found in estuaries or waters with lower salinities. The dusky shark preys on a variety of fish and invertebrates, such as herring, grouper, sharks, skates, rays, crabs, squid, and starfish. The species is highly migratory, moving north during the summer and wintering in warmer southern waters. Males and females make the seasonal migrations separately (Florida Museum of Natural History, 2009).

7.9.3 Project Impacts

EFH for neonates and juveniles may be adversely affected by dredging operations associated with the proposed project, as the species is known to frequent the bottom habitats of coastal areas. The disturbance of bottom sediments associated with dredging could interfere with feeding, predation, avoidance, and migratory movements of this shark species. The dusky shark would experience a deficit of prey items in the immediate dredging area; however, this adverse impact is expected to be temporary and highly localized.

7.10 KING MACKEREL *(Scomberomorus cavalla)*

7.10.1 EFH for King Mackerel

EFH for all stages of king mackerel includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, from the Gulf Stream shoreward, including *Sargassum*. For king mackerel, EFH also includes high salinity bays, estuaries, and seagrass habitat. In addition, the Gulf Stream is considered EFH because it provides a mechanism to disperse coastal migratory pelagic larvae. For king mackerel, EFH occurs in the South Atlantic and Mid-Atlantic Bights (USACE, 2009).

7.10.2 Background

King mackerel live in large schools in pelagic waters at depths from about 23 to 34 meters (75 to 112 feet). Spawning takes place over the Outer Continental Shelf from May through October, with peaks between late May and early July, and between late July and early August. The larval stage of this species is very brief, with growth rates of 0.51 mm to 1.27 mm (0.02 to 0.05 inches) per day (Florida Museum of Natural History, 2009). Larvae are found in estuaries with water temperatures from 26° to 31° C (79° to 88° F). Juveniles prey on fish larvae, small fish such as anchovies, and squid. In addition to pelagic fish and squid, adults prey on mollusks, shrimp, and other crustaceans. The adult king mackerel is present in waters with temperatures above 20° C (68° F), so their migration along the Atlantic coast migration depends heavily on the temperature of the coastal waters.

7.10.3 Project Impacts

King mackerel is a coastal, pelagic species not associated with bottom habitats. Therefore dredging operations should not significantly impact king mackerel EFH. Being highly mobile, king mackerel should be able to avoid and/or quickly exit areas impacted by dredging operations. Adverse impacts to king mackerel EFH, such as increased turbidity and decreased prey populations, would be highly localized and temporary.

7.11 LITTLE SKATE *(Leucoraja erinacea)*

7.11.1 EFH for Little Skate

For juveniles, EFH includes bottom habitats with a sandy or gravelly substrate or mud, ranging from Georges Bank through the Mid-Atlantic Bight to Cape Hatteras, North Carolina. Generally, juvenile little skates are found from the shore to depths of 137 meters (449 feet), with the highest abundance from 73 to 91 meters (240 to 299 feet). Most juvenile skates are found in waters between 4° to 15° C (39° to 59° F).

For adults, EFH consists of bottom habitats with a sandy or gravelly substrate or mud, ranging from Georges Bank through the Mid-Atlantic Bight to Cape Hatteras, North Carolina. Generally, little skate adults are found from the shore to depths of 137 meters (449 feet), with the highest abundance from 73 to 91 meters (240 to 299 feet). Most juveniles prefer temperatures in the range of 2° to 15° C (36° to 59° F).

7.11.2 Background

Little skate make no extensive migrations, although where it occurs inshore the species moves onshore and offshore with seasonal temperature changes. This species is found on sandy or gravelly bottoms but may also occur on mud bottoms. They are known to remain buried in depressions during the day and become more active at night (NOAA, 2003b). Common prey items include crabs, shrimp, worms, amphipods, ascidians (sea squirts), bivalve mollusks, squid, small fishes, and some copepods.

7.11.3 Project Impacts

The disturbance of bottom habitat by dredging could negatively impact the little skate EFH. Little skate are known to bury themselves in sea floor depressions during daylight hours. Additionally, turbidity could interfere with little skate feeding, predation, and avoidance patterns. It is expected that these adverse impacts, however, would be temporary and highly localized.

7.12 MONKFISH *(Lophius americanus)*

7.12.1 EFH for Monkfish

For eggs, EFH consists of surface waters of the Gulf of Maine, Georges Bank, southern New England, and the Middle Atlantic south to Cape Hatteras, North Carolina. Generally, the monkfish egg veils are found at sea surface temperatures below 18° C (64° F), and water depths from 15 to 1000 meters (49 to 3,281 feet). Monkfish egg veils are most often observed from March to September.

For larvae, EFH is the pelagic waters of the Gulf of Maine, Georges Bank, southern New England and the Middle Atlantic south to Cape Hatteras. Generally, the following conditions exist where monkfish larvae are found: water temperatures 15° C (59°F) and water depths from 25 - 1000 meters (82 to 3,281 feet). Monkfish larvae are most often observed from March to September.

7.12.2 Background

Monkfish are demersal, and prefer sand, mud, and shell habitats. They can be found from inshore up to 899 meters (2,950 feet) deep, at a wide range of temperatures. Fish, crustaceans, mollusks, shrimp, squid and even seabirds are prey for juvenile and adult monkfish. Larval monkfish prey on zooplankton in the water column. Spawning occurs from February to October, from the southern part of the range to the north. Monkfish are believed to spawn over inshore shoals and in deeper offshore waters.

7.12.3 Project Impacts

Monkfish eggs and larvae may be present in the water column within the project area from March to September. If they are present at the offshore shoals during dredging, some eggs and larvae may be entrained during dredging operations; however, this will be temporary and localized to the area being dredged. In addition, eggs and larvae may be disturbed by the turbidity created in the water column. The sediment is expected to settle from the water column shortly after dredging activities cease. In addition, eggs and larvae may be when sand is pumped along the shoreline. It is expected that these adverse impacts to monkfish EFH, however, would be temporary and highly localized.

7.13 RED DRUM *(Sciaenops occelatus)*

7.13.1 EFH for Red Drum

For all stages of red drum, EFH includes all the following habitats to a depth of 50 meters (164 feet) offshore: tidal freshwater; estuarine emergent vegetated wetlands (flooded salt marshes, brackish marsh, and tidal creeks); estuarine scrub/shrub (mangrove fringe); submerged rooted vascular plants (sea grasses); oyster reefs and shell banks; unconsolidated bottom (soft sediments); ocean high salinity surf zones; and artificial reefs. The area covered extends from Virginia through the Florida Keys.

7.13.2 Background

Red drum are distributed along the Atlantic coast in temperatures ranging from 2° to 33°C (36° F to 91° F). Larval and juvenile red drum use the shallow backwaters of estuaries as nursery areas and remain there until they move to deeper water portions of the estuary associated with river mouths, oyster bars, and front beaches. The types of estuarine systems vary along the Atlantic and subsequently, the preferred juvenile habitat also varies with distribution. Young red drum are found in quiet, shallow, protected waters with grassy or slightly muddy bottoms. Shallow bay bottoms or oyster reef substrates are preferred by subadult and adult red drum. Nearshore artificial reefs along the Atlantic are also known to attract red drum as they make their spring and fall migrations. In the fall and spring red drum concentrate around inlets, shoals, capes, and from the surfzone to several miles offshore. Spawning occurs in or near passes of inlets, with larvae being transported into the upper estuarine areas of low salinity. As larvae develop into juveniles and subadults, they use progressively higher salinity estuarine and beachfront surf zones. Red drum move out of estuarine areas as adults and occupy the high salinity surf zone nearshore and offshore coastal waters. In North Carolina and Virginia, large adults move into estuaries during summer months (SAFMC, 1998). Red drum feed on the bottom on small bony fish, crabs, and shrimp (Davis, 1990).

7.13.3 Project Impacts

EFH for this coastal migratory pelagic species may be impacted by proposed project activities, especially EFH for juveniles and adults which feed on crabs, shrimp, and fish that inhabit littoral and nearshore environments. Disturbance to bottom habitat by dredging may affect prey availability in the project area. However, these adverse impacts are likely to be highly localized and temporary.

7.14 RED HAKE *(Urophycis chuss)*

7.14.1 EFH for Red Hake

EFH for eggs includes the surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, hake eggs are found in areas where sea surface temperatures are below 10° C (50° F) along the inner continental shelf with salinity less than 25 ppt. Eggs are most often present during the months from May through November, with peaks in June and July.

EFH for larvae includes surface waters of Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, red hake larvae are found where sea surface temperatures are below 19° C (66° F), water depths are less than 200 meters, and salinity is greater than 0.5 ppt. Red hake larvae are most often observed from May through December, with peaks in September and October.

EFH for juveniles consists of bottom habitats with a substrate of shell fragments, including areas with an abundance of live scallops, in the Gulf of Maine, on Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Generally, red hake juveniles are found where water temperatures are below 16° C (61° F), depths are less than 100 meters (328 feet), and salinity ranges from 31 to 33 ppt.

7.14.2 Background

Red hake migrate seasonally, coming from as far north as Maine to the warmer southern waters of Virginia and North Carolina. Spawning for red hake populations throughout the eastern Atlantic occurs in the Mid-Atlantic Bight. Not much is known about the eggs, other than that they float near the surface and hatching occurs about a week after spawning. Larvae can be found in the upper water column from May through December. Juveniles are pelagic and stay close to floating debris and patches of *Sargassum* until they are approximately 2 months old, at which time they become demersal. Juveniles prefer silty, fine sand sediments while adults favor muddy substrates (NOAA, 1999b).

7.14.3 Project Impacts

Potential impacts to red hake EFH would be limited to temporary disruption of juvenile habitats due to dredging operations. Because significant population centers for this species tend to occur from New Jersey northward of the project area, project impacts would negligible.

7.15 SAND TIGER SHARK *(Odontaspis taurus)*

7.15.1 EFH for Sand Tiger Shark

EFH is defined within the project area for larvae and adult sand tiger sharks. The sand tiger shark may be found in the western Atlantic from the Gulf of Maine to Argentina, the Atlantic coast of Europe and North Africa, and the Mediterranean Sea. Sand tiger sharks may occur singly or in small schools and are active primarily at night. They are generally coastal and usually found from the surf zone to depths of around 25 meters (82 feet). However, they may also be found in shallow bays and to depths of 200 meters (656 feet).

7.15.2 Background

The sand tiger shark is found inshore in areas including the surf zone, shallow bays, reefs, and wrecks. It can also be found in deeper areas like the Outer Continental Shelf. The sand tiger shark usually gives birth to only one or two pups at a time. Although the shark can be found throughout the water column, it prefers to drift along the bottom. To become buoyant in the water column, the shark comes to the surface to gulp air, as it lacks the swim bladder that bony fish possess. The species is seasonally migratory, moving north during the summer and wintering in warmer southern waters. Common prey includes herring, bluefishes, flatfishes, eels, mullets, snappers, rays, squid, crabs, and other sharks (Florida Museum of Natural History, 2009).

7.15.3 Project Impacts

Because sand tiger sharks favor littoral and inshore areas, EFH may be adversely affected by dredging operations associated with the proposed project. These sharks also feed on crabs that may be impacted by bottom habitat disturbance. However, adverse impacts are expected to be temporary and highly localized.

7.16 SANDBAR SHARK *(Charcharinus plumbeus)*

7.16.1 EFH for Sandbar Shark

For neonates/early juveniles, EFH consists of shallow coastal areas to the 25-meter (82-foot) isobath from Montauk, Long Island, New York, south to Cape Canaveral, Florida (all year); nursery areas in shallow coastal waters from Great Bay, New Jersey, to Cape Canaveral, Florida, especially Delaware and Chesapeake Bays (seasonal-summer); shallow coastal waters to up to a depth of 50 meters (164 feet) on the west coast of Florida and the Florida Keys from Key Largo to south of Cape San Blas, Florida. Typical parameters include salinity greater than 22 ppt and temperatures greater than 21° C (70° F).

For late juveniles/subadults, EFH includes offshore southern New England and Long Island, both coastal and pelagic waters; also, south of Barnegat Inlet, New Jersey, to Cape Canaveral, Florida, shallow coastal areas to the 25–meter (82-foot) isobath; also, in the winter, in the Mid-Atlantic Bight, at the shelf break, benthic areas between the 100- and 200-meter (328- and 656-foot) isobaths; also, on the west coast of Florida, from shallow coastal waters to the 50–meter (164-foot) isobath, from Florida Bay and the Keys at Key Largo north to Cape San Blas, Florida.

For adults, EFH is on the east coast of the United States, shallow coastal areas from the coast to the 50-meter (164-foot) isobath from Nantucket, Massachusetts, south to Miami, Florida; also, shallow coastal areas from the coast to the 100-meter (328-foot) isobath around peninsular Florida to the Florida panhandle near Cape San Blas, Florida, including the Keys and saline portions of Florida Bay.

7.16.2 Background

The sandbar shark is the most common gray shark along the Mid-Atlantic Coast (Chesapeake Bay Program, 2009). From late May to early June, females head to the inlets and coastal bays of Virginia to give birth to litters of between 6 and 13 pups. The pups remain in the area until

September or October, when they school and migrate south, along with the adults, to the warmer waters of North Carolina and Florida. The sharks begin to return to the coastal waters of Virginia around April. Pups and juveniles feed primarily on crustaceans, graduating to a more diverse diet of fish from higher in the water column, as well as rays skates, mollusks, and crustaceans near or in the benthic layer. The sharks are bottom-dwellers found in relatively shallow coastal waters 18 to 61 meters (60 to 200 feet) deep on oceanic banks and sand bars with smooth, sandy substrates. The adults can also occasionally be found in estuaries in turbid waters with higher salinity (Florida Museum of Natural History, 2009).

7.16.3 Project Impacts

Because sandbar sharks favor habitats such as sand shoals, EFH may be adversely affected by dredging operations associated with the proposed project. No impacts to neonates/early juveniles are expected, as they tend to congregate in estuaries. Juveniles and adults are opportunistic bottom feeders whose prey items might be negatively impacted by dredging operations. The disturbance of bottom sediments associated with dredging could interfere with feeding, predation, avoidance, and migratory movements of this shark species. However, these adverse impacts are expected to be temporary and highly localized.

7.17 SCALLOPED HAMMERHEAD SHARK (*Sphyrna lewini*)

7.17.1 EFH for Scalloped Hammerhead Shark

EFH for juvenile sharks includes all shallow coastal waters of the U.S. Atlantic seaboard from the shoreline to the 200-meter (656-foot) isobath south to the vicinity of the Dry Tortugas and the Florida Keys.

7.17.2 Background

Litters of between 12 and 38 pups are born inshore in shallow waters during the summer months. The pups remain in shallow coastal areas, where they live until males reach 1.8 meters (6 feet) long and females reach 2.5 meters (8.2 feet). Although adult scalloped hammerheads are generally coastal-pelagic species found in shallow inshore waters, they can also be found in estuaries and deeper offshore habitats of up to 275 meters (902 feet) in depth. The sharks tend to school as juveniles, preferring to swim in pairs or alone as they mature. Typically the adults are found inshore during the day and move offshore at night to feed on prey including fish, cephalopods, crustaceans, rays, and smaller sharks (Florida Museum of Natural History, 2009).

7.17.3 Project Impacts

EFH for juvenile hammerhead sharks may be adversely affected by dredging operations associated with the proposed project. This species is known to move between inshore and offshore environments and favored prey fish species might be negatively impacted by turbidity associated with dredging. Any adverse impacts, such as increased turbidity and decrease in availability of prey would be highly localized and temporary.

7.18 SCUP *(Stenotomus chrysops)*

7.18.1 EFH for Scup

For juveniles, EFH includes: 1) offshore, the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina; and 2) inshore, the estuaries where scup are identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. In general during the summer and spring, juvenile scup are found in estuaries and bays between Virginia and Massachusetts, in association with various sands, mud, mussel and eelgrass bed type substrates and in water temperatures greater than 7.2°C (45^{o} F) and salinities greater than 15 ppt.

For adults, EFH consists of: 1) offshore, the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina; and 2) inshore, the estuaries where scup were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Generally, wintering adults (November through April) are usually offshore, south of New York to North Carolina, in waters above 7.2° C (45^{o} F).

7.18.2 Background

Although EFH is not designated for eggs and larvae within the project areas, they can be found inshore from May through September in Virginia in waters between 13 and 23° C (55^{o} and 73^{o} F) and in salinities greater than 15 ppt. Both juveniles and adults are demersal. Juveniles are found in a variety of benthic habitats in offshore waters, as well as inshore estuaries and bays in temperatures greater than 7° C (45^{o} F) and salinities greater than 15 ppt. Adults are found both inshore and offshore of Virginia during warmer months. From November through April, they are found offshore in waters above 7° C (45^{o} F). Scup form schools based on their body size, utilizing a wide range of areas, such as smooth and rocky bottoms, and around piers, rocks, underwater infrastructure, wrecks, and mussel beds, at depths of 2 to 37 meters (6 to 120 feet) (MDFG, 2009). Migration occurs from the coastal waters in the summer to offshore waters in the wintertime (USACE, 2009d).

7.18.3 Project Impacts

The disturbance of bottom sediments associated with dredging could adversely impact scup EFH and interfere with the feeding, predation, avoidance, and migratory movements of scup juvenile and adult pelagic life stages. As a demersal species, there is a possibility that scup may become entrained in the dredge. However, no permanent effects to the species or the shallow water habitat are anticipated. Any adverse impacts, such as increased turbidity and loss of benthic prey would be highly localized and temporary.

7.19 SPANISH MACKEREL *(Scomberomorus maculatus)*

7.19.1 EFH for Spanish Mackerel

EFH for all stages of Spanish mackerel includes sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters, from the surf to the shelf break zone, but from the Gulf Stream shoreward, including *Sargassum*. All coastal inlets and all state-designated nursery habitats are of particular importance to Spanish mackerel. EFH also includes high salinity bays, estuaries, and seagrass habitat. In addition, the Gulf Stream is considered EFH because it provides a mechanism to disperse coastal migratory pelagic larvae. For Spanish mackerel, EFH occurs in the South Atlantic and Mid-Atlantic Bights.

7.19.2 Background

Spanish mackerel eggs are found in open water off the coast of Virginia from April through September. The Spanish mackerel is most commonly found in waters with a temperature above 20° C (68° F) and salinity greater than 30 ppt. The species prefers the waters from the surf zone to shelf break from the Gulf Stream shoreward, especially sandy shoal and reef areas, and can occasionally be found in shallow estuaries and in grass beds. In the open ocean, Spanish mackerel feed on pelagic fish including herring, sardines, mullet, and anchovy; shrimp; crabs; and squid (NOAA, 2009). Spanish mackerel are a fast-swimming, highly migratory species which is found in large schools. They winter in the warm pelagic waters of Florida, moving north along the coast to Virginia waters in April or May.

7.19.3 Project Impacts

Spanish mackerel are a fast moving coastal, pelagic species not associated with bottom habitats. Therefore, dredging operations should not significantly impact Spanish mackerel EFH. Being highly mobile, Spanish mackerel should be able to avoid and/or quickly exit areas impacted by dredging operations. Adverse impacts, such as increased turbidity and absence of prey would be highly localized and temporary.

7.20 SPINY DOGFISH *(Squalus acanthias)*

7.20.1 EFH for Spiny Dogfish

For Adults, EFH includes the following: North of Cape Hatteras, the waters of the Continental shelf from the Gulf of Maine through Cape Hatteras, North Carolina in areas that encompass the highest 90% of all ranked ten-minute squares for the area where adult dogfish were collected in the NEFSC trawl surveys. 2) South of Cape Hatteras, EFH is the waters over the Continental Shelf from Cape Hatteras, North Carolina through Cape Canaveral, Florida, to depths of 450 meters (1476 feet) 3) Inshore, EFH is the "seawater" portions of the estuaries where dogfish are common or abundant on the Atlantic coast, from Passamaquoddy Bay, Maine to Cape Cod Bay, Massachusetts. Generally, adult dogfish are found at depths of 10 to 450 meters (33 to 1476 feet) in water temperatures ranging between 3^{o}F (37°F) and 28^{o}C (82 ^{o}F).

7.20.2 Background

Dogfish are located both inshore and offshore at the Continental Shelf. Although dogfish can be found at the surface and in the water column, they spend most of their time on the bottom. They can also be found inshore and in estuaries. Spiny dogfish primarily prey on a variety of species including herring, mackerel, squid, silver hake, and comb jellies. Flatfishes, polychaetes, marine worms, shrimp, crab, snails, and squid also comprise their diet. Dogfish are seasonally migratory and would most often be found in the project area during the spring and fall. During the summer they are found in waters to the north, and during the winter they migrate south to warmer waters.

7.20.3 Project Impacts

Because dogfish may be present near the offshore shoals, EFH may be adversely affected by dredging operations. Adults are typically found on the sand bottom, so they may temporarily vacate the area during dredging. The disturbance of bottom sediments associated with dredging could interfere with feeding, predation, avoidance, and migratory movements of this species. However, these adverse impacts are expected to be temporary and highly localized, and would be minimized if the dredging occurs in the summer or winter.

7.21 SUMMER FLOUNDER *(Paralicthys dentatus)*

7.21.1 EFH for Summer Flounder

EFH for juveniles consists of: 1) north of Cape Hatteras, the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina; 2) south of Cape Hatteras, the waters over the continental shelf (from the coast out to the limits of the EEZ) to depths of 150 meters (500 feet) from Cape Hatteras, North Carolina, to Cape Canaveral, Florida; and 3) inshore, all of the estuaries where summer flounder were identified as being present (rare, common, abundant, or highly abundant) in the ELMR database for the "mixing" and "seawater" salinity zones. In general, juveniles use several estuarine habitats as nursery areas, including salt marsh creeks, seagrass beds, mudflats, and open bay areas in water temperatures greater than 3° C (37^{o} F) and salinities from 10 to 30 ppt.

For adults, EFH consists of: 1) north of Cape Hatteras, the demersal waters over the continental shelf (from the coast out to the limits of the EEZ), from the Gulf of Maine to Cape Hatteras, North Carolina; 2) south of Cape Hatteras, the waters over the continental shelf (from the coast out to the limits of the EEZ) to depths of 150 meters (500 feet) from Cape Hatteras, North Carolina, to Cape Canaveral, Florida; and 3) inshore, the estuaries where summer flounder were identified as being common, abundant, or highly abundant in the ELMR database for the "mixing" and "seawater" salinity zones. Generally summer flounder inhabit shallow coastal and estuarine waters during warmer months and move offshore on the outer continental shelf at depths of 150 meters (500 feet) in colder months.

7.21.2 Background

EFH is defined within the project area for juvenile and adult summer flounder. The geographical range of the summer flounder encompasses the shallow estuarine waters and outer continental shelf from Nova Scotia to Florida. The center of the species abundance lies within the MAB from Cape Cod to Cape Hatteras, North Carolina. Adult and juvenile summer flounder normally inhabit shallow coastal and estuarine water during the warmer months of the year. In Virginia, adult flounder use the Eastern Shore seaside lagoons and lower Chesapeake Bay as summer feeding areas. The fish concentrate in shallow warm water at the upper reaches of the channels and larger tidal creeks on the Eastern shore in April and then move toward the inlets as spring and summer progress. Juveniles apparently utilize a range of substrate types ranging including mud, silt, and submerged aquatic vegetation. Adults seem to prefer sandy habitat in order to avoid predation and conceal themselves from prey. Seasonal temperature shifts appear to drive juveniles and adults in and out of estuary habitats (NOAA, 1999c). Juveniles prey on crustaceans, small pelagic fish and shrimp, and adults feed opportunistically on a variety of fish, crustaceans, squid, and polychaetes.

7.21.3 Project Impacts

Juvenile and adult summer flounder may face minimal impacts from proposed project activities. The project area itself does not appear to offer favorable habitat to this species which seems to prefer estuarine environments. Minor temporary impacts, including disturbance of bottom habitat by dredging operations, may occur as the flounder enter into and exit the favored estuarine environments provided on the eastern shore of Virginia. Also, flounder that remain on the bottom during dredging could be entrained and destroyed.

7.22 SURF CLAM *(Spisula solidissima)*

7.22.1 EFH for Surf Clams

Juveniles and adults are found throughout the substrate, to a depth of 1 meter (3 feet) below the water/sediment interface, within Federal waters throughout the Atlantic Exclusive Economic Zone (EEZ), which is the area that extends 200 nautical miles from the United States coastline. Surf clams were found in areas that encompass the top 90% of all the ranked 10-minute squares in the Northeast Fisheries Science Center (NEFSC) surf clam and ocean quahog dredge surveys. The species generally occurs from the beach zone to a depth of about 61 meters (200 feet), but beyond about 38 meters (125 feet) abundance is low.

7.22.2 Background

The surf clam is a bivalve mollusk which prefers substrates of fine to medium grained sand, in waters with salinities above 14 parts per thousand (ppt) (NJMSC, 2009). The clam rarely moves locations unless it becomes uncovered, it filter-feeds on plankton in its immediate area. Surf clams reproduce by releasing eggs and sperm directly into the water column; in Virginia waters this occurs from May to July (Cargnelli et al., 1999). Larvae are planktonic for approximately three weeks, at which time they grow a hard shell and settle to the bottom (NEFSC, 2006).

7.22.3 Project Impacts

Unnamed Shoals A and B fall within the area designated as EFH for the juvenile and adult surf clam. The dredging of these offshore sand shoals is expected to cause temporary adverse effects to this non-motile organism. Entrainment in the dredger would destroy surf clams in the areas of the shoals where sand is dredged, but the population would have the ability to rebound from undisturbed adjacent areas. Studies conducted from 2002 to 2005 by the Virginia Institute of Marine Science (VIMS) examined the effects of dredging to the benthic community in offshore sand shoals. The study suggests that benthic invertebrate communities destroyed by the dredger are able to rebound within a few years (Diaz et al., 2004). Dredging would also cause an increase in turbidity, which may temporarily impair the ability of the clams to feed by filtering plankton from the water. Surf clam predators would have a shortage of prey in the dredged shoal area until the population recovered.

7.23 TIGER SHARK *(Galeocerdo cuvieri)*

7.23.1 EFH for Tiger Shark

For tiger shark larvae (referred to as "neonates"), EFH extends from shallow coastal areas to the 200 m isobath in Cape Canaveral, Florida, north to offshore Montauk, Long Island, NY (south of Rhode Island); and from offshore southwest of Cedar Key, FL north to the Florida/Alabama border from shallow coastal areas to the 50 m isobath.

7.23.2 Background

The tiger shark is found in turbid coastal and pelagic waters of the Continental shelf, at depths of up to 350 meters (1,148 feet), although the shark has a tolerance for a wide variety of marine habitats (MBS, 2009). Tiger sharks have been found in estuaries and inshore as well. Prey items for the tiger shark include fish, crustaceans, mollusks, and plankton. Little is known about the nursery areas for tiger sharks, though they are believed to occur in offshore areas (NMFS, 2006b). Females are thought to produce a litter of pups every other year.

7.23.3 Project Impacts

Although it is possible that there may be tiger sharks in the project area, it is unlikely that they would experience significant adverse effects. A highly mobile species, the shark would be able to temporarily leave disturbed areas while dredging and placement of sand on the shoreline is occurring. Because of the shark's highly varied diet, the activities of the proposed action are not expected to cause difficulties in finding prey. Only short-term localized impacts on the tiger shark are anticipated.

7.24 WINDOWPANE FLOUNDER (*Scopthalmus aquosus*)

7.24.1 EFH for Windowpane Flounder

For eggs and larvae, EFH consists of pelagic waters around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Generally, windowpane flounder larvae are found at sea surface temperatures less than 20° C (68° F) and water depths less than 70 meters (230 feet). Larvae are often present from February to November with peaks in May and October in the middle Atlantic and July through August on Georges Bank.

EFH for juveniles is bottom habitat with a substrate of mud or fine-grained sand, around the perimeter of the Gulf of Maine, on Georges Bank, southern New England, and the middle Atlantic south to Cape Hatteras. Generally, windowpane flounder juveniles are found at water temperatures below 25° C (77° F), at depths from 1 to 100 meters (3 to 328 feet), and salinities between 5.5 to 36 ppt.

EFH for adults is comprised of bottom habitats with a substrate of mud or fine-grained sand around the perimeter of the Gulf of Maine, on Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border. Generally, windowpane flounder adults are found in water temperatures below 26.8° C (80° F), depths from 1 to 75 meters (3 to 246 feet), and salinities between 5.5 to 36 ppt.

EFH for spawning adults is bottom habitats comprised of mud or fine-grained sand in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to the Virginia-North Carolina border. Spawning windowpane flounder are found in water temperatures below 21° C (70° F), depths from 1 to 75 meters (3 to 246 feet), and salinities between 5.5 to 36 ppt. Windowpane flounder are most often observed spawning during the months February to December with a peak in May in the middle Atlantic.

7.24.2 Background

Windowpane flounder inhabit estuaries, nearshore waters, and the continental shelf of the middle Atlantic. The species is demersal and prefers substrates of sand or mud. Juveniles that settle in shallow inshore waters move to deeper waters as they grow, migrating to nearshore or estuarine habitats in the southern MAB in the autumn. Juvenile and adult windowpane feed on small crustaceans and various fish larvae.

7.24.3 Project Impacts

There may be some limited adverse impacts to windowpane flounder, particularly juveniles and adults due to their presence year-round (slightly less in the warmest summer months) in bottom habitats like the type present at the dredging sites. The disturbance of benthic sediments organisms caused by dredging operations would likely cause a temporary, localized reduction in prey species.

7.25 WINTER FLOUNDER *(Pleuronectes americanus)*

7.25.1 EFH for Winter Flounder

For eggs, EFH consists of bottom habitats with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Generally, winter flounder eggs are found in water temperatures less than 10° C (50° F), salinities from 10 to 30 ppt, and water depths of less than 5 meters (16 feet). On Georges Bank, winter flounder eggs are generally found in water less than 8° C (46° F) and less than 90 meters (295 feet) deep. Winter flounder eggs are often observed from February to June with a peak in April on Georges Bank.

For larvae, EFH consists of pelagic and bottom waters of Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the middle Atlantic south to the Delaware Bay. Generally, winter flounder larvae are found in sea surface temperatures less than 15° C (59° F), salinities from 4 to 30 ppt, and water depths of less than 6 meters (20 feet). On Georges Bank, winter flounder larvae are generally found in water less than 8° C (46° F) and less than 90 meters (295 feet) deep. Winter flounder larvae are often observed from March to July with peaks in April and May on Georges Bank.

For juveniles, EFH is bottom habitats with a substrate of mud or fine grained sand on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, winter flounder juveniles are found in water temperatures below 28°C (82° F), depths from 0.1 to 10 meters, and salinities from 5 to 33 ppt. Juveniles over one year old prefer water temperatures below 25°C (77° F), depths from 1 to 50 meters (3 to 164 feet), and salinities between 10 and 30 ppt.

For adults, EFH includes bottom habitats including estuaries with a substrate of mud, sand, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Generally, winter flounder adults are found in water temperatures below 25° C (77° F), at depths from 1 to 100 meters (3 to 328 feet), and salinities between 15 and 33 ppt.

EFH for spawning adults consists of bottom habitats, including estuaries with a substrate of sand, muddy sand, mud, and gravel on Georges Bank, the inshore areas of the Gulf of Maine, southern New England and the middle Atlantic south to the Delaware Bay. Spawning adults are found at water temperatures below 15° C (59° F), depths of less than 6 meters (20 feet), except on Georges Bank where they spawn as deep as 80 meters (262 feet), and salinities between 5.5 and 36 ppt. Winter flounder spawn from February through June.

7.25.2 Background

Winter flounder eggs are found inshore on sandy bottoms and algal mats. Approximately six weeks after hatching, larvae become demersal and their left eye migrates to the right side of their body. The coloring of the winter flounder includes shades of light sandy brown, enabling the fish to blend in with the substrate. Juveniles inhabit these inshore areas with sand or sand-silt substrates until they reach one year of age. Adults are found in offshore waters during the warm summer months, where they feed on shrimp, clams, worms, and other invertebrates. Winter flounder feed during the day due to its dependence on eyesight to locate prey. During the winter, adults migrate to inshore coastal areas with sandy, clay, and gravel bottoms. The flounder buries itself so that only the eyes are above the substrate. Winter flounder spawn from winter through springtime in shallow inshore waters, usually at the same location each year.

7.25.3 Project Impacts

Winter flounder are demersal and can be found on sandy bottoms similar to those found in the project area, and as a result EFH is likely to be adversely affected by the proposed project. The juveniles and adults are found at lower salinities, which are mostly found in the MAB in the spring. However, because the majority of winter flounder populations at all stages are found north of the Delaware Bay, impacts should be negligible. If any adult or juvenile flounder are present at the dredging sites, they would likely vacate the area when dredging begins, however, juveniles may be more vulnerable because of slower swimming speeds.

7.26 WINTER SKATE *(Leucoraja ocellata)*

7.26.1 EFH for Winter Skate

For juveniles, EFH consists of bottom substrates of sand and gravel or mud in Cape Cod Bay, on Georges Bank, the southern New England shelf, and through the Mid-Atlantic Bight to North Carolina. Winter skate juveniles are generally found at a depth range from shoreline to about 400 meters (1,312 feet) and are most abundant at depths less than 111 meters (364 feet). Preferred temperatures are from -1.2° to 21° C (30° to 70° F), with most found in water with temperatures ranging from 4° to 16 °C (39° to 61° F), depending on the season.

For adults, EFH includes bottom substrates of sand and gravel or mud in Cape Cod Bay, on Georges Bank, the southern New England shelf, and through the Mid-Atlantic Bight to North

Carolina. Winter skate adults are generally found at a depth range from shoreline to 371 meters and are most abundant at depths of 111 meters. Preferred temperatures are from –1.2° to 20° C (30° to 70° F), with most found in water with temperatures ranging from 5° to 15° C (41° to 59° F), depending on the season.

7.26.2 Background

The winter skate is found all along the western Atlantic, from Newfoundland to North Carolina. In the cooler winter months, the winter skate comes closer to shore. Winter skates prefer sandy and gravelly bottoms but may also be found in mud substrates. The skate lies on the ocean floor covered by a layer of sand during the day, and at night preys upon crabs, worms, squid, shrimp, clams, and occasionally small fish. Winter skates are oviparous. Although there is no defined reproductive season, skate reproduction peaks during the summer months. Each female produces approximately 40 egg cases per year, each containing one embryo. The egg cases are released by the female in offshore waters on rock bottom habitats.

7.26.3 Project Impacts

The disturbance of bottom habitat by dredging could negatively impact skate EFH. Skates are known bury themselves in sea floor depressions during daylight hours. Additionally, turbidity could interfere with feeding, predation, and avoidance patterns (NOAA, 2003a). It is expected that these adverse impacts, however, would be temporary and highly localized.

7.27 WITCH FLOUNDER *(Glyptocephalus cynoglossus)*

7.27.1 EFH for Witch Flounder

EFH for eggs consists of surface waters of the Gulf of Maine, Georges Bank, the continental shelf off southern New England, and the middle Atlantic south to Cape Hatteras. Witch flounder eggs are generally found at sea surface temperatures below 13° C (55° F) over deep water with high salinities. Eggs are most often observed during March through October.

7.27.2 Background

Witch flounder eggs are spawned from March through October, with May and June as the peak months. Eggs are spawned close to the bottom of deep pelagic waters, but they rise to the top of the water column where they develop and hatch. Eggs and larvae are found in waters with a temperature between 4° to 13° C (40° to 55° F). After metamorphosis, juveniles become demersal and generally remain in waters from 30 to 150 meters (98 to 492 feet), including the continental slope off Virginia (NOAA, 1999a).

7.27.3 Project Impacts

Within the project areas, EFH is not designated for larvae, juveniles, or adult witch flounder. No adverse effects to witch flounder eggs are anticipated because eggs are primarily found in areas to the north of the project area in waters of greater depths than those in the project area.

SECTION EIGHT: CUMULATIVE IMPACTS

The SRIPP Project Area includes sand shoals, sand bottom, and water column that may be utilized by managed fish and their prey. The Proposed Action would impact both offshore sand shoals and the nearshore waters adjacent to the Wallops Island shoreline.

Summary of Project Impacts

The dredging of sand from the offshore sand shoals would have a significant and immediate adverse impact on the local benthic community of the shoal. The primary direct effect would be the removal of sand and entrainment of the infauna and epifauna that reside within and on the sediment, including the managed surf clam. The anchors and anchor sweeps from the nearshore pump-out station would also have an adverse impact on the local benthic community. However, it is expected that there would be a negligible impact on the regional benthic ecosystem from these activities because: (1) the benthic assemblages on the sand shoals and the flat bottom nearshore area are not unique and are similar to assemblages in adjacent areas and (2) the spatial extent of the dredging and pump-out area is small compared to the broad area of the nearshore continental shelf. Studies conducted from 2002 to 2005 by the Virginia Institute of Marine Science (VIMS) examined the effects of dredging to the benthic community in offshore sand shoals. The study suggests that benthic invertebrate communities destroyed by the dredge are able to rebound within a period of a few years (Diaz et al., 2004).

The hopper dredge would cause an increase in turbidity which could temporarily disturb the ability of surf clams and other mollusks to feed by filtering plankton from the water; however, this effect would be temporary. In the nearshore area of Wallops Island, the placement of sand for beach nourishment can cause a smothering effect, likely to result in the loss of some immobile benthic species. The amount of individuals lost would depend on factors such as the size of the area to be dredged, the amount of sand removed, and the time of year that the beach nourishment takes place. The loss of these benthic invertebrates would create a loss of prey for local wildlife, including some managed fish species, but the effect will be localized and temporary.

Finfish inhabiting the sand bottom and shoals, such as black sea bass, summer flounder, windowpane flounder, winter flounder, and witch flounder would temporarily exit the disturbed area upon commencement of dredging, and would return shortly after dredging operations cease. It is likely that a small number of these fish will become entrained in the dredging equipment. The juvenile and adult bony finfish found in the water column are highly motile and will also likely exit the area during dredging, although a number of these fish may still become entrained in the dredger or ship propellers. Eggs and larvae are the life stages that are most likely to be affected by the temporary increase in turbidity and decrease in dissolved oxygen caused by dredging. These stages are more delicate and are unable to flee the area like juveniles and adults, and therefore will be more greatly impacted.

Cartilaginous finfish found within the project area, like the clearnose skate, spiny dogfish, sand tiger shark, sandbar shark, dusky shark, and the Atlantic angel shark are seasonally migratory, moving southward along the Atlantic Coast in search of warmer waters during the winter. They are usually found alone or in pairs when not migrating, so it is unlikely that there would be any concentrations of these species in the project area, especially in the wintertime. While pups and small juveniles are primarily found inshore in estuaries and in shallow coastal waters, adults can more readily be found offshore on the sand bottom, shoals, and occasionally in the water column. If the managed species were in the disturbed area upon commencement of dredging, they would migrate to another area and would likely return shortly after dredging operations cease. It is possible, though highly unlikely, that one of the managed skates or sharks would become entrained in the dredging equipment. This is due to their sparse numbers in any one area at a given time, and their ability to avoid the dredge.

Indirect impacts to managed fish species include diminished availability of bottom-dwelling food sources such as crustaceans and other invertebrates. A number of benthic prey species found on the shoals and sand bottom, such as crustaceans and worms, would be destroyed during dredging. Sedimentation at the shoals and burial during the beach nourishment on Wallops Island shoreline would likely smother a number of benthic species. This is expected to cause only a temporary reduction in prey, as the area is expected to become repopulated by benthic organisms from neighboring areas within approximately two years (Diaz et al., 2004). Increased turbidity and decreased dissolved oxygen are expected in the water column in both the dredging area and directly offshore of Wallops Island when sand is placed on the shoreline (MMS, 2006). The increased turbidity may temporarily clog the gills of fish, preventing them from extracting oxygen from the water and interfering with feeding ability. It can also slow egg growth and impair the survival of larvae (Gordon et al., 1972). However, any adverse effects due to increased turbidity and decreased dissolved oxygen in the water column would be minor and short-term.

This turbidity may temporarily cause difficulty in locating prey, but this would not cause adverse effects to any species in the area, as they can easily migrate to another area to feed. The dredging for the initial beach nourishment would be limited to an area of Unnamed Shoal A which is approximately 520 hectares (1,280 acres), so prey would still be accessible at the nearby Unnamed Shoal B (would not be considered for dredging until the first renourishment cycle approximately 5 years after initial beach fill), Blackfish Bank Shoal, and Chincoteague Shoals. These nearby shoals may experience increases impacts such as increases in turbidity and sedimentation, but it is anticipated to be temporary and minor.

While it is likely that there may be a number of individuals of managed species destroyed during both the dredging of the offshore shoals and the beach nourishment activities, the overall populations are not expected to be adversely affected in the long-term. Several environmental studies of beach nourishment indicate that there are no detrimental long-term changes in the beach fauna as a result of beach nourishment (USACE, 1992; Burlas *et al.*, 2001). The greatest influencing factor on beach fauna populations appears to be the composition of the placed material not the introduction of additional material onto the beach. The deposited sediments, when similar in composition (grain size and other physical characteristics) to existing beach material (whether indigenous or introduced by an earlier nourishment or construction event), do not appear to have the potential to result in long term impacts on the numbers of species or community composition of beach infauna (USACE, 1994, Burlas *et al.*, 2001).

Summary of Impacts on Offshore Shoals

Dredging activities would result in changes to the bathymetry of the selected offshore borrow site. The crest of Unnamed Shoal A is approximately 8 meters (25 ft) below msl with the adjacent troughs approximately 20 meters (70 ft) below msl. The crest of Unnamed Shoal B is approximately 9 meters (30 feet) deep. Dredging would be conducted in a manner to remove a uniform thickness of material from the chosen borrow area, and would deepen the shoal area by approximately 0.3 to 1.5 meters (1 to 5 feet) for both the initial nourishment and for each renourishment cycle. The shoal's general profile would be maintained, though at a lower elevation than pre-project conditions.

Within the borrow area, dredging may create a series of parallel furrows in the shoal surface up to several feet deep along the length of the dredged area. Based on the final dredging design, dredging may occur once in a given area of a shoal or multiple times.

The area impacted within the borrow site during a typical renourishment event would depend on the volume of sand needed and the thickness of material dredged, but is anticipated to be a significant change in bathymetry for each borrow cycle.

Dredging would remove a significant amount of sand from the shoal and shoal complex; approximately 30 percent of the total volume of Unnamed Shoal A and approximately 15 percent of the total volume of Unnamed Shoal B.

In addition, the bottom substrate at and near either of the borrow sites may be modified in several ways. A change in the hydrological regime as a consequence of altered bathymetry may result in a change of depositional patterns at the site and therefore a change in sediment grain size. Exposure of underlying sedimentary units may also change the depositional patterns by exposing material that has different textural and compositional properties than the existing bottom substrate.

Bottom substrate at a distance from the borrow site may also be modified by the deposition of fine-grained sediments in benthic and surface plumes generated by dredging activities. Sediments contained within plumes produced from the disturbance and resuspension of bottom sediments (benthic plume), and from discharges of the dredging vessel and equipment (surface plume), would settle out from the water column and be deposited at a distance from the dredge site. The deposition of resuspended sediments may result in a layer of sediment that differs from the existing substrate.

The approximate area that would be impacted throughout the 50-year project lifespan is presented in Table 2 below.

Table 2: Offshore Borrow Site Impacts

Borrow Area	Area Impacted by SRIPP[1]	Estimated Total Shoal Volume	Maximum Volume That Could Be Removed Over SRIPP Lifetime
Unnamed Shoal A	520 hectares (1,280 acres)	30 million m^3 (40 million yd^3)	9,990,000 m^3 (13,066,250)
Unnamed Shoal B	520 hectares (1,280 acres)	57 million m^3 (70 million yd^3)	6,932,500 m^3 (9,067,245)

[1]The total area that is proposed to be dredged. Assuming a trailer suction hopper dredge would remove approximately 0.3 meters (1 foot) of sediment during a single pass, the dredge would make approximately 2.3 passes over the entire 520 hectare (1,280 area) on each shoal to obtain the required volume of sediment.

Other Impacts to EFH

Impacts to EFH come from a wide variety of sources, including dredging, pollution, commercial and recreational fishing, disease, weather events, and climate change.

Chincoteague Inlet, which is immediately to the north of Wallops Island, has been periodically dredged by The USACE Norfolk District since the mid-1990s, placing the material in the offshore disposal site that is approximately 4,000 feet offshore of Wallops Island. The disposal site has an area of 300 meters (1,000 feet) by 900 meters (3,000 feet). This activity likely causes similar temporary impacts to turbidity and EFH species and habitat as the SRIPP Proposed Action. Commercial fishing, including activities like surf clam dredging, trawling, and anchoring, directly impact habitats utilized by EFH species. Impacts from non-point source pollution from nearby agriculture and stormwater runoff can deposit chemicals in the estuaries and out to the ocean, sometimes inhibiting the growth or survival of EFH species. Natural events can also impact EFH species. Hurricanes and nor'easters can increase turbidity and destroy benthic habitat used by EFH species and associated species. This can result in detrimental indirect impacts to fish through changes in the food web. The magnitudes of these impacts range greatly depending on their intensity. Generally the effects of these events are only temporary (USACE, 2009).

The proposed action, when considered along with known or anticipated projects, would result in temporary adverse impacts to EFH within the region.

SECTION NINE: MITIGATION MEASURES

Every possible measure would be considered to avoid and minimize effects on EFH and managed species. Minimization has included extensive consultation with Federal and state agencies and sampling to select borrow sites with sand of appropriate grain size. In correspondence from NMFS to NASA dated June 18, 2009, methods to conserve the geomorphic features of the shoals were suggested (Attachment B). This can be achieved through two methods: 1) minimizing the total amount of sand removed from the shoals over the 50-year life of the project, and 2) controlling the methods used for hopper dredging borrow from the shoals. The mitigation techniques suggested by NMFS (2009) will be evaluated for technical and economic viability and utilized to the fullest extent possible. Per NMFS' suggestion, NASA would consider native dune plantings to attempt to decrease the amount of sand required for beach nourishment in the future.

The main biological impacts from the Proposed Action would occur to the benthos and benthic habitats and potentially to commercial fisheries, marine mammals, and sea turtles. Measures to reduce impacts to sea turtles and marine mammals would be adapted to reduce the adverse effects to EFH species and habitats in the project area. The following mitigation measures have been identified:

1. Implement best engineering and management practices.
2. Complete a hydrographic survey before and after dredging which covers each area of the shoals where dredging would take place.
3. Coordinate with NMFS to develop a long-term strategy and dredging management plan for future re-nourishment cycles which identifies rotation criteria and schedule for specific shoal use.

The shoals are not expected to accrete additional sediment once sediment is dredged. However, care would be taken during dredging to maintain the morphology of the shoals, and the benthic community is expected begin recolonization shortly after dredging ends and would be expected to recover to background or predredge conditions within 1 to 5 years (MMS, 2001). One or more mitigation techniques could be utilized to decrease the impacts to EFH, such as 1) minimizing the amount of sand dredged; 2) maintaining shoal morphology; and 3) leaving undisturbed sections of benthic habitat within the designated dredged area(s) to facilitate benthic recolonization and recovery. Use of these techniques would in turn decrease adverse effects to pelagic fish, prey species, and EFH (NMFS, 2009).

The timing of dredging will also be an important factor in determining the eventual recovery of the dredged area because many benthic species have distinct reproductive and recruitment periods (Diaz et al., 2004). Recolonization of the dredged area would be primarily from larval recruitment from the water column as well as adult immigration from undisturbed adjacent areas.

Another source of adverse impacts to fish and other marine life during dredging operations is entrainment. The centrifugal force of the pump, located behind the intake pipe of the drag head, draws fish and other marine life into the pipe. Fish may be killed by the pump and then pulled into the hopper. It is believed that entrainment primarily takes place when the drag head is operating on bottom sediments. Affected fish are usually feeding or resting near the bottom at the time the drag head moves along the bottom. In some rare instances, suction may be created when currents flow around the drag head as it is placed or moved.

SECTION TEN: CONCLUSION AND AGENCY VIEW

NASA is proposing to engage in a shoreline restoration program at WFF that involves the use of one or more offshore borrow sites for initial beach nourishment, as well as for future renourishment cycles. In addition, the existing seawall would be extended. This project would result in some unavoidable adverse impacts to habitats designated as EFH for several federally managed species and their prey. This includes disturbance to the dredged area which is comprised of unvegetated, unconsolidated sand bottom, temporary degradation of the marine water column due to an increase in suspended sediment concentrations, and placement of beach fill and burial of benthic prey species. However, all adverse impacts on managed species, associated species, and EFH are expected to be temporary and localized. With the careful use of mitigation measures and BMPs during project implementation, these effects are not anticipated to have substantial, long-term adverse impacts on EFH. Accordingly, NASA has determined that the proposed SRIPP would have “site-specific adverse effects on EFH” but the impacts would not be significant within a regional context.

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ATTACHMENT A

NMFS EFH CONSERVATION RECOMMENDATION MEMORANDUM

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Northeast Region
Habitat Conservation Division
410 Severn Avenue, Suite 107A
Annapolis, MD 21403
Commercial Phone: (410) 267-5675
FAX#: ~~(410) 267-5666~~, (410) 295-3154

FAX TRANSMITTAL

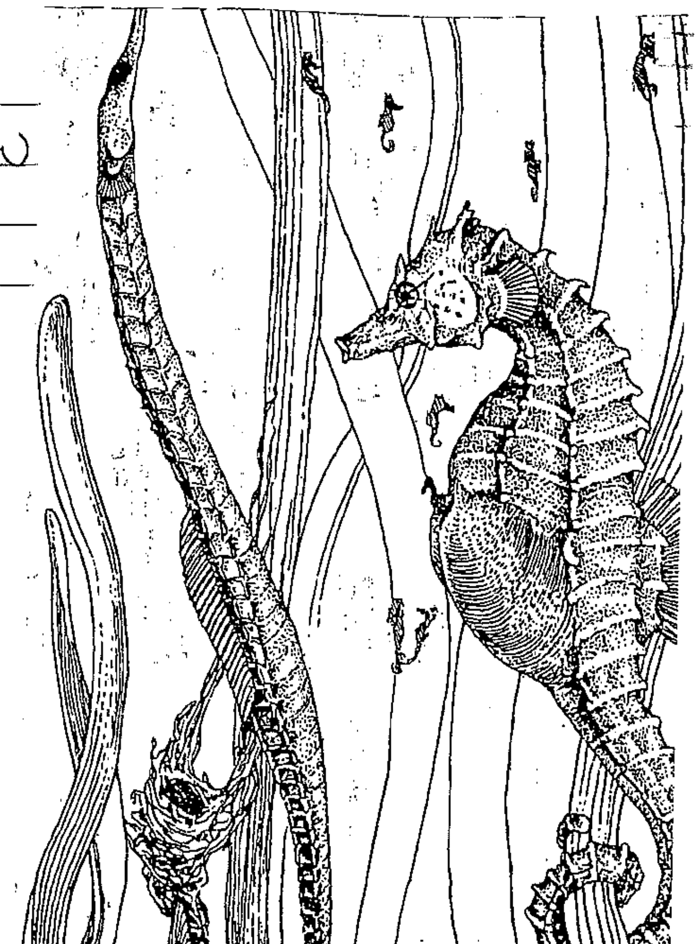
TO: Josh Bundick

LOCATION: NASA, NEPA Program

NUMBER: (757) 824-2319

FROM: John Nichols

Number of Pages (3), Including Transmittal



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Habitat Conservation Division
Chesapeake Bay Program Office
410 Severn Ave , Suite 107A
Annapolis, Maryland 21403

May 14, 2007

MEMORANDUM TO: Joshua A Bundick
NEPA Program Manager
National Aeronautics and Space Administration
Goddard Space Flight Center, Wallops Flight Facility
Wallops Island, VA 2337-5099

FROM: John S. Nichols JSN
Fishery Biologist

SUBJECT: Shoreline Restoration & Infrastructure Protection Program

This pertains to your request for Essential Fish Habitat (EFH) consultation, dated April 9, 2007, for the proposed Shoreline Restoration and Infrastructure Protection Program at the NASA Wallops Flight Facility on Wallops Island, Virginia. We have reviewed your EFH Assessment for this proposal, and in accordance with Section 305(b)(4)(A) of the Magnuson-Stevens Fishery Conservation & Management Act, we offer the following comments and EFH Conservation Recommendations.

Your Assessment, although detailed and well prepared, should have more thoroughly addressed long-term and cumulative impacts to coastal bottom habitat off Wallops Island from this proposal. Our concerns relate primarily to proposed offshore borrow activities, which would provide a short-term and/or long-term source of sand material for nourishing the facilities' shoreline. Although no estimates were provided on borrow volumes, sand requirements for nourishing 22,309 linear feet of shoreline will likely be significant (i.e., millions of cubic yards of material), particularly if the beach fill only option is selected, and would require borrow from off-shore sites in perpetuity. Such long-term borrow activities have the potential to significantly alter the bottom topography off Wallops Island.

Coastal waters off mid-Atlantic barrier islands possess bottom features, such as sand knolls, which are important to many of the managed species covered in your EFH Assessment. In particular, coastal migratory species, such as cobia, king mackerel, Spanish mackerel, and various sharks make use of coastal topographic bottom features for migratory orientation. The presence of sand knolls has also diversified coastal bottom habitat, forming troughs between the knolls with finer-grained sediments and rich benthic communities, which provide forage for migratory fish. Sand knolls are geologically ancient formations, and once removed (i.e., by borrow actions), will not reform. The proposed borrow activities should, therefore, be designed to conserve ecologically important topographic features that may exist in proposed borrow areas off Wallops Island.

In order for NMFS to fully evaluate the impacts of this proposal on EFH, more detailed information is needed on proposed borrow areas (e.g , Sectors 1-3) We offer the following EFH Conservation Recommendations pertaining to the borrow requirement issue.

1) The forthcoming Programmatic Environmental Assessment (PEA) should provide more detailed information on the physiography of preferred borrow site(s) for this project. Much of this information should focus on the following physical parameters.
   a. Bathymetry, and topographic bottom features
   b. Substrate, including predominant surficial substrates, and sedimentary profiles showing areas of preferred substrate, depths to which preferred substrates extend, and substrates underlying layers of preferred material.

2) Your agency should identify measures that will be used to minimize adverse changes to the topography of borrow site(s) selected for this project. Such measures may include avoidance of areas with unique topographic bottom features (e g., sand knolls), and/or use of borrow methods that conserve such bottom features; and, post-borrow monitoring to determine the effectiveness of conservation-based borrow methods.

3) The PEA should identify and describe recreational and commercial (trawling, gill-netting) fishing activities that occur in proposed borrow areas. It is preferred that important fishing grounds be avoided for borrow, to conserve existing bottom features that may be responsible for sustaining fisheries in those areas.

4) Chincoteague Bay is a highly important nursery for larval and juvenile summer flounder Following offshore spawning by adults, planktonic larval flounder move inshore and into Chincoteague Bay through the Chincoteague Inlet, from mid-autumn into spring. Many larvae metamorphose, move to the bottom, and over-winter in coastal waters prior to entering Chincoteague Bay as juveniles. Consequently, coastal bottom off Wallops Island, including Borrow Sectors 1-3, may be important to over-wintering and migratory activities of early stage flounder. The PEA should consider alternative borrow sites, and borrow measures for minimizing impacts on larval and juvenile summer flounder. We suggest consulting with Virginia Institute of Marine Science fisheries staff regarding local flounder ecology, and areas off Wallops Island where, and/or seasonal periods when borrow activities should be avoided.

5) The PEA should address the cumulative impacts of the proposed borrow action on fish and fisheries within mid-Atlantic coastal waters

We also have provided the following EFH Conservation Recommendations regarding other project issues.

6) NMFS prefers options that include the use of sand-retention structures to reduce the long-term need for offshore borrow.

7) Stone is the preferred material for constructing sand-retention structures. Geo-textile fabric tubes do not possess the resilience for protecting high-energy shorelines, such as along Wallops Island, for short or long-term duration.

8) NMFS strongly recommends against Alternative 2/Option 4 (i.e , building a levee around the entire island), which would result in significant long-term and cumulative impacts to marine and estuarine fauna, and their essential habitats

9) Cross-sectional profiles should be provided in the PEA reflecting the extent of channelward encroachment of preferred nourishment options, and in relation to MHW and MLW

Protected Resources

Any questions or new information pertaining to the on-going Endangered Species Act Section 7 Consultation for this proposal should be directed to Julie Crocker of our Protected Resources Division, Gloucester, MA; Julie.Crocker@NOAA.GOV, (978) 281-9328, ext. 6530.

ATTACHMENT B

NMFS SUPPLEMENT TO EFH CONSERVATION MEMORANDUM

JAB 6/22/09

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northeast Region
Habitat Conservation Division
410 Severn Avenue, Suite 107A
Annapolis, MD 21403
Commercial Phone: (410) 267-5675
FAX#: ~~(410) 267-5666~~ (410) 295-3154

FAX TRANSMITTAL

TO: Josh Bundick

LOCATION: NEPA Manager

NUMBER: (757) 824-2319

FROM: John Nichols

Number of Pages (5), Including Transmittal

Sorry about the tardiness of this response, but hope it is helpful in preparing the EIS

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Habitat Conservation Division
Chesapeake Bay Program Office
410 Severn Ave., Suite 107A
Annapolis, Maryland 21403

June 18, 2009

MEMORANDUM TO: Joshua A. Bundick
NEPA Program Manager
National Aeronautics and Space Administration
Goddard Space Flight Center, Wallops Flight Facility
Wallops Island, VA 2337-5099

FROM: John S. Nichols JSN

SUBJECT: Shoreline Restoration & Infrastructure Protection Program

National Marine Fisheries Service (NMFS) has reviewed the Description of the Proposed Action and Alternatives, dated March 2009, proceeding release of the Environmental Impacts Statement (EIS; in preparation) for the Shoreline Restoration and Infrastructure Protection Program at the NASA Wallops Island Flight Facility in Virginia.

NMFS provided Essential Fish Habitat (EFH) Conservation Recommendations in a May 14, 2007 memorandum, in response to your EFH Assessment for this proposal, dated April 17, 2007. Subsequent to the earlier consultation, this proposal has changed substantially, with identification of a preferred alternative (Alternative 1), and identification of two offshore sand borrow sites. Furthermore, more than two years have passed since submittal of the earlier EFH Assessment. We are, therefore, recommending that NASA re-initiate EFH Consultation, and provide NMFS with an appended EFH assessment, with revised description of project alternatives, and detailed analyses of potential impacts of each alternative on managed species and their EFH. The supplemental EFH assessment can be incorporated into the forthcoming EIS, provided it is clearly identified in a distinct section of the EIS. NMFS will provide final comments on this project following review of the EIS and supplemental EFH assessment.

We offer the following comments to supplement to our earlier conservation recommendations, and to assist you in preparation of the forthcoming EIS.

CONSERVATION OF OFFHSORE SHOALS

Offshore sand shoals, such as Blackfish Bank and the unnamed shoal proposed as borrow sites for this project, are irreplaceable geologic features of the near shore continental shelf. Shoals are dynamic features, which diversify the sea floor, producing a variety of substrate types and foraging opportunities for finfish and epibenthic fauna. Shoals serve as congregating areas for finfish, and provide guiding features for coastal migratory species. Consequently, the most important issue to NMFS in the review of this proposal is to ensure that proposed borrow actions do not result in direct adverse changes to the geomorphic characters of the shoals from which material will be removed, nor secondary changes to surrounding habitats.

There are two avenues that can be followed for developing measures to conserve geomorphic features of Blackfish Bank and the unnamed shoal; 1) minimizing the total amount of borrow removed from these shoals over the 50-year life of the project; and, 2) controlling the methods used for hopper dredging borrow from these shoals. Various options for conserving the offshore shoals are discussed below, with inclusion of verbal comments NMFS provided during the November 20, 2008 Stakeholder Meeting.

We recommend that your agency consult with the U.S. Army Corps of Engineers, Baltimore District, Planning Division (e.g., Chris Spaur, (410) 962-6134, or Christopher.C.Spaur@usace.army.mil) for information on hopper dredge sand borrow and post-borrow monitoring methods used on Great Gull Bank, an offshore shoal off the Maryland coast, specifically discussed the following document:

U.S. Army Corps of Engineers, Baltimore District. May 2007. Atlantic Coast of Maryland Shoreline Protection Project. Supplemental Environmental Impact Statement, General Reevaluation Study for Borrow Sources for 2010 – 2044.

We also recommend that your agency consult with Minerals Management Service to obtain a copy of the following document, in preparation, regarding physical environment investigations and modeling of the continental shelf off Maryland for dealing with borrow activities.

CSA International, Inc., Applied Coastal Research & Engineering, Inc., Barry A. Vittor & Associates, Inc., C.F. Bean, L.L.C., and Florida Institute of Technology. 2009. Analysis of Potential Biological and Physical Impacts of Dredging on Offshore Ridge and Shoal Features. *Prepared for:* U.S. Department of the Interior, Minerals Management Service, Leasing Division, Marine Minerals Branch, Herndon, VA. OCS Study MMS 2009.

Minimizing Total Borrow From Offshore Shoals

The greater the proportion of material removed from any given offshore shoal, the more likely that the shoal's long-term geomorphic integrity will be threatened. Any approach for removing sand from the subject shoals should be conservative in amount, and apportioned relative to their ability to maintain their existing geomorphic features.

To lessen impacts on the offshore shoals, the amount of material required over the 50-year life of this project can be minimized by constructing sand retention structures along the target shoreline. Alternative 1 would include a terminal groin to partially limit sand movement to the south. However, your agency should also closely investigate Alternative 2, which includes detached offshore breakwaters. Similar to the terminal groin, offshore breakwaters can be designed to permit continued movement of sand to shorelines south of the project area. More importantly, breakwaters assist in retaining material on the beach, and in minimizing seaward movement of beach sand during storms, where it can more easily enter the southerly long shore drift system and be lost to the project shoreline. The sand retention capability of Alternatives 1 & 2 should be modeled and compared to determine which would result in the lowest nourishment requirement of the target shoreline over the life of this project.

NMFS also recommends vegetative planting of nourishment material as a supplemental retention measure. Beach grass (*Ammophila*), and saltmeadow cordgrass (*Spartina patens*) are species frequently used for stabilizing beach nourishment areas. Plantings should be repeated, as necessary, to repair beach damaged by storm action.

Borrow impacts to the offshore shoals can also be lessened by using alternative near shore sand sources for nourishing the target beach. As part of the Long Term Assateague Island Restoration Project near Ocean City, Maryland, near shore shoals are periodically harvested using a small shallow-draft hopper dredge (the "Currituck"), to supplement borrow taken from offshore shoals. Material dredged from maintenance of the Chincoteague Inlet Federal Project, or borrow from near shore shoals such as Fishing Point, should be investigated as supplemental sand sources for this project. Structural and vegetative beach sand retention measures would add stability to finer-grain sand taken from near shore sources to nourish the target shoreline.

Controlling Hopper Dredging Sand Harvest Methods On Offshore Shoals

Borrow impacts to the offshore shoals can also be lessened by using constraints on where, and to what depth material is removed from each shoal. Enclosure 1 (*from:* Atlantic Coast of Maryland Shoreline Protection Project SEIS, 2007) provides two tables showing dredging guidelines and constraints proposed for harvesting individual offshore shoals along the Maryland coast to optimize for long-term geomorphic integrity maintenance; and, estimates on the total permissible proportion of material (5%) that could be safely removed from a given shoal to maintain its integrity.

Offshore shoals are dynamic features of the sea floor, tending to migrate in a southwesterly direction along the mid-Atlantic coast. The dynamics of a given shoal affects the character of adjacent seafloor habitats. A sand harvest protocol for Blackfish Banks and the unnamed shoal should be designed to maintain the existing dynamics of each shoal.

Borrow constraints needed to maintain shoal integrity will require a thorough knowledge of the depths and distribution of suitable materials on each of the target borrow sites, obtained through a repetitive core sampling regime. We also recommend periodic pre- and post-borrow monitoring of shoal geomorphic features, to ascertain that borrow methods are not damaging shoal integrity.

I look forward to continued coordination with your agency on this proposal, and the forthcoming EIS and appended EFH assessment. If you have any questions, please contact me at (410) 267-5675; or, John.Nichols@NOAA.GOV.

Table 5-6: Dredging guidelines and constraints for dredging individual offshore shoals to optimize for long-term geomorphic integrity maintenance.

	Dredging Guideline/Constraint	Reasons (1)
1	Avoid the crest	Maintain shallowest water wave-action processes which are likely important for long-term shoal maintenance (2); Maintain coarse-grained lag deposits in-place since these may serve to ensure crest stability (more wave-erosion resistant) (2);
2	Preferentially dredge sand from downdrift accreting (south*) (2) (3) or updrift eroding side (north**) (2)	Minimizing risk of interrupting sand recycling pattern/process
3	Dredge thin uniform thickness of material from a large area	Least disturbance to existing topography/geometry believed to offer least likelihood of substantial disturbance to physical processes that maintain shoal (3)(4)
4	Dredge no deeper than ambient seafloor depth (i.e., not below shoal)	To confine dredging to active portion of seafloor, and avoid creation of pits which could alter physical process patterns (3)(4)

(1) Reasons more specific than maintaining geomorphologic integrity which is assumed to be of long-term importance for biota
(2) Dr. Robert Nairn, Personal communication to Chris Spaur September 2004
(3) Dr. Randy McBride, Personal communication to Chris Spaur for planning dredging of Great Gull Bank for Short-Term Restoration of Assateague Island, March 2001
(4) Dr. Mark Byrnes, Personal communication to Chris Spaur April 2004

*Determined to be southerly based on Swift and Field (1981), McBride (personal communication), limited USACE monitoring conducted of nearby Great Gull Bank, and MGS monitoring work of Borrow Areas 2 and 3 conducted for this study.
**Assumed to be north based on MGS monitoring work of Borrow Areas 2 and 3 conducted for this study.

Table 5-5: Maximum volume of material permissible to dredge from individual offshore shoals meeting 5% environmental constraint.

	Weaver	Isle of Wight	A	B
Maximum volume (yd^3)	4,650,000	6,800,000	5,150,000	2,500,000

National Aeronautics and
Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Reply to Attn of: 250.W

February 12, 2010

Mr. David O'Brien
Habitat Conservation Division
National Marine Fisheries Service
7580 Spencer Road
Post Office Box 1346
Gloucester Point, Virginia 23062 01930

Dear Mr. O'Brien:

In accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, and the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSA), the National Aeronautics and Space Administration (NASA) has prepared a Draft Programmatic Environmental Impact Statement (DPEIS) and Essential Fish Habitat (EFH) Assessment for the proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP) at its Goddard Space Flight Center's Wallops Flight Facility (WFF) on Wallops Island, Virginia.

As the project sponsor, NASA is serving as the lead agency for NEPA and EFH consultation with the National Marine Fisheries Service. The U.S. Department of the Interior, Minerals Management Service (MMS) and the U.S. Army Corps of Engineers (USACE) would undertake actions connected to the SRIPP and are participating in NASA's NEPA process and EFH consultation. The effects of their actions are considered in all project-related environmental documentation, including the enclosed DPEIS and EFH Assessment (Appendix H of the DPEIS). As such, please include all three action agencies in future correspondence regarding the SRIPP.

In cooperation with MMS and USACE, NASA has determined that the proposed SRIPP would adversely affect EFH but the impacts would not be significant. NASA respectfully requests that you review the enclosed DPEIS and EFH Assessment and provide Conservation Recommendations within 60 days of receiving this letter.

If you have any questions or require any additional information please contact me at (757) 824-2319, or Ms. Shari Silbert at (757) 824-2327.

Sincerely,

Joshua A. Bundick
WFF NEPA Program Manager

Enclosure
cc:

228/Mr. P. Bull
250/Ms. C. Turner
MMS/Mr. D. Herkhof
USACE /Mr. R. Cole

Meeting Minutes

Meeting at USFWS office in Gloucester, Virginia: March 30, 2010

Shoreline Restoration and Infrastructure Protection Program EIS

Attendees (in person)

MMS – Dirk Herkhof
NASA - Carolyn Turner
NASA - Joe Mitchell
NASA - Josh Bundick
NASA - Paul Bull
NMFS - Dave O'Brien
URS - Angela Chaisson
URS - Jeff Reidenauer
URS – Shari Silbert
USACE - Gregg Williams
USACE - Mark Hudgins
USACE – Robert Cole
USFWS – Cindy Schulz (briefly)
USFWS - Kim Smith
USFWS - Mike Drummond
USFWS - Tylan Dean

Attendees (via phone)

EPA III - Barbara Rudnick
EPA III - Carol Petrow
EPA III - Elaina DeGeorgio
NMFS - Danielle Palmer
NMFS - John Nichols

<u>EFH Discussion:</u>

John Nichols – Response to draft PEIS is partially written. Main concern is borrow action on Shoals A & B and the open-endedness of action.

Read draft MMS document by Mark Byrnes (permission granted by Coleen Finnegan in Leasing Office to share the draft) – preliminary recommendations include:

1. Limit or set a threshold on the amount of sand removed, especially from Shoal A (smaller shoal than B with greater relief); greater topography equates to greater fish value.
    a. Recommends setting a 5% cumulative removal over life of the project as a threshold (e.g., Great Gull Bank)
    b. Initial fill for SRIPP = 3.9Mcu yd of a ~40Mcu yd shoal or ~10% required.
    c. Larger concern for Shoal A then B (higher fish value); worried about recovery of the shoal
    d. Don't want another Sandbridge; that shoal has lost +25% of its volume

2. Method of dredging – leading edge of shoal will recover more quickly because it is a depositional area; dredging a static or erosional edge should be avoided (harder to recover).

3. Striping – shallow cuts removed in a slow progression; parallel cuts separated by furrows that promote faster benthic recovery

4. Crests can be removed on the leading edge of the shoal but remove a minor amount or shoal will only minimally recover.

Josh - Promoting sand management plan that could involve a retention structure; possibly even a north groin. We will know better after monitoring. Possibly install a temporary geotextile groin and monitor effects. Any additional structures will have additional NEPA.

Dave O'Brien – Look at hot spots of erosion after the initial fill for where retention structures may need to go.

Josh - How do we handle consultation?
1. How much sand can we get from shallow striping on the western side of Shoal A?
2. How shallow is a shallow stripe? Unknown now – John
3. Will you share draft recommendations before formal consultations go out? Yes – John and Dave

Dredging in a striped pattern will lengthen time on the shoal, slow down dredging, burn more fuel, cause more emissions, and may cause more entrainment. Weeks Marine, Inc. is a dredging contractor that has performed this type of action with Baltimore Corps (talk to Chris Spaur at USACE Baltimore).

EPA – fisheries impacts may be more critical than air impacts from steaming to Shoal B and slower dredging.

Danielle - Risk to turtles is greatest when draghead is off the bottom and lowest when draghead in contact with sediment. She will talk to sea turtle biologist about potential for creating more turtle habitat with dredging in a striped pattern and causing more impacts.

Danielle - NMFS may need to reissue Take Statement – increasing habitat through striping may increase population and require an increase in Take. Takes are given over the life of the project not per cycle.

John - Remainder and renourishment volumes can all be taken from Shoal B if we follow the same dredging management techniques. Striping is a function of scale: deeper and further apart vs shallow and closer. The more shallow will infill and "heal" more quickly.

<u>Section 7</u>

Josh, summary of prior consultation – 2007: 1 sea turtle/2M cu yd (28 loggerheads & 3 Kemps Ridley over project life) based on borrowing sand inside 3 miles of Wallops Island.

<u>NMFS</u> - Danielle
1. Based on turbidity effects, dredge process, and entrainment, the current Take Permit will be MUCH lower than the 2007 Permit.

    a. Longer times on a shoal may increase Take
    b. Quicker in/out the better for turtles
    c. Furrows creating habitat/striping may increase Take – will consult with turtle biologist

2. Whale and marine mammal impacts are still the same – dredge speeds will remain under the 10 knots, whale watchers will be on board all vessels.

3. Dredge noise is a bigger issue – out to 120dB level for harassment. Haven't dealt with it before. Other offices do not consider this a big concern. Unknown level of impacts. Two studies that Danielle will send us to review (Greene and 1 from Kyle Baker).

4. 120dB extends to 147km – How/Would this impact our Take Statement?

5. Draft BO by end of April.

6. How do Navy & shipping acoustics compare to dredging and limits?

7. The concern arose due to the Noise section in our DPEIS

8. What do we do if EFH recommends something that is in direct conflict with a Protected Species recommendation? EFH & Protected Species go up the chain for one Take Statement and Letter of Recommendations.

9. Seasonal restrictions – NMFS is not going to suggest seasonal restrictions because it's not feasible for the project proponent. Takes will be calculated based on worst case time of year scenario.

10. Current Take may read – 1 turtle/2M cu yd x 50 years w/ less material needing to be dredged = 7 loggerheads & 1 Kemps Ridley – NOT FINAL!!!

11. Cumulative impacts include other dredging projects, water quality, etc.

12. Global warming and rising sea temps may increase turtle populations in the Mid-Atlantic and is addressed BRIEFLY in the BO. Changes noted in new research may warrant new consultation. Can be initiated by NMFS if large changes are noted or otherwise by the proponent during tiered NEPA consultation.

<u>USFWS</u> - Tylan

1. Recommended including leatherbacks and greens.
    a. NMFS –considered but non-existent entrainment or turbidity plumes impact to leatherbacks and greens. No seagrass beds for greens, no concentration of jelly fish on shoals for leatherbacks.
    b. NMFS - No nesting leatherbacks or greens in area.
    c. Separate Take Statement from USFWS for nesting turtles will be issued
2. Programmatic vs. defined project consultation
    a. Lack of boundedness or specificity of the program (e.g., north groin)
    b. Suggested proceeding with informal consultation for programmatic vs. formal consultation at this point
    c. What does USFWS consider Programmatic vs. Finite?
        i. Pre-authorize incidental programmatic takes?
        ii. Can USFWS authorize the proposed actions and state that follow-on actions will require further Section 7 consultation?
    d. No constraints on seasonality – look at worse case time frames to yield a Take Permit

e. NASA stated that all the details/specifics of the initial sand placement activities have been provided in the DPEIS.
f. NASA stated that for sand placement, qualified monitoring staff will search for turtles and Plovers before sand placement
g. Paul - Possibly work in open water in front of seawall during nesting season and in the existing beach areas in non-nesting season.
h. Tylan - Will get a reply/BO back as soon as possible or request more information on the programmatic side. He has all the information he needs at this point.
    i. Paul - No additional information is available for future actions until monitoring has been conducted

Action Items

- NASA – track Chris Spaur (Baltimore District for OC project) and talk about their dredging methodology
- NASA/USACE – identify and map dredging areas on the Shoals based on constraints suggested by NMFS
- NMFS EFH and NASA – estimate how much volume we can get using recommended methods from Shoal A
- NMFS EFH – define depth for shallow dredging?
- NMFS Protected Species- will consult with turtle biologist on impacts from furrows creating turtle habitat
- NMFS Protected Species – will research underwater acoustic impacts
- NMFS Protected Species– sending acoustic research
- NASA/USACE – will collect post dredging bathymetry data (as required by MMS lease agreement) and include in any future tiered NEPA
- NASA/USACE – will conduct pre renourishment dredging monitoring for bathymetry and include in tiered NEPA

From: Bundick, Joshua A. (WFF-2500)
Sent: Monday, April 05, 2010 8:39 AM
To: 'John Nichols'; 'David L. O'Brien'
Cc: Bull, Paul C. (WFF-2280); 'Dirk Herkhof'; 'Wikel, Geoffrey L'; Williams, Greggory G NAO; Mears, George H NAO; Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; 'Jeffrey_Reidenauer@URSCorp.com'; 'Robert Cole'; 'Roger Amato'
Subject: EFH Meeting

Importance: High

Gentlemen,

If possible, I would like to schedule a meeting next week to discuss (in more detail) the Wallops Shoreline Program EFH consultation. The project team, consisting of representatives from NASA, MMS, and USACE, would like to discuss its concerns regarding the potential conservation recommendations prior to their being officially issued by NOAA-HCD. In speaking with those familiar with the recently released MMS report, it appears that there are some inherent issues with the modeling that we would like to discuss, especially regarding the striping dredge technique. We also would like to discuss the proposed 5% limitation.

We all feel that it would be mutually beneficial to meet in person to discuss such important issues. At this time I propose that we meet in Annapolis at the NOAA office, which would be a good mid-point for those traveling from Herndon and those of us in the Wallops area. John, would this be OK with you?

Please advise on availabilities. Thanks.

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

From: John.Nichols@noaa.gov
Sent: Monday, April 05, 2010 12:27 PM
To: Bundick, Joshua A. (WFF-2500)
Subject: Re: EFH Meeting

Josh:
That is fine. I obviously have no problem with holding a meeting at my office, since it minimizes my travel requirements.

I will be working on completing the NOAA EFH response this week. I realize that there are issues regarding some of the tentative recommendations on harvesting sand from Shoal A. Striping may be an issue within NOAA, since our Protected Resources staff still has concerns regarding turtle impacts.
However, NOAA is firm on limiting the amount of sand harvested by this project; especially on Shoal A.
The 5% rule is an approximate bench mark; if we agree to you taking 3 MCY, you have exceeded it slightly. We will not change our recommendations that harvest be restricted to the west and southwest leading edge of the shoal, and that the majority of the crest be conserved. Our agency takes the conservative route in making recommendations (conservative in protecting the resource). We will not accept a wait and see approach to affecting these shoals. Impacts from this project also have precedent setting issues for opening up other ridge/swale complexes for borrow activities in the future.

What happen to the conference call with Chris Spaur? Is it still on?

Meeting Minutes

Teleconference Regarding Essential Fish Habitat Consultation: April 7, 2010

Shoreline Restoration and Infrastructure Protection Program PEIS

Participants

MMS – Roger Amato
MMS – Dirk Herkhof
MMS – Geoff Wikel
NASA - Josh Bundick
NASA - Paul Bull
NMFS - John Nichols
URS – Alan Niedoroda
URS - Jeff Reidenauer
URS – Suzanne Richert
URS – Shari Silbert
USACE Baltimore – Chris Spaur
USACE Norfolk - Gregg Williams

EFH Discussion:

- NASA representatives explained a recent geospatial analysis that had been performed. The analysis concluded that dredging an area covering approximately 25% of Shoal A to a depth of 2 meters would likely yield the sand volume necessary to complete the initial beach fill phase of the project.

- Participants then discussed the additional cost that would be incurred if Shoal B were used for initial fill. It is estimated that the additional $3 million would result in a substantial reduction in sand placement as the construction budget is fixed.

- John Nichols mentioned that NMFS is using MMS guidelines to recommend Shoal B as the preferred borrow site as it is a larger shoal with gentler slopes.

- NASA representatives questioned the origin of the percentage threshold limitation for dredging projects. Chris Spaur explained that the five percent figure that was developed for the Atlantic Coast of Maryland project was a product of consultation among members of his Project Delivery Team and that is was not necessarily based on computer modeling. He also mentioned that the financial implications from employing a conservative dredging plan would have limited effects on project implementation.

- The discussion of modeling continued. Geoff Wikel explained that the CSA International study employed a half-plane spectral wave model (i.e., a spectral wave model generally handles wave directions of up to 45 degrees relative to the orientation of grid) that may have inherent limitations with accurately predicting wave direction in the presence of complex topography and slopes (i.e., sand ridges represent severe condition for accurate refraction and wave focusing prediction), versus the Baird report that uses full-plane modeling. He also suggested that shoal height is likely a more important factor to consider than a numerical threshold.

- John Nichols expressed his concern regarding the cumulative effects of the project. He explained that NMFS must be conservative in its recommendations and that despite the fact that there may be numerous shoals within the Mid-Atlantic Bight; each one is an important habitat.

- Josh Bundick asked whether NMFS considered the sand that would be lost overboard at the dredge site as permanently removed from the shoal. Following discussion between John Nichols and Gregg Williams, it was decided that this material was rather coarse, and following a relatively short time in suspension, it would likely settle in the same general vicinity of the shoal. As such, only the material that would be placed on the beach would be considered when calculating removal volumes.

- John Nichols suggested considering shortening the length of beach fill so that Shoal B could be used. NASA representatives explained that not only would this result in more frequent future renourishment, but it would also not provide the recommended level of storm damage reduction as recommended by USACE designers. John explained that project cost is not a driving factor when developing EFH Conservation Recommendations.

- Jeff Reidenauer mentioned that the project team had already factored in consideration of Essential Fish Habitat when deciding to remove Blackfish Bank from the list of potential borrow sites.

- Gregg Williams asked John Nichols if NMFS had assigned a monetary value on offshore shoal habitat. John responded that the agency had not.

- NASA representatives inquired about the differing effects on how a shoal is dredged, especially in light of the concept of dredging in a striped pattern to foster quicker infaunal recovery.

- John Nichols re-emphasized the value of the shoals to the marine food web, and that maintaining a shoal’s morphometry (by avoiding crests and erosional areas) was a more important consideration than stripe dredging.

- Geoff Wikel mentioned that when comparing the effects on benthic infauna with shoal morphometry, the benthic community will likely recover on a shorter timescale.

- John Nichols mentioned that NMFS is not likely to include stripe dredging as a Conservation recommendation, and that dredging to a depth between 2-2.5 meters would likely be acceptable. John also mentioned that NASA should avoid dredging the highest parts of the shoal crests.

- The discussion concluded with John Nichols requesting several informational items from NASA.

Action Items

- NASA – Identify areas proposed for dredging on Shoal A by Friday, April 9, 2010, and provide a map to John Nichols
- NASA – Estimate how much sand could be obtained from Shoal B given the current cost constraints and provide summary to John Nichols.
- NMFS EFH and NASA – estimate how much volume we can get using recommended methods from Shoal A

From: John Nichols [John.Nichols@noaa.gov]
Sent: Wednesday, April 07, 2010 4:04 PM
To: Bundick, Joshua A. (WFF-2500)
Subject: Wallops Conference Call

Josh:
Just to clarify the NOAA current position, we are still considering Shoal B as the primary source for initial re-construction of the beach.
That is why I requested the figures on the amount of sand that could be obtained, under your project cost ceiling, if Shoal B was the sole source for the initial phase of the project.

Another information request also came to mind; if we were to recommend that only 5% of Shoal A total volume be used for this project (i.e., 2 MCY), and the remainder of sand for the initial phase of the project were to come from Shoal B (1.2 MCY), would this reduce cost, and provide more sand under your cost ceiling?

If our agency goes with Shoal A is the sole source of sand for initial beach re-construction, the 3.2 MCY would be our recommended threshold for removal.

From: Bundick, Joshua A. (WFF-2500)
Sent: Tuesday, April 13, 2010 4:46 PM
To: 'John.Nichols@noaa.gov'; 'David L. O'Brien'
Cc: Bull, Paul C. (WFF-2280); Mears, George H NAO; Williams, Greggory G NAO; 'Wikel, Geoffrey L'; Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; Jeffrey_Reidenauer@URSCorp.com
Subject: Requested info - SRIPP EFH
Attachments: Shoal A Volume Analysis 3D Map_Rev1.pdf; Shoal A Volume Analysis 3D Map_Onetoone.pdf; Shoal A Volume Analysis Map.pdf

Importance: High

Good Afternoon,

As requested by John at our last telecon regarding the Wallops SRIPP EFH consultation, I am providing information regarding Shoal A volume, proposed depth of cut, and a map depicting the proposed dredge area. Also is information regarding impacts to the project if Shoal B were used for the initial fill cycle. Please see below and attached.

Shoal A Volume: Based upon analysis above the 72' depth contour, there is approximately 68 MCY on the shoal. This pans out to about 4.7% of the shoal's total volume for the initial fill cycle. The attached map presents these results graphically. Also, please keep in mind that there is a 35:1 vertical exaggeration. To put this into perspective, I have also included a 1:1 image.

Proposed Depth of Cut: We have calculated that we can remove the needed volume of material from Shoal A with a 2-meter cut from within the southwest quadrant depicted on the map entitled "Shoal A Volume Analysis Map."

Project Impacts: If we were to obtain all initial fill sand from Shoal A, we would be short approximately 310,000 CY of fill. If we were to remove 2.0 MCY from Shoal A and 1.2 MCY from Shoal B, we would be short approximately 115,000 CY of fill. Clearly, these are substantial impacts to our proposed project and design template.

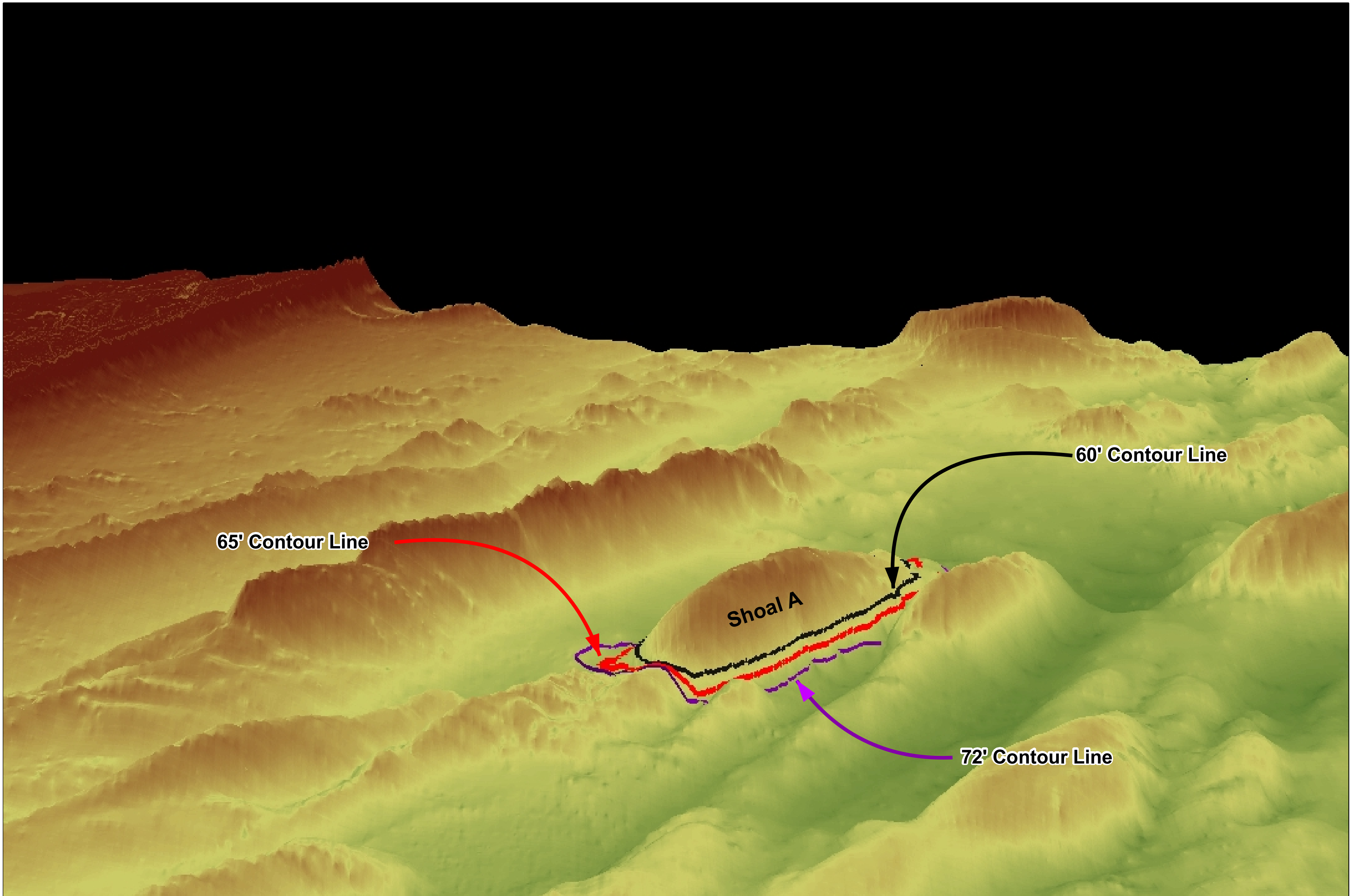
Finally, I would like to try to set up a call with Mark Byrnes of Applied Coastal Research and Engineering to discuss his thoughts on the percentage threshold limitation and how what was applied to the ACM project does not necessarily apply to ours. I have left a message with him and he will be in the office on Thursday. I will let you know what we are able to work out. Based on the volumes that we have calculated, it seems that the 5% limitation might not be an issue for the initial fill, but it could still drive renourishment costs up substantially, and I think it would be worthwhile to have Mark share his thoughts and educate the larger group.

Anyway, I think this is all of the requested information. Please don't hesitate to let me know if you have any questions. We look forward to continued coordination on the project.

Thanks,

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W



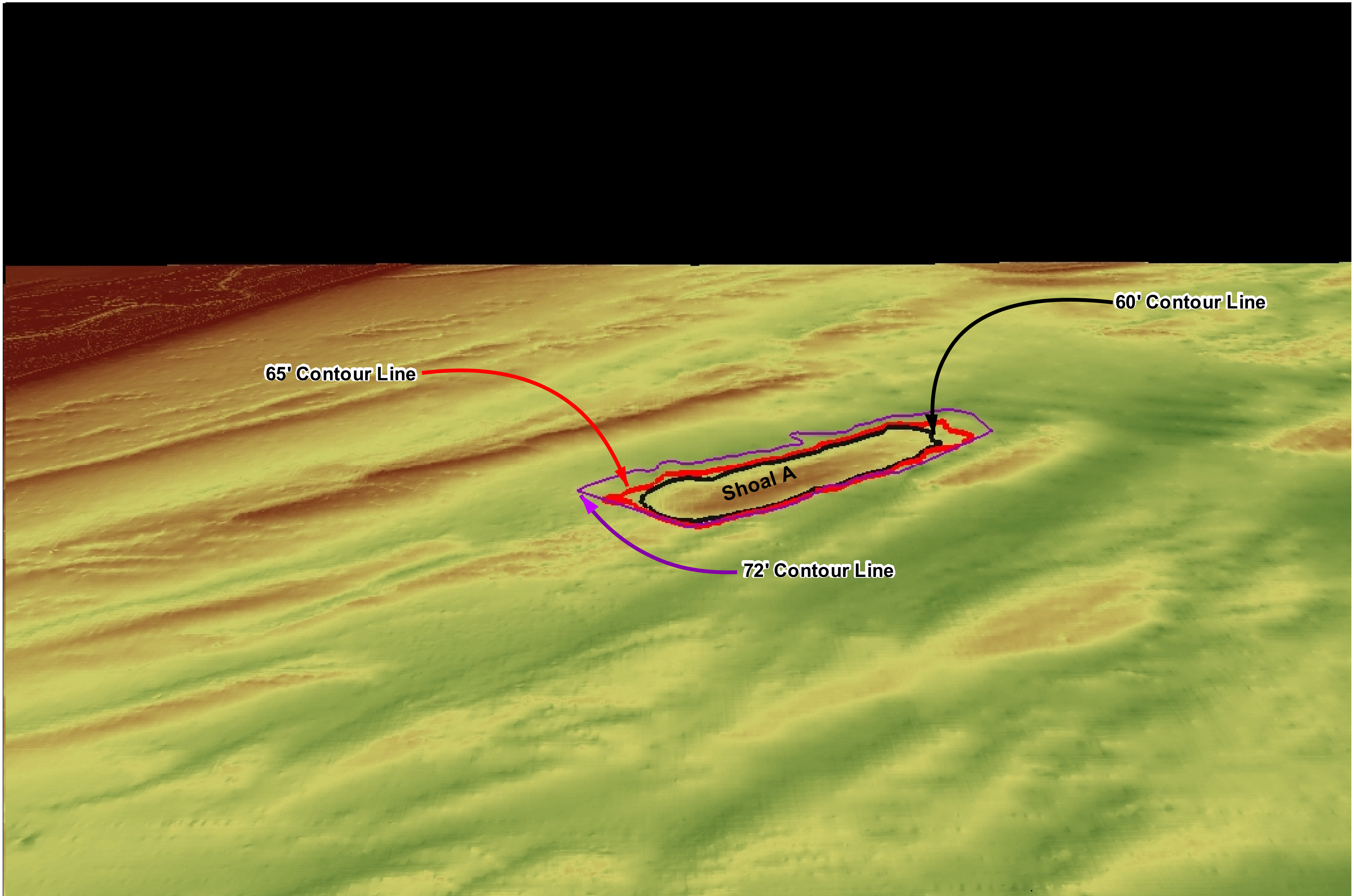
Vertical Exaggeration: 1:35

Shoal A Volume Analysis 3D Map

Z Unit Conversion: Meters to Feet, 3.2810

Volume Calculations Based Upon:
NOAA Ocean City, MD 1/3 arc-second MHW Tsunami Inundation DEM
DEM Development Report: http://www.ngdc.noaa.gov/mgg/inundation/tsunami/data/ocean_city_md/ocean_city_md.pdf

Volume Above 60' Depth Contour:	30,544,000 Cubic Yards
Volume Above 65' Depth Contour:	44,371,000 Cubic Yards
Volume Above 72' Depth Contour:	67,845,000 Cubic Yards



Vertical Exaggeration: 1:1	**Shoal A Volume Analysis 3D Map**	**Z Unit Conversion: Meters to Feet, 3.2810**

Volume Calculations Based Upon:

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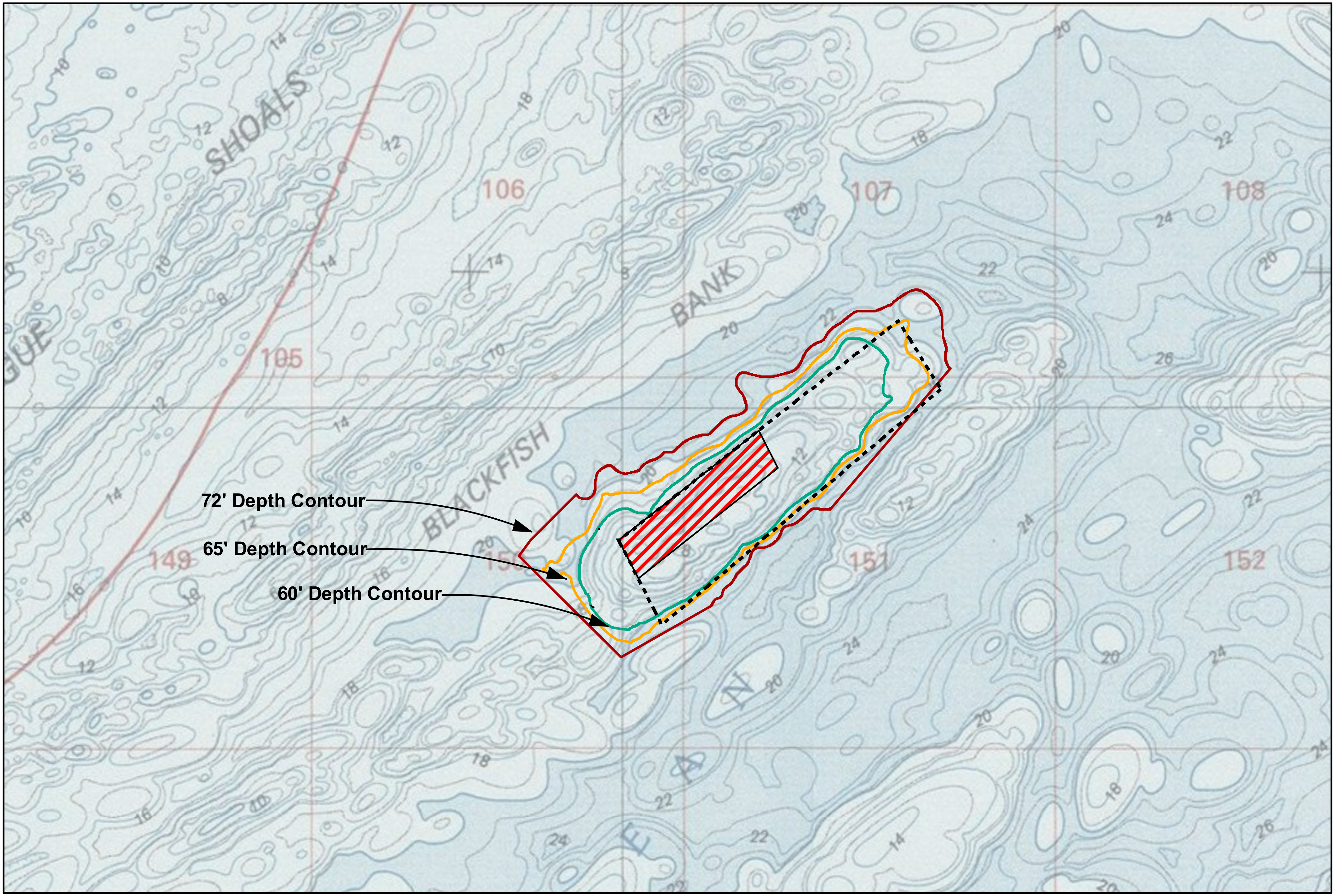

Shoal A Volume Analysis Map

Shoal Study Limits

Proposed Dredging Area

Dredge Volume= 3,200,000 Cubic Yards

Volume Above 60' Depth Contour: 30,544,000 Cubic Yards
Volume Above 65' Depth Contour: 44,371,000 Cubic Yards
Volume Above 72' Depth Contour: 67,845,000 Cubic Yards

0 3,750 7,500 15,000 Feet

From: Bundick, Joshua A. (WFF-2500)
Sent: Wednesday, April 14, 2010 8:34 AM
To: Bundick, Joshua A. (WFF-2500); John.Nichols@noaa.gov; David L. O'Brien
Cc: Bull, Paul C. (WFF-2280); Mears, George H NAO; Williams, Greggory G NAO; Wikel, Geoffrey L; Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; Jeffrey_Reidenauer@URSCorp.com
Subject: RE: Requested info - SRIPP EFH

The third bullet should read "SHOAL B" and that would make us come up short due to our inability to afford that quantity of sand from the more "expensive" shoal.

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

From: Bundick, Joshua A. (WFF-2500)
Sent: Tuesday, April 13, 2010 4:46 PM
To: 'John.Nichols@noaa.gov'; 'David L. O'Brien'
Cc: Bull, Paul C. (WFF-2280); Mears, George H NAO; Williams, Greggory G NAO; 'Wikel, Geoffrey L'; Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; Jeffrey_Reidenauer@URSCorp.com
Subject: Requested info - SRIPP EFH
Importance: High

Good Afternoon,

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Anyway, I think this is all of the requested information. Please don't hesitate to let me know if you have any questions. We look forward to continued coordination on the project.

Thanks,

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

National Aeronautics and Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337-5099

May 17, 2010

Reply to Attn of: 250.W

Mr. Peter Colosi
Assistant Regional Administrator
Habitat Conservation Division
National Marine Fisheries Service
55 Great Republic Drive
Gloucester, Massachusetts 01930-2276

Dear Mr. Colosi:

On April 19, 2010, the National Aeronautics and Space Administration (NASA) received your Essential Fish Habitat (EFH) Conservation Recommendations for the Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program. NASA will give your recommendations full consideration as we develop the Final Programmatic Environmental Impact Statement for this project. Pursuant to section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), NASA is required to respond to your EFH Conservation Recommendations within 30 days of receiving them. However, the final decision on this project will not be made until all public comments have been reviewed and appropriate changes made to the document. We anticipate that this will occur by July 2010. At that time, NASA will provide the response required by the MSA, which will be given to you at least 30 days before the Record of Decision is signed if the response is inconsistent with any of your EFH Conservation Recommendations.

Thank you for your interest in this worthwhile project. If you have any additional questions, please don't hesitate to contact me at (757) 824-2319 or at Joshua.A.Bundick@nasa.gov.

Sincerely,

Joshua A. Bundick
Lead, Environmental Planning

cc:
MMS/Mr. D. Herkhof
NMFS/Mr. J. Nichols
USACE/Mr. R. Cole
USACE/Mr. G. Mears

From: Bundick, Joshua A. (WFF-2500)
Sent: Tuesday, May 18, 2010 3:52 PM
To: 'John.Nichols@noaa.gov'
Subject: Examples

John,

Hope all is well. We are currently working on a response to your EFH Conservation Recommendations.

Quick question—

Can you point me to other, similar projects, where NOAA Fisheries has specified threshold limitations for sand removal from offshore shoals? We are having difficulty tracking down representative examples, and any that you could provide would be helpful.

Thanks,

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

From: John Nichols [John.Nichols@noaa.gov]
Sent: Tuesday, May 18, 2010 3:59 PM
To: Bundick, Joshua A. (WFF-2500)
Subject: Re: Examples

One example that I was involved in was the Atlantic Coast of Maryland shoreline stabilization project, and the Great Gull Bank borrow site. We put limitations on the % of borrow to be removed (in total) from the shoal, and specific locations where material could be removed on the shoal.

From: Bundick, Joshua A. (WFF-2500)
Sent: Wednesday, May 19, 2010 11:27 AM
To: 'John Nichols'
Cc: Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]
Subject: RE: Examples
Attachments: Requested info - SRIPP EFH

John,

Are you aware of any others in the NER, perhaps others in other regions?

Also, never heard back from you regarding the re-calculated shoal volumes, sent via email on 4/13/10, and attached to this email. Have you had a chance to review those images, and if so, could you share your thoughts on the volumes?

Thanks,

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

From: John Nichols [John.Nichols@noaa.gov]
Sent: Wednesday, May 19, 2010 4:56 PM
To: Bundick, Joshua A. (WFF-2500)
Subject: Re: Examples

Josh:
I am not aware of other examples of limiting sand ridge borrow throughout the NER. That does not mean there aren't any. You could try contacting Karen Greene of our Sandy Hook, NJ office, (732) 872-3023, since she reviews sand borrow projects off NJ and Delaware. Nationwide, I suggest looking to the Southeast Region Habitat offices, for I am sure they have similar projects along the Atlantic and Gulf Coasts. I would suggest accessing the NOAA home website for locations and contacts on Southeast Regional Habitat Offices.

NMFS does not have a nationwide policy on sand ridge borrow. Those policies that may exist within Regions likely differ between Regions. Remember that scientific literature on the ecological values of sand ridges is brand new, as are borrow methods for sand ridge conservation. There is always a lag in the development of government policies in the face of new information. Unfortunately, development of nationwide policies often come too late; i.e., after specific habitats are threatened with complete loss of resource value by human activities. It is not acceptable to allow un-restricted borrow activities to continue until habitats and resources are threatened. MMS guidance, which we used in our comments, although rudimentary, exists now for up-front protection of mid-Atlantic sand ridge/swale complexes.

Your re-calculated shoal volumes were taken into consideration in our Regional comments. We are concerned that the re-calculated volumes may be inflated, and incorporate areas that extend beyond the actual basal foot print of the shoal. Additionally, our primary concerns pertain to the shoal crests and maximum shoal elevations. Because of the potential for post-borrow slumping, the borrow volumes and areas we recommend are also based on shoal morphometry, and provide conservative measures to better ensure that shoal elevations will remain unchanged following borrow for this project by keeping your actions a sufficient distance from the crests.

National Aeronautics and
Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

June 25, 2010

Reply to Attn of: 250.W

Mr. Peter Colosi
Assistant Regional Administrator
Habitat Conservation Division
National Marine Fisheries Service
55 Great Republic Drive
Gloucester, Massachusetts 01930-2276

Dear Mr. Colosi:

I would like to thank you and your staff for the thorough review of our February 2010 Draft Programmatic Environmental Impact Statement (PEIS) and Essential Fish Habitat (EFH) Assessment for the Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP). We are in receipt of your April 19, 2010 letter that contains the National Marine Fisheries Service's (NMFS) EFH Conservation Recommendations regarding the proposed project. In accordance with Section 305(b)(4)(B) of the Magnuson-Stevens Fisheries Management and Conservation Act (MSA), NASA and its Cooperating Agencies [Minerals Management Service (MMS) and U.S. Army Corps of Engineers (USACE)] offer responses to your Recommendations.

<u>Overall Project Direction</u>
Our project team has made it a priority to protect and preserve EFH while balancing the need to protect mission-critical assets. In the early planning stages of the SRIPP, we evaluated the possibility of dredging sand from several offshore shoals including Chincoteague Shoal and Blackfish Bank. Both shoals are substantially closer to the Wallops Island project site than Shoals A and B and each shoal likely has enough sand of compatible grain size to meet the needs of the SRIPP.

However, given its proximity to shore, Chincoteague Shoal was eliminated as a sand source due to the possible negative impacts to the Assateague Island shoreline from dredging and lowering the shoal height. Because Blackfish Bank was identified as an important fishing ground during a survey of commercial and recreational fishermen, and due to potential impacts to the Assateague shoreline, NASA also eliminated this shoal from further consideration. Consequently, NASA evaluated Shoals A and B, both of which are further offshore but still contain an adequate volume of sand with compatible grain size for placement along the shoreline. These shoals are not ideal locations as the increased distances from the sand placement site will certainly result in higher project costs, increased fuel consumption, longer construction periods, and increased air emissions.

Offshore Shoals in Context

The offshore shoals evaluated for the SRIPP are not unique habitats, but part of a complex of shoals that are present on the inner shelf off the Delmarva coast (Swift and Field, 1981). A recent study by Dibajnia and Nairn (2010, OCS Study MMS 2010-xxx) identified and examined 181 shoals between Delaware and Chesapeake Bays. However, many more shoals are present in the region, as the study was limited to offshore (shore-detached) shoals between the 10 and 40 meter (m) (33 and 131 feet [ft]) depth contour and greater than 2 kilometers (1.2 miles) in length.

The ecological value of the shoals of the mid-Atlantic, and in particular their value as EFH, is inconclusive due the limited number of studies conducted, sampling design limitations, and narrow geographic scope. CSA International, Inc. et al. (2009, OCS Study MMS 2010-010) reports that; "For most managed species relatively little is known regarding the use of shoals and ridges as EFH" (page 134), and "The role of shoals as potential settlement habitat remains not well known for many species" (page 135). The paper by Vasslides and Able (2008) cited in your April 19, 2010 letter used one transect across one shoal off southern New Jersey. While the authors did report 61 species, only 6 were Federally-managed species. In addition, Able et al. (2006) acknowledge the limitations of their study: (1) the data analyzed and reported were from only one year of data and that "Recent analysis suggests that longer-term changes such as climate effects may influence settlement habitats…," and (2) different gear was used between the estuary and ocean samples "…that could bias results." For their 2-year study on the inner continental shelf of the Mid-Atlantic Bight, Slacum *et al.* (in press) stated that "There was a trend of greater abundance, species richness, and species diversity in flat-bottom habitats than shoal habitats…"

Dredging Techniques and Effects on Shoals as EFH

We know of no published reports or studies that recommend specific dredging thresholds for offshore shoals. Additionally, published reports do not recommend avoiding the shoal crest when dredging. For example, CSA International, Inc. et al. (2009, OCS Study MMS 2010-010) recommend that "Excavation should occur on shoal crests and higher areas of the leading edge rather than lower areas of the shoals because of greater exposure to wave-generated turbulence and greater sediment mobility, which potentially results in more rapid sediment reworking and site infilling, and likely would induce the benthic community to recover more rapidly" (page ES-8). Slacum *et al.* (in press) suggest that "…the crests of shoals where species diversity appears relatively lower could be targeted for mining." In addition, guidelines contained in Dibajnia and Nairn (2010, OCS Study MMS 2010-xxx) do not provide recommendations for avoiding dredging of shoal crests.

In summary, we do not concur with all of your EFH Conservation Recommendations. Below, we provide a specific response to each Recommendation in your April 19, 2010 letter.

Recommendation 1:
NMFS will not object to limited amounts of sand being removed from each shoal. However, because Shoal B has a larger total volume than Shoal A (70 MCY vs. 40 MCY), and has more-gently sloped walls (resulting in less slumping of material following dredge excavations), more material can be removed from Shoal B over the life of this project without affecting its elevations and geomorphic features. Removal of sand borrow from Shoal B should not exceed 5.6 MCY (8% of its total volume), for the life of the project.

Response: The volumes of the shoals presented in the DPEIS and EFH Assessment were estimates. Since issuing the Draft, we have performed detailed computer-based volumetric analyses of Shoals A and B. Furthermore, we undertook an analysis of the shoal parameters similar to the evaluation presented in Dibajnia and Nairn (2010, OCS Study MMS 2010-xxx). Based on the surrounding bathymetry, we estimate a Base Depth for Shoal A of approximately 22 m (72 feet [ft]) and 25 m (82 ft) for Shoal B. Cross shelf profiles generated through the shoals indicate our rationale for selection of these depths (Figures 1 and 2). With these subsequent analyses, it is evident that the total volumes of sand for Shoals A and B that were presented in the Draft PEIS and EFH Assessment were underestimated at 40 million cubic yards (MCY) and 70 MCY, respectively. The revised analyses indicate that the shoals contain approximately 68 and 132 MCY, respectively.

In developing the SRIPP, we are balancing economic, environmental, and engineering considerations. For example, the potential use of Blackfish Bank and Chincoteague Shoals was eliminated from the project due to environmental concerns at a substantial cost to the SRIPP budget over its lifetime. We understand NMFS's mandate to protect EFH but we do not agree with shoal dredging thresholds that create an imbalance in the economic and environmental considerations. In addition, the relative value of these specific shoals to fish, fisheries, and EFH is not that clear—shoals may be an important habitat but they are not a rare habitat in the mid-Atlantic. We assume that the thresholds presented were based on the Atlantic Coast of Maryland (ACM) project which was also faced with balancing economics, engineering, and the environment. For ACM, the USACE was able to find the necessary volume within close proximity to the project area and maintain a conservative volume threshold while keeping the project within budget constraints. Given different project factors for the SRIPP, these thresholds are unnecessarily conservative and do not give consideration to all factors dictating the success of the project.

We agree that it is important to maintain the geomorphic integrity of the shoals and would implement dredging best management practices such as shallow dredging (further detailed in response to Recommendation 5, below). However we cannot concur with a recommendation that could have millions of dollars of implications in the near and long term and would not provide adequate volume requirements needed for the SRIPP. We plan to use Shoal A for the entire initial fill volume and would evaluate the potential use of either Shoal A or B for renourishment in the future.

Recommendation 2:
Borrow from Shoal A should not exceed 2 MCY of material (5% of its total volume), for the life of the project. If Shoal A is used for Phase 1 (beach re-construction), the remainder of the material needed for Phase 1 (1.2 – 1.9 MCY) should be taken from Shoal B.

Response: As expressed in our response to Recommendation 1, we are concerned that assigning a removal threshold without appropriate justification is unwarranted. We plan to obtain the entire initial fill volume (approximately 3.2 MCY) from Shoal A and would consider revisiting Shoal A for renourishment only after survey and analyses of post-dredge shoal recovery, and subsequent consultation with your agency.

Recommendation 3:
On both Shoal A and B, sand should be removed only from the depocenters of the shoal (active accretional features), generally located on the southern or southwestern downdrift wall of the shoal. These areas should be definitively demarcated on a bathymetric map of each shoal, to be approved by NMFS prior to release of the final EIS; and understood by the dredge contractor prior to sand harvest.

Response: We agree that targeting active accretional shoal features will likely minimize long term effects to geomorphology and habitat value. Figure 3 depicts the long term accretional and erosional areas of the shoals based on bathymetric changes from 1934 to 2002 (the most recent available) using bathymetric data from NOAA. As indicated on Figure 3, over the long term the southern and eastern portions of Shoal A are accreting. The southern part of the landward side of the shoal is shown as eroding over the long term. These patterns are consistent with the observations on Fenwick Shoal presented in USACE (2008, Figure 2-7, modified from Hayes and Nairn (2004)). We plan to avoid dredging the erosional area within the 2-square-mile study area shown on Figure 3 to the extent practicable. Since we are only targeting Shoal A for initial fill, we will evaluate the use of Shoal B for renourishment events in the future as needed.

Recommendation 4:
Under no circumstances should sand be removed from the erosional or static features of each shoal, including the seaward or east walls, and upper crests. Sand excavation by the dredge should occur only on the downdrift wall of the shoal below the minus 10 meter (MLL) contour on the crest of Shoal A; and below the minus 12-meter MLLW contour on the crest of Shoal B.

Response: We concur that removing sand from erosional shoal features would have a more detrimental effect to the long term maintenance of shoal geomorphology. However, regarding the avoidance of shoal crests, Dibajnia and Nairn (2010, OCS Study MMS 2010-xxx) state that there is potential for recovery of shoal crest height provided that dredging cut depth is not excessive. Therefore, we do not concur with your recommendation to avoid shoal crests.

Based on our analysis of the bathymetric changes in Shoal A from 1934-2002, the seaward or east flank is accreting. As a result, we will target these areas for dredging to the extent practicable, but will also dredge material from the crests. According to geotechnical sampling of the shoals, the crests of the shoals contain coarser sediments compared to the east (seaward) flank thereby reducing the total volume needed for the project, the duration of activities, and the associated environmental impacts.

Recommendation 5:
Excavation should be shallow in depth on both shoals, not extending below 2 meters on the existing bottom.

Response: We agree that providing a shallower excavation over a larger surface area will minimize adverse effects to shoal geomorphology; however, shallower dredge cuts translate into a larger dredge area which would cause more direct impacts to benthic habitat, benthic communities, and trophic impacts to fish communities. We will avoid dredging deep pits and will strive for a uniform cut depth to the greatest extent practicable. Provided we can obtain the volume necessary, we will restrict the dredge cut depth to 2 m during the initial dredge event. We will evaluate the depth of dredge cuts for renourishment events in the future as needed.

Recommendation 6:
Pre- and post-borrow bathymetric maps of each shoal should be provided to NMFS for review and comment (post-borrow map corresponding to the period immediately following borrow for Phase 1 of the project).

Response: We concur and will provide NMFS pre- and post-borrow bathymetric maps of the dredged areas. The post-borrow survey will be performed soon after dredging is completed, likely not more than two weeks following completion of the initial fill phase of the project. We will follow standard USACE bathymetric survey procedures as stated in USACE survey manual publication number EM 1110-2-1003 (USACE, 2002).

Recommendation 7:
We recommend that re-construction of the NASA beach during Phase I of the project be done in long-shore sections (e.g., beach and dune reconstruction be completed in 2,000 linear foot sections, with one section completed before moving to the next adjacent section), to reduce project cost, and increase the feasibility of using both shoals as borrow sources for Phase 1 (Rick Schmidt, Weeks Marine; 2010 personal communication; (985) 875-2500).

Response: We appreciate your recommendation for reducing project costs; however, we will defer to the contractor that is ultimately selected to implement the most cost effective method for beach fill.

Recommendation 8:
NASA should develop a beach monitoring protocol and sand management plan, to be implemented following Phase I construction of the restored beach. The plan should include the following components:

- ***Delineation of areas of significant sand loss (vertical and spatial loss) from the nourished beach, with estimation of annual CY of sand loss***
- ***Identifying/constructing of structural components (groins, offshore parallel stone breakwaters), as prescribed by the sand management plan, to minimize sand loss***

Response: We have developed a beach monitoring plan as part of the PEIS, which includes your recommended components. Regarding identification and construction of rock sand retention structures, we feel that our adaptive design and management philosophy for the project will enable us to make informed decisions in the future regarding such construction based on empirical data obtained from our monitoring efforts.

Recommendation 9:
The proposed dune covering the existing and new seawall should be planted with native dune community vegetation (e.g., American beachgrass [Ammophil spp.], saltmeadow cordgrass [Spartina patens]) to stabilize dune material. The dune plant community should be re-planted/maintained, as needed.

Response: We agree that planting the created dune with native plants would be an effective measure for stabilizing the feature and capturing wind-blown sand to perhaps increase its size over time and reduce renourishment requirements. As such, we will include dune planting as a contractual requirement for the project. Maintenance of the plantings will be performed as funds allow.

Recommendation 10:
NOAA strongly supports the use, and expansion (where feasible) of the North Wallops Island borrow site for beach re-nourishment, and to reduce borrow requirements from Shoal B for the life of the project.

Response: We appreciate your comment regarding the backpassing of sand from North Wallops Island for renourishment fill; however at this time we are unable to accurately define the extent of that activity. Substantial concern has been raised by other resource agencies (e.g., U.S. Fish and Wildlife Service, Virginia Department of Game and Inland Fisheries, and U.S. Environmental Protection Agency) regarding the effects of this proposal as it could detrimentally affect habitat valued for its continuing support of federally and state listed species. We may implement this borrow site alternative in the future, but would only do so after undertaking a much more detailed evaluation of its potential effects on project economics and the environment.

Recommendation 11:
NOAA recommends that NASA implement a long-term program for increasing the integrity and elevation of the existing and proposed seawall to improve protection of NASA infrastructure. Improved seawall design may ultimately reduce the continued need for sand fill on the beach.

Response: We will continue to maintain the integrity of the existing seawall as funds allow.

Again, thank you for your interest in this project. If you have any additional questions regarding our responses, please do not hesitate to contact me at (757) 824-2319 or at Joshua.A.Bundick@nasa.gov.

Sincerely,

Joshua A. Bundick
Lead, Environmental Planning

Enclosures

cc:
200/Ms. C. Massey
220/Mr. W. Phillips
228/Mr. P. Bull
250/Ms. C. Turner
MMS/Mr. D. Herkhof
MMS/Mr. G. Wikel
USACE/Mr. R. Cole
USACE/Mr. G. Mears

<u>Literature Cited</u>

Able, K.W., M.P. Fahay, D. A. Witting, R.S. McBride, and S.M. Hagan. 2006. Fish settlement in the ocean vs. estuary: Comparison of pelagic larval and settled juvenile composition and abundance from southern New Jersey, U.S.A. Est. Coast. Shelf Sci. 66: 280 – 290.

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Dibajnia, M. and R.B. Nairn. 2010. Investigation of Dredging Guidelines to Maintain and Protect the Integrity of Offshore Ridge and Shoal Regimes. U.S. Department of the Interior, Minerals Management Service, Leasing Division, Marine Minerals Branch, Herndon, VA. OCS Study MMS 2010-xxx. 150 pp. + apps.

Hayes, M.O. and R.B. Nairn. 2004. Natural maintenance of sand ridges and linear shoals on the U.S. Gulf and Atlantic continental shelves and the potential impacts of dredging. Journal of Coastal Research, 20(1): 138 – 148.

Slacum, Jr., H.W., W.H. Burton, E.T. Methratta, E.D. Weber, R.J. Lanso, & J. Dew-Baxter. (*in press*). Assemblage Structure in Shoal and Flat-bottom Habitats on the Inner Continental Shelf of the Middle Atlantic Bight, U.S.A. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science.

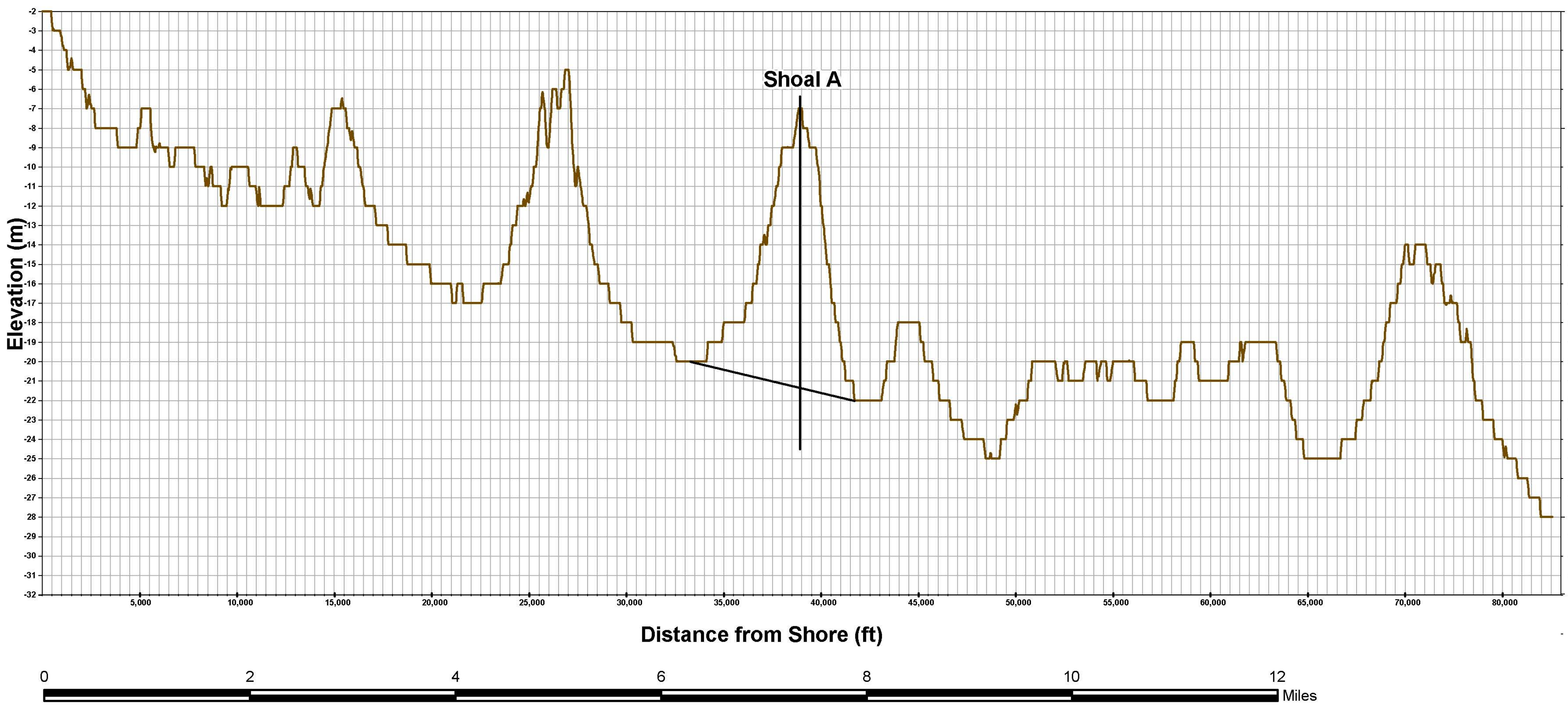
Swift, D.J.P. and M.E. Field. 1981. Evolution of a classic sand ridge field: Maryland sector, North American inner shelf. Sedimentology 28: 461 – 482.

USACE. 2002. Engineering and Design – Hydrographic Surveying. EM 1110-2-1003.

USACE. 2008. Atlantic Coast of Maryland Shoreline Protection Project Final Supplemental Environmental Impact Statement General Reevaluation Study: Borrow Sources for 2010-2044. August.

Vasslides, J.M. and K.W. Able. 2008. Importance of shoreface sand ridges as habitat for fishes off the northeast coast of the United States. Fish. Bull. 106: 93 – 107.

Profile 1

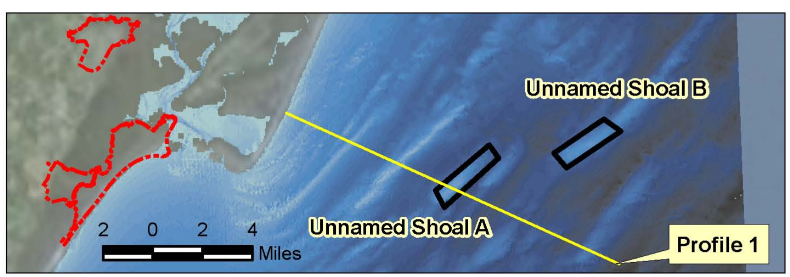


Bathymetric Surface Along Transect

Vertical Exaggeration = 1000x

Shoal Location

WFF Boundary



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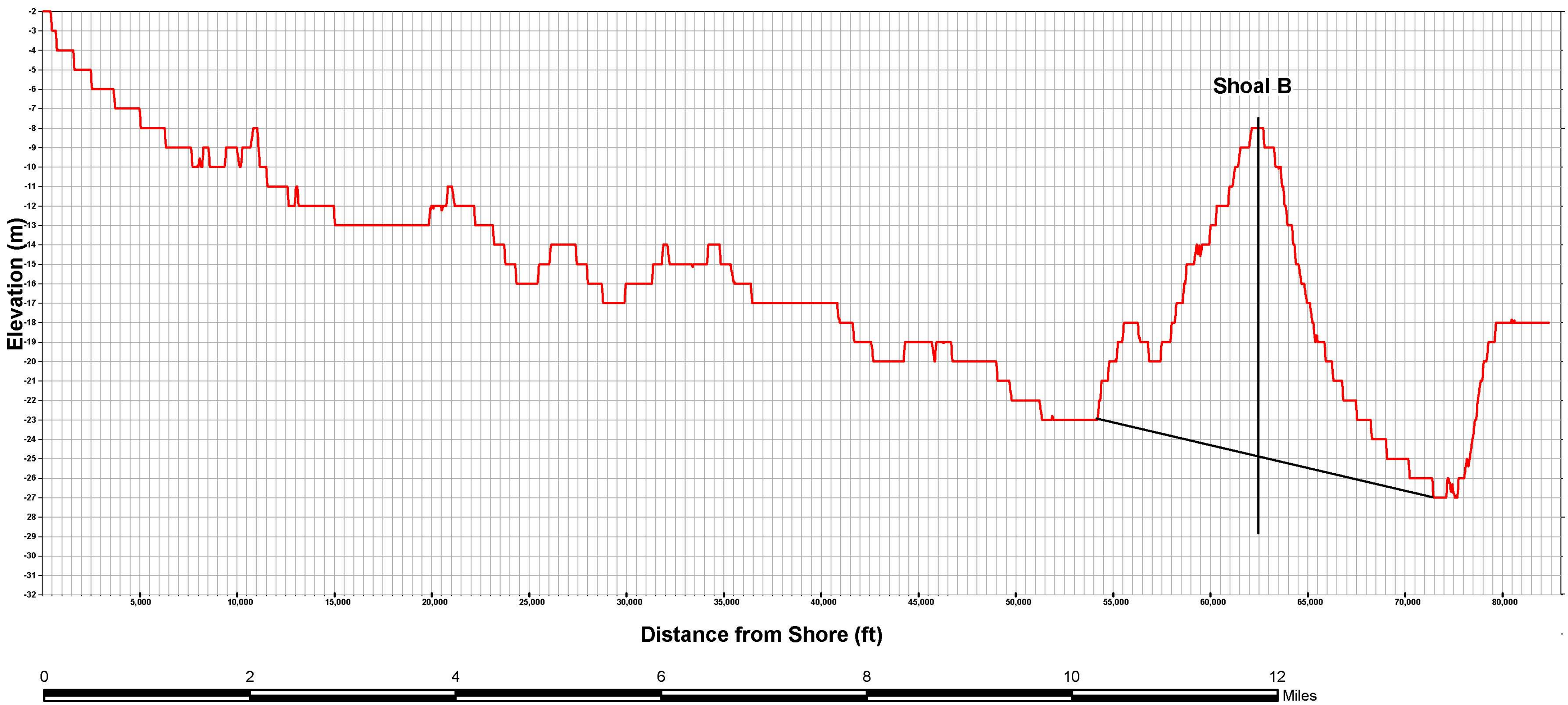
	URS Proj No: 15301785
	Figure: 1
Client : NASA	
Shoreline Restoration Environmental Impact Statement	

Profile 2

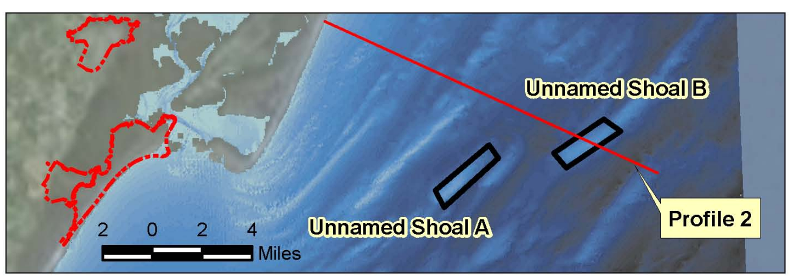


Bathymetric Surface Along Transect

Vertical Exaggeration = 1000x

Shoal Location

WFF Boundary



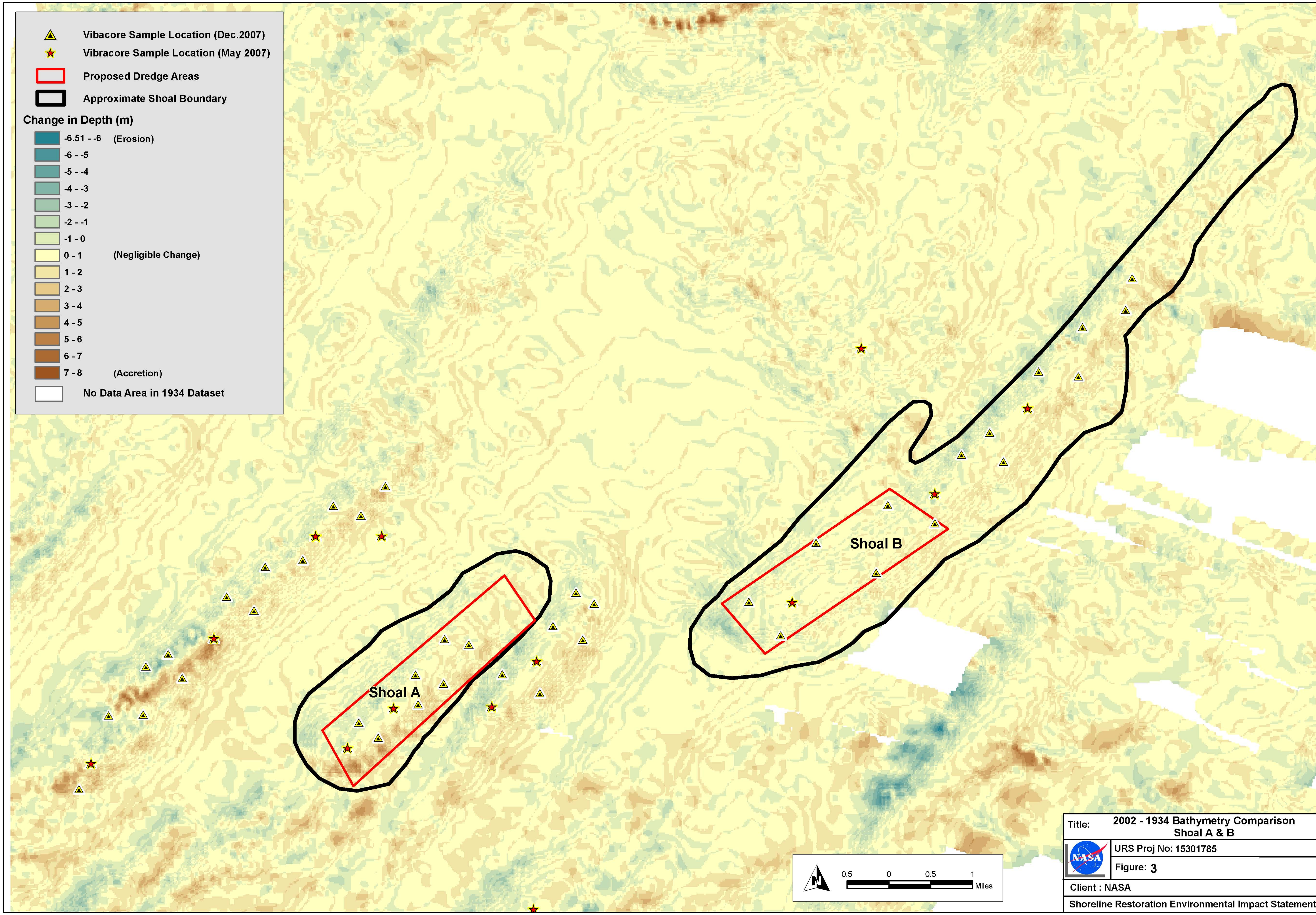
Title: **Profile 2**

URS Proj No: **15301785**

Figure: **2**

Client : NASA

Shoreline Restoration Environmental Impact Statement



Vibracore Sample Location (Dec.2007)
Vibracore Sample Location (May 2007)
Proposed Dredge Areas
Approximate Shoal Boundary
Change in Depth (m)
-6.51 - -6 (Erosion)
-6 - -5
-5 - -4
-4 - -3
-3 - -2
-2 - -1
-1 - 0
0 - 1 (Negligible Change)
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7
7 - 8 (Accretion)
No Data Area in 1934 Dataset
Shoal A
Shoal B
0.5 0 0.5 1
Miles
Title: 2002 - 1934 Bathymetry Comparison
Shoal A & B
URS Proj No: 15301785
Figure: 3
Client : NASA
Shoreline Restoration Environmental Impact Statement

From: Bundick, Joshua A. (WFF-2500)
Sent: Tuesday, July 13, 2010 2:27 PM
To: 'John Nichols'
Subject: EFH Response

Importance: High

John,

I just wanted to check in with you to inquire as to whether NMFS would like to have additional discussion about the Conservation Recommendation responses that we sent regarding the Wallops SRIPP.

Please advise.

Hope all is well.

Thanks,

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

From: John Nichols [mailto:John.Nichols@noaa.gov]
Sent: Tuesday, July 13, 2010 2:56 PM
To: Bundick, Joshua A. (WFF-2500)
Subject: Re: EFH Response

I skimmed through your response, but need to review it more thoroughly before identifying discussion points. I also want to discuss your response with Mineral Management Services before our discussion. Finally, I would also like to have my first line supervisor on the line (Stan Gorski) to discuss rejection of many of our Conservation Recommendations.

If you need to finalize by the end of July, I could plan on a conference discussion next week

Meeting Minutes

Teleconference Regarding Essential Fish Habitat Consultation: July 26, 2010

Shoreline Restoration and Infrastructure Protection Program PEIS

Participants

MMS – Dirk Herkhof
MMS – Geoff Wikel
NASA - Josh Bundick
NASA - Paul Bull
NMFS – Stan Gorski
NMFS - John Nichols
URS - Jeff Reidenauer
URS – Shari Silbert
USACE – George Mears
USACE - Gregg Williams

<u>EFH Discussion:</u>

- NASA representatives explained that the purpose of the meeting was to discuss the EFH Conservation Recommendation responses that were provided to NMFS.

- Josh Bundick and Jeff Reidenauer provided a brief description of the topographic change analysis that was performed to identify accreting and eroding areas on the shoals, and that the accreting areas identified differed from what NMFS had suggested in its Conservation Recommendations.

- John Nichols stated that it is important to preserve the topographic integrity of the shoals. He also requested that the northeast sections of the shoal be conserved as they are likely eroding, and consequently are the primary source of sand for maintaining other parts of the shoal. Both he and Stan Gorski emphasized the importance of the offshore shoal habitats as fish habitat.

- NASA and USACE participants explained the cost constraints on the project and how the sand removal threshold limitations would not enable a complete project to be built.

- NASA and USACE participants asked NMFS if the Conservation Recommendations offered for the SRIPP would be precedent setting. John Nichols stated that they would likely set precedent for future projects.

- The discussion then focused on NMFS priorities for mitigation of impacts to offshore sand shoals. NMFS stated that the priorities could be ranked in the following order:

  1) Dredging should target areas on the shoal that are accreting and should avoid erosional areas;

  2) Dredging should not take place along the entire longitudinal axis of a shoal, rather it should be along the southern half or third of the shoal;

3) Portions of the crest should remain intact; and

4) There should be a long-term cap on how much material is removed from a shoal during the lifetime of a project.

- NASA indicated its reluctance to bind the entire 50-year project at such an early stage and that establishment of a long-term cap at this point would not be possible. Josh Bundick explained that tiered or supplemental NEPA documentation would be prepared for each renourishment cycle and that additional EFH consultation would occur at that time. NASA would provide NMFS pre- and post-dredge bathymetric survey data to enable such consultations.

- At the end of the meeting, NASA and NMFS agreed that NASA would provide NMFS additional information regarding the proposed dredging plan.

Action Items

- NASA – Identify revised areas proposed for dredging on both shoals and provide a map to John Nichols

From: Bundick, Joshua A. (WFF-2500)
Sent: Thursday, July 29, 2010 8:17 AM
To: 'John Nichols'; 'Stanley W Gorski'
Cc: Bull, Paul C. (WFF-2280); Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; Jeffrey_Reidenauer@URSCorp.com; 'Wikel, Geoffrey L'; 'Williams, Greggory G NAO'; 'Mears, George H NAO'; Valdes, Sally J; 'Cole, Robert H NAO'
Subject: SRIPP map w/ volumes
Attachments: Dredging for NMFS 20100727.pdf

Importance: High

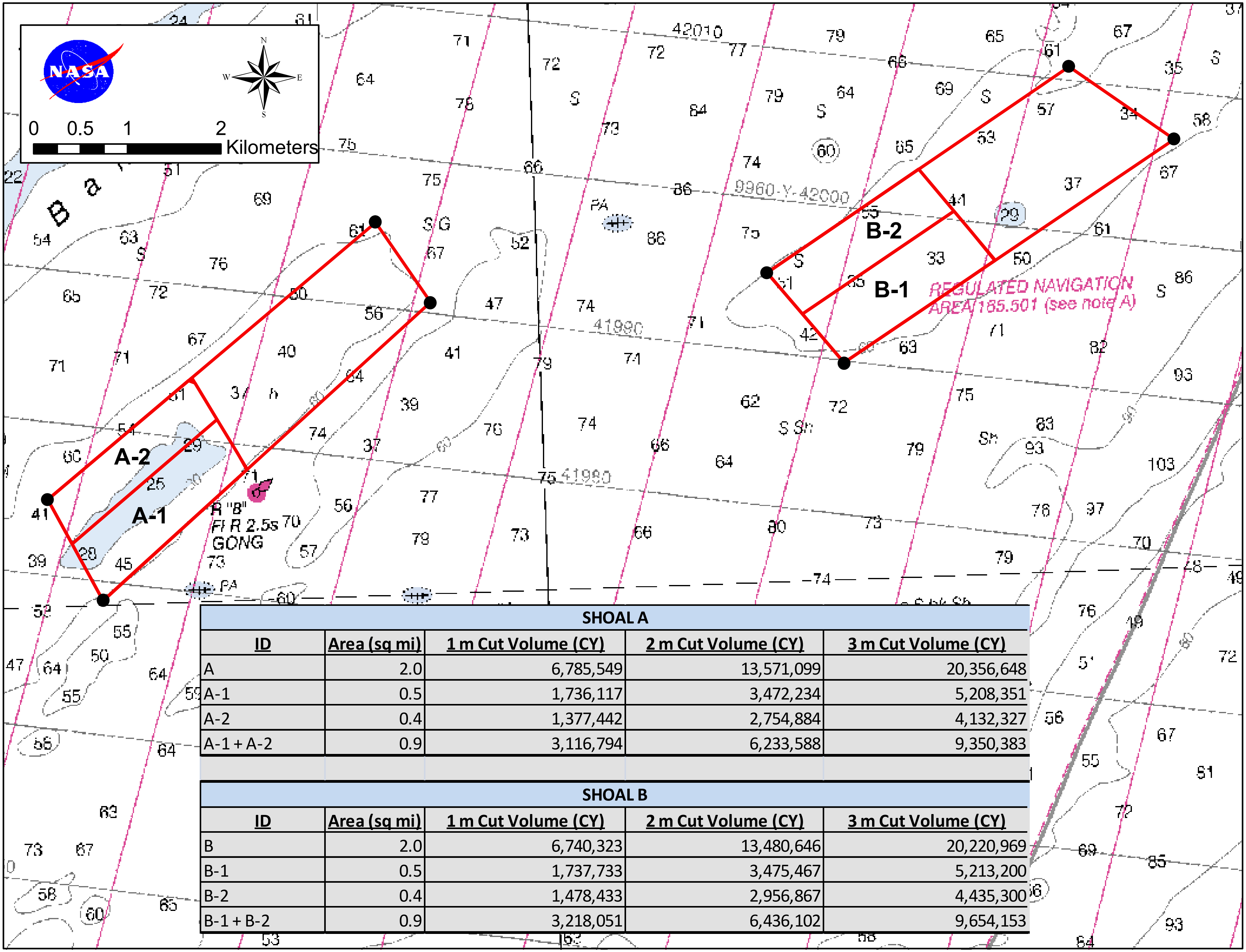
John,

Attached is a map that I put together to depict what we talked about Monday. For initial construction of the project, it seems reasonable that we would target A-1 with a 2 m cut depth, and provided that we got what we needed, that's where we'd stay. We would only cut deeper within A-1 or go to A-2 only in an off-nominal case.

Please let me know your thoughts.

Thanks,

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov



SHOAL A				
ID	**Area (sq mi)**	**1 m Cut Volume (CY)**	**2 m Cut Volume (CY)**	**3 m Cut Volume (CY)**
A	2.0	6,785,549	13,571,099	20,356,648
A-1	0.5	1,736,117	3,472,234	5,208,351
A-2	0.4	1,377,442	2,754,884	4,132,327
A-1 + A-2	0.9	3,116,794	6,233,588	9,350,383

SHOAL B				
ID	**Area (sq mi)**	**1 m Cut Volume (CY)**	**2 m Cut Volume (CY)**	**3 m Cut Volume (CY)**
B	2.0	6,740,323	13,480,646	20,220,969
B-1	0.5	1,737,733	3,475,467	5,213,200
B-2	0.4	1,478,433	2,956,867	4,435,300
B-1 + B-2	0.9	3,218,051	6,436,102	9,654,153

From: John.Nichols@noaa.gov
Sent: Thursday, July 29, 2010 10:44 AM
To: Bundick, Joshua A. (WFF-2500)
Subject: Re: SRIPP map w/ volumes
Attachments: ATT00001..txt; ATT00002..htm

Thanks for the quick input. However, it is difficult for me to relate the depicted borrow areas with the shoal features (i.e., crest, flanks, etc.). Could these delineated areas be transcribed onto a map showing shoal depth contours (in meters)? Thanks.

From: Bundick, Joshua A. (WFF-2500)
Sent: Monday, August 02, 2010 1:00 PM
To: 'John.Nichols@noaa.gov'
Cc: Bull, Paul C. (WFF-2280); Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; 'Jeffrey_Reidenauer@URSCorp.com'; Williams, Greggory G NAO; george.h.mears@usace.army.mil; Hudgins, Mark H NAO; 'Herkhof, Dirk'; 'Wikel, Geoffrey L'; Valdes, Sally J; 'Stanley W Gorski'
Subject: RE: SRIPP map w/ volumes
Attachments: Dredge Optimization Calcs 20100802.xls; Dredging for NMFS SHOAL B w contours 20100802.pdf; Dredging for NMFS SHOAL A w contours 20100802.pdf

John,

Additional information attached as requested. Please note that we have performed some additional analysis for optimizing length of dredge pass and have adjusted the map accordingly. The back-up calculations are attached.

I have discussed this proposal this morning with our colleagues with the Corps of Engineers, and we are all in agreement that this presents a reasonable approach for obtaining the material needed in a cost-effective and environmentally-conscious manner.

As proposed before, for initial fill we would target area A-1, and would only direct the contractor to A-2 in an off-nominal case.

Please let me know your thoughts on this, as we would like to solidify our dredging plans so that we can complete the EIS on schedule. Look forward to hearing from you.

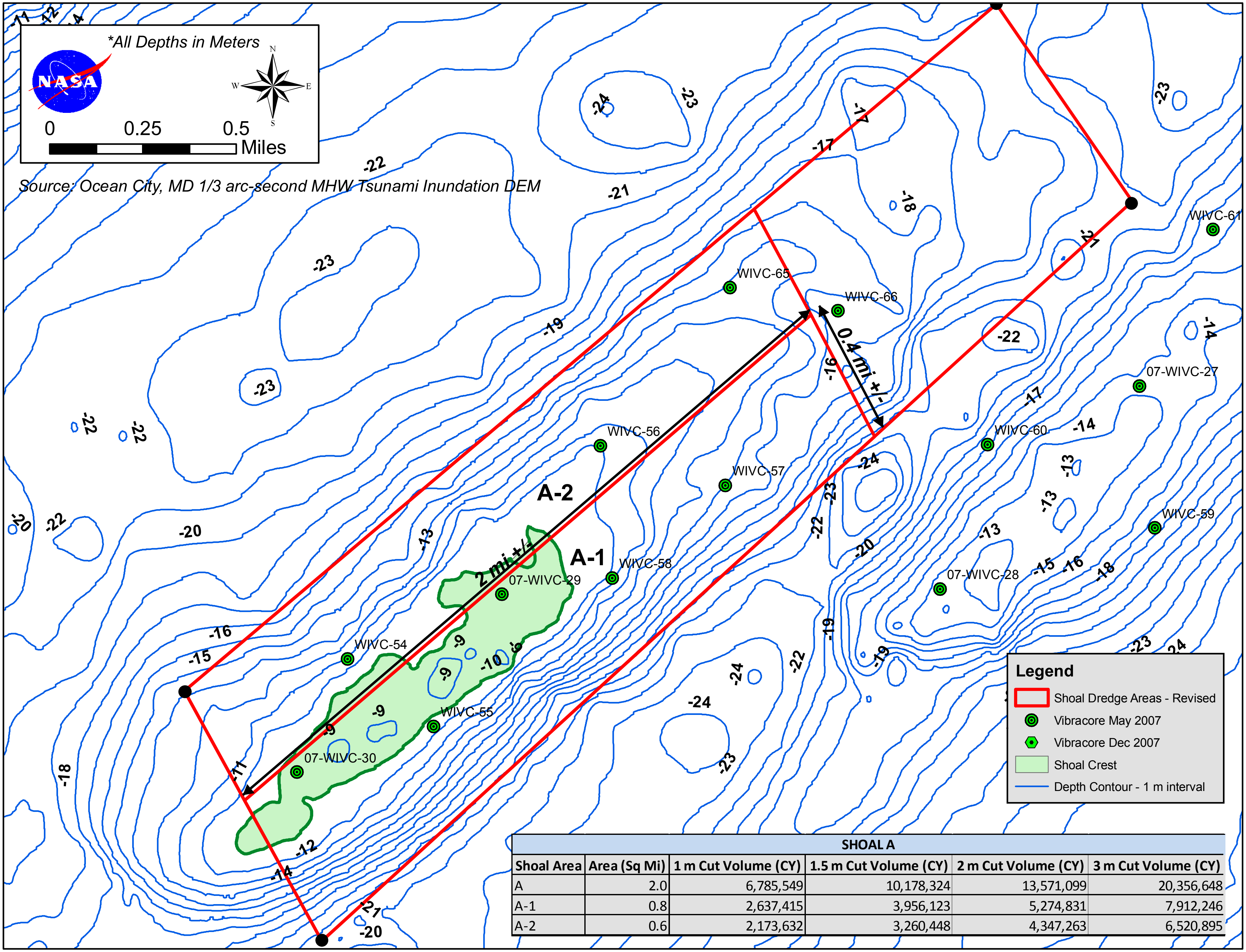
Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

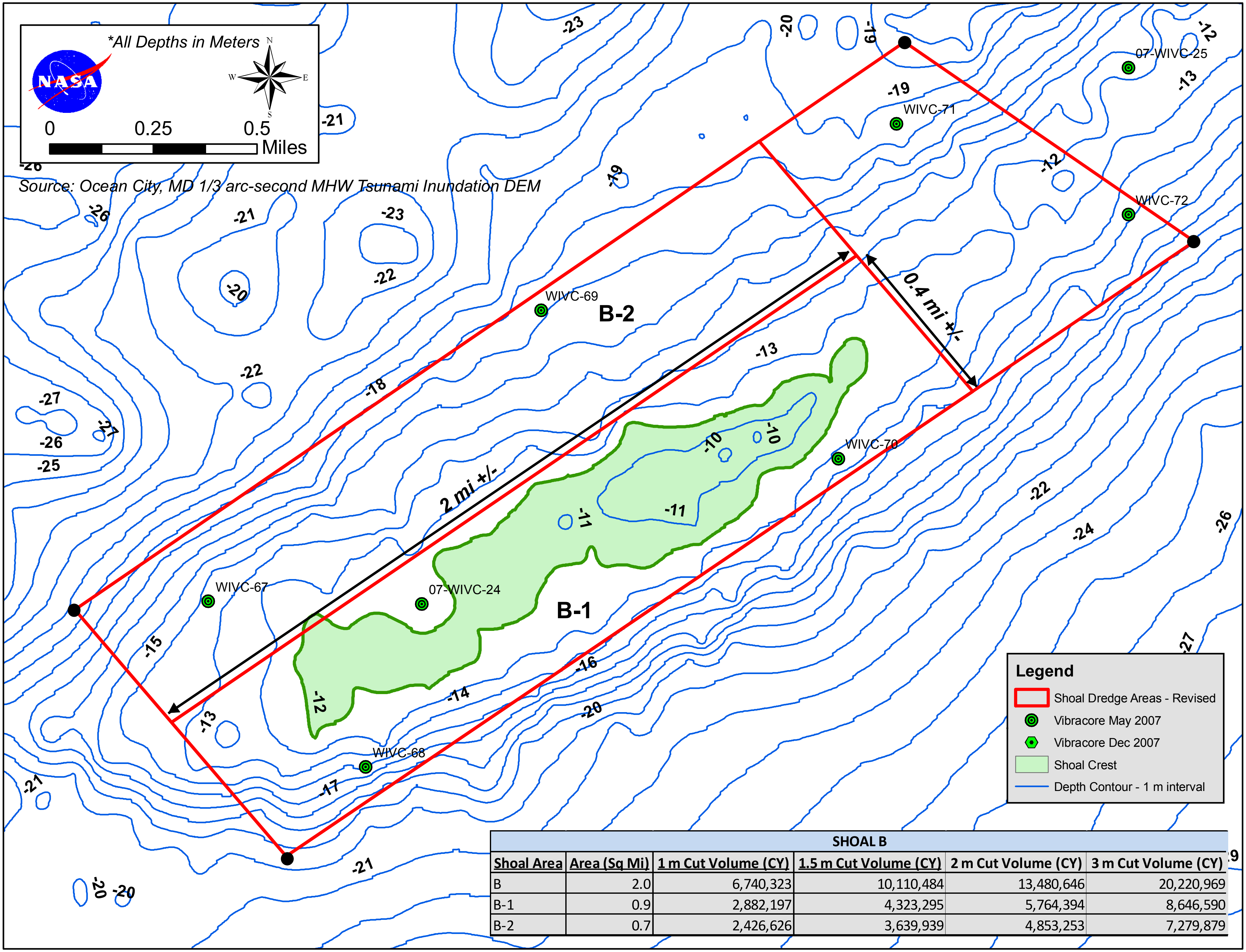
NASA WFF SRIPP
Dredge Operation Optimization Calculations
Aug-10

Dredge Capacity:	3,000	CY
Width of Draghead:	4	feet
Depth of Cut:	0.5	feet
Number of Dragheads	2	
Production per linear foot:	4	Cubic Feet/Foot
	5,280	feet/mile
Production per linear mile:	21,120	Cubic Feet/mile
	27	Cubic Feet/CY
	782	CY/mile
Miles to fill hopper:	3.8	miles

Optimal Length of Dredge Pass for "up and back" fill cycle: ~2 miles



SHOAL A					
Shoal Area	Area (Sq Mi)	1 m Cut Volume (CY)	1.5 m Cut Volume (CY)	2 m Cut Volume (CY)	3 m Cut Volume (CY)
A	2.0	6,785,549	10,178,324	13,571,099	20,356,648
A-1	0.8	2,637,415	3,956,123	5,274,831	7,912,246
A-2	0.6	2,173,632	3,260,448	4,347,263	6,520,895



SHOAL B					
Shoal Area	Area (Sq Mi)	1 m Cut Volume (CY)	1.5 m Cut Volume (CY)	2 m Cut Volume (CY)	3 m Cut Volume (CY)
B	2.0	6,740,323	10,110,484	13,480,646	20,220,969
B-1	0.9	2,882,197	4,323,295	5,764,394	8,646,590
B-2	0.7	2,426,626	3,639,939	4,853,253	7,279,879

From: John.Nichols@noaa.gov
Sent: Monday, August 02, 2010 3:33 PM
To: Bundick, Joshua A. (WFF-2500)
Subject: Re: RE: SRIPP map w/ volumes

Josh:
Having trouble opening your first attachment (Dredge Optimization Calcs). If you can, please FAX to (410) 295-3154.

Attachments two and three depict borrow areas that do not differ much from what were proposed in your response letter of June 2010. For both shoals, you are borrowing along most of the long axis of the shoals, and borrowing from the entire crest. A portion of each shoal crest should be left intact (untouched) to allow for recovery of the crest to pre-existing elevations.

The boxes depicting borrow areas should favor the southern third of the shoal (southwest and southeast sections), and extend down the flank of the southern ends. Tomorrow when I return to my office, and will FAX you a diagram from the MMS study on the Maryland coastal protection project, depicting location of borrow areas for Isle of Wight Shoal, similar to that which should be used on Shoals A and B. If borrow must taken to a depth deeper that 2 meters below existing bottom, we are willing to agree to borrow down to 3 meters, in order to protect the static/erosional features of each shoal.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northeast Region
Habitat Conservation Division
410 Severn Avenue, Suite 107A
Annapolis, MD 21403
Commercial Phone: (410) 267-5675
FAX#: ~~(410) 267-5666~~ (410) 295-3154

FAX TRANSMITTAL

TO: Josh Bundick

LOCATION: NASA WFF Wallops

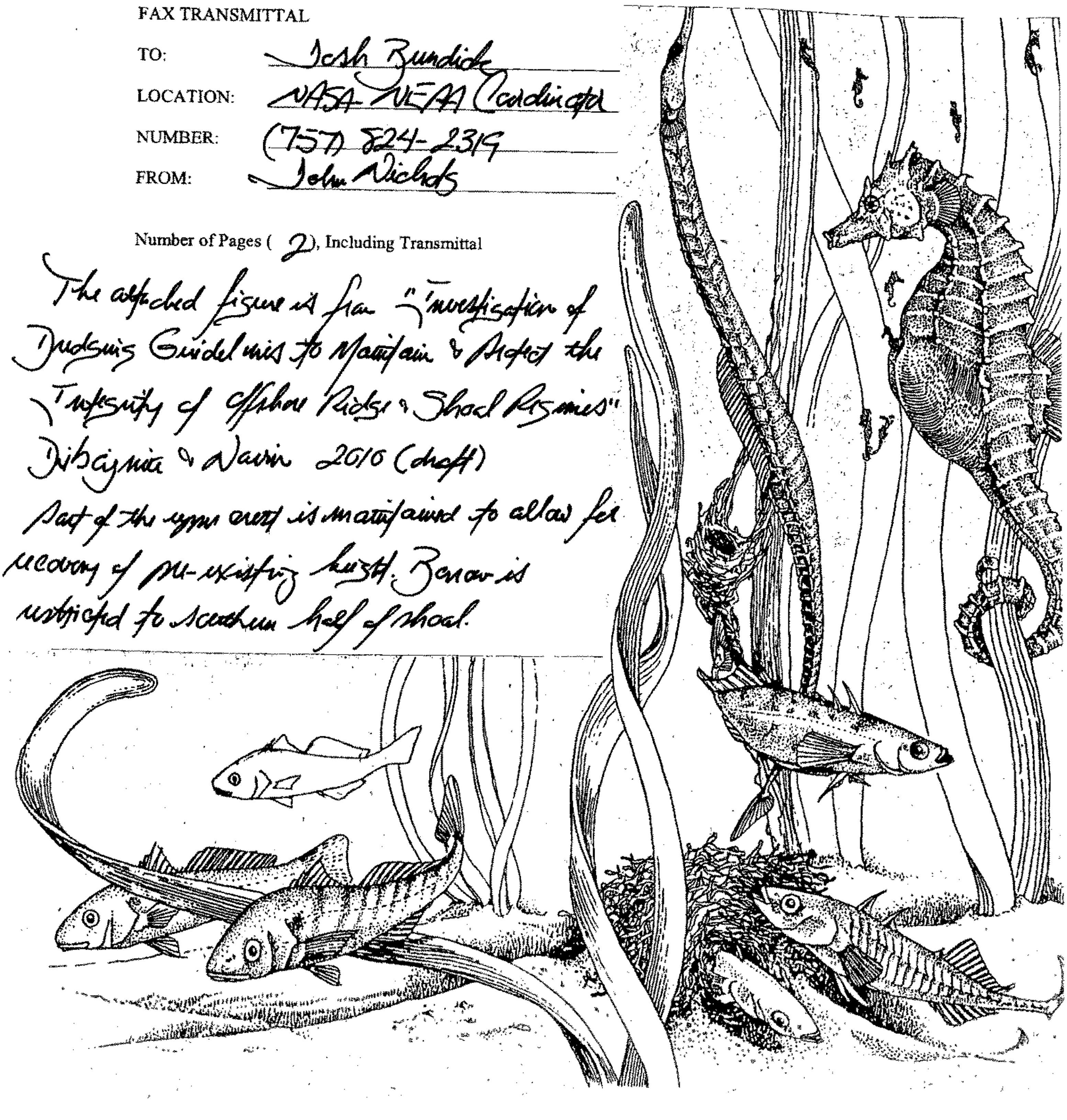
NUMBER: (757) 824-2319

FROM: John Nichols

Number of Pages (2), Including Transmittal

The attached figure is from "Investigation of Dredging Guidelines to Maintain & Protect the Integrity of Offshore Ridge & Shoal Resources" Dibajnia & Nairn 2010 (draft)

Part of the upper crest is maintained to allow for recovery of pre-existing height. Borrow is restricted to southern half of shoal.



Scenario 3

In this scenario the southwestern half of the crest of Isle of Wight is dredged to -10 m contour, as shown in Figure 7.11, to provide about 1.8 million m^3 of sand.

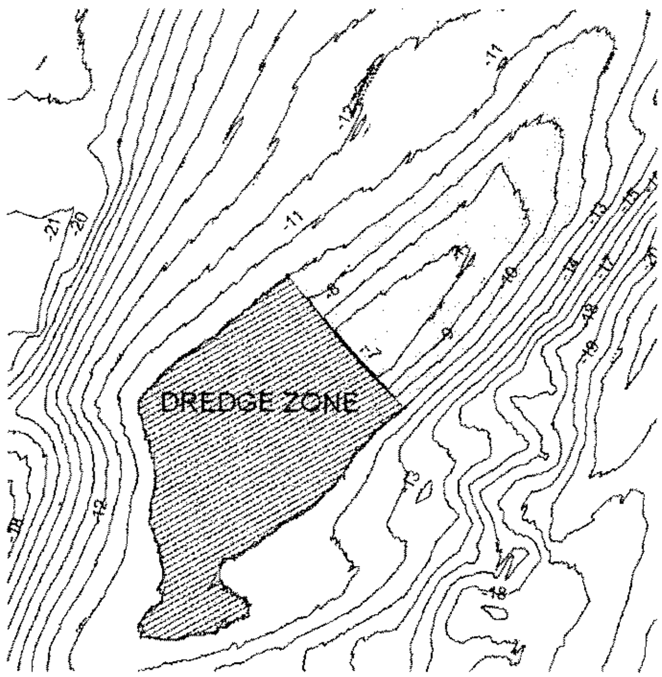


Figure 7.11 Dredging Scenario 3.

Figure 7.12 shows the initial and predicted future bathymetry for the Scenario 3 dredging configurations. IOW is reintegrated into a shoal with shorter crest length than the pre-dredge conditions. Figure 7.13 shows the initial and final depth contours as well as a map of change in bottom elevations. There is considerable accumulation over the northeast half of the dredged part. The rest of the dredged platform stays nearly unchanged. Comparisons at selected transects presented in Figures 7.14 and 7.15 show that the reformed shoal crest has the same height as the pre-dredge shoal. The new crest, however, is shorter and does not extend far beyond Transect 7 towards southwest. Therefore, this dredging scenario is expected to result in a shoal with the same height but with a shorter crest length than the pre-dredge conditions.

From: Bundick, Joshua A. (WFF-2500)
Sent: Thursday, August 05, 2010 11:48 AM
To: 'John.Nichols@noaa.gov'
Cc: 'Stanley W Gorski'; Bull, Paul C. (WFF-2280); 'Herkhof, Dirk'; 'Wikel, Geoffrey L'; Valdes, Sally J; Mears, George H NAO; 'Williams, Greggory G NAO'; Hudgins, Mark H NAO; 'Cole, Robert H NAO'; Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; Jeffrey_Reidenauer@URSCorp.com
Subject: Additional EFH Information: NASA WFF SRIPP
Attachments: NASA SRIPP EFH Follow up Paper FINAL.pdf; NASA SRIPP EFH Follow up Paper ATTACHMENTS FINAL.pdf

Importance: High

John,

Please find attached a point paper and supporting documentation regarding the EFH Consultation for the NASA WFF SRIPP.

As you will see when you read the document, we have taken a hard look at the issue, and this is our final decision. Please let me know if you have any questions or require additional clarification.

Thanks,

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

NASA WFF SRIPP

Summary of Consistency with Recently Developed Dredging Recommendations

Supporting Essential Fish Habitat Consultation

August 2010

Purpose:

The purpose of this document is to clearly demonstrate the consistency of the Wallops Shoreline Restoration and Infrastructure Protection Program (SRIPP) with the number of recently published dredging considerations. Recent discussions with the National Marine Fisheries Service (NMFS) regarding Essential Fish Habitat (EFH) are also summarized, and conclusions are drawn regarding the National Aeronautics and Space Administration's (NASA) final plan for dredging sand from SRIPP Shoal A[1] for the initial project fill.

The two most recent publications, which will be the primary focus of this document, are *Analysis of Potential Biological and Physical Impacts of Dredging on Offshore Ridge and Shoal Features*, prepared in 2009 by CSA International, Inc. in cooperation with Applied Coastal Research and Engineering, Inc. Barry A. Vittor and Associates, Inc., C.F. Bean, L.L.C., and the Florida Institute of Technology (CSA et al., 2009), and the 2010 *Investigation of Dredging Guidelines to Maintain and Protect the Integrity of Offshore Ridge and Shoal Regimes* prepared by Mohammad Dibajnia and Robert Nairn of Baird and Associates (Dibajnia and Nairn, 2010). Both reports were prepared under contract with the U.S. Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE). Presented below are the individual recommendations from the two reports and a response demonstrating how the SRIPP is consistent with each.

From CSA et al., 2009:

1. Recommendation: *Extract sand from a depocenter, or leading or downdrift margin of a shoal, to avoid interrupting natural shoal migration and potentially reduce the time required for site refilling.*

   Response: According to the Geographic Information System (GIS)-based analysis performed by URS, NASA's contractor, the depocenters on SRIPP Shoal A are along the southern half of the east flank. Consistent with the above recommendation, a large portion of the area targeted for initial fill will be along the east flank.

2. Recommendation*: Avoid dredging in erosional areas that source downdrift depocenters, which also may be slow to refill after dredging.*

[1] Note that there are two different "Shoal As" discussed in this document. As such, the shoal under consideration for the SRIPP is identified as "SRIPP Shoal A" and the shoal considered for the Atlantic Coast of Maryland (ACM) project is referred to as "ACM Shoal A."

Response: According to the GIS-based analysis, the target area for initial fill will almost completely avoid areas identified as erosional.

3. Recommendation: *Shallow dredging over large areas rather than excavating small but deep pits.*

   Response: The dredging proposed would be shallow with a targeted cut of approximately 2 meters. However, due to the inherent inaccuracies in open ocean hopper dredging (the tolerance is estimated to be about 0.6 meters), it is likely that actual dredged depths could be closer to 3 meters in some areas.

4. Recommendation: *Dredge in a striped pattern to leave sediment sources adjacent to and interspersed throughout target areas, leading to a more uniformly distributed infilling process.*

   Response: At the current time NASA has no plans to implement stripe dredging as its effects on efficiency as well as environmental resource areas has yet to be proven. It is also expected that implementing such a methodology would add significant cost, thereby prohibiting the project from being constructed as designed.

5. Recommendation: *Excavation should occur on shoal crests and higher areas of the leading edge rather than lower areas on the shoals because of greater sediment mobility, which potentially results in more rapid sediment reworking and site infilling.*

   Response: At least one quarter of the proposed dredge area on SRIPP Shoal A is on the shoal crest and areas of higher elevation along the leading edge. At least one third of the proposed area on Shoal B is on the shoal crest and areas of higher elevation.

<u>From Dibajnia and Nairn, 2010:</u>

1. Recommendation: *Only those shoals located in less than 30 m depth have the potential to re-grow after dredging, and therefore, shoals with a Base Depth of greater than 30 m should not be dredged if it is determined to be important to maintain the pre-dredge shoal height from an ecological perspective.*

   Response: Both shoals under consideration have base depths less than 30 meters. The measured base depths are 22 meters (SRIPP Shoal A) and 25 meters (Shoal B).

2. Recommendation: *Shoals with Relative Shoal Height (defined as H/BD) of less than 0.5 are not likely to recover after dredging. Therefore, shoals with Relative Shoal Height of less than 0.5 should not be dredged if shoal recovery to its pre-dredge height is desired from an ecological perspective.*

Response: Using the shoal cross-sections presented in our June 2010 EFH Conservation Recommendation response letter, both SRIPP Shoals A and B have Relative Shoal Heights (RSHs) of approximately 0.68. Lowering either shoal by 2 meters yields RSHs of 0.59 and 0.60, respectively. Removal of an additional meter (totaling 3 m) would still yield values above the 0.5 RSH threshold identified in the referenced report.

3. Recommendation: *The maximum Relative Shoal Height, $(H/BD)_m$, varies from 0.5 at 10 m depth to 0.75 at 20 m depth. A shoal that has reached the maximum relative shoal height corresponding to its Base Depth may be considered as a fully grown shoal at that depth. A fully grown shoal (in height) can potentially re-grow and rebuild itself to the same height upon being dredged. Therefore, if shoal recovery to its pre-dredge height is desired, shoals that have reached their maximum relative shoal height are recommended for dredging. For the present study area, maximum Relative Shoal Height at a certain Base Depth (BD) may be estimated as: $(H/BD)_m = (BD-5)/BD$.*

   Response: Using the formula provided to estimate maximum shoal growth potential, SRIPP Shoal A has a value of 0.77 with Shoal B at 0.80. Based on this metric, neither shoal has yet reached its maximum at approximately 0.68. However, cross-sectional evaluation of nearby shoals indicates that Blackfish Bank, by this definition, is a fully grown shoal at approximately 0.74. Although Blackfish might meet this definition of a recommended shoal for dredging, it clearly has other properties that outweigh this consideration, including commercial and recreational fishing value and sheltering Assateague Island from incoming wave energy. Clearly, this demonstrates the need to look at the larger picture and consider the importance of numerous factors and the trade-offs associated with each.

4. Recommendation: *Sand should not be removed from the entire length of the shoal. Longitudinal dredging (i.e. dredging all along the longer axis) is not preferred because it affects wave focusing processes and the shoal does recover to the same pre-dredge height.*

   Response: As presented in the maps sent to NMFS on August 2, 2010 (attached), the areas targeted for dredging on either shoal do not run the entire lengths of the shoals. Additionally, the areas are sized lengthwise to maximize dredging efficiency, a cost-saving benefit to the project.

5. Recommendation: *Dredging from shoal flanks below the -10m contour over the SW half of the shoal is expected to have little effect on shoal integrity and little change is anticipated to happen to the dredged area. This dredging option is thus recommended if it can provide sand suitable for nourishment.*

   Response: Approximately 75 percent of the area targeted on SRIPP Shoal A for dredging is below the -10 m contour. Approximately 95 percent of the area on Shoal B is below this contour.

<u>NMFS Recommendations:</u>

A recent discussion on July 26, 2010 with NMFS indicated the agency's top priorities for mitigating the effects of dredging on long-term maintenance of shoal morphometry, particularly with regard to shoal height. These priorities include:

1) Targeting the accretional leading edge of shoal;
2) Avoiding longitudinal dredging;
3) Maintaining shoal crest;
4) Not dredging to excessive depth; and
5) Not removing excessive volumes from a given shoal

With respect to the above five recommendations, the SRIPP's consistency with them has been described under the responses to the BOEMRE report recommendations with the exception of numbers 3 and 5. Regarding NMFS recommendation 3, although the shoal crest would be dredged, it still would be maintained in that it would not be completely eliminated. The dredge would employ the "contour method," which would essentially leave the crest in place at a slightly lower (approximately 2-3 meters) elevation. Avoiding the shoal crest altogether would seem to conflict with CSA 2009, which suggests that dredging from higher elevations, including crests, could have less of a long term impact due to greater sediment mobility, which could potentially result in more rapid sediment reworking and site infilling. Given the geographic location of the SRIPP Shoal A crest (on the southwest half of the shoal immediately adjacent to the leading edge), leaving a substantial portion of the crest untouched (as could be done for other shoals) would not only be operationally inefficient, but it would also require dredging material from either the trailing edge of the shoal or increasing the cut depth. Additionally, it would result in the dredge removing nearly all of the fill material from areas on the shoal which have limited sediment analysis and could likely have finer sediment.

Regarding NMFS recommendation 5, the initial fill cycle would remove approximately 5 percent of SRIPP Shoal A's total volume, which the project team considers to be very conservative. As discussed on the July 26, 2010 phone call, NASA cannot commit to restricting itself to volumetric thresholds at this time in the SRIPP. Consideration of removing additional material from the shoal for renourishment would only take place after appropriate pre- and post-dredge bathymetric survey work has been completed and NASA has performed additional consultation with NMFS, the U.S. Army Corps of Engineers (USACE), and BOEMRE.

Additional e-mail correspondence with NMFS indicates that dredging should be performed in a manner similar to what has been developed for the Atlantic Coast of Maryland Project and more specifically, Isle of Wight (IOW) Shoal. A fax sent by NMFS on August 3, 2008 (attached), indicates that Scenario 3 of the Baird Report is preferable. Further NASA review of the abovementioned reports and the NMFS recommendations in the context of the Wallops project suggests that the two shoal areas (SRIPP Shoal A and IOW) are different and that implementing this same dredging scenario may not be appropriate. An explanation and scientific justification (per (50 CFR 600.920(k))) is provided below.

Scientific Justification:

The eastern half of the entire longitudinal axis on SRIPP Shoal A is accretional over the time period 1933/4 to 1978/82 (Figure 1).The same trend is clearly seen in the shoal immediately west of SRIPP Shoal A. On IOW, the northeastern half of the shoal is erosional (Figure 2). The footprint and magnitude of long-term accretion on the southern terminus of SRIPP Shoal A and IOW are also different (Figures 1-2). The accretional footprint on IOW is larger and wraps further west/southwest. Between 1929 and 2002, IOW accreted a maximum of 3.5 m. SRIPP Shoal A accreted upwards of 4-6 m along its leading edge over a fifty year period.[2] The morphologic behavior of the leading edge shoal is an important factor in shoal crest height recovery. Over the inter-centennial timescale, IOW appears to better fit the wave-dominated shoal evolution paradigm of Hayes and Nairn (2004) on which most of the above recommendations are premised. It should also be noted that the principal patterns of morphologic change vary over shorter time scales (i.e., inter-centennial (Figure 2) vs. decadal (Figure 3)), as well as between adjacent shoals. A comparison of bathymetric change maps for ACM Shoal A, Weaver, and IOW shoals illustrates notable variability in physical behavior of the same time frame (Figures 3-5).

The orientation (relative to true north) of ACM Shoal A, Weaver, and IOW shoals varies between 30-40 degrees (Dibajnia and Nairn, 2010); whereas the orientation (relative to true north) of SRIPP Shoals A and B is approximately 50 degrees (Dibajnia and Nairn, 2010), suggesting again the former are more sensitive to waves, whereas the later waves and currents. Correspondingly, SRIPP Shoals A and Shoal B are comparatively elongated. ACM Shoal A, Weaver, and IOW have relatively wide and gently sloped trailing edges that are actively being eroded across their entire width. There are other notable differences in shoal properties, such as asymmetry, which in part dictates wave transformation and refraction across shoal bodies. Because of these different geometries despite similar water depths, incident waves and currents will interact differently with the shoals and contribute to differences in sediment transport. The differences in morphologic evolution may also relate to the fact that IOW is the most seaward and a comparatively isolated large, shallow shoal. SRIPP Shoal A is located in a complex of shoals that are physically linked. In the case of SRIPP Shoal A, and in contrast to IOW, the more seaward shoals may modify the approach of waves, which ultimately influences shoal morphodynamics.

Conclusion:

NASA is confident that the dredging plan for the initial fill cycle of the Wallops SRIPP is consistent with nearly all recommendations presented in the latest BOEMRE-funded studies and in discussions with NMFS. However, NASA and its Cooperating Agencies (BOEMRE and USACE) share a different opinion than NMFS regarding the applicability of the ACM project to the SRIPP and the literal interpretation of the guidelines within the recently published studies. The primary concern is that rigidly applying guidelines developed for other shoals might not be the most appropriate means of ensuring the long-term maintenance of shoal geometry following

[2] Note that the SRIPP Shoal A isopach has not been corrected for sea level rise (~20 cm).

a dredging project. Moreover, given the relatively new state of the science behind the recently developed recommendations, NASA feels that the guidelines should not be interpreted literally at this point, but rather should be given consideration as guidance for planning a project. Regarding any disagreement with NMFS about how the shoals would be dredged under the SRIPP, NASA feels that it has provided sufficient scientific justification for its position in both its June 25, 2010 EFH response letter and in this document as required by 50 CFR 600.920(k).

In conclusion, targeting Area A-1 shown on Figure 6 employing the methodology described in this document is NASA's final decision regarding how SRIPP Shoal A would be dredged for the initial fill cycle. Specifics regarding the use of either SRIPP Shoal A or B for renourishment would be considered in supplemental EFH consultation during the planning for that phase of the project.

Literature Cited:

CSA International, Inc., Applied Coastal Research and Engineering, Inc., Barry A. Vittor & Associates, Inc., C.F. Bean, L.L.C., and Florida Institute of Technology. 2009. Analysis of Potential Biological and Physical Impacts of Dredging on Offshore Ridge and Shoal Features. Prepared by CSA International, Inc. in cooperation with Applied Coastal Research and Engineering, Inc., Barry A. Vittor & Associates, Inc., C.F. Bean, L.L.C., and the Florida Institute of Technology for the U.S. Department of the Interior, Minerals Management Service, Leasing Division, Marine Minerals Branch, Herndon, VA. OCS Study MMS 2010-010. 160 pp. + apps.

Dibajnia, M. and R.B. Nairn. 2010. Investigation of Dredging Guidelines to Maintain and Protect the Integrity of Offshore Ridge and Shoal Regimes. U.S. Department of the Interior, Minerals Management Service, Leasing Division, Marine Minerals Branch, Herndon, VA. OCS Study MMS 2010-xxx. 150 pp. + apps.

Hayes, M.O. and R.B. Nairn. 2004. Natural maintenance of sand ridges and linear shoals on the U.S. Gulf and Atlantic continental shelves and the potential impacts of dredging. Journal of Coastal Research, 20(1): 138 – 148.

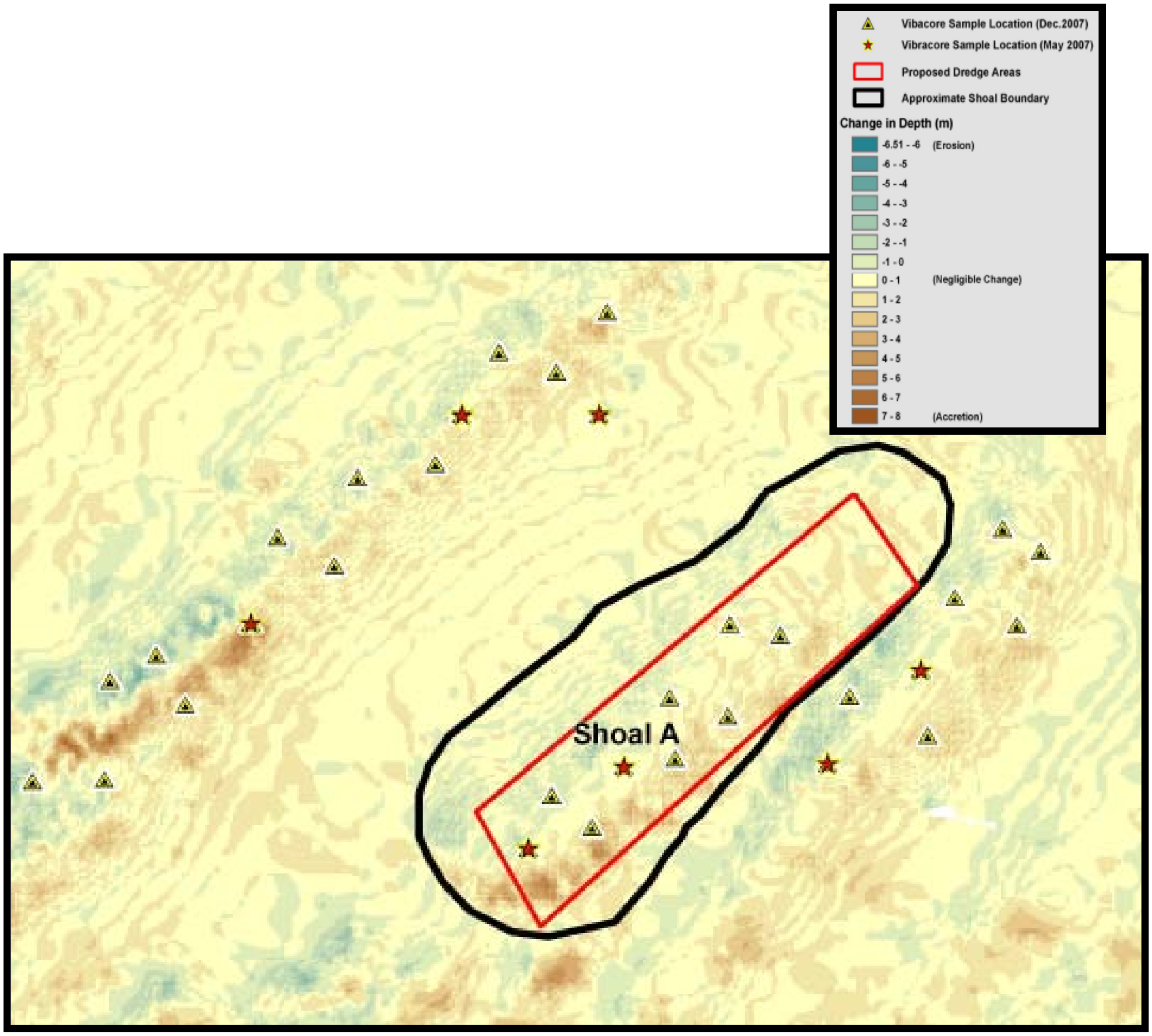


Figure 1: Bathymetric isopach for Shoal A (1933/34 to 1978/82). Maximum accretion within shoal footprint (black) and dredge area (red) is 6 m. Maximum erosion within shoal footprint (black) and dredge area (red) is 3 m.

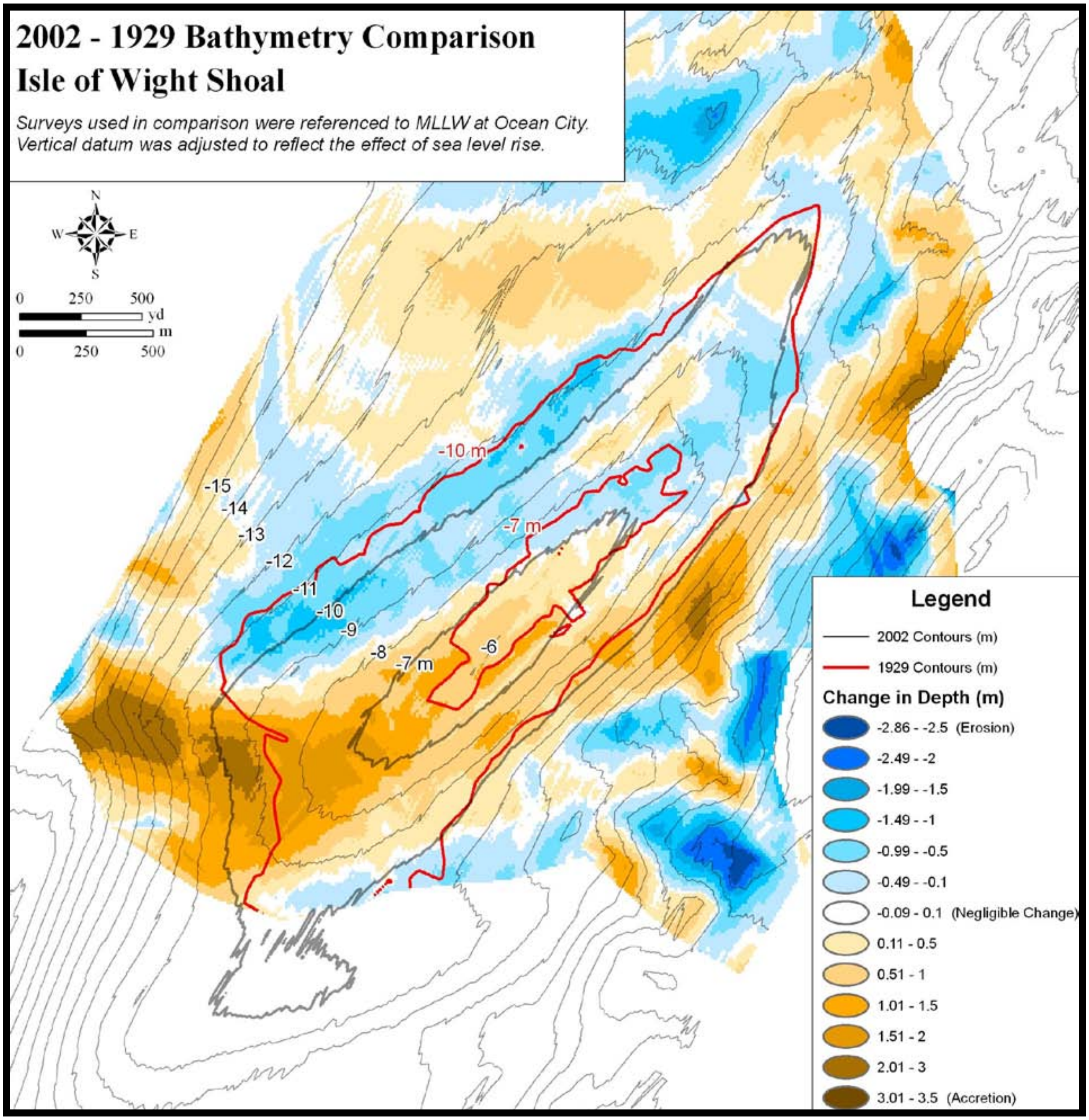


Figure 2: Bathymetric isopach for Isle of Wight Shoal (1929 to 2002) (Dibajnia and Nairn, 2010)

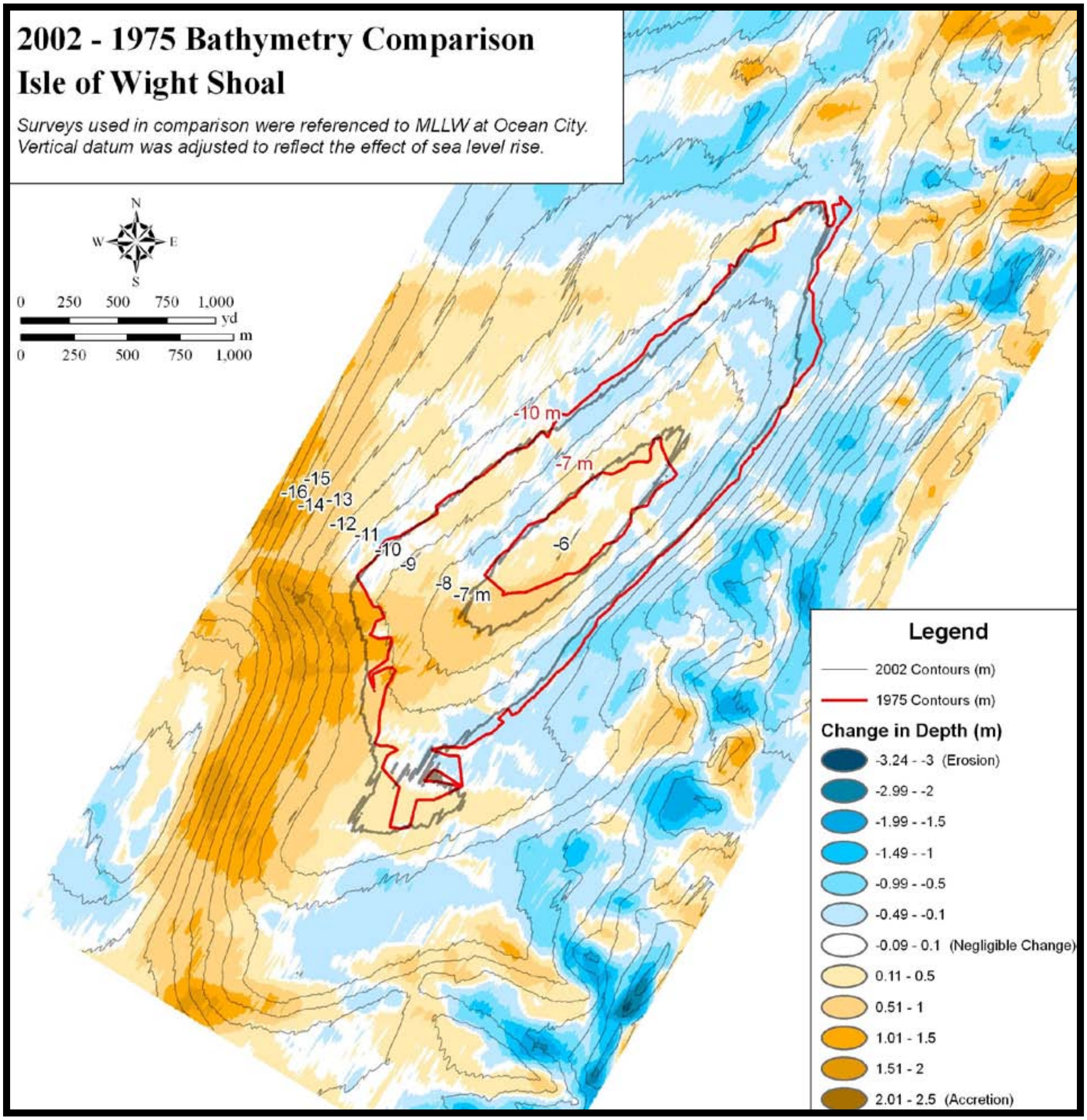


Figure 3: Bathymetric isopach for Isle of Wight Shoal (1975 to 2002) (Dibajnia and Nairn, 2010)

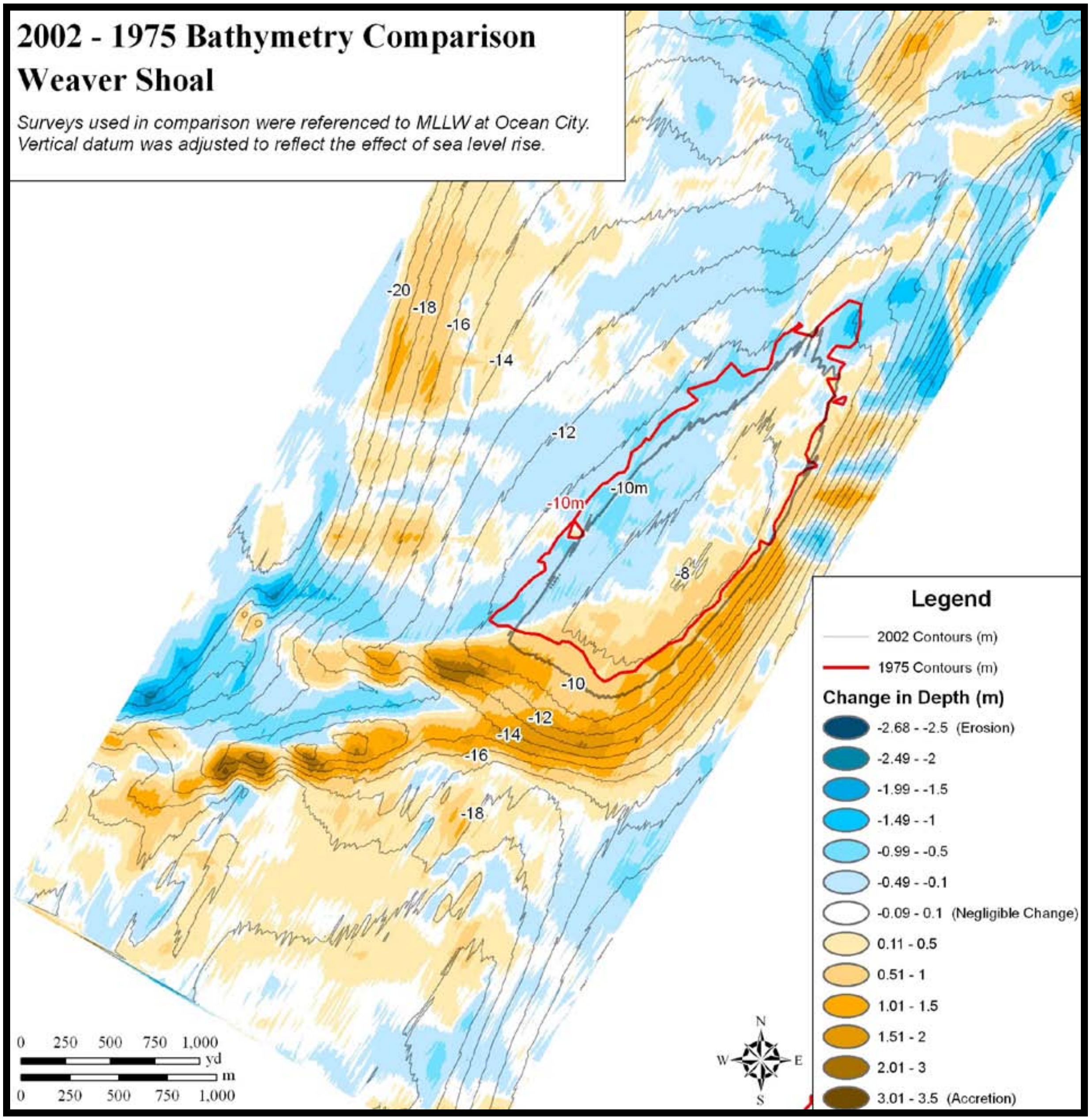


Figure 4: Bathymetric isopach for Weaver Shoal (1975 to 2002) (Dibajnia and Nairn, 2010)

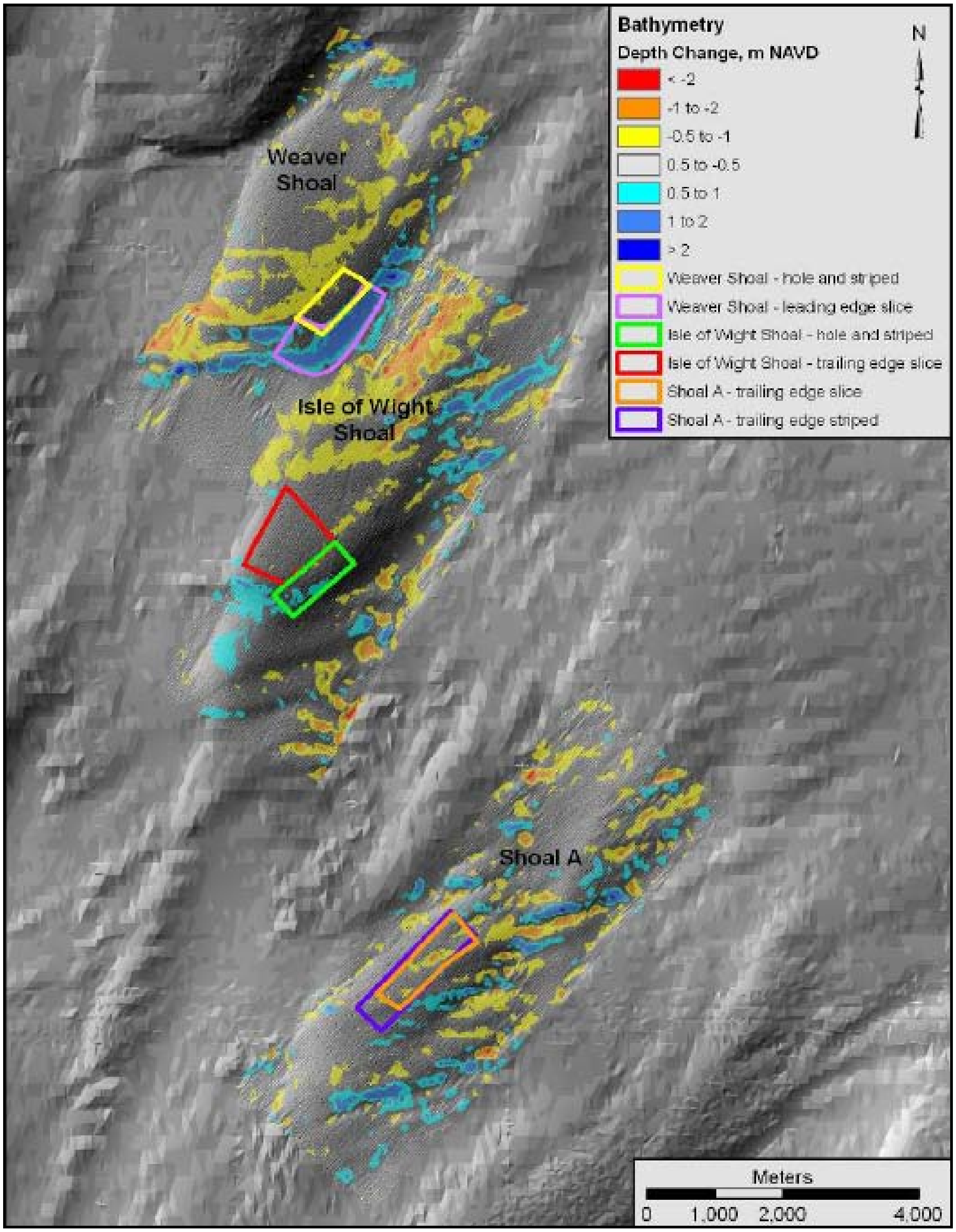
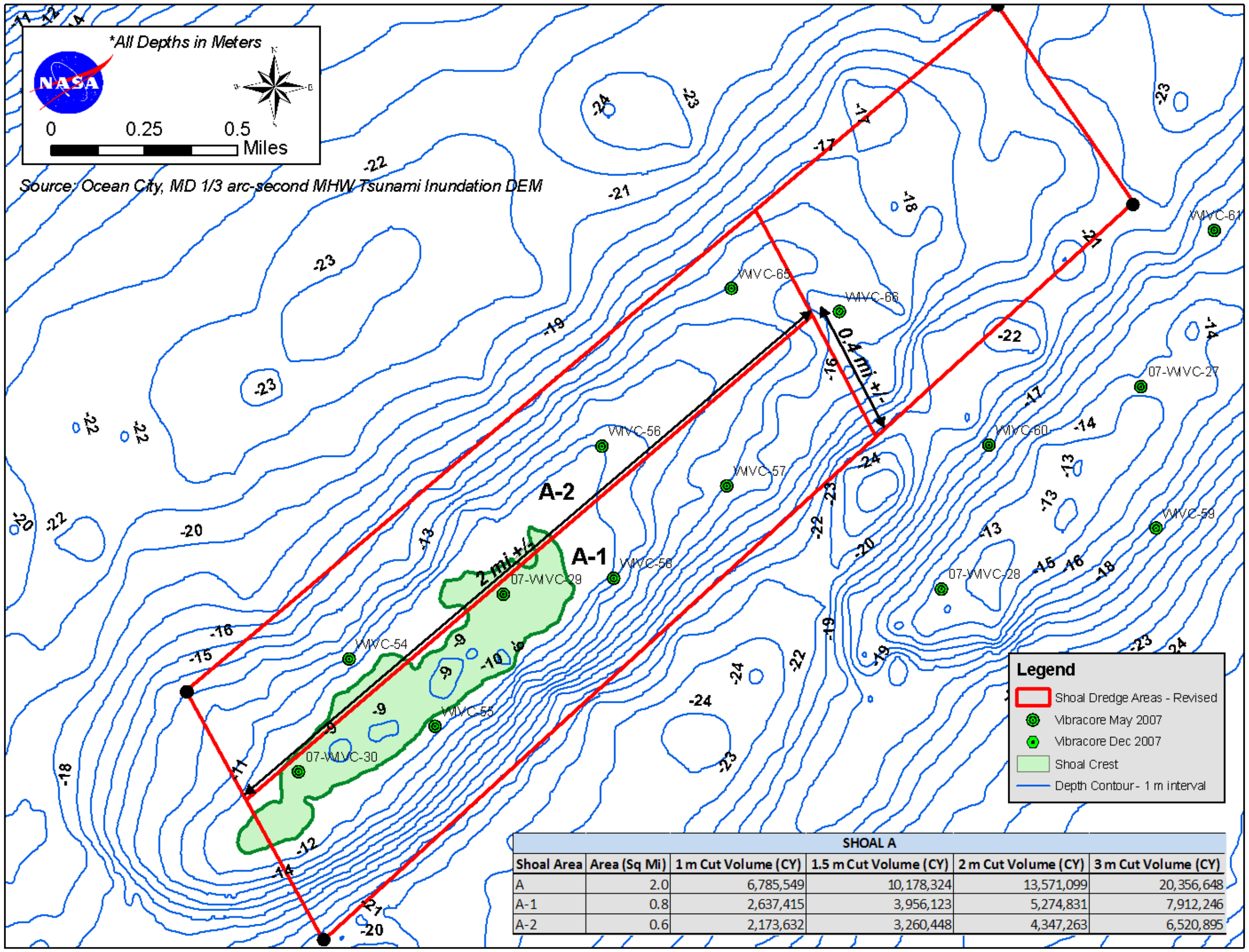


Figure 5: Bathymetric isopach for Fenwick, Isle of Wight, and ACM Shoal A (1975 to 2002) (CSA et al., 2009)



SHOAL A					
Shoal Area	Area (Sq Mi)	1 m Cut Volume (CY)	1.5 m Cut Volume (CY)	2 m Cut Volume (CY)	3 m Cut Volume (CY)
A	2.0	6,785,549	10,178,324	13,571,099	20,356,648
A-1	0.8	2,637,415	3,956,123	5,274,831	7,912,246
A-2	0.6	2,173,632	3,260,448	4,347,263	6,520,895

Figure 6: SRIPP Shoal A Dredge Areas

From: John.Nichols@noaa.gov
Sent: Thursday, August 05, 2010 5:32 PM
To: Bundick, Joshua A. (WFF-2500)
Subject: Re: Additional EFH Information: NASA WFF SRIPP
Attachments: ATT00001..txt; ATT00002..htm

Josh:
I have reviewed the borrow delineation figures for Shoals A & B, sent earlier this week, and the consistency report received today.

NMFS continues to have major concerns regarding long term impacts NASA will have on these Shoals A & B.

Cut estimates of available material within the delineated sections of both shoals appear to have much greater amounts of material than what you need to complete the various phases of this project. For example, you estimate that Section A1 has 3.9 MCY for a 1.5 M cut. You stated that Phase I of this project required 3.2 MCY. This leads us to believe that the borrow sections extend for a longer length along the long axis of the shoals than necessary, and/or that you will be cutting to depths deeper than necessary. The borrow sections should not be treated as NMFS-approved areas for repeated returns over the 50-year life of the project. Once material is removed from a section of shoal during Phase I, or subsequent renourishment, effects should be tracked, and it should be given time to recover to pre-existing conditions.

Lowering the upper crest of each shoal by 2-3 meters does not conserve the morphometry of the shoal, if the shoal does not recover its pre-existing height. Borrow should be taken in a manner that facilitates recovery of pre-existing shoal height. A portion of the southern crest of Shoal B should also be maintained, to facilitate shoal height recovery.

Your consistency statement is also very inconsistent with conservation measures recommended in the two MMS studies cited.

NMFS intends to provide a written response to the revised borrow plans next week, addressing these are other issues. The letter will be signed by either Stan Gorski, or our Regional Office. This may be your final action, but we want to be on the record regarding our concerns, and the inconsistency issues.

From: Bundick, Joshua A. (WFF-2500)
Sent: Monday, August 09, 2010 1:04 PM
To: 'John.Nichols@noaa.gov'
Cc: 'Wikel, Geoffrey L'; 'Herkhof, Dirk'; Cole, Robert H NAO; 'Mears, George H NAO'; Williams, Greggory G NAO; Hudgins, Mark H NAO; Bull, Paul C. (WFF-2280); Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; 'Jeffrey_Reidenauer@URSCorp.com'; 'Stanley W Gorski'
Subject: RE: Additional EFH Information: NASA WFF SRIPP

John,

It is unfortunate that NMFS and the three action agencies involved in the SRIPP cannot reach resolution regarding the dredging methodology. Among the members on our team, we feel that what we have proposed not only works to minimize effects on EFH consistent with the two latest publications, but at the end of the day we still have a project that is buildable as designed. I recall that our decision to leave Blackfish Bank alone (due in part to fisheries concerns) added substantial cost to the project, so any optimization that we could incorporate into the dredging plan at Shoals A & B (such as the 2-mile-long cut longitudinal cut lengths), we did. However, that major decision to head further offshore never seemed to receive any consideration from NMFS, especially regarding how the increased fuel costs would drive our need for maximum efficiency.

Regarding your concerns about cut length--the calculation spreadsheet that I provided to you explains why we are targeting a 2-mile long section of the shoal--it's about efficiency--and it also happens to be mostly within the areas found to be accreting on the shoal, and not along the entire length of either shoal, consistent with your recommendations. Regarding depth--we will be working in the open ocean and the bathymetric data that we have been using thus far during the EFH consultation is more than 25 years old. That being said, for us to say right now that we can absolutely maintain a 1.5 or 2 meter cut and get what we need, we would be knowingly tying our hands. If, in the field, we were to encounter unforeseen conditions and need to cut deeper that presented in the EIS, would we then be inconsistent with our NEPA analysis? I would say yes. What do we do then? Tell the contractor to stand down until additional analysis and consultation is performed...? We don't want to be faced with that issue.

Furthermore, I do not want to paint an unreasonable picture in the EIS. At the end of the project, if all goes well, as you mention below, the cut depth may only be 1.5 meters, but for us to say so right now is impractical. So as we're presenting in the EIS, the cut depth will be targeted at 2 meters, but due to some expected inaccuracy, cuts in some areas could approach 3 m...again, so that what's presented in the document (as an upper bound of environmental effects) and what actually happens aren't inconsistent. There needs to be a margin of error considered, and we have done just that.

Regarding shoal monitoring, we plan to conduct pre- and post-dredge surveys to monitor shoal recovery. Only after assessment of the survey data and subsequent consultation among NASA, MMS, USACE, and NMFS would we consider detailed options for dredging on the shoals. The shoal recovery that you mention below may take some time, so that will obviously be a factor to again consider when we get to that point.

Finally, I am surprised that you found the latest submittal to be inconsistent with the two papers. We enlisted more than 5 contributors and reviewers, several of whom had substantial involvement with the two BOEMRE-funded reports, and we were all in agreement regarding the document's contents. We felt that we made it very clear regarding our consistency with the two new papers, and any differences were supported with scientific analysis. I apologize for some of this being repetitive, but I feel that over the past couple of years, we have taken a hard look at the issues using the best available data consistent with NEPA and M-SA and are making an informed decision regarding economics, engineering, and environment--and by judging by the responses we have received from NMFS thus far (including below), you would think we had not--so I just wanted to make it clear that we have.

Thank you again for your continued coordination regarding the project, and we look forward to receiving your letter in the near future.

Sincerely,

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

From: Bundick, Joshua A. (WFF-2500)
Sent: Tuesday, October 05, 2010 1:21 PM
To: 'John.Nichols@noaa.gov'
Cc: 'Stanley W Gorski'
Subject: FW: EFH telecon minutes
Attachments: 20100726 EFH Telecon Minutes.docx; 20100407 EFH Telecon Minutes.docx; Re: Additional EFH Information: NASA WFF SRIPP

John, just wanted to follow up with you regarding the below. Also, when was NMFS planning on providing the formal written response that you mentioned in your 8/5/2010 email (attached)?

Just wondering as we are planning on issuing the Final PEIS in the month of October.

Thanks,

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

From: Bundick, Joshua A. (WFF-2500)
Sent: Thursday, September 30, 2010 7:51 AM
To: John.Nichols@noaa.gov
Cc: Bundick, Joshua A. (WFF-2500)
Subject: EFH telecon minutes

Hi John,

We are in the process of completing the administrative records for the Shoreline EIS before releasing the Final. Attached please find drafts of minutes from the two different teleconferences that we held among NMFS, NASA, BOEMRE, and USACE.

Please let me know if you have any comments regarding the contents of the minutes or if your notes show that anything was left out. Any edits are requested by next Tuesday, 10/5.

Hope all is well.

Thanks,

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819

From: John Nichols [John.Nichols@noaa.gov]
Sent: Wednesday, October 13, 2010 6:47 PM
To: Bundick, Joshua A. (WFF-2500)
Subject: Re: EFH telecon minutes

Josh:
I was sick with a flu-like bug during most of the latter half of September. I have not had a chance to put together my referred to response from our Regional Office.

Essentially, unresolved issues that remain between us pertain to impacts to the crests of Shoals A and B. In both cases, too little of the existing upper elevations of the shoal crests will be untouched by borrow. This may not allow the shoals to recover their pre-existing elevations. More of the west and north portions of the crests should remain untouched. Estimated sand volumes from each shoal indicate that all of the upper crests need not be disturbed to obtain the necessary borrow for Phase I; or, that borrow can extend to a shoaler depth (i.e., 1.5 meters), to obtain the desired 3.2 MCY. If NASA is willing to negotiate further of this issue, we can reach agreement.

From: Bundick, Joshua A. (WFF-2500)
Sent: Thursday, October 14, 2010 8:37 AM
To: 'John Nichols'
Subject: RE: EFH telecon minutes

John, after talking to the project team, it appears that the plan, as proposed, will remain. However, please note that as you mention, we don't need a 3m cut over the entire area to get the requisite fill volume, so in all actuality, the cut will likely be shallower, but we are hesitant to completely restrict the contractor to such a shallow depth as in some areas the cut could be deeper and we didn't want to mislead anybody by portraying an absolute limiting depth in the EIS that we felt could not be guaranteed.

As such, are you going to provide a response upon receipt of the Final EIS? That way you would have a chance to review how the information is presented…

Also, do you have any input regarding the two sets of telecon minutes that I attached to the below email?

Thanks

Josh

Joshua A. Bundick
Lead, Environmental Planning
NASA Wallops Flight Facility
Code 250.W
Wallops Island, VA 23337
Phone: (757) 824-2319
Fax: (757) 824-1819
Email: Joshua.A.Bundick@nasa.gov

From: John Nichols [John.Nichols@noaa.gov]
Sent: Thursday, October 14, 2010 12:38 PM
To: Bundick, Joshua A. (WFF-2500)
Subject: Re: EFH telecon minutes

It may be that NMFS and NASA will have to agree to disagree on the remaining outstanding issues. My Regional Office has left it up to me whether a response will be forthcoming. I will try to provide a response to the Final EIS.

National Aeronautics and
Space Administration

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Reply to Attn of: 228

December 3, 2009

Office of Review and Compliance
Attn: Mr. Ronald Grayson
Archaeologist
Virginia Department of Historic Resources
2801 Kensington Avenue
Richmond, VA 23221

Subject: Request for Project Review for the Proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP)
NASA, Goddard Space Flight Center's Wallops Flight Facility, Wallops Island, VA
VDHR File #: 2007-0084

To satisfy its obligations under the National Environmental Policy Act (NEPA), the National Aeronautics and Space Administration (NASA) has retained the URS Group, Inc. (URS) and EG&G to assist with the preparation of an Environmental Impact Statement (EIS) for its proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP) at Wallops Island in Accomack County, Virginia. NASA is the lead agency preparing the SRIPP EIS; the U.S. Army Corps of Engineers (USACE) and the Department of the Interior's Minerals Management Service (MMS) are cooperating agencies on the EIS and other SRIPP-related compliance including Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, and the Abandoned Shipwreck Act of 1987. The SRIPP is intended to provide shoreline damage reduction and beach restoration to protect valuable infrastructure at Wallops Island from wave damage during storms, thereby ensuring continued operations.

Because the proposed undertaking has the potential to affect historic properties, NASA, USACE, and MMS are initiating consultation with the Virginia Department of Historic Resources (VDHR) in compliance with Section 106 of the NHPA and its implementing regulations provided in 36 CFR Part 800. Section 106 consultation is occurring concurrent with the development of the EIS under NEPA. Accordingly, NASA is evaluating potential effects to historic properties for all three proposed action alternatives, and will summarize the resolution of the Section 106 process for this undertaking in the final EIS.

Proposed Action Alternatives

The EIS evaluates three proposed action alternatives that include a combination of beach fill, seawall extension, and sand retention structures (groin or breakwater) that would be placed in nearshore state waters.

Alternative One. Alternative One, the preferred alternative, would involve an initial construction phase with follow-on renourishment cycles. The initial construction phase would include two distinct elements: extending Wallops Island's existing rock seawall a maximum of 1,400 meters (4,500 feet) south of its southernmost point; and placing sand dredged from Unnamed Shoal A, located offshore in Federal waters, on the Wallops Island shoreline. For renourishment activities, it is anticipated that approximately half of the fill volume could be excavated from the north Wallops Island borrow site, and the remaining half could be dredged from either Unnamed Shoal A or Unnamed Shoal B.

Alternative Two. Under Alternative Two, the beach fill and seawall extension would be the same as described under Alternative One (although slightly less fill volume would be required for initial and renourishment phases). In addition, a terminal groin would be constructed at the south end of the Wallops Island shoreline. Groin construction would likely follow seawall construction and would involve the placement of rocks in a linear structure perpendicular to the shoreline at approximately 445 meters (1,460 feet) north of the Wallops Island-Assawoman Island border. The groin would extend approximately 50 meters (165 feet) offshore and have an approximate 15 meter (50 foot) wide footprint on the seafloor.

Alternative Three. Under Alternative Three, the beach fill and seawall extension would be the same as described under Alternative One (although slightly less fill volume would be required for initial and renourishment phases). In addition, a nearshore breakwater structure would be constructed at the south end of the Wallops Island shoreline. The breakwater would be located approximately 230 meters (750 feet) offshore and would measure 90 meters (300 feet) long and have an approximately 35 meter (110 foot) wide footprint on the seafloor.

Previous Surveys and Section 106 Consultation

In November 2003, URS and EG&G prepared a *Cultural Resources Assessment of Wallops Flight Facility, Accomack County, Virginia* that examined each of the three land areas of the facility within WFF's property boundaries: Wallops Main Base, Wallops Mainland, and Wallops Island. This report established a predictive model for archaeological potential for the entire WFF property. VDHR concurred with the findings of this report in a letter dated December 3, 2003.

In December 2004, URS and EG&G prepared a *Historic Resources Survey and Eligibility Report for Wallops Flight Facility* that included an evaluation of buildings and structures at WFF built prior to 1956 for their eligibility for listing in the National Register of Historic Places (NRHP). Two resources—the Wallops Coast Guard Lifesaving Station (VDHR #001-0027-0100; WFF# V-065) and its associated Coast Guard Observation Tower (001-0027-0101; WFF# V-070)—

were found to be eligible for listing in the NRHP and Virginia Landmarks Register. The other surveyed resources were determined not to be NRHP eligible because they lacked the historical significance or integrity necessary to convey significance. In a letter dated November 4, 2004, the VDHR concurred with the findings and determinations in the *Historic Resources Survey and Eligibility Report*.

NASA has since determined that the Wallops Coast Guard Lifesaving Station is located inside the explosive hazard arc of a nearby rocket motor storage facility and, as a result, is planning the demolition or removal of the Lifesaving Station and Observation Tower. In compliance with Section 106 of the NHPA, NASA, and VDHR are currently negotiating a Memorandum of Agreement to resolve the effects of demolition or removal.

In January 2007, in anticipation of the need for slurry pits for installation of geotextile tubes along the shoreline, URS conducted a limited cultural resources survey along 2.98 kilometers (1.85 miles) of beach. This survey included a portion of beachfront that the predictive model indicated to have moderate potential for the presence of historic archaeological sites. During the survey, archaeologists searched for all significant cultural materials within the geotextile tubes project area. No significant cultural remains or archaeological sites were discovered during this evaluation. An architectural historian identified and evaluated three buildings on the beach within the Area of Potential Effects (APE). The Tracking Camera Turret with Dome (WFF #Z-35, VDHR #001-0027-0122), was previously determined to be ineligible for listing in the NRHP in the *Historic Resources Survey and Eligibility Report for Wallops Flight Facility* (2004). The two other buildings – the Launch Pad Terminal Building (WFF #Z-42) and Launch Control Center (WFF #Z-40) —were evaluated and found to be ineligible for listing in the NRHP. Based upon the findings of the cultural resources survey of the APE, NASA determined no further archaeological evaluation of this beachfront was merited and that no historic properties would be affected by the installation of the geotextile tubes. In a response letter dated January 27, 2007, VDHR concurred with NASA's determination that the proposed undertaking would have no adverse effect on historic properties.

Area of Potential Effects (APE)

As the proposed SRIPP project area extends beyond that of the installation of the geotextile tubes and includes the construction of sand retention structures, NASA engaged URS to conduct additional cultural resources survey to determine whether maritime related cultural resources were present in the project area.

Since September 2006, archaeological studies have been conducted to identify maritime related cultural resources, particularly submerged watercraft, and buried archaeological sites within the survey areas. The survey consisted of four tasks: remote sensing of the proposed breakwater location, a scientific diving survey of the proposed groin location, a pedestrian survey of the Wallops Island shoreline, and archaeological monitoring of geotextile tube installation on the shoreline. A total of 37 hectares (92 acres) was evaluated during the survey efforts.

The studies were conducted within three separate survey parcels that include the proposed beach groin location, the proposed breakwater location, and the entire Wallops Island coastline. The APE for the Wallops Island shoreline is 6.2 kilometers (3.85 miles), or approximately 28 hectares (69 acres), of coastal beach in Accomack County. A pedestrian survey was undertaken from the waterline to the beach edge within this portion of WFF. Archaeological monitoring of the 1,400 meters (4,600 feet) of shoreline protected by geotextile tubes occurred within this study area, beginning at the southern terminus of the seawall and extending to the camera station at the southern end of WFF property. The APE for the proposed groin is located in the Atlantic Ocean, directly opposite of the camera station at the southern end of WFF. It measures approximately 150 meters (500 feet) by 30 meters (100 feet), or 0.45 hectares (1.1 acres). The APE of the proposed breakwater is located on the seaward edge of the proposed beach groin, and extends 120 meters (400 feet) to either side of the groin. It measures approximately 350 meters (1,200 feet) by 250 meters (800 feet), or 9 hectares (22 acres).

Identification of Historic Properties – Terrestrial

Archaeological Resources. In anticipation of the need for shoreline restoration measures, URS conducted a pedestrian survey of 6.2 kilometers (3.85 miles) of Wallops Island shoreline on September 18, 2006. The north and south beaches were littered with modern materials thrown to shore during recent storm events. These materials included wooden pallets, portions of wooden decks, and fishing nets. According to the 2004 *Historic Resources Survey and Eligibility Report for Wallops Flight Facility*, no extant evidence remains of the two structures that may have existed on the northern half of the island. These resources included the U.S. Lifesaving Station established in 1883 and a small resort and hunting lodge built by a private association in 1889, both of which were completely demolished by a hurricane in 1933. The 2003 *Cultural Resource Assessment of Wallops Flight Facility,* identified Site 44AC159 as a three-foot high shell pile located on the southern end of the island that probably dates to the 20th century. The 2006 pedestrian survey stated that the southern portion of the beach contained evidence of structures at the surf line and in the sea itself, including caisson foundation posts and pier remnants. These structural features relate to the above-referenced civilian occupation of Wallops Island and were noted in the 2003 *Cultural Resource Assessment of Wallops Flight Facility*. None of the identified features appear to be eligible for listing in the NRHP. No further work on this shoreline is recommended.

Above-ground Resources. The majority of above-ground resources over fifty years of age located at WFF and in the project vicinity were formally evaluated and determined not eligible for listing in the NRHP in the 2004 *Historic Resources Survey and Eligibility Report for Wallops Flight Facility*. Only the Lifesaving Station and the Observation Tower, referenced above, have been determined to be eligible for listing in the NRHP. No additional evaluation of above-ground resources was undertaken for this project; however, since no structures or buildings are present in the APE for this project, no further work is recommended

Identification of Historic Properties – Underwater

Proposed Groin Location. A wading survey was undertaken of the first 75 meters (250 feet) of the proposed beach groin location. Scientific diving was not possible at this location because the corroded rebar that littered the area represented aserious impalement and laceration hazards to divers operating in the near zero visibility water of the turbulent swash zone. Comprehensive analysis of survey data was conducted using criteria that included magnetic complexity, amplitude, duration, and contouring, along with the spatial patterning of all anomalies. Analysis included review of all side scan sonar data to identify any structures or geomorphic features associated with submerged historic cultural materials. The wading survey did not identify any significant cultural resources. The final 60 meters (200 feet) of the proposed beach groin location was not surveyed due to the aforementioned safety concerns and because this section has the a very low potential to contain significant historic resources. This assessment is based on the general ground disturbance that has occurred in this area , which includes the construction of the original groin, the disposal of concrete construction waste throughout the area, and the general erosion and sediment transport that routinely takes place in the first 125 to 200 meters (500 to 600 feet) of the Wallops shoreline. No further work is recommended for the proposed beach groin location.

Proposed Breakwater Location. The breakwater survey area measured approximately 400 meters by 250 meters (1200 feet by 800 feet) and consisted of 17 transects spaced at 15 meter (50 foot) intervals. A total of 5 target clusters were identified from the four acoustic anomalies and 21 magnetic anomalies recorded during the breakwater survey. Acoustic and magnetic signatures from the five targets and isolated anomalies are consistent with modern debris that has originated from two sources. The first source was the rubble and construction debris deposited on the eastern edge of beach groin. Other debris has likely emanated from early beach engineering efforts along the Wallops Flight Facility shoreline. This may include refuse derived from piers, pilings, and other materials deposited by wave energy reflection. None of the detected anomalies have the potential to represent significant submerged cultural resources. The final 60 meters (200 feet) of the survey area were not surveyed because it has a very low potential to contain significant cultural resources and there was a serious safety risk to the crew and survey array. No further work is recommended within the proposed breakwater survey area.

Determination of Effects

Above-ground Resources. NASA, USACE, and MMS have determined that the proposed undertaking, including all three alternatives, does not have the potential to directly affect above-ground historic properties within the APE. Additionally, NASA has determined that the project may have indirect (visual) effects on above-ground historic properties should they be present in the APE, but that these would not be adverse.

Archaeological Resources. Because there were no historic properties identified within the APE and because the archaeological review of recent ground disturbance in the area found no archaeological resources, NASA, USACE, and MMS have determined that no archaeological historic properties will be affected by the proposed undertaking.

Accordingly, NASA, USACE, and MMS have determined that the proposed SRIPP project, including all three alternatives, will have no adverse effect on historic properties. NASA, USACE, and MMS request that VDHR review the attached report and concur with this finding.

If you have any questions of comments regarding this portion of the project, please contact me, Randall Stanley, at (757) 824-1309 or Shari Silbert at (757) 824-2327.

Sincerely,

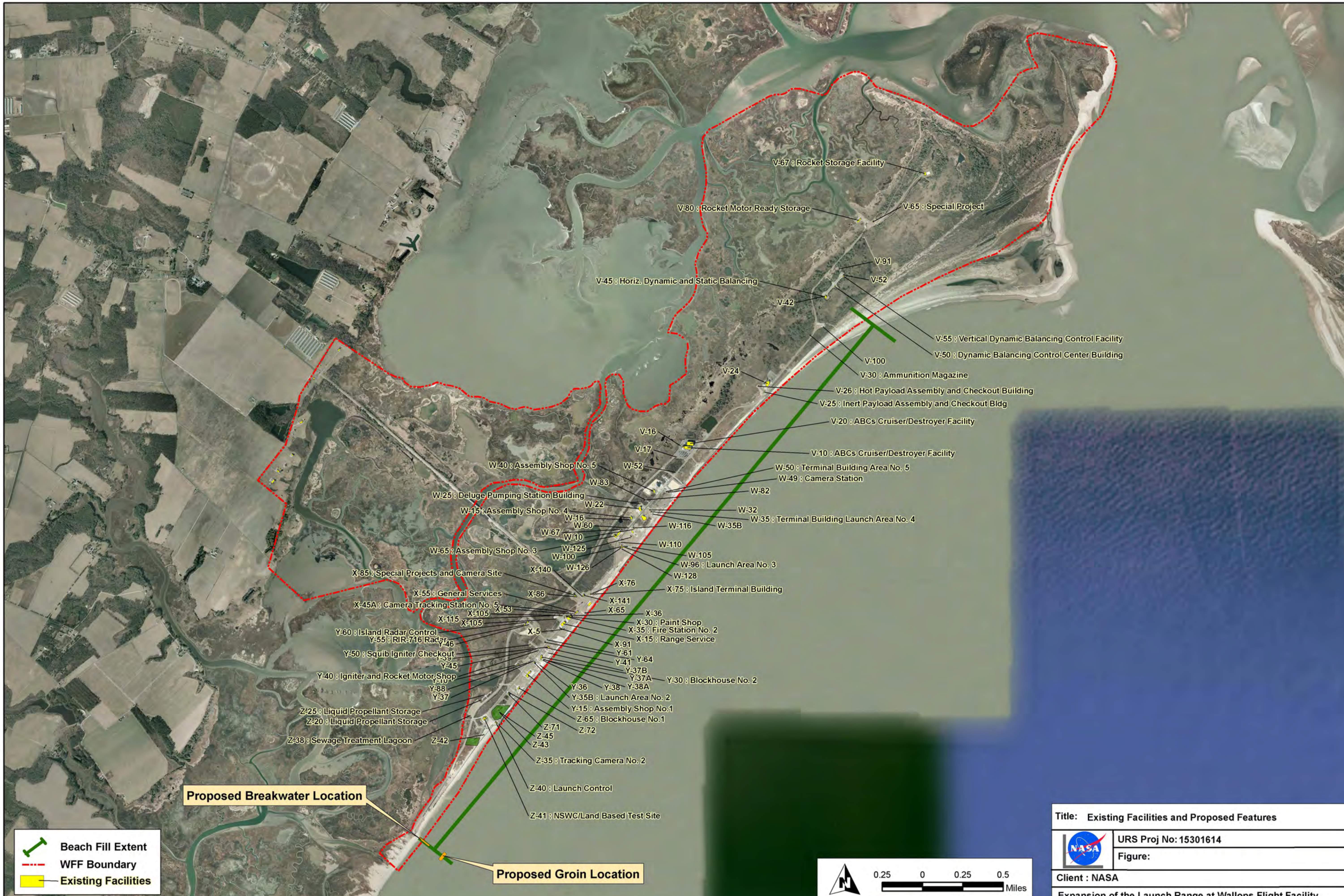
Randall M. Stanley

Randall M. Stanley
WFF Historic Preservation Officer

Enclosures:

Exhibit 1: Figure 1 from EIS – Project Vicinity
Exhibit 2: Figure 4 from EIS – Wallops Island Viewed from the South
Exhibit 3: Figure 5 from EIS – Aerial of Geotubes and Old Groin Point
Exhibit 4: Figure 8 from EIS – Seawall Extension and Beach Fill Overview
Exhibit 5: Existing Facilities and Proposed Features Figure
Report – *Draft Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resources Survey, Accomack County, Virginia* (November 2009)

cc:
200/Ms. C. Massey
228/Mr. G. Lilly
250/Ms. C. Turner
USACE/Mr. R. Cole
MMS/Mr. D. Herkhof
AINS/ Ms. P. Kicklighter



V-67 : Rocket Storage Facility
V-80 : Rocket Motor Ready Storage
V-65 : Special Project
V-91
V-52
V-45 : Horiz. Dynamic and Static Balancing
V-42
V-55 : Vertical Dynamic Balancing Control Facility
V-50 : Dynamic Balancing Control Center Building
V-100
V-30 : Ammunition Magazine
V-24
V-26 : Hot Payload Assembly and Checkout Building
V-25 : Inert Payload Assembly and Checkout Bldg
V-20 : ABCs Cruiser/Destroyer Facility
V-16
V-17
V-10 : ABCs Cruiser/Destroyer Facility
W-40 : Assembly Shop No. 5
W-52
W-50 : Terminal Building Area No. 5
W-49 : Camera Station
W-83
W-82
W-25 : Deluge Pumping Station Building
W-22
W-32
W-15 : Assembly Shop No. 4
W-16
W-35 : Terminal Building Launch Area No. 4
W-60
W-116
W-35B
W-67
W-10
W-110
W-125
W-65 : Assembly Shop No. 3
W-100
W-105
W-96 : Launch Area No. 3
W-126
W-128
X-140
X-85 : Special Projects and Camera Site
X-76
X-75 : Island Terminal Building
X-55 : General Services
X-86
X-141
X-45A : Camera Tracking Station No. 5
X-53
X-65
X-105
X-36
X-115
X-105
X-30 : Paint Shop
X-5
X-35 : Fire Station No. 2
Y-60 : Island Radar Control
X-15 : Range Service
Y-55 : RIR-716 Radar
Y-46
X-91
Y-50 : Squib Igniter Checkout
Y-61
Y-45
Y-41
Y-64
Y-40 : Igniter and Rocket Motor Shop
Y-37B
Y-37A
Y-30 : Blockhouse No. 2
Y-88
Y-36
Y-38
Y-38A
Y-37
Y-35B : Launch Area No. 2
Z-25 : Liquid Propellant Storage
Y-15 : Assembly Shop No.1
Z-20 : Liquid Propellant Storage
Z-65 : Blockhouse No.1
Z-71
Z-72
Z-38 : Sewage Treatment Lagoon
Z-42
Z-45
Z-43
Z-35 : Tracking Camera No. 2
Z-40 : Launch Control
Proposed Breakwater Location
Z-41 : NSWC/Land Based Test Site
Proposed Groin Location
Beach Fill Extent
WFF Boundary
Existing Facilities
0.25
0
0.25
0.5
Miles
Title: Existing Facilities and Proposed Features
URS Proj No: 15301614
Figure:
Client : NASA
Expansion of the Launch Range at Wallops Flight Facility

From: Herkhof, Dirk [Dirk.Herkhof@mms.gov]
Sent: Tuesday, December 15, 2009 3:13 PM
To: Bundick, Joshua A. (WFF-2500)
Cc: Jeffrey_Reidenauer@URSCorp.com
Subject: RE: Arch - Wallops SRIPP

Josh,

Our archaeologist has finished reviewing the report and the additional information provided by you and it looks fine to him.

No archaeological mitigation is required for this project; however, the applicant should be reminded of the following:

If you discover any archaeological resource while conducting your operations, you must immediately halt operations within 1,000 feet of the area of the discovery and report the discovery to the Regional Supervisor, Leasing and Environment, Gulf of Mexico Region within 72 hours of discovery. Once notified, the Regional Supervisor will tell you how to proceed.

If you have any questions, please let me know.

Dirk

Dirk Herkhof
Meteorologist
Environmental Assessment Branch
Minerals Management Service
381 Elden Street
Herndon, VA 20170
Ph. 703-787-1735
Fax 703-787-1026
E-mail: dirk.herkhof@mms.gov

COMMONWEALTH of VIRGINIA

L. Preston Bryant, Jr.
Secretary of Natural Resources

Department of Historic Resources
2801 Kensington Avenue, Richmond, Virginia 23221-0311

Kathleen S. Kilpatrick
Director

Tel: (804) 367-2323
Fax: (804) 367-2391
TDD: (804) 367-2386
www.dhr.virginia.gov

January 5, 2010

Mr. Randall Stanley
Facility Historic Preservation Officer
NASA / WFF FMB, Code 228
Building N-161, Room 127
Wallops Island, VA 23337

Re: Proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP)
Wallops Flight Facility, Wallops Island, Accomack County
DHR File #: 2007-0087
Date Received: December 11, 2009

Dear Mr. Stanley:

We have received information regarding our review of the above referenced undertaking, including a copy of the report *Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program: Proposed Groin, Breakwater and Shoreline Cultural Resource Surveys, Accomack County, Virginia* (Randolph et all: 2009). Based upon information presented in the report, the level of effort appears to be sufficient to have identified any historic properties within the area investigated. We are pleased to inform you that the report meets the Secretary of the Interior's *Standards and Guidelines for the Documentation of Archaeological Sites* (48 FR 44734-44742) as well as our Department's *Survey Guidelines*. Based upon the information provided, we concur with your determination that there are no historic properties located within the project area and that no further work is needed within the area studied.

Based upon the information provided, we concur with your determination that the Alternative 1, 2, and 3 will *not adversely affect any historic properties*. In the event that previously unrecorded historic properties are discovered during project activities, stop work in the area and contact DHR immediately.

If you have any questions about our comments, please contact me at: ron.grayson@dhr.virginia.gov or (804) 367-2323, Ext. 105.

Sincerely,

Ronald Grayson, RPA, Archaeologist
Office of Review and Compliance

Administrative Services
10 Courthouse Avenue
Petersburg, VA 23803
Tel: (804) 862-6416
Fax: (804) 862-6196

Capital Region Office
2801 Kensington Ave.
Richmond, VA 23221
Tel: (804) 367-2323
Fax: (804) 367-2391

Tidewater Region Office
14415 Old Courthouse Way, 2nd Floor
Newport News, VA 23608
Tel: (757) 886-2807
Fax: (757) 886-2808

Roanoke Region Office
1030 Penmar Ave., SE
Roanoke, VA 24013
Tel: (540) 857-7585
Fax: (540) 857-7588

Northern Region Office
5357 Main Street
PO Box 519
Stephens City, VA 22655
Tel: (540) 868-7029
Fax: (540) 868-7033

COMMONWEALTH of VIRGINIA

L. Preston Bryant, Jr.
Secretary of Natural Resources

Department of Historic Resources

2801 Kensington Avenue, Richmond, Virginia 23221-0311

Kathleen S. Kilpatrick
Director

Tel: (804) 367-2323
Fax: (804) 367-2391
TDD: (804) 367-2386
www.dhr.virginia.gov

March 16, 2010

Mr. Josh Bundick
NEPA Manager
NASA Goddard Space Flight Center, Wallops Flight Facility
Wallops Island, VA 23337

Re: Proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP)
Wallops Island, Accomack County
DHR File #: 2007-0087
Date Received: February 17, 2010

Dear Mr. Bundick:

We have received information regarding our review of the above referenced undertaking, including a copy of the report DRAFT *Programmatic Environmental Impact Statement, Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program* (URS: 2010).

Based upon the information provided, we concur with your determination that the Proposed Alternatives 1, 2, and 3 will *not adversely affect any historic properties*. In the event that previously unrecorded historic properties are discovered during project activities, stop work in the area and contact DHR immediately.

If you have any questions about our comments, please contact me at: ron.grayson@dhr.virginia.gov or (804) 367-2323, Ext. 105.

Sincerely,

Ronald Grayson, RPA, Archaeologist
Office of Review and Compliance

From: Stanley, Randall M. (WFF-2280)
Sent: Wednesday, May 26, 2010 10:11 AM
To: Ron.Grayson@dhr.virginia.gov
Cc: Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; Suzanne_Richert@URSCorp.com; Bundick, Joshua A. (WFF-2500); Bull, Paul C. (WFF-2280)
Subject: Shoreline PEIS question

Ron,

A comment arose during public review of the WFF Shoreline Restoration and Infrastructure Protection Program (SRIPP) draft Programmatic Environmental Impact Statement (PEIS) regarding the anchor points for the dredge pump-out buoys. A single buoy, with three anchor points, would be used at any one time. The buoy would be located within the 3-mile Virginia boundary in approximately 30 feet of water. The question was "what is usual and customary as far as cultural resources at the anchoring points for pump-out or Scotts buoys?" According to the Corps of Engineers who manage off-shore dredging projects "This has never come up with our projects, probably because the anchoring points would be so small, especially considering the borrow or channel sites, where all the dredging or borrow material removal takes place."

We wanted to run this by you to see if you concur that no further offshore cultural surveys are required, including for the pump-out buoy anchor points? Please call Shari Silbert at 757.824.2327 or Shari.A.Silbert@nasa.gov if you have any additional questions.

Thank you.

Randall M. Stanley
NASA / WFF FMB, Code 228
Building N-161, Room 127
Wallops Island, VA 23337

Direct: 757-824-1309
Fax: 757-824-1831

From: Grayson, Ron (DHR) [mailto:Ron.Grayson@dhr.virginia.gov]
Sent: Monday, June 07, 2010 9:30 AM
To: Stanley, Randall M. (WFF-2280)
Subject: RE: Shoreline PEIS question

Randy:

Temporary buoy placement, especially in shallow waters is not something we typically concern ourselves with. Usually, in the case of channel dredging, the buoys are relatively minor and we have survey coverage extending outside of the channel itself so we know if there is anything there. In the case of your project, do you know exactly where they buoys will be placed and the exact size and type of anchor? Hopefully, they will be placed in an area that has survey coverage and it won't be an issue. If not, then maybe the anchors are small and will have relatively little impact, especially in the dynamic environment you are looking at.

Hope this helps.

ron

From: Stanley, Randall M. (WFF-2280)
Sent: Friday, July 02, 2010 8:34 AM
To: 'Grayson, Ron (DHR)'
Cc: Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; Bundick, Joshua A. (WFF-2500)
Subject: RE: Shoreline PEIS question

Ron,

In your email of June 7, 2010 (see below), you asked for the exact location of the placement of the buoys associated with the WFF Shoreline Restoration and Infrastructure Protection Program (SRIPP) project we are working on. The attached map entitled “Fig14 EIS Seawall&BeachFill pumpout buoy.pdf” should answer this question as to the location of the buoys.

Additionally, sizes and types of the anchors are detailed in the attachment entitled “Anchor info from DRP-CR-92-2.pdf”. On this attachment, you will see that the mooring chains consist of four legs, each 600-ft-long, 2-in.-diam ORQ (Oil Rig Quality) stud link chain. Mooring anchors may either be 10,000-lb Navy Navmoor or 6,000-lb Bruce International FFTS anchors.

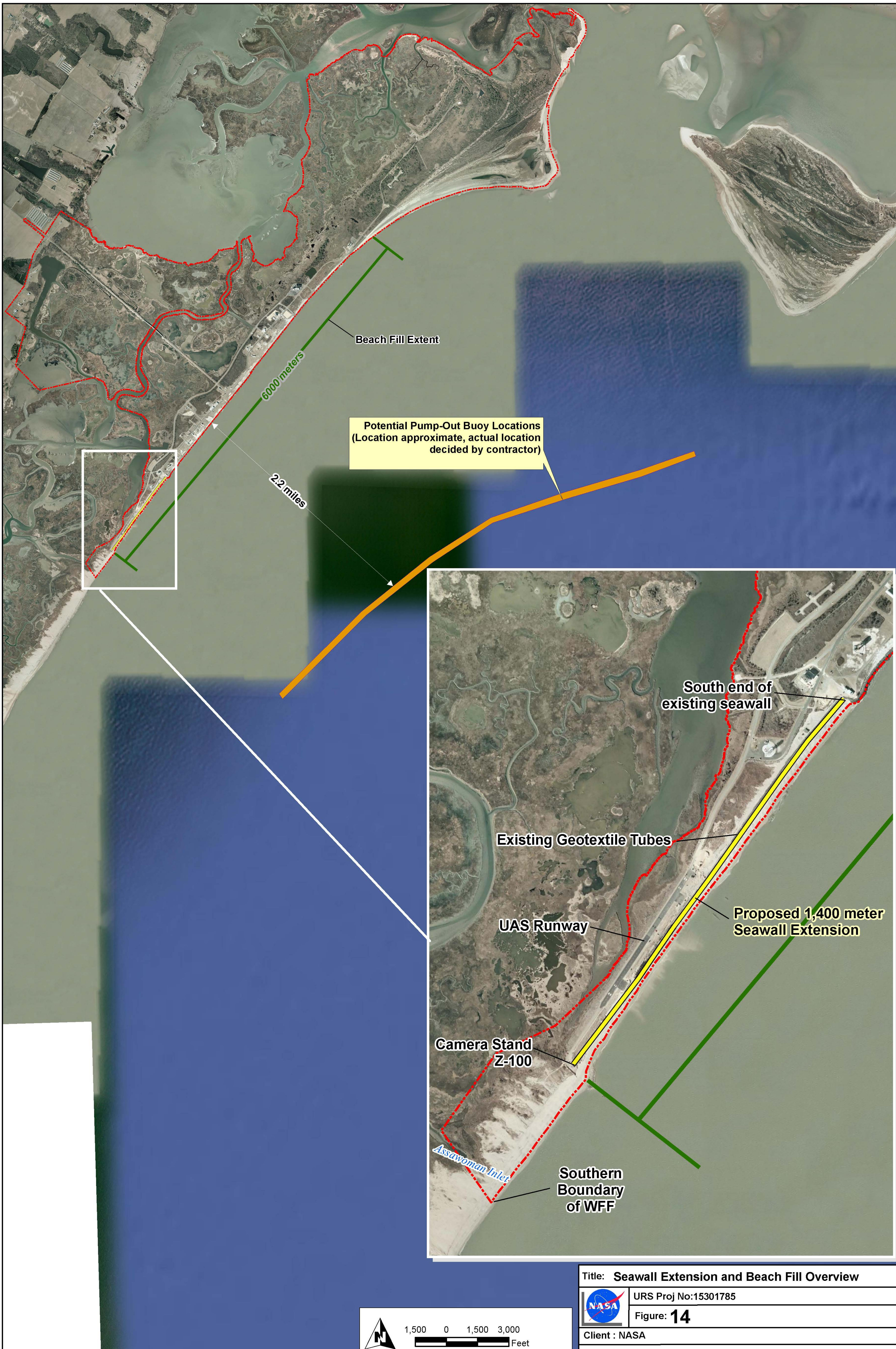
We believe that there will be no adverse affects to cultural resources within Virginia state waters as a result of the use of these anchors, and respectfully request your concurrence with this finding.

Thanks.

Randy Stanley

Randall M. Stanley
NASA / WFF FMB, Code 228
Building N-161, Room 127
Wallops Island, VA 23337

Direct: 757-824-1309
Fax: 757-824-1831



Title: Seawall Extension and Beach Fill Overview

URS Proj No:15301785

Figure: 14

Client : NASA

Shoreline Restoration Environmental Impact Statement

From: Grayson, Ron (DHR) [mailto:Ron.Grayson@dhr.virginia.gov]
Sent: Thursday, July 22, 2010 12:03 PM
To: Stanley, Randall M. (WFF-2280)
Subject: RE: Shoreline PEIS question

Randy:

It looks like the anchors will be pretty substantial, 4.5-6 tons each. If I am reading the plans correctly it appears that they will penetrate at least 9 feet deep and are expected to drag up to 30 feet. I have a few questions before I can comment on the effects.

1. How many buoys and anchors are going to be placed?
2. Have these buoys and associated anchors been discussed before? I can't seem to find them when we discussed the project in our Conference Call in October? I now you weren't there but it doesn't seem to be discussed in my notes.
3. Has the area of proposed buoy placement (I realized that the actual placement will be determined by the contractor but I am looking at the possible areas) been surveyed? It doesn't look like it was part of the surveys for the offshore borrow areas or the near shore impacts.

I know that this may seem last minute but I just want to make sure that all the appropriate actions are taken. Please feel free to give me a call and we can talk about it.

ron

From: Stanley, Randall M. (WFF-2280)
Sent: Wednesday, August 04, 2010 2:24 PM
To: Grayson, Ron (DHR)
Cc: Bundick, Joshua A. (WFF-2500); Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]; Chris_Polglase@URSCorp.com; Jeffrey_Reidenauer@URSCorp.com
Subject: RE: Shoreline PEIS question

Ron,

Thanks for taking the time to discuss aspects of the Shoreline Restoration and Infrastructure Protection Program (SRIPP) with us. Does the following capture your understanding of our conversation?

As it is unknown at this time what methods a contractor may employ to pump sand from dredge barges to Wallops Island and as these methods may have an impact on unidentified cultural resources, NASA and VDHR have agreed that the Final EIS for the SRIPP will include our best known information and will state that the 106 process is still ongoing. The ROD for the SRIPP will state that the contractor shall supply NASA with a dredge plan prior to implementation. NASA shall review that plan with VDHR and jointly decide on whether or not further investigation is required and, if warranted, agree on a survey methodology. If underwater resources are discovered during the survey, they will be reported to VDRH with a proposed avoidance buffer which will be imposed on the contractor. VDHR's concurrence with the survey report shall conclude the 106 process. Avoidance buffers shall be given to the contractor without identifying the source of the avoidance.

If you agree with the above approach, we respectfully request that you concur with the above by replying to all on this email.

Thanks,

Randall M. Stanley
NASA / WFF FMB, Code 228
Building N-161, Room 127
Wallops Island, VA 23337

Direct: 757-824-1309
Fax: 757-824-1831

From: Grayson, Ron (DHR) [mailto:Ron.Grayson@dhr.virginia.gov]
Sent: Monday, August 09, 2010 9:12 AM
To: Stanley, Randall M. (WFF-2280)
Subject: RE: Shoreline PEIS question

Randall:

This approach looks good to me. I concur that continued consultation regarding the nature and placement of the buoys is appropriate in this instance. Hopefully by then we will have survey guidelines for underwater surveys making the process even easier.

Let me know if you need anything else from me of if this e-mail suffices for your purposes.

ron

Previous Section 106 Consultation Correspondence

COMMONWEALTH of VIRGINIA
Department of Historic Resources
2801 Kensington Avenue, Richmond, Virginia 23221

W. Tayloe Murphy, Jr.
Secretary of Natural Resources

Kathleen S. Kilpatrick
Director

Tel: (804) 367-2323
Fax: (804) 367-2391
TDD: (804) 367-2386
www.dhr.state.va.us

November 4, 2004

Ms Barbara Lusby
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337-5099

RE: "Historic Resources Survey and Eligibility Report for Wallops Flight Facility"
NASA Wallops Flight Facility
Accomack County, Virginia
DHR File No. 2003-0571

Dear Ms Lusby:

We have received the draft report prepared by URS titled "Historic Resources Survey and Eligibility Report for Wallops Flight Facility, Accomack County, Virginia" for our review and comment. It is our understanding that the subject survey of the National Aeronautics and Space Administration (NASA) facility is in preparation for the development of an Integrated Cultural Resource Management Plan (ICRM) and in compliance with Section 110 of the National Historic Preservation Act.

The inventory of Wallops Flight Facility identified 124 buildings and structures fifty years old or older. Of those, the consultants from URS recommend only two as individually eligible for the National Register of Historic Places. These two properties are the Wallops Beach Lifeboat Station (DHR Survey No. 001-0027-0100; WFF #V-065) and Coast Guard Observation Tower (DHR Survey No. 001-0027-0101; WFF #070). The consultants recommend both properties eligible under Criteria A and C. The period of significance for both begins at the date of construction, 1936; and ends in 1947 when the United States Coast Guard decommissioned the properties. The consultants also recommend that there is not the potential for a historic district due to a large amount modern infill construction and a lack of historic integrity for most of the buildings and structures from the period of significance.

We concur that the Lifeboat Station and Observation Tower appear to be potentially eligible for listing in the National Register. However, we believe that the tower is not significant individually but as a contributing structure to the Lifeboat Station. We further agree that there does not seem to be justification for a historic district at WFF. Please note that we will need two copies of the final report once available.

If you have any questions about our comments please contact me at (804) 367-2323, Ext. 114.

Sincerely,

Marc Holma, Architectural Historian
Office of Review and Compliance

January 24, 2007 Correspondence between Mr. Kent Stover, WFF Historic Preservation Officer, and Kathleen Kilpatrick, VDHR, is provided in the attached "*SRIPP Proposed Groin, Breakwater, and Shoreline Restoration Cultural Resources Surveys, Accomack County, VA*"

Comments Received from Federal Agencies

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
1849 C Street, NW - MS 2462 - MIB
WASHINGTON, D.C. 20240

TAKE PRIDE IN AMERICA

April 14, 2010

In Reply Refer To:
ER 10/198

250/NEPA Manager
WFF Shoreline Restoration and Infrastructure
Protection Program
NASA Goddard Space Flight Center's Wallops Flight Facility
Wallops Island, Virginia 23337

Re: **Draft Programmatic Environmental Impact Statement (PEIS) for the Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP)**

Dear NEPA Manager:

This letter is submitted in response to the National Aeronautics and Space Administration's (NASA) Notice of Availability of Draft Programmatic Environmental Impact Statement (DPEIS) for the Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP), published in the *Federal Register*, February 26, 2010. This letter represents the comments of the Department of Interior (Department) and its bureaus, the U.S. Fish and Wildlife Service (FWS), the National Park Service (NPS), and the U.S. Geological Survey (USGS). Our comments are provided under the authority of the National Environmental Policy Act of 1969 (P.L. 91-190, 42 U.S.C. 4321-4347, 83 Stat. 852) as amended, the Fish and Wildlife Coordination Act (16 U.S.C. 661-667e, 48 Stat. 401) as amended, and the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712, 40 Stat. 755) as amended. The NASA has also requested formal consultation under section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531-1544, 87 Stat. 884), as amended. The FWS will address section 7 consultation in separate correspondence, and endangered species comments provided herein are provided to the extent that they contribute to the evaluations under the other authorities mentioned.

FWS COMMENTS

We are concerned about the potential magnitude and duration of the effects to fish and wildlife resources and conservation lands, including cumulative effects that may result from this project. The long duration of the project, and the large amount and frequency of potential impacts to fish and wildlife and their habitats are the primary reasons for our concern. In the context of the regional significance of the habitats around and adjacent to the project area, these effects may be significant. The benefits of this project, as expressed in the purpose and need do not appear to justify the effects that are likely to occur. The project, as proposed, is not being designed or implemented to prevent loss or damage of infrastructure, but to reduce the likelihood of damage or loss. Based on the design criteria cited, with the implementation of the proposed project, over its full lifetime, there remains nearly a 50 percent chance that the impacts to infrastructure and mission that this project is intended to protect will occur anyway as a result of a storm that exceeds design criteria.

Considering the significant cost and impact to the environment that may result, and the partial protection that will result, we recommend that NASA consider other alternatives, provide additional analysis of the effects of the evaluated alternatives, and seek to mitigate the potential effects to the maximum extent practicable. There are ample opportunities to incorporate mitigative activities into the proposed action such as timing implementation of project activities to avoid sensitive periods for fish and wildlife, working to improve habitat quality in conjunction with project features, and monitoring and adaptive management to specifically address environmental issues and minimize effects.

Based on our review of the document, we recommend revision to include additional description of the proposed action and affected analysis and additional analysis of effects to better explain the action, the environmental context, and its effects. Specific comments are provided below:

<u>Description and Comparison of Alternatives</u>

While the DPEIS states that the actual renourishment cycle would be determined by the magnitude and frequency of storm events and would vary throughout the 50-year life of the proposed action, all subsequent discussion references only the assumed renourishment of 616,000 m^2 of sand every five years, and nine renourishment cycles. This description does not adequately represent the range of reasonably foreseeable outcomes or provide any way to assess whether this estimate of renourishment frequency and projected fill volumes is an average estimate, or what range of variation might be appropriate to expect. Based on our experience from similar types of projects, we believe it would not be unreasonable to expect this amount to vary by 25 percent or more over the life of the project, and expressing the appropriate expectation is critical to appropriately consider the environmental impacts of the project.

Similarly, the proposed action indicates that topography and bathymetry monitoring would occur as part of the project. The description of monitoring proposed indicates the types of information that would result, but does not provide information about how monitoring results will be used to make decisions about renourishment, to evaluate environmental impacts, or to evaluate the performance or efficacy of the proposed action. We fully expect that NASA has developed an understanding of the proposed use of monitoring information, and we

recommend providing it in detail within the EIS to further provide an expectation of the outcome and NASA's future decisions regarding implementation of the project.
We recommend revising the alternatives discussed to be more consistent with the implementation and intent of a programmatic EIS. There appears to be unexplained discrepancy in the level of detail provided for individual project components. For example, beach fill and sand borrow/mining activities are very loosely defined, yet the analysis only discusses a limited amount and frequency of sand placement. In these cases, there is acknowledged uncertainty about the performance of the project, the environmental factor that will affect the project performance and implementation of future renourishment. However, this makes it very difficult to foresee what types of future actions, and the limits of these future actions, may be considered analyzed within this document.

In contrast, the sand retention structures described in alternatives 2 and 3 are described in specific detail, including location, size, and material. In addition, several other configurations of these features were apparently considered and dismissed with only cursory mention in the EIS. As a result of this treatment, it appears that only the specific designs mentioned in this document could be considered analyzed. While we again understand the reason for this treatment, we do not think the combination of these different approaches lends to a full and programmatic consideration of the project and the alternatives.

The north Wallops borrow site description does not appear to adequately express the intent or extent of the proposed activity in the area and use of this material. As delineated in the DPEIS, the area is identified as 150 acres. Constraints of vegetation and wildlife are identified as limiting the extent of the area, but these constraints are not identified. The proposed area appears to include all recent nesting habitat for the federally listed threatened piping plover, nesting areas for the loggerhead sea turtle (*Caretta caretta*) and most of the other existing high-quality beach habitat on Wallops Island. These factors do not appear to be considered constraints. We recognize the reasons why it may not be appropriate to delineate or limit an area where sand may be removed, but the extent of effects to the habitats should be described, even if only in a relative sense (e.g., is removal of the entire beach habitat in that generally area under consideration, or will some portion of the beach and beach vegetation be left unaffected). Throughout the DPEIS, there are references to beneficial effects resulting from introducing sand into the long shore transport system, but these benefits are not weighed against the losses of habitat that may result from use of northern Wallops as a borrow site. We recommend revision to address these points.

<u>Affected Environment and Environmental Consequences</u>

The section on the affected environment does not adequately describe the environment on site or the environmental context of the project area. The DPEIS fails to adequately describe the context of the adjacent conservation lands and their significance to regional and national fish and wildlife populations. In addition to the referenced National Wildlife Refuge ownership of adjacent lands, Wallops Island lies within a network of conservation lands that constitutes the longest expanse of coastal wilderness remaining on the eastern seaboard of the United States. This region has received several designations based on its ecological significance, including its inclusion within the Barrier Island/Lagoon System Important Bird Area (IBA). IBAs are identified by the National Audubon Society for their significance to bird conservation. Audubon's website (http://www.audubon.org/bird/iba/virginia/) describes this IBA in the following manner:

> "The Virginia Barrier Island Lagoon System includes the seaward margin of the lower Delmarva Peninsula from the mouth of the Chesapeake Bay to the Maryland-Virginia border. This location is the most important bird area in Virginia and one of the most important bird areas along the Atlantic Coast of North America. The area has been designated as a UNESCO Biosphere Reserve, a Western Hemisphere Shorebird Reserve Site with international status, is the site of a National Science Foundation Long-Term Ecological Research site, and is the focus of a multi-organizational partnership dedicated to bird conservation. The area includes the most pristine chain of barrier islands along the Atlantic Coast, maritime forests, extensive salt marshes, inter-tidal mudflats, and open water."

We believe that providing this type of context is necessary to adequately understand and consider the potential environmental effects of the project.

The DPEIS indicates that the Assateague National Seashore does not extend into Virginia. While the Virginia portion of the island is owned by The National Wildlife Refuge system, the beach in this area is still within the Assateague National Seashore.

The migratory birds identified and considered in the DPEIS do not sufficiently address or represent the species that may occur in the area or the potential effects on them. For example, the discussion of marine birds fails to mention the sea ducks, mergansers, and similar species that are closely associated with the offshore shoals in the region, including those proposed as borrow areas. As we recommended in our previous letter on this project, we encourage NASA to develop appropriate monitoring to allow assessment of the effects of dredging on these species.

The DPEIS does not sufficiently describe the effects of the project on upland wildlife species and migratory birds in particular. While the cumulative effects discussion does recognize that NASA mission-related disturbance may occur to birds occupying the beaches that are created, it does not describe or characterize the effects. While the proposed project is expected to result in a larger amount of beach habitat, the location of much of this habitat immediately adjacent to NASA facilities including launch pads, the existing UAV runway, and other infrastructure, reduces the value of this habitat, and may effectively result in the creation of an attractive nuisance by providing otherwise suitable habitat in an area where wildlife will be regularly (and potentially significantly) disturbed. In this context, it is not clear that the addition of this habitat is beneficial, except during those times when no NASA activities are under way. While a larger amount of beach may result, it is unclear whether this beach will provide suitable or equivalent beach habitat because the relatively frequent renourishment and associated activities may prevent development of normal beach communities (e.g., insect and plant species composition and abundance).

The cumulative effects section describes the impacts from onshore activities in the following manner: "The proposed SRIPP would create a beach where one currently does not exist and augment the existing beach at the northern and southern ends of Wallops Island." This description does not appear to address the potential use of the north Wallops borrow site. The potential removal of beach habitat from the northern end of Wallops Island for renourishing the southern beaches may further exacerbate the reduced habitat suitability of these beaches resulting from their proximity to disturbance because the northern Wallops beaches that will be removed are generally persistent, extensive, and relatively isolated from the more disruptive activities that NASA conducts (e.g., rocket launches and UAV flights). The proposed action will result in significant degradation or complete removal of all existing beach habitat that is protected from disturbance to create an ephemeral beach proximate to numerous disturbances. We recognize that use of the northern borrow area would help to reduce impacts to offshore borrow areas, but as we expressed in our previous letter, we believe that a thorough discussion and evaluation of these tradeoffs and the different impacts to different species and resources is needed.

We recommend providing a more detailed and comprehensive analysis of cumulative effects on all resources beyond stating that cumulative effects will occur. A cursory treatment of cumulative effects, particularly in light of the ecological significance of the region, does not provide a sufficient understanding of the type and magnitude of cumulative effects.

NPS COMMENTS

Potential Impacts on Assateague Island National Seashore

Congress established Assateague Island National Seashore (ASIS) to preserve the natural and recreational resources of Assateague Island, including the oceanic and bayside beaches that are maintained by natural coastal processes, portions of the surrounding waters of the Atlantic Ocean and Chincoteague Bay, and the living resources that depend on these aquatic and terrestrial habitats. Those living resources include sea turtles, marine mammals, shorebirds, sea birds that feed on offshore shoals, and fish[i] that use both offshore shoals and Chincoteague Bay for different life stages. The coastal processes that shape the island are controlled by regional factors, including sediment supply and sediment transport pathways, offshore and nearshore bathymetry, and wave direction, height, and energy.

ASIS is concerned about the potential impacts that the Preferred Alternative may have on the wave climate, cross-shore sediment supply, and pelagic habitat value of ASIS.

Potential Impacts to Wave Climate

The Preferred Alternative plans to dredge two shoals that are located 7 and 11 miles offshore of ASIS. Recognizing that offshore shoals dissipate incoming wave energy, and thereby help to shelter shorelines from the erosive effects of large waves, ASIS is concerned that the proposed dredging will significantly reduce the volume, height, and associated sheltering effect of the targeted shoals and will ultimately impact shoreline conditions on Assateague Island.

We appreciate NASA's effort to model the potential impacts of shoal dredging on the wave climate and longshore transport off of Assateague Island, but we are concerned about the apparent discrepancy between the modeling results[ii] (Volume II of the Draft PEIS) and the Executive Summary of those modeling results (Table ES-1). Although the modeled Impact Factor is lower than a Minerals Management Service (MMS) threshold of 1.0, it is still higher than 0.75 along portions of the already vulnerable Assateague Island shoreline. The modeling report goes on to clarify that "it is not clear that a value for this factor of < 1 equates to a negligible long term shoreline impact." The Executive Summary, in contrast, states that "dredging of the offshore shoals would result in [...] no impact to the Assateague Island shoreline." In consideration of the largely unknown consequences of dredging the shoals, and with the recognition that our regional sediment transport pathways are poorly understood, ASIS is concerned about the potential impacts of the project on the wave climate that shapes Assateague Island's shoreline.

We recommend that the Preferred Alternative use site-specific dredging methods that protect existing geomorphologic integrity and wave sheltering properties by following two new MMS guidelines[iii]:

1. Avoid the crests[iv] of the two targeted shoals to maximize the shoals' wave attenuation function; to maintain the shallowest water wave-action processes, which are likely important for long-term shoal maintenance; and to maintain coarse-grained lag deposits in-place since these may serve to ensure crest stability by increasing resistance to wave erosion[v,vi].

2. Avoid longitudinal dredging (i.e., dredging from the entire length of the shoal, along the longer axis), which affects wave focusing processes[vii].

We also recommend that the Preferred Alternative consider the possibility that future research may identify increased impacts to the Assateague Island shoreline, so subsequent dredging for beach renourishment may need to include mitigation of shoreline impacts on Assateague Island and consideration of alternative dredging locations.

Potential Impacts to Cross-Shore Sediment Supply

We are concerned that potential dredging impacts on cross-shore sediment transport pathways were not addressed in the Draft PEIS, as we requested during the scoping process. We remain concerned that removal of such a large volume of either shoal may impact the regional sediment budget and sediment transport pathways, specifically the sediment transport from the shoal and nearshore areas to Assateague Island, to the detriment of the island's shoreline, topography, natural coastal processes, and ability to keep pace with sea level rise. Multiple mapping and modeling studies[viii,ix,x,xi,xii,xiii,xiv,xv,xvi] have indicated that cross-shore transport is an important sediment pathway linking offshore shoals, shelf, and shorelines, on time scales ranging from years to decades, far beyond the expected depths of closure[xvii,xviii,xix]. We believe that a similar linkage may exist between southern Assateague Island and the offshore shoals proposed as dredging targets. Recognizing that cross-shore sediment transport budgets are poorly understood and quantified in the Chincoteague Inlet area, we recommend that the Preferred Alternative incorporate research efforts to clarify and quantify the cross-shore sediment transport pathways and budgets through the collection and analysis of additional geophysical and hydrodynamic data offshore of Assateague Island. The lack of information on regional cross-shore dynamics also compels us to recommend that the Preferred Alternative consider dredging sediments that are farther offshore and that are unlikely to contribute to onshore sediment transport, either as a sediment source or as a conduit for that sediment.

Because of our previously expressed concerns that the proposed dredging will reduce the sheltering effect of the shoals and increase erosion along the already vulnerable Assateague Island shoreline, we support NASA's decision to dredge no deeper than the shoal base or seafloor, because that method will confine dredging to the active portion of the seafloor, and will avoid the creation of pits which could alter physical process patterns[xx].

We recommend that the Preferred Alternative use site-specific dredging methods that minimize impacts to sediment transport processes by following new Minerals Management Service guidelines[xxi] that dredged sediment be taken from the extreme downdrift accreting side of each shoal or, secondarily, from the extreme updrift eroding side of each shoal, to minimize the risk of breaking the sediment transport pathways by interrupting sand recycling and transport patterns and processes[xxii]. In those non-crest areas, we support NASA's proposal to dredge a thin uniform layer of material from a large area, because this method is likely to cause the least disturbance to existing shoal topography and geometry and, therefore, offers the least likelihood of substantial disturbance to the physical processes that maintain the shoals[xxiii].

<u>Potential Impacts to Pelagic Habitat Value</u>

ASIS is concerned that the proposed dredging of shoal habitat will impact pelagic fish and birds that use both shoal areas and the oceanic and estuarine waters within the ASIS boundary. Offshore shoals are known to be populated with benthic communities[xxiv] that in turn support a complex food web for fish,[xxv] turtles, marine mammals, and pelagic seabirds. Studies offshore the Maryland and Virginia coastlines indicate that the majority of the species inhabiting the shoals and reference site habitats are seasonal residents, and suggest that pelagic fish are using habitats differently between day and night,[xxvi] such as moving between the shoal sides and the surrounding seafloor.

We support NASA's decision to avoid Blackfish Bank, which is known as a rich shoal habitat, as a dredge target. Additionally, we recommend that the Preferred Alternative use site-specific dredging methods that avoid the crests of the two targeted shoals to protect habitat value[xxvii,xxviii] for finfish, which preferentially congregate around higher-relief shoals for a variety of reasons including geomorphology, and for pelagic seabirds such as scoters, which congregate in waters less than 30 meters deep such as those above shoal crests.

USGS COMMENTS

Page 102: The text states that saltwater intrusion is not a problem "because the salt water is not hydraulically connected to the groundwater aquifer". The PEIS would benefit from a reference or data to support the contention that the system is not connected.

Use of the Barlow (2003) reference that salt water intrusion is most often caused by pumping from coastal wells (not site specific) implies that a hydraulic connection between salt and fresh water might exist.

The Barlow (2003) reference is not included in the list of references.

Barlow, P.M., 2003, Ground water in freshwater- saltwater environments of the Atlantic coast: U.S. Geological Survey Circular 1262.

EDITORIAL COMMENTS

We also provide the following recommendations for minor edits and clarifications:

- The net sand transport direction shown in Figure 7 appears incorrect and inconsistent with discussion and photographs of groins and their function.

- We recommend additional explanation of Figure 33. The identification of plover habitat areas should be explained in the context of the several recent plover nests shown outside of that area.

- In Table 22, we recommend clarifying VDGIF's joint jurisdiction concerning federally listed species that they also identify as threatened or endangered.

- We recommend adding to the account of listed invertebrates that the northeastern beach tiger beetle is not currently known to occur on Atlantic coastal beaches in Virginia.

- We recommend removing mention of potentially planting vegetation on the beach/dunes from the discussion of mitigation unless there is a commitment to conduct the planting.

Thank you for the opportunity to review and comment on the DPEIS. If you have any questions concerning our comments, please contact Tylan Dean, Assistant Supervisor, FWS, Endangered Species and Conservation Planning Assistance, at (804) 693-6694 (x166) or at tylan_dean@fws.gov; Joe Carriero, External Affairs Program Manager, NPS Environmental

Quality Division, at (303) 987-6999 or at joe_carriero@nps.gov; Gary LeCain, USGS Coordinator for Environmental Document Reviews, at (303) 236-5050 (x229) or at gdlecain@usgs.gov or Shawn Alam, of my staff, Office of Environmental Policy and Compliance, at (202) 208-5465 or shawn_alam@ios.doi.gov. We appreciate the opportunity to provide these comments.

Sincerely,

Willie Taylor
Director, Office of Environmental
Policy and Compliance

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[i] Vasslides, J.M. and K.W. Able, 2008. "Importance of shoreface sand ridges as habitat for fishes off the northeast coast of the United States." *Fishery Bulletin* 106(1), pp. 93-107.
[ii] King, D., D. Ward, G. Williams, and M. Hudgins, 2010. "Storm Damage Reduction Project Design for Wallops Island, Virginia." In: Draft Programmatic Environmental Impact Statement Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program Volume II of II. NASA, Wallops Island, Virginia.
[iii] Dibajnia, M. and R.B. Nairn, in prep. Investigation of Dredging Guidelines to Maintain and Protect the Integrity of Offshore Ridge and Shoal Regimes. U.S. Department of the Interior, Minerals Management Service, XXX OCS Region, 2010. OCS Study MMS 2010-XXX. 150 pp. and appendices.
[iv] Dibajnia, M. and R.B. Nairn, in prep.
[v] U.S. Army Corps of Engineers Baltimore District, 2008.
[vi] U.S. Army Corps of Engineers, 1998. "Appendix D Restoration of Assateague Island." In: Ocean City, Maryland, and Vicinity Water Resources Study Final Integrated Feasibility Report and Environmental Impact Statement. Baltimore, Maryland.
[vii] Dibajnia, M. and R.B. Nairn, in prep.
[viii] Wright, L.D., J.D. Boon, S.C. Kim, and J.H. List, 1991. "Modes of cross-shore sediment transport on the shoreface of the Middle Atlantic Bight." *Marine Geology* 96, pp. 19–51.
[ix] Thieler, E.R., A.L. Brill, W.J. Cleary, C.H. Hobbs III, and R.A. Gammisch,1995. "Geology of the Wrightsville Beach, North Carolina shoreface: Implications for the concept of shoreface profile of equilibrium." *Marine Geology* 126, pp. 271-287.
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of London Special Publications 274, pp. 91–101.
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[xv] Park, J., P.T. Gayes, and J.T. Wells, 2009. "Monitoring beach renourishment along the sediment-starved shoreline of the Grand Strand, South Carolina." *Journal of Coastal Research*, 25(2), 336–349.
[xvi] Hapke, C.J., E.E. Lentz, P.T. Gayes, C.A. MCCoy, R. Hehre, W.C. Schwab, and S.J. Williams, in press. " A Review of Sediment Budget Imbalances along Fire Island, New York: Can Nearshore Geologic Framework and Patterns of Shoreline Change Explain the Deficit?" *Journal of Coastal Research.*
[xvii] Wright, L.D., J.D. Boon, S.C. Kim, and J.H. List, 1991.
[xviii] Thieler, E.R., A.L. Brill, W.J. Cleary, C.H. Hobbs III, and R.A. Gammisch,1995.
[xix] Hinton, C.L. and R.J. Nicholls, 2007.
[xx] U.S. Army Corps of Engineers Baltimore District, 2008. "Section 5 Development of a Borrow Plan." In: Atlantic Coast of Maryland Shoreline Protection Project Final Supplemental Environmental Impact Statement General Reevaluation Study: Borrow Sources for 2010 – 2044. Baltimore, MD.
[xxi] Dibajnia, M. and R.B. Nairn, in prep.
[xxii] U.S. Army Corps of Engineers Baltimore District, 2008.
[xxiii] U.S. Army Corps of Engineers Baltimore District, 2008.
[xxiv] Diaz, R.J., G.R. Cutter Jr., and C.H. Hobbs III, 2004. "Potential impacts of sand mining offshore of Maryland and Delaware: Part 2—biological considerations." *Journal of Coastal Research*, 20(1), pp. 61–69.
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

April 19, 2010

Joshua Bundick
WFF NEPA Manager
National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Re: Draft Programmatic Environmental Impact Statement (DPEIS), Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Project, Wallops Island, Virginia, February 2010

Dear Mr. Bundick:

In accordance with the National Environmental Policy Act (NEPA) of 1969, Section 309 of the Clean Air Act and the Council on Environmental Quality regulations implementing NEPA (40 CFR 1500-1509), the U.S. Environmental Protection Agency (EPA) has reviewed the Draft Programmatic Environmental Impact Statement (DPEIS) for the Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Project (SRIPP). The proposed action involves the extension of the existing seawall and the placement of dredged sand on 3.7 miles of the Wallops Island Shoreline. Based on our review of the DPEIS, EPA has rated the environmental impacts of the preferred alternative as "EC" (Environmental Concerns) and the adequacy of the impact statement as "2" (Insufficient Information). The basis for this rating is contained in the remainder of this letter. A description of our rating system can be found at: www.epa.gov/compliance/nepa/comments/ratings.html.

The purpose and need of the proposed action is to reduce the potential for damage to, or loss of, NASA, U.S. Navy, and Mid-Altantic Regional Spaceport (MARS) assets on Wallops Island from wave impacts associated with storm events. WFF located at Wallops Island is the only research range in the US that is controlled solely by NASA. Over fifty buildings are located on Wallops Island, including runways, sounding rocket launch pads and various support facilities. These assets are valued at over $1 billion. NASA plans to protect existing and possible future infrastructure located on the barrier island by augmenting the shoreline with additional sand from offshore shoals and extending the seawall over a 50 year project lifespan.

The DEIS examines four alternatives for the SRIPP. They are: the No-Action Alternative, in which no beach fill would continue current conditions; Alternative One (the Preferred Alternative), which would extend the seawall up to 1,400m and place 3.199 million yd^3 of dredged sand over 3.7 miles of shoreline; Alternative Two, which would extend the seawall up to 1,400m, place 2.916 million yd^3 of dredged sand over 3.7 miles of shoreline, and the construct a terminal groin; and Alternative Three, which would extend the seawall up to 1,400m, place 2.839 million cy^3 of dredged sand over 3.7miles of shoreline, and construct an offshore breakwater. Alternative One has been selected as the preferred alternative. We have rated Alternative One, the Preferred Alternative, as "EC-2" (Environmental Concerns, Insufficient Information). Alternatives other than the preferred are not rated by the EPA, but would likely to be considered to have higher potential environmental impact to adjoining barrier islands. Additional details on adverse impacts to aquatic resources, cultural resources, threatened and endangered species are needed to determine the full scale of potential impact.

The immediate actions in the preferred alternative lack the construction of hard structures; however, future replenishment cycles may include hard structures such as ones discussed in alternatives two and three. Since specific detail on future actions were not fully addressed in the DPEIS, specific information on the possible adverse impacts is unavailable. EPA is concerned about the unknown effects of future renourishment cycles. Future NEPA documentation for additional phases of the SRIPP may likely warrant the preparation of Environmental Impact Statements. EPA encourages NASA to continue to receive input from interagency teams and continue public involvement in the NEPA process. EPA looks forward to work with NASA as the life of the SRIPP continues.

EPA is concerned that sand borrow and placement operations will have adverse affects on the shoal and beach habitats, wildlife, and other environmental resources. Additional information is also needed to clarify monitoring and mitigation plans. EPA believes the DPEIS does not adequately provide analysis of secondary and cumulative effects of past, current and foreseeable future activities on the barrier island habitat and resources. Comments specific to the DPEIS can be found in an attachment to this letter. EPA cannot adequately assess the effects of the proposed undertaking on cultural resources since the location(s) of the pump-out station(s) has not been identified by WFF; detailed comments are included in the attachment. A review of Environmental Justice (EJ) portion of the document was completed by EPA's Regional Environmental Justice Coordinator, and comments provided in the enclosed attachment

Please consider the issues, questions and comments included in this letter and attachment. We would appreciate the opportunity to discuss the comments at your convenience. Thank you for allowing EPA with the opportunity to review and comment on the DPEIS. If you have questions regarding these comments, the contact for this project is Ms. Barbara Rudnick, NEPA Team Leader, at (215) 814-3322 or rudnick.barbara@epa.gov.

Sincerely,

Jeffrey D. Lapp, Associate Director
Office of Environmental Programs

Attachment

Detailed Comments

Purpose and Need & Alternatives

- The relocation of at risk infrastructure was not carried forward for detailed analysis. Explain why a relocation of pad and support facilities would need to maintain the same general size and layout of the current facilities. Are other configurations possible that may allow some or the entire infrastructure to be relocated? Has the acquisition of additional property been investigated to add to the NASA controlled buffer, which may enable additional Wallops Island infrastructure to be move onto the Mainland or Main Base?

- If facilities are not going to be relocated further on inland, EPA would recommend that further investment into future infrastructure on Wallops Island be avoided. The barrier island is a dynamic and unstable system that is very vulnerable to sea-level rise and intense storms. It may be prudent to consider this dynamic nature when looking at future development projects.

- Clarify what level of storm protection has been determined and why this specific level is necessary.

- All of the alternatives presented in the DPEIS include the extension of the existing seawall by 1400 meters, yet no discussion for why this extension is needed was included. Please explain why the seawall needs to be extended beyond its existing length and what infrastructure it is intending to protect, include existing and future projects. Clarify what is meant by 'critical infrastructure.'

- Please provide more information on rationale for eliminating options during secondary screening, particularly the use of reduced beach fill. Clarify why this alternative was eliminated, the level of storm protection it would provide and how that relates to the purpose and need of the project.

- Page 64 states that if year two or three funding is pulled "the completed portions of the project would be viable projects themselves and wouldn't have negative shoreline consequences." If seawall only and seawall and partial beach fill are considered to be viable, they should both be considered as alternatives for the proposed action. Additionally, funding for the replenishment cycles should be discussed, as well as possibilities for funding not being secured for future cycles.

- Shoal B was eliminated from consideration for use during the initial beach fill for cost purposes. The environmental effects of sand borrow operations on both shoals should be evaluated prior to eliminating this option. It is not clear which shoal would be environmentally preferable for use in this project. The use of shoal A would require a greater percentage of total volume and total surface area, compared to shoal B. What analysis has been conducted to determine the ability of shoals to rebound after dredging?

Environmental Impacts

Wildlife, Endangered Species and Cumulative Effects

- EPA is concerned about the potential use of North Wallops Island as a potential borrow area for future nourishment cycles. This area is known piping plover habitat, a federally listed endangered species. Recirculation activities may have an adverse effect on plover habitat and actions should be consulted with FWS. Page 203 of the document states that "short-term adverse impacts to shoreline in the period of a few months to years after excavation activities" would occur. Include a discussion of North Wallops recovery time, the relationship to plover habitat. Additional information on monitoring is needed.

- Of further concern is the possibility of expanding plover habitat resulting from initial beach fill. Future nourishment activities may result in the disruption of newly created plover habitat. The proposed activity may also result in the development of SAV beds in the project area. These resources should be monitored for and protected.

- Page 255 says that a NMFS-approved observer will be present on board the dredging vessel during certain times of year. The role of the observer on the vessel needs further clarification.

- For adverse affects on wildlife and endangered species, a detailed monitoring and mitigation plan is needed. EPA encourages NASA to coordinate with FWS to develop and approve this plan. Additional coordination with FWS and NMFS for potential impacts to birds, threatened and endangered species, and essential fish habitat. Impacts to state listed species should be coordinated with appropriate state agencies.

- It is suggested that a secondary and cumulative effects analysis begin with defining the geographic and temporal limits of the study; this is generally broader than the study area of the project. Geographic boundaries are typically shown on a map; and a historic baseline is often set at a major event changing the local environment. In the case of WFF, this could be the start of the facility in the 1940's. Analysis of the trend of the value and quantity of the resources of interest should be developed and considered as part of cumulative impacts.

- The secondary and cumulative effects analysis should provide the documentation of consultation and coordination with agencies holding expertise. For instance, consultation on marine bathymetry and sand shoal resources should be added to support conclusions. Conclusion on assessment of impacts to turtles should not be presented until consultation with National Marine Fisheries and Fish and Wildlife Service has been finalized.

- The DPEIS does not provide a complete evaluation of activities that are expected to occur within the project timeframe, most notably the proposed cycling of sand. It would benefit the document to evaluate sand replenishment projects (including other replenishment projects, structures, etc.) on the barrier island complex as a whole. A discussion of potential impacts of the follow-up actions to the preferred alternative would be appropriate in the cumulative impacts analysis. The conclusion that WFF projects may contribute, but would not be significant impact to endangered species has not supported; for instance, appropriate studies recommended by Fish and Wildlife Service for bird and bat impacts from the proposed turbines has not been completed.

Offshore Shoals

- The proposed dredge removal method involves contour and plane dredging. What other methods were considered and which method will allow the greatest recovery of the shoal? What is the expected recovery time for shoal A based on the proposed borrow operations? Include recommendations made by resource agencies with this expertise.

- Provide a map showing proposed mined areas. Proposed borrow areas within the shoals should be delineated.

- If a sand management plan has been prepared for the proposed action, please include it in the Final PEIS. EPA recommends that a sand management plan be prepared if it has not been done already. What are the monitoring efforts for shoals? How will erosional hotspots be identified?

- Clearly present the sand grain sizes that exist at Wallops, and how this compares to grain sizes found in both shoals A & B. What grain size has been determined to be ideal for this beach nourishment project?

Other

- A 25% loss rate of material during sand dredge and placement operations is predicted for this project, which results in 2-3 million yd^3 of additional fill generated over the lifetime of the project. Please provide information supporting the use of this loss rate and what measures will be taken to reduce amounts of sand lost. Discuss any possible impacts that could result from these losses.

- Please discuss facility adaptation and the air emissions of the proposed action with respect to WFF as a whole, such as is directed by CEQ draft NEPA guidance (2010) on Considerations of the Effects of Climate Change and Greenhouse Gas Emissions.

- Existing underwater noise conditions have not been evaluated. Noise monitoring was last conducted in 1992. However, since that time conditions on the island have changed and operations have expanded. EPA recommends updating the 1992 study of baseline noise conditions at WFF.

- The DPEIS showed possible locations for MEC on WFF. Have potential shoal borrow areas been examined for possible MECs? Are any other hazardous materials beyond MECs found in the project area or on Wallops Island? Please identify any active or past hazardous sites, CERLA or RCRA, that are known at WFF. An analysis should be conducted to determine if any of these areas have an adverse environmental effect with respect to the proposed action, as well as an MEC avoidance plan. Figure 29 presents MEC locations at WFF, which appear to cover a significant portion of the study area. Please explain how it is that MECs are not anticipated to be encountered.

- It is not clear how the proposed groin and breakwater structures will impact sand transport and effect neighboring barrier islands. What analysis has been conducted to determine these effects?

Cultural Resources

- Page 177 states, "In a letter dated December 4, 2003, the Virginia Department of Historic Resources (VDHR) concurred with the recommendations of the CRA and VDHR accepted the predictive model for archaeology at WFF, noting that many of the areas with moderate to high archaeological potential are unlikely to be disturbed by future construction or site use." A copy of the letter dated December 4, 2003 from VDHR should be included in the Appendix. It would also be beneficial to include the *Cultural Resources Assessment for Wallops Flight Facility* in the Appendix of the FEIS to understand VDHR determination concluding that future construction or site use would not disturb potential archaeological areas without knowing the type of project work that could result in the future.

- Page 177 states, "In anticipation of the need for shoreline restoration measures, NASA conducted a pedestrian survey of 6.2 km (3.85 mi) of beach/coastline on Wallops Island on September 18, 2006 (Appendix C)." Please note that the pedestrian survey referenced is not included in Appendix C.

- Page 183, "Since the 2004 report, no additional identification and evaluation of above-ground historic properties has been conducted at WFF." Considering the magnitude of the proposed project and other projects planned for WFF, it would be prudent to update the survey during the planning and environmental analysis phase of the proposed action to consider and evaluate all resources that may have the potential to be impacted. Since the location(s) of the pump-out station(s) has not been identified by WFF, this information would be useful in avoiding sites that may affect a resource.

- Page 185 states, "The archaeological predictive model presented in the CRA identified the potential to encounter pre-historic and historic sites on WFF (which was approved by VDHR in a letter dated December 3, 2003), including the Atlantic coast shoreline and near shore waters." A copy of the letter from VDHR should be provided in the Appendix. Also, it is assumed that the letter referenced on page 177 and on page 185 from VDHR is one in the same; however, the date quoted is not the same (December 3 versus December 4). Please correct this discrepancy. Again, it would be helpful to include the *Cultural Resources Assessment for Wallops Flight Facility* in the Appendix of the FEIS.

- Page 269 states, "Underwater actions, which include dredging within Unnamed Shoal A or Unnamed Shoal B, pump-out operations in the nearshore environment east of Wallops Island, and the construction of a groin or breakwater, would only affect archaeological resources." Please give more detail as to the archaeological resources that would be impacted. "The location(s) of the pump-out station(s) has not been identified by WFF." Please indicate the possible number of pump-out stations that may be needed and identify potential locations for the pump-out stations. "Additional Section 106 consultation would be required for the area(s) around the pump-out station(s) once the location(s) has been identified." It is recommended that the VDHR be consulted early and throughout the planning effort of determining pump-out station locations.

Environmental Justice Comments

- The EJ assessment should assure the protection and appropriate level of consideration for the potential adverse impacts that may have an effect on minority and low income populations living in the area near the site. The document should identify where such populations are located, and what potential impacts may occur.

- A definition of a minority community can be found on page 186 of the DPEIS. An exact definition of what constitutes a minority has not been released by EPA or the EJ Coordinators, this definition is inaccurate. We recommend, along with the removal of this statement, that minority and low income populations be compared to state and local demographics, defining minority and low income populations in relation to the state, county or local averages. More comprehensive demographic information regarding the minority and low-income populations of each community should be supplied along with maps highlighting the localization of those communities in relation to the site and any and all work that will be conducted.

- Please describe the efforts to ensure the protection of minority and low-income populations. Describe which communities were identified as potential EJ concern and how these populations are being involved through outreach in the decision making process.

- Residential displacements are not the only concern that should have been taken into consideration for potential EJ issues. Describe what other types of impacts were considered and include them in the DEIS. Potential concerns that were not included may be noise, air and water quality issues, changes in employment opportunities, and subsistence fishing impacts.

Please note that the April 19, 2010 correspondence from the National Marine Fisheries Service regarding Essential Fish Habitat is provided in Appendix K.

From: Cole, Robert H NAO [Robert.H.Cole@usace.army.mil]
Sent: Monday, April 05, 2010 3:39 PM
To: Bundick, Joshua A. (WFF-2500); Silbert, Shari A. (WFF-200.C)[EG&G, Inc. (WICC)]
Cc: Cotnoir, Audrey L NAO
Subject: NASA DEIS and EAs

Josh/Shari,

I have reviewed the DEIS for the SRIPP and the Alternative Energy EA. The cumulative impacts section lacks sufficient information and detail. Cumulative Impacts assessments should begin when NASA began using Wallops Island and needs to include, not only NASA's impacts, but Navy and any other tenant that has done work on the island, such as the Napalm testing that was accomplished on the Island.

Barrier Islands are dynamic and migrate naturally. Because of the cumulative impacts on Wallops Island a shoreline hardening project is now required to protect the resources that are now located on the Island. The impacts associated with the construction and uses of those resources need to be addressed in the cumulative impacts section of the EA. For example: the Draft EIS does not include the cumulative impacts of conversion of land use by construction of buildings and pavement resulting in an increase in impervious area and mitigation for increased stormwater runoff resulting from the conversion. The Navy has constructed a few large buildings on the Island for training. Those structures have created a significant amount of impervious land, and restricted the use of a large portion of the ocean. However these impacts are detailed in cumulative impacts section of the Draft EIS. According to a NASA representative, these impacts have resulted in the proposal to place wind turbines in a less than optimal location (tide marsh with decreased wind resources).

I am not familiar with all of the past activities; however the Cumulative Impacts section must address all impacts, past, present, and for the foreseeable future. Future expansion is being planned that is not addressed by the EIS. For Example: NASA is proposing to install an electrical loop on the southern end of the island to facilitate future development. The proposed shoreline stabilization project will protect this area; therefore the proposed expansion must somehow be addressed by the Cumulative Impacts portion of the EIS.

In conclusion, the Draft EIS needs to address cumulative impacts in more detail to pass 404(b) requirements.

Robert Cole
Environmental Scientist
Norfolk District Corps of Engineers
Eastern Shore Field Office
22545 Center Parkway
Accomac, VA 23301-1330
757-787-7567

Comments Received from State Agencies

COMMONWEALTH of VIRGINIA
DEPARTMENT OF CONSERVATION AND RECREATION
Division of Natural Heritage
217 Governor Street
Richmond, Virginia 23219-2010
(804) 786-7951 FAX (804) 371-2674

March 19, 2010

Mr. Joshua, Bundick
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Re: Wallops Island Flight Facility Shoreline Restoration and Infrastructure Protection Program

Dear Mr. Bundick:

The Department of Conservation and Recreation's Division of Natural Heritage (DCR) has searched its Biotics Data System for occurrences of natural heritage resources from the area outlined on the submitted map. Natural heritage resources are defined as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations.

According to the information currently in our files, this site is located within the North Wallops Island Conservation Site. Conservation sites are tools for representing key areas of the landscape that warrant further review for possible conservation action because of the natural heritage resources and habitat they support. Conservation sites are polygons built around one or more rare plant, animal, or natural community designed to include the element and, where possible, its associated habitat, and buffer or other adjacent land thought necessary for the element's conservation. Conservation sites are given a biodiversity significance ranking based on the rarity, quality, and number of element occurrences they contain; on a scale of 1-5, 1 being most significant. North Wallops Island Conservation Site has been given a biodiversity significance ranking of B2, which represents a site of very high significance. The natural heritage resources of concern at this site is:

Piping Plover	Charadrius melodus	G3/S2B, S1N/LT/LT

The Piping Plover inhabits coastal areas, utilizing the flat, sandy beaches of barrier islands for breeding (Cross, 1991). Threats to this species include predation of eggs and young and the development and disturbance of barrier island breeding sites (Cross, 1991). Please note that this species is listed as threatened by the United States Fish and Wildlife Service (USFWS) and the Virginia Department of Game and Inland Fisheries (VDGIF).

Additionally the site is also within the North Assawoman; South Wallops Island Conservation Site. The North Assawoman; South Wallops Island Conservation Site has been given a biodiversity significance ranking of B2, which represents a site of very high significance. The natural heritage resources of concern at this site are:

Piping Plover	Charadrius melodus	G3/S2B, S1N/LT/LT
Least Tern	Sterna antillarum	G4/S2B/NL/SC
Wilson's Plover	Charadrius wilsonia	G5/S1B/NL/LE

Wilson's Plover is a rare, short-term summer visitor along the lower Chesapeake Bay and the Atlantic Coast south of Cape Henry. The summer males have a thick black bill and a white breast with a single band while the females, young, and winter males are grayish brown to reddish brown (Bergstrom, 1991).

Wilson's Plover habitat consists of the upper portions of sandy beaches on barrier islands, usually within 30 m of dune vegetation. Requirements for nesting include suitable foraging sites nearby for chicks, usually mud or sand flats. Predatory threats include foxes, herring gulls, great black gulls, and fish crows who eat the eggs and young. Nesting habitats are lost to both natural processes such as erosion and coastal development, as well as human disturbance during the nesting season. Since the eggs are a pale tan or buff with irregular black specks, they blend easily into the sand which allows for them to be overlooked by unsuspecting beach visitors who crush them. Recommendations for protecting these birds consist of predator control measures involving protection from predators for nests and discouraging development on the nesting islands. Wilson's Plover is protected under the Migratory Bird Treaty Act (Bergstrom, 1991).

The Least Tern nests on broad, flat beaches with minimal vegetation and forages in saltwater near the shore. Threats to this species include loss of nesting habitat due to development and disturbance of breeding colonies by human activities and high numbers of predators (Beck, 1991). Please note that the Least Tern is listed as a special concern species by the Virginia Department of Game and Inland Fisheries (VDGIF).

Due to the legal status of the Piping Plover and Wilson's Plover,DCR recommends coordination with the VDGIF and USFWS to ensure compliance with protected species legislation. DCR also recommends the protection of rare bird habitat (Least tern, Wilson's plover, and Piping plover) during the nesting season from April 15th to August 15th. Additionally, the source for beach nourishment should be limited to the sand shoals (Unnamed Shoal A or Unnamed Shoal B) located offshore in Federal waters and not from the Piping plover habitat on the north end of Wallops Island. Please note, DCR continues to be concerned in regards to the effects of the shoreline hardening on the islands downdrift of the project area including The Nature Conservancy and DCR properties.

Alternative One (Preferred Alternative) would be DCR's preferred alternative provided sand is not taken from the beach on the north end of Wallops Island and the proposed seawall extension is limited to the minimum length absolutely necessary for the protection of the facility. The absence of groin or breakwater for this alternative makes it less likely to disrupt sand transport for resources located to the south of the project area. DCR continues to recommend exploring the feasibility of inland relocation of existing facilities.

Our files do not indicate the presence of any State Natural Area Preserves under DCR's jurisdiction in the project vicinity.

Under a Memorandum of Agreement established between the Virginia Department of Agriculture and Consumer Services (VDACS) and the Virginia Department of Conservation and Recreation (DCR), DCR represents VDACS in comments regarding potential impacts on state-listed threatened and endangered plant and insect species. The current activity will not affect any documented state-listed plants or insects.

New and updated information is continually added to Biotics. Please contact DCR for an update on this natural heritage information if a significant amount of time passes before it is utilized.

The Virginia Department of Game and Inland Fisheries maintains a database of wildlife locations, including threatened and endangered species, trout streams, and anadromous fish waters that may contain information not documented in this letter. Their database may be accessed from http://vafwis.org/fwis/ or contact Shirl Dressler at (804) 367-6913.

Thank you for the opportunity to comment on this project.

Sincerely,

Alli Baird

Alli Baird, LA, ASLA
Coastal Zone Locality Liaison

Cc: Amy Ewing, VDGIF
Tylan Dean, USFWS

Literature Cited:

Bergstrom, P.W. 1991. Wilson's Plover. In Virginia's Endangered Species: Proceedings of a Symposium. K. Terwilliger ed. The McDonald and Woodward Publishing Company, Blacksburg, Virginia. pp.502-503.

Beck, R. A. 1991. Least Tern. In Virginia's Endangered Species: Proceedings of a Symposium. K. Terwilliger ed. The McDonald and Woodward Publishing Company, Blacksburg, Virginia. pp. 505-506.

Cross, R.R. 1991. Piping Plover. In Virginia's Endangered Species: Proceedings of a Symposium. K. Terwilliger ed. The McDonald and Woodward Publishing Company, Blacksburg, Virginia. pp. 501-502.

U.S. Fish and Wildlife, Northern Florida Office. Loggerhead sea turtle. Decemeber 29, 2005. http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/loggerhead-sea-turtle.htm

Please note that the April 14, 2010 correspondence from the Virginia Department of Environmental Quality regarding consistency with the Virginia Coastal Zone Management Program is provided in Appendix I.

COMMONWEALTH of VIRGINIA

Douglas W. Domenech
Secretary of Natural Resources

Department of Game and Inland Fisheries

Robert W. Duncan
Executive Director

April 19, 2010

Mr. Joshua A. Bundick
Wallops Flight Facility NEPA Program Manager
c/o National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337

received
4/22/10 TMB

RE: Draft PEIS – NASA Wallops
Flight Facility SRIPP
ESSLog # 23888

Dear Mr. Bundick:

We have reviewed the Draft Programmatic Environmental Impact Statement (draft PEIS) for the Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP) that proposes three alternative projects to restore the shoreline along Wallops Island for the purpose of securing the flight facility's infrastructure. During scoping for the PEIS, we provided our comments and recommendations to NASA via the letter which has been enclosed for your reference. The Virginia Department of Game and Inland Fisheries (VDGIF), as the Commonwealth's wildlife and freshwater fish management agency, exercises full law enforcement and regulatory jurisdiction over those resources, inclusive of State or Federally *Endangered* or *Threatened* species, but excluding listed insects. We are a consulting agency under the U. S. Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et *seq.*), and we provide environmental analysis of projects or permit applications coordinated through the Virginia Department of Environmental Quality, the Virginia Marine Resources Commission, the Virginia Department of Transportation, the U. S. Army Corps of Engineers, and other state or federal agencies. Our role in these procedures is to determine likely impacts upon fish and wildlife resources and habitats, and to recommend appropriate measures to avoid, reduce, or compensate for those impacts.

Shoreline stabilization efforts have been ongoing at Wallops Island since the 1940's and yet the island continues to experience shoreline retreat; thus placing the increasing number of expensive

4010 WEST BROAD STREET, P.O. BOX 11104, RICHMOND, VA 23230-1104
(804) 367-1000 (V/TDD) ***Equal Opportunity Employment, Programs and Facilities*** **FAX (804) 367-9147**

assets on the beach at risk. Oertel *et al.* (2008) refers to the area between the southern end of Assateague Island to the north tip of Parramore Island as the Chincoteague Bight and proposes that the extremely rapid retreat of the barrier islands within this major offset along the barrier island chain is due to natural processes driven by topographic features that existed during previous ice ages. Moreover, the "Storm Damage Reduction Project Design" study (Appendix A) suggests the growing cape of Fishing Point, located at the southern end of Assateague Island, is capturing sand that would otherwise be available to the neighboring islands to the south; a further indication that much of Wallops Island will continue to retreat, thereby necessitating continual and costly efforts to slow natural movement of the island over the long term. In light of this information, we caution that the shoreline along Wallops Island is likely to continue to shift under natural conditions and that attempts to delay or alter these natural fluctuations in shoreline may be futile over the long term.

Currently, management of Virginia's barrier island chain is minimal and basically allows nature to take its course. This management scheme has proven, over time, to benefit the fish and wildlife that inhabit these areas. All of the alternatives presented in the draft PEIS directly counter this management scheme. Based on this and the scope and location of the activities proposed to stabilize the shoreline at WFF, we cannot fully support any of the alternatives presented in the draft PEIS as they are all likely to result in adverse impacts upon wildlife under our jurisdiction and/or impact the resources upon which they depend (as described in the attached letter). Of the alternatives presented in the draft PEIS, however, VDGIF agrees with the decision to designate Alternative 1 as the Preferred Alternative since it no longer includes installation of a permeable groin, which would reduce the southerly longshore transport of sand thereby adversely affecting the islands south of Wallops. We continue, though, to have concerns about several aspects of the activities proposed in the Preferred Alternative. We offer the following comments and recommendations about the three alternatives presented in the draft PEIS.

Alternative 1 (Preferred Alternative): Full Beach Fill, Seawall Extension
Alternative 1, the Preferred Alternative, proposes to, during the initial construction phase, extend Wallops Island's existing rock seawall a maximum of 1,400 meters south of its currently existing southernmost point. We are concerned that extension and increase in height of the existing seawall will prevent natural island overwash processes from occurring over a large area of the island. As mentioned in the draft PEIS (chapter 4, page 195, third paragraph), this would likely result in a greater loss of surface area on the landward side of the seawall and enhance island narrowing with the rise of sea level. Over the long term (i.e., beyond the 50-year life span of the project), a reduction in land mass may seriously affect the island's natural function as the first line of protection against storm surge and other weather-related events for the marshes and mainland that lie west of the island. Moreover, it will reduce the island's value to beach and marsh-dependent wildlife through loss of beach seaward of the seawall if renourishment efforts are not be able to keep up with beach fill erosion rates, and the loss of marshes behind the island should significant island narrowing occur. Lastly, the results from the models presented in Appendix A of the draft PEIS suggest that seawall extension will have less of an impact on Assawoman Island's shoreline over the long term than the current changes in shoreline incurred by yearly variation in wave climate and storms. The draft PEIS goes on to say that any negative

impacts from the seawall would be mitigated following beach fill placement, implying that without renourishment negative impacts are possible. We recommend further explanation of possible adverse impacts resulting from any of the proposed activities and how such impacts may be mitigated.

Because of these and other potential impacts this project may have on wildlife resources beyond the project area, we requested that the PEIS present a threshold at which WFF considers the environmental cost of the project to outweigh the benefits to its mission and goals as detailed in the attached letter. We recommend that the cost/benefit analysis not only examine monetary costs, but also take into account costs to fish and wildlife resources, physical integrity of the barrier island chain, and other stakeholder interests. We also requested that the PEIS include a discussion on the availability of funding for continuous beach renourishment since it is being presented as a key element to the project's success. We do not believe that either request was adequately addressed, making it far more difficult to assess the project's risk to the broader environment over the lifetime of the project.

The project's predicted success is the main theme presented throughout the draft PEIS. What it does not include is a plan of action should SRIPP fail within the project's lifetime (i.e., it does not adequately protect the physical assets on the beach and/or it significantly interrupts the natural geologic processes on the islands to the south of the project area). According to the draft PEIS, the project's success is highly dependent on regular beach renourishment, which is expensive and its required frequency unpredictable. The PEIS did not explain what actions would be taken should future funding for renourishment activities be significantly reduced or withdrawn and/or should the availability of beach compatible sand from offshore sources become depleted. Without adequate renourishment, the seawall would serve as the last line of defense against storms; a strategy that has been recently tried and failed on Wallops Island. We recommend that a contingency plan that details the steps to be taken if the proposed project fails be developed and provided to us for review so that we may better understand the long term environmental impacts of the proposed project.

The Preferred Alternative also proposes placing sand dredged from offshore federal waters along a 6-kilometer stretch of shoreline 460 meters north of the Wallops-Assawoman Island property boundary. Sand for initial fill will be dredged from Unnamed Shoal A, a portion of the renourishment fill volumes would be excavated from the north Wallops Island borrow site, and the remaining portion would be dredged from either Unnamed Shoal A or Unnamed Shoal B. We are strongly opposed to using the north end of Wallops Island as a borrow site for beach fill during renourishment cycles. In 2009, four pairs of federally-threatened Piping Plovers nested in the area proposed for sand excavation. Collectively they fledged 10 young, which resulted in the highest reported fledge rate in Virginia last year, clearly indicating this portion of the island provides suitable habitat for the species.

The total potential area for sand excavation at the north end of Wallops Island encompasses 150 acres and the proposed excavation depth is 1 meter. The draft PEIS states that the area proposed for excavation was developed in consideration of "wildlife habitat constraints", but this is not further explained. We recommend a detailed explanation of what wildlife habitats at this end of the island are being avoided during excavation. While only a portion of the proposed area will be excavated during each renourishment cycle, this will likely result in direct loss of an appreciable amount of nesting habitat for Piping Plovers, state-threatened Wilson's Plovers, and other avian beach nesting species, many of which have been identified as Species of Greatest Conservation Need (SGCN) in Virginia's Wildlife Action Plan (VDGIF 2005). Sand excavation activities also result in loss of nesting habitat for Diamondback Terrapins, a Tier II SGCN, as well as for federally-threatened Loggerhead Sea Turtles (it should be noted that the Northwest Atlantic Loggerhead population, whose range includes Virginia, is currently being proposed as an endangered Distinct Population Segment (FR 2010)). Although this loss may not be permanent as indicated by the north end's current accretion rates, the excavated areas will likely remain unsuitable for beach nesting species until they build back up to their original elevations. The draft PEIS predicts the recovery period may range from a few months to a few years following excavation activities (page 203, last paragraph). It appears the draft PEIS did not consider the possibility that excavated sites may not have the opportunity to fully recover because the 1 meter reduction in elevation will allow a greater volume of water to come ashore, which may hinder sand deposition through frequent flooding and scouring of artificially created low areas on the beach. Even if excavated areas on the north end are able to recover within several years, it is possible that adequate recovery time will not be provided if renourishment occurs every two – three years rather than every five years as currently predicted. We recommend consideration of the actual recovery time and analysis of the sustainability of beaches at the north end of Wallops Island.

The draft PEIS does not include any measurement of the density, abundance or species composition of benthic invertebrates in the proposed sand excavation area. The draft PEIS also does not address the potential effects sand removal to a depth of 1 meter will have on the benthic community and the species that forage on these organisms, such as Piping Plovers, Red Knots, a candidate species for federal listing (in recent years, up to 25% of the Virginia's weekly Red Knot population occurred on Wallops Island during spring migration;Watts and Truitt, unpubl. data), and other migrant and breeding shorebirds. These omissions in analysis of environmental consequences represent a serious oversight and a discussion of such analysis should be included in future iterations of the document. The draft PEIS does briefly discuss biological impacts to the benthic community from beach fill deposition (chapter 4, page 242 – 243), which may last as long as eight months or more (Bishop *et al.* 2006). We believe the combination of sand excavation on the north end and beach renourishment activities to the south may substantially reduce the benthic invertebrate prey base at Wallops Island for prolonged periods of time, diminishing the quality of the island's shorebird foraging (and breeding) habitat.

The draft PEIS reports that the sand on the north end of Wallops Island is not an optimal grain size for use as beach fill, but that it offers potential renourishment material without the mobilization and operational costs associated with offshore dredging (chapter 2, page 48, first paragraph). We are concerned that the Preferred Alternative sacrifices important and unique wildlife habitat in the only section of undeveloped beach on Wallops Island, to acquire fill material at the lowest cost. Moreover, this counters the mitigation measure developed for sand placement activities (chapter 5, page 300), which states that beach nourishment will be done so that the beach is restored to a comparable sediment type (a similar percentage of sand, silt and clay), grain size and color as the existing beach material.

The proposed mitigation measures for sand removal on the north end of Wallops Island listed in Table 11 (Chapter 2, page 73-74) state that a qualified biologist would closely monitor the area during excavation activities to ensure that impacts to any listed species and their nests would be avoided or minimized, thereby implying the work would be conducted during the nesting season. However, in Chapter 5, page 302, Section 5.1.5.2, it states that work in the proposed north Wallops Island borrow site area would be limited to the non-nesting season for the Piping Plover (September-March). This contradiction in the draft PEIS needs to be addressed. We want to reiterate that we are opposed to using the north end of Wallops Island as a borrow site. However, if it is used for this purpose, we recommend that all excavation and related activities on the beach at the north end occur outside of the nesting season for Piping Plover and sea turtles. Therefore, we recommend that all work at the site occur from November – March of any year.

In addition, we note that a State Threatened bald eagle nest has been documented on the north end of Wallops Island. To ensure protection of this species from harm during excavation activities, we recommend that no large machinery be operated within 660 feet of the bald eagle nest from December 15 through July 15 of any year. We note that eagles have high nest site fidelity and will typically return to the same nest each year to raise young. However, eagle pairs may also build alternate nest sites within their territory for use. We recommend that prior to each excavation cycle, the north end of Wallops be surveyed to determine if any new nests are built within 660 feet of the excavation area and that the same excavation time of year restriction be applied to any new or alternate active nest sites.

Based on information included in the draft PEIS, it appears that no effort was made to measure the density, abundance and species composition of infaunal organisms at the two offshore borrow sites during the benthic habitat survey (Appendix B). Instead, the final report for the benthic survey cites two studies conducted offshore of northern Maryland and southern Delaware (Cutter and Diaz 2000 and Diaz *et al.* 2004) which found that infaunal communities were dominated by annelid worms, followed by mollusks and crustaceans, and that mollusks accounted for over 85 percent of the biomass. Various species of seaducks including white-winged scoters, surf scoters, black scoters and long-tailed ducks forage primarily on mollusks and crustaceans on marine wintering grounds (Bellrose 1978) in water depths ranging from 1 – 60 meters (SDJV 2010). Sea ducks occur in high densities within 12 nautical miles off of Virginia's coastline in areas with sandy shoals during the winter (Forsell 2003). Therefore, it is possible that the two unnamed shoals A and B, proposed for sand mining, are utilized by these birds as forging sites.

The draft PEIS acknowledges that repeated dredging activities at intervals of three years or less may not allow sufficient time for benthic communities to recover between dredging cycles. Studies examining the effects of sand mining on infaunal communities found that levels of abundance and diversity may recover within 1 to 3 years, but recovery of species composition may take longer (Byrnes *et al.* 2004). While the draft PEIS mentions that reductions in benthic fauna could negatively affect the fish that forage on these organisms, no consideration was given to potential impacts on sea ducks that could result from reductions in the abundance and species composition of infaunal organisms. We strongly recommend that before commencement of any dredging activities, a minimum of three aerial offshore transect surveys be conducted over the course of at least one winter season (one in early November, one in mid-December, and one in late January) along the entire barrier island chain and out to 15 nautical miles to establish relative use of the two unnamed shoals by sea ducks. This information will facilitate assessment of the impact dredging activities will have on these avian species. Please note that based on recent consultation with our waterfowl experts, the recommended timing of the surveys has been changed since we submitted comments to the Virginia Department of Environmental Quality's Office of Environmental Impact Review.

Alternative 2: Full Beach Fill, Groin, Seawall Extension
In addition to the extension of the seawall and beach fill as described in Alternative 1 (and recognizing differences in beach fill amount between Alternatives 1 and 2), Alternative 2 includes the construction of a groin at the south end of the Wallops Island shoreline and perpendicular to the shoreline. We are concerned about the adverse effects placement of a groin at the south end of Wallops may have on islands south of Wallops as it may reduce naturally occurring transport of sands to those areas. Although we recognize NASA's need to protect its assets, we do not support any action to do so that adversely affect other barrier islands that provide important shorebird and sea turtle nesting areas and other wildlife habitats.

Alternative 3: Full Beach Fill, Breakwater, Seawall Extension
In addition to the extension of the seawall and beach fill as described in Alternative 1 (and recognizing differences in beach fill amount between Alternatives 1 and 3), Alternative 3 includes the construction of a nearshore breakwater structure parallel to the south end of the Wallops Island shoreline. We are concerned that the reduction in beach erosion resulting from wave attenuation performed by the breakwaters will be negated by the newly constructed seawall extension. We are also concerned that the combination of the seawall and breakwaters may result in accelerated shoreline erosion to the south of these structures.

Sea Level Rise:
While the draft PEIS acknowledges that the shoreline at Wallops Island will certainly experience the effects of future sea level rise, it was not included as a variable in the models used to design SRIPP. Moreover, the Storm Damage Reduction Project Design for Wallops Island, VA report (Appendix A) offered a very limited discussion on climate change and sea level rise; the only concession it made to address the problem is to follow current US Army Corps of Engineers policy which is to include an additional amount of material during each renourishment event that would raise the entire profile by an amount equal to the projected amount of sea level rise. There was no discussion about what steps would be taken to account for sea level rise within the project's lifetime if renourishment at the required volume and frequency is no longer possible due to lack of funding or availability of beach compatible sand. This omission in the PEIS makes it difficult to fully assess the scope and breadth of the project's risk to the environment over the next 50 years.

Mitigation and Monitoring Plan:
Seawall Extension - According to the draft PEIS, impacts upon wildlife associated with extension of the seawall would be avoided through on site monitoring to ensure that Red Knots and Piping Plovers are not directly affected during the construction of the wall. We contend that avoidance could better be achieved by timing construction activities outside of shorebird nesting season. In addition, we recommend discussion in this section about potential impacts upon sea turtles. Although none are known to nest along this section of beach, it is always possible, especially with the placement of beach fill. In addition, we recommend consideration of cumulative effects upon wildlife resulting from the project, not just direct affects resulting from specific construction activities.

Offshore Dredging Activities - We support the recommendations provided in this section regarding protection of sea turtles, and we recommend continued coordination with the NMFS regarding protection of sea turtles and marine mammals. As stated above, we recommend that studies be performed ahead of dredging to determine how the unnamed shoals are utilized by sea ducks and that those data be used to analyze what, if any, impacts the removal of shoal material will have upon these species. We further recommend that based on the results of these studies, a plan to mitigate any impacts upon sea ducks be developed.

North Wallops Island Sediment Removal - As previously stated, we recommend that all sand removal, if performed, occur outside of the nesting season for Piping Plovers and sea turtles. Statements that indicate that a biologist would be on site during excavation to ensure avoidance of direct impacts upon these species may not be necessary if the work is timed appropriately. We recommend clarification of this point. Adverse impacts upon listed species may occur as a result of habitat impacts in addition to possible direct impacts associated with construction activities. We recommend consideration of indirect and cumulative impacts.

Beach Profile Monitoring Program - The beach profile monitoring program discussed in Appendix A will be conducted throughout the lifetime of the project. Analysis of these data will be used to determine when renourishment should take place and the amount of material needed from all three borrow sites. Moreover, the information collected will be the primary tool used to monitor the success of the project and identify any negative impacts. As this effort is currently proposed, it is confined to Wallops and Assawoman islands. We strongly recommend that beach profile monitoring also be conducted on Metompkin and Cedar islands at a frequency that allows for accurate assessment of project impacts further south along the island chain. We believe this is a necessary component in the beach profile monitoring program given that shoreline movement on Wallops, Metompkin, and Cedar islands is driven by similar geologic processes (Oertel *et al.* 2008) and therefore may act more as a unit than as independent landmasses.

We appreciate the opportunity to provide comments on the draft PEIS for the SRIPP at NASA Wallops Flight Facility. Please contact me or Amy Ewing at 804-367-6913 if we can be of further assistance.

Sincerely,

Raymond Fernald, Manager
Nongame and Environmental Programs

RTF/AME

Encl

Cc: David Whitehurst, VDGIF Wildlife Bureau Director

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COMMONWEALTH of VIRGINIA

L. Preston Bryant, Jr.
retary of Natural Resources

Department of Game and Inland Fisheries

Robert W. Duncan
Executive Director

May 7, 2009

Mr. Joshua A. Bundick
Wallops Flight Facility NEPA Program Manager
c/o National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337

RE: EIS Scoping – NASA Wallops
Flight Facility SRIPP
ESSLog # 23888

Dear Mr. Bundick:

This letter is in response to your notice of scoping for the Environmental Impact Statement (EIS) for the Shoreline Restoration and Infrastructure Protection Program (SRIPP) at NASA Wallops Flight Facility (WFF). The Virginia Department of Game and Inland Fisheries (VDGIF), as the Commonwealth's wildlife and freshwater fish management agency, exercises full law enforcement and regulatory jurisdiction over those resources, inclusive of State or Federally *Endangered* or *Threatened* species, but excluding listed insects. We are a consulting agency under the U. S. Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et *seq.*), and we provide environmental analysis of projects or permit applications coordinated through the Virginia Department of Environmental Quality, the Virginia Marine Resources Commission, the Virginia Department of Transportation, the U. S. Army Corps of Engineers, and other state or federal agencies. Our role in these procedures is to determine likely impacts upon fish and wildlife resources and habitats, and to recommend appropriate measures to avoid, reduce, or compensate for those impacts.

Virginia's Barrier Islands

Virginia's barrier islands represent a critically important breeding area for a number of beach nesting shorebirds and seabirds that are of high conservation concern, including the federally Threatened piping plover *(Charadrius melodus)*, the state Endangered Wilson's plover (*C. wilsonia*), the American oystercatcher (*Haematopus palliatus*), which is ranked nationally as a high conservation priority species in the US Shorebird Conservation Plan (Brown *et al.* 2001), the state Threatened gull-billed tern (*Sterna nilotica*), and the least tern (*S. antillarum*), which is

4010 WEST BROAD STREET, P.O. BOX 11104, RICHMOND, VA 23230-1104
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a state species of special concern. The Commonwealth's northern barrier islands that extend from Assateague Island south to Cedar Island typically support over 75% of Virginia's piping plover breeding population and in some years over 90% of the Commonwealth's breeding pairs have occurred on the northern islands (Boettcher *et al.* 2007). Since 2000, Virginia's Wilson's plover breeding population has been confined to Assawoman, Metompkin and Cedar islands with the exception of 2008 when one pair was discovered nesting on Assateague Island (Wilke *et al.* 2009). The barrier islands support over 50% of Virginia's American oystercatcher breeding population with a significant proportion occurring on Metompkin and Cedar islands (Wilke *et al.* 2005; Wilke *et al.* 2009). Moreover, oystercatcher productivity rates along the barrier island chain are some of the highest reported on the US the Atlantic coast, suggesting that the islands may serve as important population sources for the east coast population (Wilke 2008). The barrier islands also provide critical breeding habitat for least terns; since 1975 35% – 67% of the Commonwealth's population has been documented on the barrier island chain (VDGIF, unpubl. data). Virginia's statewide gull-billed tern breeding population has declined from approximately 2,000 pairs in the mid-1970's (Erwin *et al.* 1998) to fewer than 300 pairs in the last three years with the majority of nesting occurring on Virginia's seaside marshes and barrier islands (VDGIF, unpubl. data). While gull-billed terns are able to exploit barrier island and marsh habitats with equal success in response to rapidly changing conditions (Boettcher and Wilke 2009), the barrier islands remain important habitat for the declining species in Virginia. Other barrier island nesting species of greatest conservation need (as defined in Virginia's Wildlife Action Plan, available at www.bewildva.com) include black skimmer (*Rynchops niger*), common tern (*S. hirundo*), royal tern (*S. maxima*) and sandwich tern (*S. sandvicensis*) (VDGIF 2005).

Collectively, the aforementioned avian species' habitat requirements include broad beaches with low discontinuous dunes and expansive sand-shell flats. In addition, piping plover broods require unimpeded access from beach nest sites to the moist-soil ecotones of backside marshes and mudflats for forage and cover (Boettcher *et al.* 2007). These areas are highly susceptible to storm-generated disturbances, which serve to maintain the open active sand zones favored by these species. Any beach restoration activities that attempt to stop the natural movement of an island, counter storm-generated disturbances, or disrupt the longshore transport of sand may result in widespread loss of suitable nesting habitat for avian beach nesting species.

Over the past 20 years, the red knot (*Calidris canutus rufa*) population has declined by over 80% (Morrison *et al.* 2004) and this species is currently a candidate for federal listing under the Endangered Species Act. A significant portion of the population that migrates north along the US Atlantic coast in the spring uses the barrier islands as stopover sites (Smith *et al.* 2008). This includes Wallops Island where more than 1,000 birds have been recorded during a single survey (Center for Conservation Biology, The Nature Conservancy, and VDGIF, unpubl. data). Typical beach renourishment may impact long-distance migrant shorebirds that forage on sand-dwelling invertebrates, such as red knot, by reducing the availability of prey within reach of the birds' bills for a period of time following sand deposition (Bishop *et al.* 2006). Moreover, beach armouring and the installation of groins may result in significant loss of suitable shorebird foraging habitat in the intertidal zone seaward and south of these structures, respectively. These effects are likely to become even more pronounced in the face of sea level rise (Galbraith *et al.* 2002).

Virginia is the northern extreme of the federally Threatened loggerhead sea turtle (*Caretta caretta*) nesting range. While the majority of the Commonwealth's nesting activity has been confined to southern mainland beaches (Fort Story - NC/VA border), nesting activity on the northern barrier islands, including Wallops Island, has increased slightly in recent years (VDGIF, unpubl. data). Nesting sea turtles typically nest on dynamic ocean beaches that have a wide berm and a relatively intact natural dune system. This species typically avoids or has poor nesting success on armoured beaches, which over time, become devoid of dry beaches and natural primary dune systems. Moreover, there is concern that beach renourishment may affect the quality of turtle nesting habitat (Crain *et al.* 1995). For example, the deposition of sand could change beach sand color thereby affecting sand temperature. Because the sex of sea turtles is determined by the temperature of sand surrounding the nest cavity, beach renourishment could alter sex ratios. Beach renourishment also may influence other physical characteristics of beaches such as sand-grain size and shape, silt-clay content, sand compaction, moisture content, porosity/water retention and gas diffusion rates. The altering of one or more of these physical characteristics may not necessarily impact beach selection by nesting females (Crain *et al.* 1995), but may reduce reproductive success of nests laid in these renourished areas (Ackerman 1996).

Alternatives Analysis

- Alternative 1 (the preferred alternative) proposes to extend the existing seawall an additional 4,500 feet south, enlarge the beach with offshore dredged sand, and construct a rock jetty near the southern WFF property line. The proposed groin would allow some fill to pass through and, according to the description of the SRIPP, the net sand transport to Assawoman Island would be equal to or exceed pre-construction conditions. We are concerned that the proposed jetty may impede existing longshore transport of sand to Assawoman, Metompkin and Cedar islands, especially if funding can not be secured for the anticipated 5 – 7 year renourishment cycle. In addition, we are concerned that the extension of the seawall will further accelerate sand loss seaward of the seawall, particularly during periods of frequent storm events. Lastly, regular beach renourishment is very costly and may negatively affect local wildlife habitats in the short term, especially if non-compatible sand is used. This practice also may threaten the biological integrity of the two shoals from where sand will be obtained and may reduce the overall sand budget in the nearshore system, accelerating erosion of nearby beaches.

- We have similar concerns with Alternative 4 as we do with Alternative 1 because it involves the same actions, only less beach fill will be used. The reduced beach fill will likely require more frequent beach renourishment; therefore Alternative 4 does not appear to offer any cost benefits or reduce barrier island ecosystem impacts over the long term.

- We have concerns with Alternatives 2 and 5, which involve beach fill, detached breakwaters, and seawall extension mainly due to issues surrounding the seawall extension as discussed above. While the breakwaters may attenuate wave action and thereby reduce beach erosion to some degree, the stable seawall, which will inhibit the natural movement of sand and water, will likely negate any benefits the breakwaters may provide.

- We do not consider Alternatives 3 and 6, which are limited to beach fill, to be viable options since both will likely result in the rapid loss of sand placed on the beach.

- We recommend a thorough analysis and discussion of a seventh alternative that involves the installation of detached breakwaters to attenuate wave action, but excludes the seawall extension and beach fill options, and considers limited retreat or removal of infrastructure that does not require a beachfront location.

Recommended items for discussion in the EIS:

- The impacts of sand mining at Blackfish Bank Shoal and unnamed shoal on erosion rates at Assateague Island and islands to the south including results from studies on this topic.

- All potential sand mining impacts on the aforementioned shoals' avifauna and to fishes and other wildlife species that forage on the shoals' benthos.

- Results from a compatibility analysis that examine how well the sand on the two offshore shoals matches the existing sand on the barrier islands (i.e., grain size, color, etc.).

- What level of protection each alternative will realistically offer and a full presentation of the analyses conducted to determine these protection levels. We recommend the analyses take into account sea level rise and the potential for future increases in storm activity and intensity.

- A detailed description of the beach fill design (i.e., targeted beach slope, elevation and width to be maintained over the long term).

- A thorough analysis and discussion of potential impacts each alternative poses on the islands to the south of the project area, with a special focus on Assawoman, Metompkin and Cedar islands.

- A detailed description of a post-construction beach monitoring plan. This plan should present methods for measuring changes to island shorelines over time. We strongly recommend that the monitoring plan not be confined to Assawoman Island, but that it also include, at a minimum, Metompkin and Cedar islands.

- A threshold at which NASA considers the cost of the project to outweigh the benefits to NASA's mission and goals. The cost/benefit analysis should not only examine monetary costs, but should also take into account costs to fish and wildlife resources, the physical integrity of the barrier island chain, and other stakeholder interests.

- The availability of funding for typical renourishment in the long term since, according to the SRIPP scoping document, beach renourishment is key to the project's success.

- Consultations with National Marine Fisheries Service regarding potential impacts of hopper dredging on sea turtles.

We appreciate the opportunity to provide comments regarding the development of the EIS for the SRPP at NASA Wallops Flight Facility. Please contact me or Amy Ewing at 804-367-6913 if we can be of further assistance.

Sincerely,

Raymond Fernald, Manager
Nongame and Environmental Programs

Encl: Literature Cited

Cc: David Whitehurst, VDGIF Wildlife Bureau Director

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From: Forsgren, Diedre (VDH) [Diedre.Forsgren@vdh.virginia.gov]
Sent: Friday, March 19, 2010 10:50 AM
To: Pinion, Anne (DEQ); Bundick, Joshua A. (WFF-2500)
Cc: Matthews, Barry (VDH)
Subject: (10-019F) EIS/CD: Shoreline Restoration and Infrastructure Protection Program, NASA

DEQ Project #: 10-019F
Name: Shoreline Restoration and Infrastructure Protection Program
Sponsor: National Aeronautics and Space Administration
Location: Accomack County

VDH – Office of Drinking Water has reviewed DEQ Project Number 10-019F. Below are our comments as they relate to proximity to public drinking water sources (groundwater wells, springs and surface water intakes).

Potential impacts to public water distribution systems or
sanitary sewage collection systems must be verified by the local utility.

No groundwater wells are within 1 mile radius of the project site.

No surface water intakes are located within 5 miles radius of the project site.

Project does not fall within Zone 1 or Zone 2 of any public surface water sources.

There are no apparent impacts to public drinking water sources due to this project.

Diedre Forsgren
Office Services Specialist
VIRGINIA DEPARTMENT OF HEALTH
Office of Drinking Water, Room 622-A
109 Governor Street
Richmond, VA 23219
Phone: (804) 864-7241
email: diedre.forsgren@vdh.virginia.gov

COMMONWEALTH of VIRGINIA

Marine Resources Commission
2600 Washington Avenue
Third Floor
Newport News, Virginia 23607

Douglas W. Domenech
Secretary of Natural Resources

Steven G. Bowman
Commissioner

February 19, 2010

Mr. Joshua A. Bundick
Wallops Flight Facility NEPA Program Manager
c/o National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility (250.W)
Wallops Island, Virginia 23337

Re: Shoreline Restoration Wallops Island

Dear Mr. Bundick:

You have inquired regarding the permitting requirements for Shoreline Restoration on Wallops Island. The Marine Resources Commission requires a permit for any activities that encroach upon or over, or take use of materials from the beds of the bays, ocean, rivers and streams, or creeks, which are the property of the Commonwealth.

In addition, since Accomack County has not yet adopted the model Coastal Primary Sand Dune Zoning Ordinance, the Commission is charged with reviewing the impacts associated with any project that may fall within the Coastal Primary Sand Dunes/Beaches of Accomack County.

Based upon my review of the reference maps and drawings, it appears that alternatives 1 through 3 will require authorization from the Marine Resources Commission. (The proposed dredged sits appear to be greater than 3 miles offshore, therefore, that portion of the project will not require a permit from our agency.)

<u>Alternative 1.</u> (NASA's Preferred Alternative) Proposes to extend the existing stone riprap an additional 4,600 feet south and place 3,199,000 cubic yard of sandy dredged material along the Wallops Island shoreline. **This alternative would help alleviate some of our concerns with the anticipated 5 year nourishment cycles long term funding. If funding was not secured the existing longshore transport of sand to Assawoman Island would have less impact than in the proposed Alternative 2 (jetty).**

If I may be of further assistance, please do not hesitate to contact me at (757) 414-0710.

Sincerely,

George H. Badger, III
Environmental Engineer

Comments Received from Local Government

COUNTY OF ACCOMACK
DEPARTMENT OF BUILDING AND ZONING

23296 COURTHOUSE AVENUE, ROOM 105
Post Office Box 93
Accomac, Virginia 23301-0093
(757) 787-5721 (757) 824-5223
FAX (757) 787-8948
building@co.accomack.va.us

David A. Fluhart
Director

Building/Fire Inspections
Zoning and Wetlands

March 5, 2010

Goddard Space Flight Center
Wallops Flight Facility
Attn: 250.W
Josh Bundick, WFF NEPA Manager
Wallops Island, Virginia 23337

In Re: Draft PEIS

Dear Mr. ~~Bundick:~~ Josh

This will acknowledge receipt of the Draft Programmatic Environmental Impact Statement (PEIS) for the proposed Shoreline Restoration and Infrastructure Protection Program on Wallops Island, Accomack County, Virginia. The CD and cover letter was received in this office on behalf of the Accomack County Wetlands Board on February 17, 2010.

I reviewed the Draft PEIS and at the Accomack County Wetlands Board meeting on Thursday, February 25, 2010 advised the Board of the project and explained the project would not impact wetlands within their jurisdiction (local Wetlands Board).

As there was no local Wetlands Board jurisdiction, the Accomack County Wetlands Board took no action on the project and offered no comments regarding the Draft PEIS. It was noted that parts of this project will require approval from the Virginia Marine Resources Commission.

Thank you for the opportunity to review this Statement while in its draft form. Please feel free to contact this office if you have any questions.

Sincerely,

David ~~A. Fluhart~~, Secretary
Accomack County Wetlands Board

A-NPDC
ACCOMACK-NORTHAMPTON PLANNING DISTRICT COMMISSION
P.O. BOX 417 • 23372 FRONT STREET • ACCOMAC, VIRGINIA 23301
(757) 787-2936 • TOLL FREE (866) 787-3001 • FAX: (757) 787-4221
EMAIL: anpdc@a-npdc.org • WEBSITE: www.a-npdc.org

April 6, 2010

Mr. Josh Bundick
NASA Wallops Flight Facility NEPA Manager
Code 250.W
Wallops Island, VA 23337

Dear Mr. Bundick,

The Eastern Shore of Virginia Ground Water Committee is a bi-county commission consisting of local Supervisors and members of the public with experience in ground water issues and science. The Committee works with farmers, local and state officials, and the interested public on various types of ground water preservation and protection measures.

The Ground Water Committee would like to voice its support for the Shoreline Restoration and Infrastructure Protection Program (SRIPP) at the Wallops Flight Facility on Wallops Island, Virginia. The Committee found your summary of the Draft Programmatic Environmental Impact Statement at its last meeting to be very informative. The Ground Water Committee greatly supports the SRIPP.

Thank you for your consideration.

Sincerely,

Larry Trala

Larry Trala
Chairman
Eastern Shore of Virginia Ground Water Committee

cc: Elaine K.N. Meil
Executive Director
Accomack-Northampton Planning District Commission

Comments Received from Other Organizations and Individuals

ACT TO PRESERVE OUR COASTAL BAYS
Assateague Coastal Trust
PO Box 731, Berlin, MD 21842
410-629-1538

April 19, 2010

Mr. Josh Bundick
250/NEPA Manager
WFF Shoreline Restoration and Infrastructure Protection Program
NASA Goddard Space Flight Center's Wallops Flight Facility
Wallops Island, Virginia 23337
wff_shoreline_eis@majordomo.gsfc.nasa.gov

Dear Mr. Bundick:

Assateague Coastal Trust (ACT) has reviewed the NASA-WFF Shoreline Restoration and Infrastructure Protection Project Draft Programmatic EIS and would like to provide the following comments for consideration.

ACT, the oldest non-profit grassroots environmental advocacy organization in the Atlantic coastal bays watershed, works to protect and enhance the natural resources of the watershed through advocacy, conservation, and education. ACT has a long history of environmental advocacy in the Maryland and Virginia coastal bays region, beginning with its landmark efforts in the early 1970s to preserve the unspoiled character of Assateague Island, which is now protected as a National Seashore.

We support NASA's Wallops Flight Facility as part of our community and hope to work both towards the success of the Facility and the protection of our region's coastal ecosystem. However, as expressed in our letter during the Scoping Process, ACT remains concerned that the Shoreline Restoration and Infrastructure Protection Project will impact many of the natural resources that our organization works hard to protect, including barrier island habitats, coastal waters, shorebirds, sea birds, fish, and marine mammals.

Potential Impacts of Dredging on Wave Climate and Cross-Shore Sediment Transport

Barrier island morphology supports a variety of fragile and dynamic habitats, including the intertidal, beach, and dune habitats. Those habitats would potentially be impacted by accelerated shoreline erosion, addition of incompatible non-native sediments, and other changes in natural coastal processes.

Offshore shoals are known to dissipate incoming wave energy, diminishing the wave energy that reaches the shoreline, and thereby sheltering the coastline from wave-driven erosion. ACT is concerned that dredging either of the proposed shoals, located 7 and 11 miles offshore of Assateague Island, will reduce the shoal's ability to shelter Assateague Island from large waves and resulting shoreline erosion. As stated in the modeling results included in Volume II of the Draft PEIS, the Impact Factor of dredging is more than 0.75 along parts of the Assateague Island shoreline, and "it is not clear [that these values] equate to a negligible long term shoreline impact."   Any dredging with the potential to increase erosion or wave energy impact on the barrier islands should follow a detailed dredging plan that is included in the EIS. That plan should describe site-specific dredging methods that minimize impacts on island shorelines, such as maintaining the existing shoal crest height (to maintain shallow water processes and crest stability) and avoiding longitudinal (along-axis) dredging (to minimize wave focusing), as per new draft dredging guidelines currently in review by Minerals Management Service[1]. We agree with NASA's decision to dredge no deeper than the seafloor or base of the shoals; dredging pits could alter physical processes.

ACT is also concerned that removal of a significant volume of either shoal will reduce the volume of sediment currently being transported to the barrier islands, thereby accelerating erosion and impacting the islands' natural coastal processes and resilience to the ongoing effects of climate change including sea level rise and storm intensity. As noted in our comments during the Scoping Process, multiple mid-Atlantic coast studies indicate that offshore shoals are an important component of the regional sediment budget and sediment transport pathways. We are disappointed that the Draft EIS did not address potential impacts of sediment removal on cross-shore sediment transport, and we recommend that the Preferred Alternative include new studies to map and quantify cross-shore sediment transport in the area, including geophysical and hydrodynamic data collection in the nearshore and offshore regions of Assateague and Wallops Islands. In the meantime, to minimize potential impacts of dredging on the poorly-understood sediment transport processes in this region, we also recommend that sediment be dredged from as far offshore as possible, where it is less likely to contribute to onshore sediment transport; that it be dredged from the downdrift accreting side of each shoal, to minimize interruption to sediment transport pathways; and that it be dredged in a thin uniform layer from non-crest areas, to minimize disturbance to shoal topography and geometry and associated shoal-maintenance processes.

Potential Impacts to Terrestrial Wildlife

South of Wallops Island, Assawoman and Metompkin Islands provide important habitat for a variety of shorebirds, migratory birds including the declining Red Knot, and the Federally-listed Piping Plover. The importance of these habitats have been recognized by the Audubon Society, which designated this area as an Important Bird Area, and by the United Nations, which designated the chain of undeveloped Virginia barrier islands as an International Man and the Biosphere Reserve.   The habitat value of the birds' nesting and foraging areas depend on natural barrier island conditions, which are in turn controlled by natural coastal processes including sediment supply and type.

Because these islands are geologically fragile and biologically important, we strongly support NASA's decision not to build shore-perpendicular sand retention structures. Groins are well known to cause erosion on their downdrift side and the impacts to alongshore sediment transport would be unacceptable.

ACT remains concerned that dredged sediments placed on Wallops Island, and from there transported to Assawoman and Metompkin Islands, will be incompatible with native sediments, which would in turn alter the terrestrial surface texture, the shoreface slope, and the sediment transport processes driven both
Mr. Josh Bundick

[1] Dibajnia, M. and R.B. Nairn, in prep. Investigation of Dredging Guidelines to Maintain and Protect the Integrity of Offshore Ridge and Shoal Regimes. U.S. Department of the Interior, Minerals Management Service, XXX OCS Region, 2010. OCS Study MMS 2010-XXX. 150 pp. and appendices.

by wind and by overwash. Such changes in sediments would affect the nesting and foraging behavior of shorebirds on those islands. In consideration of these potential impacts, the Preferred Alternative should include guidance on ensuring the compatibility of shoal sediments with the native sediments of Wallops Island and downdrift nearshore and beach areas.

Potential Impacts to Marine Life

ACT's mission includes protection of marine and estuarine life and the habitats on which it depends. The marine waters along the Virginia barrier islands hosts a rich diversity of marine life, including benthic communities around the shoals that support pelagic fish, which feed on the shoals and live parts of their lives in the estuarine waters behind the barrier islands, and which also create feeding grounds for sea turtles, marine mammals, and sea birds. ACT is concerned that destruction of shoal habitat will impact the complex food web of these shoals, and the marine communities that depend on it. Therefore, we support NASA's decision not to dredge Blackfish Bank, which is known to support a rich biological community. Additionally, we request that the Preferred Alternative include site-specific dredging methods that protect habitat value for finfish and pelagic seabirds by avoiding the shoal crests.

Thank you for considering ACT's concerns about this proposed project. We look forward to working with NASA to evaluate alternatives for protecting both NASA infrastructure and our region's important coastal resources.

Sincerely,

Kathy B Phillips

Kathy Phillips
Assateague COASTKEEPER
Executive Director, Assateague Coastal Trust

March 11, 2010

Joshua A. Bundick
250/NEPA Manager
WFF Shoreline Restoration and Infrastructure Protection Program
NASA Goddard Space Flight Center's Wallops Flight Facility
Wallops Island, VA 23337

RE: DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT (PEIS); WALLOPS FLIGHT FACILITY SHORELINE RESTORATION AND INFRASTRUCTURE PROTECTION (SRIPP) PROGRAM

Dear Mr. Bundick:

On behalf of the Board of Directors of the Hampton Roads Military and Federal Facilities Alliance (HRMFFA), we offer the comments below regarding the Draft Programmatic Environmental Impact Statement (PEIS) for the proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP) along the beaches of the Wallops Flight Facility on Virginia's Eastern Shore.

HRMFFA is a not-for-profit corporation that represents the collective interests of 13 Hampton Roads communities in matters relating to retention, sustainment and growth of military and federal capabilities in the region.

Hampton Roads has a long and proud association with the National Aeronautics and Space Administration (NASA), chiefly through the NASA Langley Research Center located in the City of Hampton. NASA Langley is intrinsically tied to the Wallops Flight Facility through research activity in aeronautics, unmanned vehicles and climate change study. HRMFFA maintains close ties with military and federal activities at the Wallops Island complex and is a member of the Eastern Shore Defense Alliance (ESDA). Thus the interest of the entire Hampton Roads region in preserving the infrastructure and continuing uninterrupted operations associated with NASA programs at Wallops Island. We fully support the planned SRIPP proposal as economically, environmentally and operationally sound.

We find the PEIS to be exhaustive in its research and in its attention to preserving the rich environment unique to the Eastern Shore. We believe NASA has done a superb job of balancing the concerns of preserving both the environment and the NASA, U.S. Navy and Mid-Atlantic Regional Spaceport assets which would be enormously expensive to replicate should they be damaged or destroyed from wave impacts associated with storm events.

We fully support NASA and the Goddard Space Flight Center's Wallops Flight Facility in the planned Shoreline Restoration and Infrastructure Protection Program. Please don't hesitate to contact us should you desire additional input. The HRMFFA Executive Director, Frank Roberts, can be reached at (757) 644-6324 or by e-mail at froberts@hrmffa.org.

Sincerely,

William D. Sessoms, Jr.	Molly Joseph Ward
Mayor, City of Virginia Beach	Mayor, City of Hampton
Co-Chair	Co-Chair
Hampton Roads Military & Federal Facilities Alliance	Hampton Roads Military & Federal Facilities Alliance

FAR/daa

Copy to: Steven R. Haberger, Eastern Shore Defense Alliance

The Nature Conservancy
Protecting nature. Preserving life.™

The Nature Conservancy in Virginia
490 Westfield Road
Charlottesville, VA 22901

tel 434-295-6106
fax 434-979-0370
nature.org

Via email; hardcopy to follow

April 19, 2010

Mr. Josh Bundick, NEPA Manager
WFF Shoreline Restoration and Infrastructure Protection Program
NASA Goddard Space Flight Center's Wallops Flight Facility
Wallops Island, Virginia 23337

Re: Comments on the Draft Programmatic Environmental Impact Statement for Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program

Dear Mr. Bundick:

On behalf of The Nature Conservancy in Virginia, I am writing to submit our official response to the National Aeronautics and Space Administration's (NASA) Draft Programmatic Environmental Impact Statement (PEIS) for the proposed Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP). We appreciate the opportunity to comment on the Draft PEIS for this important project.

First and foremost, The Nature Conservancy applauds NASA for its selection of Alternative One (seawall extension and beach re-nourishment) as the Preferred Alternative in the SRIPP PEIS. The Nature Conservancy believes that the Preferred Alternative will provide short-term protection benefits to the WFF without creating significant deleterious impacts to the barrier islands owned by the Conservancy and other conservation partners to the north and south of Wallops Island. As you know, the Conservancy and a number of other conservation organizations and agencies voiced serious concerns during earlier comment periods and in direct meetings with NASA staff that the construction of sand retention features such as breakwaters or a groin would very likely create significant impacts to our land holdings and our years of conservation investments in this landscape. We are very appreciative of NASA for listening to those concerns, re-examining some of its earlier conclusions, and ultimately selecting a much more ecologically sensitive approach. NASA's responsiveness and willingness to make substantial modifications to its initial plan reflect well on staff and the agency as a whole. From our perspective, one of the important side benefits of our engagement on this issue has been the opportunity to develop a much closer relationship with NASA. Both our organizations clearly have a shared interest in enhancing the economic and ecological health of the Eastern Shore of Virginia and the larger Delmarva Peninsula, and we welcome working more closely with you on a number of related fronts.

This praise notwithstanding, there are a few areas of the PEIS that do raise some concerns for The Nature Conservancy, concerns that we outline in this letter and that we hope to continue to discuss and address with NASA in the future. We have organized the remainder of our comments as follows:

- A brief overview of The Nature Conservancy's ownership, investment and interest in the barrier island system south of Wallops Island
- Review of the PEIS modeling and analysis of sediment dynamics
- Recommendation for landscape-scale monitoring
- Sea level rise and the need for long-term adaptation strategies

The Nature Conservancy's Ownership, Investment and Interest in Virginia's Barrier Islands
The Nature Conservancy has been working to protect barrier islands and coastal habitats off the coast of Virginia for nearly four decades. Since its inception in 1969, the Conservancy's ownership on the Eastern Shore has grown to encompass 14 barrier and marsh islands along with multiple preserves and easements on the mainland. Collectively this network of protected lands is known as the Virginia Coast Reserve. The Conservancy and partners have protected more than 114,000 acres of land on the Eastern Shore, including 40,000 acres where we hold a direct legal interest. The 65-mile long Virginia barrier island chain is considered to be the best example of a naturally functioning barrier island system on the Atlantic coast and the last remaining Atlantic coast wilderness. The entire Eastern Shore, and especially the barrier islands, host globally-significant concentrations of breeding and migratory waterfowl, shorebirds, raptors and neotropical landbirds every year. Simply put, these lands are ecologically irreplaceable and represent one of the Conservancy's most significant holdings in all of North America. Our ownership and the incredible ecological importance of these wild barrier islands mean that protecting the islands and abating anthropogenic threats to their health, integrity, and the ecological processes that maintain them are our very highest priorities. We continue to work collaboratively with many federal, state and local partners to protect, enhance, and restore the unique and productive habitats and wildlife of the Virginia Coast Reserve, and now also the offshore areas of the Mid-Atlantic Continental Shelf.

Review of PEIS Modeling and Analysis of Sediment Dynamics
To assist in our evaluation of the more technical aspects of the Draft PEIS, the Conservancy again retained the services of Dr. Robert S. Young, and we requested that he focus his review in part on the science and engineering behind the assessment of Alternative Two. While we were pleased to see that the construction of a groin or a breakwater was no longer included in the Preferred Alternative, we have some concerns that the PEIS overestimated the benefits these structures might provide and underestimated their likely environmental impacts. While any

flawed analysis of the benefits and costs of sand retention structures may not impact the actionable outcomes of this PEIS, we believe it is important that the PEIS acknowledge these limitations so as to provide the most accurate background information in the event this issue is re-examined in the future.

As Dr. Young states very clearly in his report (enclosed), “the modeling used to examine the benefits and impacts of the proposed groin is critically flawed. All references in the PEIS to any increased durability of the re-nourishment project, cost savings, or potential downdrift impacts resulting from the construction of the proposed groin are therefore flawed and should not be used for consideration of Alternative Two.” Ultimately, Dr. Young calls into question the use of the Generalized Model for Simulating Shoreline Change (GENESIS), stating that it results in “incorrect representation of shoreline change and sedimentary processes” since the calibrated model was not successfully verified and does not account for the influence of antecedent geology on the sediment budget at Wallops.

In addition, Dr. Young raises serious concerns regarding the U.S. Army Corps of Engineers' selection of a four-meter closure depth. Dr. Young submits that this depth is too shallow, and its selection yields incorrect conclusions on the project's durability, impacts from storm events, and the overall movement of sand within the project area.

If obtaining more accurate and actionable information for the PEIS were simply a matter of correcting a few parameters on the GENESIS model run or using a different model, the Conservancy would certainly make that request for the Final PEIS. Unfortunately, we believe that the flaws in the GENESIS model are instead symptomatic of the underlying limitations of sediment transport models on complex and dynamic real-world environments. Especially when the stakes are so high (both the protection of WFF and the preservation of the larger barrier islands system) we submit that the construction of large scale structures or new engineered approaches is simply not appropriate without robust, long-term, and large-scale real world monitoring results to guide and direct future management actions. With the selection of Alternative One, NASA has taken steps that generally align with this precautionary approach, and again, we commend this decision.

Recommendation for Future Monitoring Efforts

We also commend NASA's commitment in the PEIS to monitoring changes in shoreline and beach volume, as we believe that a comprehensive monitoring program for the SRIPP provides an excellent opportunity to gain an empirically-based understanding of the sediment dynamics at Wallops and the surrounding environments currently lacking in the PEIS. We do, however, urge NASA to consider an even larger monitoring effort.

Determining the precise fate of sand as it erodes from the re-nourished beach will be critical for evaluating the viability of proposed SRIPP actions and the desirability of other efforts with much higher degrees of certainty and reliability than the PEIS currently provides. To produce credible results and conclusions about onshore-offshore sediment transport, the geographic extent of the shoreline and beach volume monitoring must extend well beyond the four-meter closure depth and include a significant buffer to the north and south of Wallops—essentially a landscape-scale monitoring effort. We strongly recommend that the monitoring project area should be clearly delineated in the final PEIS and consistent with this recommendation.

Sea Level Rise and Long-term Adaptation Strategies

As stated in our previous scoping comments, the Conservancy has real concerns that the PEIS does not adequately address the myriad of ways rising sea levels will both complicate and magnify the threats the ocean and the dynamic nature of a barrier island pose to the viability of WFF infrastructure. Dr. Young echoes many of these same concerns in his analysis, stating that "Sea level rise does not just impact the oceanfront. It will change the shoreline on all sides of the island. It will increase the frequency and magnitude of flooding from the backside as well as the front. [Sea level rise] will threaten infrastructure and access regardless of the size of the beach." Indeed, the harsh reality is that Wallops Island will remain extremely vulnerable to sea level rise and storm surges. We agree with Dr. Young's assessment that NASA must, "entertain the very real possibility that the WFF will not be maintainable as is, in situ, over the next 50 years," even if the Preferred Alternative performs as designed. The Conservancy submits that in order for the PEIS to evaluate accurately any one Alternative's likely success in protecting the infrastructure and operations of WFF over the 50-year lifespan of the SRIPP, it must more comprehensively consider the implications of rising sea levels within the PEIS.

In addition, we believe it is imperative that NASA begin to take steps to evaluate rigorously the costs and benefits of various adaptation strategies, including phased relocation to the mainland and corresponding efforts to promote the resiliency of the barrier island system. From our conversations with NASA, we understand that those evaluations are beyond the scope of this PEIS. We also appreciate that any relocation effort would pose enormous operational, engineering and financial challenges. While not at all disregarding those challenges, we do respectfully submit that those challenges are likely to increase over time, as are the impacts from rising sea levels and more intense storm events. Given the billions of dollars invested in WFF and its laudable plans to expand operations and its role in the nation's public and private spaceflight programs, starting these planning and analysis efforts earlier rather than later seems to be the most prudent course.

We suggest that one place to start would be for NASA to form an advisory team to assist with monitoring, long-term planning, and adaptive management of WFF protection strategies. Under NASA-WFF's leadership, this team could evaluate costs, benefits, feasibility and impacts associated with phased and limited relocation of infrastructure from Wallops Island to other sites within WFF, and ways to utilize the natural resiliency and migration of barrier islands as a first line of defense for NASA operations and assets. Such an advisory team could draw upon the extensive theoretical, modeling and research expertise of many academics and agency staff who have a great interest in the Virginia barrier islands and the viability of Wallops Flight Facility. The working results of this advisory team's efforts could become a national model and demonstrate how to best adapt to a dynamic coastal system in the face of global climate change. It is worth noting that a variety of federal initiatives could provide both higher level support and funding for this sort of effort.

To summarize our comments on the Draft PEIS, the Nature Conservancy:

1. Commends NASA for selecting Alternative One as the Preferred Alternative for meeting the short-term goals of the SRIPP for WFF without causing adverse impacts to downdrift barrier islands;
2. Requests that any future actions considered by NASA for short-term protection of WFF should be based on robust landscape-scale monitoring of the sediment dynamics and shoreline change at Wallops;
3. Given the reality of rising sea levels and stronger storms, strongly recommends that NASA form an advisory team of partners and experts to help develop an adaptation strategy that ensures the long-term protection of NASA's operations at Wallops and the conservation of the larger barrier island system.

Again, the Conservancy appreciates the opportunity to provide these comments to the Draft PEIS. We appreciate the very real challenges NASA faces as it seeks to protect the sizable investments and important operations at the Wallops Flight Facility. We look forward to working with NASA as this EIS process continues. Please contact Steve Parker at 757-442-3049 or sparker@tnc.org with any questions or requests for additional information.

Most sincerely,

Michael Lipford

Michael Lipford
Vice President and Virginia Director

Enclosure: Dr. Young's Evaluation

cc (via email):

Tylan Dean, Assistant Supervisor, Ecological Services, Virginia Field Office, USFWS
Lou Hinds, Superintendent, Chincoteague National Wildlife Refuge, USFWS
Trish Kicklighter, Superintendent, Assateague Island National Seashore, NPS
Laura McKay, Director, Virginia Coastal Zone Management Program, DEQ
Karen McGlathery, Director, Virginia Coast Reserve Long-Term Ecological Research, UVA
Tom Smith, Director, Division of Natural Heritage, DCR
Tony Watkinson, Deputy Chief, Habitat Management Division, VMRC
David Whitehurst, Director, Wildlife Diversity Division, DGIF

An evaluation of the proposed Shoreline Restoration and Infrastructure Protection Program at Wallops Island Flight Facility, Wallops Island, Virginia

Addendum to the April 20, 2009 Report

Robert S. Young. PhD, PG
Submitted to the Virginia Nature Conservancy
April 13, 2010

Introduction:

In April of 2009, the author prepared a report evaluating the March 2009 Description of the Proposed Action and Alternatives (DOPAA) for the proposed Shoreline Restoration and Infrastructure Protection Program (SRIPP) at NASA Wallops Flight Facility (WFF). In February 2010, NASA released the Draft Programmatic Environmental Impact Statement for the SRIPP. The author was retained by The Nature Conservancy (TNC) to evaluate a fairly narrow aspect of the recently released draft PEIS, the science and engineering behind the assessment of the proposed Alternative Two. This alternative would combine beach renourishment and seawall extension with the construction of a 130m-long groin at the southern end of the project. This report also evaluates the long-term strategy of protecting the WFF infrastructure in situ given the reality of rising sea level and storm impacts over the estimates 50 yr life of the SRIPP.

Summary of Opinion:

1) The modeling used to examine the benefits and impacts of a proposed groin is critically flawed. All references in the PEIS to any increased durability of the renourishment project, cost savings, or potential downdrift impacts resulting from the construction of the proposed groin are therefore flawed and should not be used for consideration of Alternative Two.
2) USACE (2010) seriously underestimates the closure depth along this shoreline leading to a significant underestimation of the amount of nourishment sand required, the storm benefits of the project, and project durability.

3) The impacts of rising sea level along Wallops Island over the next 50 years are also greatly underestimated.

Point #1:

The primary tool used to examine the efficacy and impacts of the groin proposed in Alternative Two is the GENESIS model. The Generalized Model for Simulating Shoreline Change (GENESIS) (HANSON and KRAUS, 1989) is used by coastal engineers to predict shoreline change resulting from spatial and temporal gradients in longshore sediment transport associated with coastal engineering projects. Shoreline change produced by cross-shore sediment transport such as that associated with storm events is not considered and cannot be simulated by GENESIS. Cross-shore transport is assumed by the model developers to average out over the long term (sand moved offshore during a storm always returns during fair weather).

The GENESIS model requires detailed calibration and verification and has a number of underlying assumptions that are often unmet in practical application (Young et al, 1995). In the case of the GENESIS model run reported by USACE (2010), the model run fails in two primary ways: the verification run can not be judged as successful, and the use of GENESIS ignores the strong underlying geological control that is an important driver of shoreline change in the vicinity of Wallops Island.

Calibration and verification of GENESIS is seemingly straightforward. One attempts to use the model to reproduce measured shoreline change for a given period in the past (in this case from 1996-2005). During this "calibration" run, model parameters can be tweaked to provide the best fit to the final shoreline. One then attempts to verify the calibrated model by reproducing shoreline change for another period of time for which adequate historical data is available. In this case, USACE (2010) used the period of 2005-2007. This is a very short period of time for a verification run; yet, they still found that "the 2007 measured shoreline does not agree well with the 2007 GENESIS verification shoreline…". It is clear that the model, as calibrated, was not successfully verified, although the modelers rationalize the failure by suggesting that the modeled shoreline fits within an envelope of shorelines generated by different wave climates. Despite the problems with verifying GENESIS over a mere two-year period, USACE (2010) elect to use the calibrated model for their analysis of beachfill performance and for evaluating the impacts of the proposed groin. One has to wonder how far off the predicted shoreline would be over a five or ten year period.

Given the poor model verification run, GENESIS should not have been used to produce detailed volume data for beach renourishment. In particular, GENESIS, as calibrated, should not have been used to examine the suggested increased durability of beachfill with the addition of a groin. In light of this, one must conclude that the USACE (2010) study and the PEIS do not, and cannot, scientifically demonstrate any clear benefit to the project from groin construction.

It is likely that one reason that GENESIS cannot be calibrated and verified successfully along this shoreline is due to the very strong underlying geological control exhibited by the nearshore, outcropping geological units. GENESIS, as run here, assumes a uniform, sandy bottom with waves moving sand as the primary control on shoreline dynamics. Oertel et al (2008) conclude that the barrier islands within the Chincoteague Bight (CB) are strongly impacted by large- and small-scale geological control. When this is the case, utilizing a model like GENESIS that accounts only for waves moving sand will result in an incorrect representation of shoreline change and sedimentary processes (Young et al, 2005). One needs only walk the beach along Assawoman Island to see that the berm is covered with shell material that is not modern, having been cast up onto the beach from nearshore, older geologic units. The modern sediment cover is thin. This is a classic example of the type of coastal setting where GENESIS should not, and cannot be used. It is no surprise then, that verification of the model was not successful. It should be noticed that this conclusion is supported by an independent technical review provided by Dean et al (2009) where they request specific criteria that were used to determine that the GENESIS verification run was “acceptable”.

In summary, the data presented in the PEIS purporting to show a small benefit to the durability of the beachfill following placement of a groin at the south end of Wallops Island cannot be used to evaluate Alternative Two. Thus, the PEIS does not provide any justification for the inclusion of a groin at any stage of the SRIPP. This conclusion is also supported by Dean et al (2009) where they " strongly recommend that the issue of initial construction of a south terminal structure be abandoned. While they leave the door open for the later inclusion of some kind of structure based on some proposed adaptive monitoring program, this program is not elucidated in the PEIS, and thus, cannot be evaluated.

Point #2:

Closure depth is assumed to be the depth beyond which no sediment is transported offshore during storms. USACE (2010) uses a surprisingly shallow depth of closure (4 m). They need to do a better job of justifying such a shallow depth of closure, particularly in light of the 8 m depth reported by Morang et al (2006). Selecting a shallow closure depth gives an optimistic view of beach width following placement of renourishment sand and suggests that large storm will not remove beachfill from the immediate nearshore. In fact, the PEIS shows pictures of oscillatory ripples at depths of 14 m and 17 m on "unnamed" shoal. Clearly, sand along this shoreline is moving at depths greater than 4 m.

It should be noted that numerous geological studies have documented transport of beach renourishment sand well offshore of any proposed closure depth (Thieler et al, 1995, for example). The PEIS assumes that all sand lost to Wallops Island will be lost alongshore. This is not a safe assumption. Any monitoring program needs to account for the precise fate of the sand as the renourished beach shrinks. If sand is lost offshore during storms, the addition of any structure designed to trap sand moving alongshore will not help increase project durability. In addition, any post-project monitoring needs to include shoreface profiles that extend well beyond 4 m in depth. The choice of a 4 m closure depth improves the project beach width and storm protection numbers, but it is not a scientifically realistic number. In order to give the public a more reasonable perspective on the benefits/costs of the project, the PEIS should use a more reasonable design closure depth.

Point #3:

The PEIS does an inadequate job of addressing sea level rise (SLR). Protecting the infrastructure at the WFF will involve more than adding a little bit to each renourishment interval to raise the elevation of the beach in order to keep up with rising sea level. Sea level rise does not just impact the oceanfront. It will change the shoreline on all sides of the island. It will increase the frequency and magnitude of flooding from the backside of the island as well as the front. SLR will threaten infrastructure and access regardless of the size of the beach. It will narrow the island. True protection of all WFF infrastructure during the 50-yr lifecycle of this proposed project will require massive re-engineering of the entire island (elevating facilities, major dikes and walls, elevating roads).

The PEIS should do much better job of examining the long-term threat of rising sea level to WFF. It should be made very clear that this project will be just one facet of the engineering that will be required to keep the WFF facilities in place over the next 50 years. No one should think that even if the project performs as designed, there would be no other expenditures needed to maintain the infrastructure. In fact, one must entertain the very real possibility that the WFF will not be maintainable as is, in situ, over the next 50 years. In addition to the monitoring proposed, it is highly recommended that an additional study be implemented, in conjunction with the initial renourishment, examining the feasibility of moving some infrastructure off the island over the next 50 years. This gradual relocation could begin with facilities that do not require close proximity to the coast, and develop contingencies for moving damaged structures following large storms. Although the timing and magnitude of future SLR is still uncertain, it is virtually guaranteed that these moves will be required at some point. Initiating this planning makes scientific and fiscal sense.

Conclusions:

Alternative Two, beach nourishment along with the construction of a groin is unsupported in the Draft PEIS from a scientific standpoint or from a benefit cost standpoint. The inclusion of a structure should be dropped from any future planning without significant additional study. The PEIS should include a more realistic depth of closure and a significantly more robust examination of the ability of the proposed project to protect against future sea level rise.

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Minutes from the March 16, 2010 Public Comment Meeting

NASA WALLOPS FLIGHT FACILITY

SHORELINE RESTORATION AND

INFRASTRUCTURE PROTECTION PROGRAM

PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

PUBLIC COMMENT MEETING

March 16, 2010

Wallops Island, Virginia

TAYLOE ASSOCIATES, INC.

Registered Professional Reporters

Telephone: (757) 461-1984

Norfolk, Virginia

Appearances:

Keith Koehler, Public Affairs Office
Paul Bull, Shoreline Restoration Project Manager
Josh Bundick, NASA Wallops Environmental Office
Dr. David King, U.S. Army Corps of Engineers
Shari Silbert, WICC Team Member

Also present:

Tracy Hand, RPR, Meeting Reporter

(The hearing commenced at 6:07 p.m.)

MR. KOEHLER: We will get started. The idea tonight is kind of give everybody on update where we are on the Shoreline Restoration Project and the EIS program.

So the process tonight, we'll have a few comments, we'll have an overview of where we're at on the project. After that you'll be allowed to ask some questions and answers to make sure everybody's clear on what's going on, and then after that we have a public comment period if anybody has any comments after that point.

When we get to the questions and answer session and the comments, raise your hands and I can give you the mike so we can get everything recorded, make sure she hears everything that everybody is saying.

So we're going to get started and we'll start out with Craig Purdy, who is the deputy director here at Wallops. He will make a short statement.

MR. PURDY: Okay. I happen to be acting facility director until my new boss gets here, so that's the capacity I'm here. These guys have done a real good job over the past year putting together a plan for the restoration and the protection of our infrastructure over on the island.

They got the input from the world's experts in this area and they got the input from the local experts in this area, and that's a lot of you sitting out there that helped us put this plan together. And they put out the EIS or the environmental Impact Statement, and this is our time to listen to your comments on it and take your comments and see if we need to do another thing to make this plan more palatable to everybody involved.

We are your neighbors, we want to do what you think is right, but we have to protect Wallops, and this plan is extremely important to the longevity of Wallops and what we are doing here. These two guys up here have put in a lot of work, a lot of good work, and I'm sure they will be able to answer all your questions. So thanks again for coming.

MR. KOEHLER: Thanks, Craig.

Okay. We're getting started with Paul Bull, who's the project manager for the station program, so, Paul.

MR. BULL: How is everybody doing this evening? I'm the project manager for the -- this project to hopefully protect or loss range. Josh is the EIS manager; he will be right after me.

And we'll tell you things that you have heard before. I think all the faces I see in the crowd for the most part are familiar, but we'll go ahead and shoot the same script we did last time. Actually, I'll get to say it this time versus the person in front of me. Kind of an inside joke.

Here is our agenda. We will talk about the nor'easter damage. This is actually the nor'easter damage from the November storm. Probably should turn this the right way. We've had several nor'easters after that storm and have done more damage, not -- it's not sustained damage, as sustained; it's just kind of chronic damage to our seawall primarily and sand on some of our infrastructure.

We will talk about the alternatives. We have three project stats where we are today, new technical information that I discussed last time and we will go over it one more time, EIS update, Josh will jump in there, and then we'll have the Q and A for anybody who has any questions for us, and then we'll open it up for public comments as well for the record.

All right. Here is the slide that basically shows why we're doing what we're doing. We have about a billion dollars worth of federal assets on Wallops Island and we have about a hundred million of annual programs that activate on Wallops all year, yearly, every year.

And this is the information we had when we actually started this project. I think Craig says we have been working the least year. Actually, 2006 is when we had the first Corps study, so it's been at least four years we've been actively working on this project.

Since that time I guess -- I'm going to get the date wrong, but I remember sitting in a conference room, Jay Pittman, our launch manager, looked at his BlackBerry, whatever, and said, we've got Taurus II. So that's after this -- this is above and beyond what's here, a hundred -- a billion dollars worth of federal assets, a hundred million dollars of annual activity on the island, and now Taurus II is coming with a $2 billion program and at least a hundred million dollars worth of assets being constructed today that's not on this slide right now.

Here is a picture of UAV runway to the south, pad 0A -- 0B, I'm sorry, 0B here. Basically, Assawoman Island is about 2000 feet off the V100 camera stand. This is a picture probably in 2008, early 2008 time frame.

Flipping to November of 2009, and you can see all the geo tubes are mostly gone, the beach is kind of gone, UAV runway is inundated with sand and debris. This is just a nor'easter. Of course, nor'easters tend to do the most damage here.

Okay. This is the alternative portion of our discussion. Ongoing seawall maintenance. As I mentioned before, these storms that we've had have been kind of chronic in nature; they have just been eating at our seawalls. They've sat here -- I think the November storm sat here for seven high tides; it just ate -- chewed up on the seawall and the sand in front of it, and we've lost some elevation because of it.

But we're going to do some ongoing seawall maintenance as part of this project. We just had funding to do that. We have three alternatives to consider. I think some of you were here when we considered the beach fill groin as our primary alternative, but we will talk about that in a little bit more detail.

So we have three alternatives: Beach fill only, which also extends the seawall. All of them have the extension of the seawall in this project embedded. Beach fill only, beach fill and groin perpendicular to our property line, and beach fill with detached breakwaters.

We have had ongoing meetings and discussions with our folks that are helping us from the Corps. The URS is doing the EIS, and we also have the ITR Team, Independent Technical Review Team. I think the next slide speaks to who those individuals are and what they are doing for us.

Through those meetings and constant dialogue and research and design, we've kind of determined that when we first met you, we were thinking that our groin project would be our primary alternative, but we got public comment against that, we got -- and then we met with our ITR team and our design team, and they basically have -- we figured out that all three of these projects have similar technical merits, and what's important for us is the cost of all three projects is similar.

So we -- knowing all that, we decided to make beach fill the preferred alternative. One other issue we discussed when we first met you-all was Blackfish Bank. The idea is taking sand off Blackfish Bank. Blackfish Bank is the closest structure out in the ocean we can pull sand from. But we had a lot of comments, we did a fish -- a survey of all the fishermen and all the charter boat captains, and they wanted us to stay away from Blackfish Bank. And then we had some further modeling by folks in the Corps, and they determined that if we mined Blackfish Bank long term, there would be some negative effects to Assateague. So we backed away from that, and I will have a slide show on that shortly.

Our implementation schedule for this project, we hope sometime later this summer to begin a seawall repair in targeted areas, about 2500 feet or so of seawall we need to repair. We need more, but that's what we have budgeted. And we hope to start extending our seawall south up to 4600 feet. Right now the project is probably in the 1500-foot range this fall as well, probably extending into 2011 calendar year.

Then in 2011, probably springtime, we hope to begin our first phase of a two-phase project to put 3 million cubic yards of beach on Wallops Island that is not there today. That will end up being somewhere between 70 feet and 110 feet of dry beach at high tide, depending on how we get bids in and what gets funded.

Project status. I won't dwell on the

draft PEIS's while you-all are here. Josh will talk a little bit about that, so I'm going to jump down and talk about design. 30 percent design we've already marched through up in October, February, Josh and I traveled to Norfolk and reviewed the 60 percent, 90 percent should be here in May, and then July timeframe to coincide with our EIS project completion will be in July, a hundred percent.

Okay. I spoke briefly about the ITR, Independent Technical Review Team, and I know a lot of you were here last time and you know who they are, but we will speak a little bit about it.

The idea about the ITR Team actually was brought up way earlier in our project, and I kind of didn't think it was a good idea, then I slowly warmed up to the idea. But, basically, it's to provide independent technical review of all documentation related to this project, to evaluate the scientific and engineering studies relative to the stakeholder comments, all the comments we received from the public, we allow them to look at that and the response on that, and they've commented on that.

They identified strengths and weaknesses for our project. They made -- or part of the deciding voice to push us away from the groin. They consist of four university professors with 125 years experience doing this kind of work, and they have -- most of them have done work in this area.

Technical information that was new to us last time, but I will repeat this time in case anybody didn't hear. We've done additional modeling. We remodeled the model again, and we've determined the net sediment transport along Wallops Island is to the north.

Any given day, any given year it could be to the south, net, but the net, sediment transport, is to the north. Primary reason of that is the groin -- fishing point groin to the south. So our predominant wave action that comes from the northeast is sheltered basically by that piece of land growing south, and we believe it's going to continue to go south.

Blackfish Bank, here's the issue of Blackfish Bank: Blackfish Bank is obviously the closest structure to us to grab sand from; however, it's also the closest to Assateague, and it costs money to steam out here.

This costs less money than going to here and there, and there is even more, so... But we got comments from the public that Blackfish Bank was a bad idea. We got the modeling results that also said it could potentially be a negative impact to Assateague, so we have now decided to go to Site A and take Blackfish totally out of the running for getting sand.

One other small thing, we have a large build-up to our north. Our north is kind of secreting sand, and we are investigating the idea anyway in the EIS to potentially take some of this sand off our own beach and use it for some of our renourishment efforts.

The problem with that is not enough sand, Number 1, but it may not be cost effective to do it as well. It might be cost effective to just bring a dredge in and do the whole shooting match.

With that, I'll turn it over to Josh, and then when Josh finishes, we will sit here and take any questions you might have.

MR. BUNDICK: Thank you, Paul. Again, Josh Bundick, and I am the project manager for the environmental impact statement. I work in the environmental office, and our job is to make sure all Wallops projects follow the NEPA process.

And I will give you the quick 15-, 20-second debrief on NEPA. NEPA is a federal requirement that the government assess the environmental impacts of its proposals prior to implementing those proposals, and that's, of course, why we're here tonight. We assess the impacts, disclose those impacts to the public and to the regulatory community, and then incorporate those comments into our final decision document, and then, in effect, make an informed decision based on the best technical and scientific information available. So that's kind of why we are here tonight, and I'm to talk more about the EIS process.

Back in April of 2009 we all were in this room listening to this initial proposal, and the purpose of that meeting was to conduct scoping, and the purpose of scoping is to get feedback on the proposal prior to beginning the EIS process.

And the concerns that were raised during that 45-day window and the meeting that we had here in April was that the preferred alternative at that time was an alternative that included a terminal groin at the south end of the project, and that was the lion's share of the comments that were received during that time.

And, of course, in the EIS we do disclose the uncertainties inherent in the modeling that we predicted and that although the modeling may have shown that the groin would not have an adverse effect on sediment transport to the south, we couldn't say that for sure.

But there is some uncertainty out there with having a rock structure in the ocean, and, therefore, it was changed that the project's preferred alternative would not include that terminal structure.

A second comment that was received was regarding the relocation of our launch range infrastructure, perhaps moving it westward from Wallops Island where it's been since the '40s to perhaps the mainland or to the main base.

And in the EIS we considered those concerns and actually worked with our range safety office in developing an analysis of what type of effects that might have on landowners in Assawoman, in Atlantic near Chincoteague if we were to do such a thing. And, again, we explained why the risks -- the safety risks are inherently unacceptable to NASA and why that's not an acceptable alternative for us to consider in the EIS.

And regarding biological impacts at the bar sites, as Paul mentioned, we did remove Blackfish Bank as a shoal under consideration due to the potential effects to commercial and recreational fishing in the area.

Also, we are consulting very heavily and closely with the National Marine Fishery Service in determining the best way to dredge the shoal, whether it be Shoal A or B, 10 or 15 miles off of Assateague to minimize the environmental impacts on those shoals throughout the life of the 50-year project.

And, of course, there was some concern regarding the ability of NASA to maintain and/or fund the project. And, of course, as being a federal agency, we are subject to the appropriations from Congress, and in the EIS we do acknowledge the fact that there is some uncertainty in the out years, say 45 years down the road, whether or not we can guarantee funding or not.

And, of course, having a rock structure in the open ocean is inherently risky given those considerations. So, again, we acknowledge that in the EIS, and our preferred alternative certainly contains the least damaging -- environmentally damaging alternative if funding in the out years was unable to be secured.

Just a brief rundown on the studies and the analyses that have been conducted to support the EIS: First, Dr. Dave King with the ERDC, down in Vicksburg with the Army Corps of Engineers, performed a very thorough sediment transport analysis, both the effects of the dredging on the offshore shoals and Assateague Island, but, also, the near shore sediment transport on Wallops Island and Assawoman Island.

And we found through that modeling, there should be no measurable impacts to either Assawoman Island or Assateague Island from the project.

Regarding the biological resources, Jeff Ridenhour and his team from URS spent a couple of the best weeks of his life out in the boat in the Atlantic Ocean this past summer, not only performing underwater archeology but actually out there with a drop camera taking video footage of those shoals at I believe it was 40 different stations at each shoal to better characterize the bottom dwelling habitat, do we have any hard substrate out there that fish might find to be preferable or is it all consistently sand.

And what we found is that both Shoals A and B are consistently the same. We are also consulting with the National Marine Fishery Service and the Fish and Wildlife Service right now to determine the level of effects we might expect to threaten an endangered species, namely sea turtles, protected whales, protected mammals, seals and porpoises and whatnot, as well as piping plovers, red knots, and the nesting birds on the beach.

And regarding the cultural resources, I mentioned before, we've been consulting with the Virginia Department of Historic Resources since the beginning of the project, and just today we received their concurrence that the project should have no effect whatsoever on historic or prehistoric archeological resources for either alternative.

And as the programatic environmental impact statement continues to develop from draft to final, we will keep our website continually updated with its status. I recall at the December 8th meeting that we had here there was some interest in our sharing the video footage from the shoals on the website. We have updated the website to include that information. Of course, it includes all of the EIS and its supporting documents.

And there's, of course, the web link. The document in its hard copy format is available at all the local libraries from Chincoteague south to Nassawadox. We also have hard copies and CD's available for those of you who might want your own personal copy, and, of course, if there is anyone that is not on our existing project distribution list for both e-mail and hard copy information, you can certainly sign up in the back tonight and we will be glad to add you to that.

And the comments on the project at this point are due April 19th. Our previous announcement that we may have sent out noted April 15th, but we have extended it out an additional four days to incorporate some processing time that was needed prior to our Federal Register announcement back in March. So, again, the comments are requested by April the 19th.

And with that, just I would like to open it up for any questions that you might have on the project. And as Keith mentioned before, this is not necessarily the time to speak for the record as, you know, this is more of an informal session where, you know, anybody has any questions regarding both the project or the environmental effects.

We will be glad to answer those, or if Paul or I can't answer them, we will certainly defer to our technical team sitting here in the audience. So thank you.

MR. KOEHLER: If anybody has any questions at this point about the project itself, just raise your hand and I will bring the mike to you.

Yes, state your name and ask away.

MR. SEYBOLT: My name is Ace Seybolt. I have a comment, which I will do later, but I have one question. Should eventually NASA have to switch to Alternative 2 or 3, would you do this whole, I guess you call it NEPA or EIS process all over?

MR. BUNDICK: Yes. The purpose of -- what -- the document that we prepared was the programatic document, meaning that there are elements within the program that are, you know, of course, unknown at this point. We can't say with absolute certainty between now and fiscal year 2017 how exactly -- are we going to have to put 2.3 million cubic yards or 2.4 million yards back on the beach.

So we recognize that uncertainty and prepared this document knowing that for future renourishment actions or changes to the program that are outside of what we select as our preferred alternative would be subject to additional NEPA review, focusing on that specific action. So the answer is yes.

MS. SCHUPP: This question, I think really is for Dr. David King. In the engineering report on the impact for the Assateague shoreline, Dr. King suggested that perhaps dredging Shoal A, which is a little further south but closer to Assateague

Island, that that might have fewer impacts on that narrow part of Assateague that's retreating a lot faster than the part just south of Tom's Cove.

I was wondering if you could shed a little more insight on the resolution of that, if that's a plus or minus ten miles shoreline impact or if it's on a smaller scale than that.

DR. KING: Can you guys hear me? I don't have the figures in front of me, but in Chapter 8 there are those three figures that show the impacts to Blackfish Bank, to Shoal A, and to Shoal B.

This isn't a real scientific study, but if you just look at where the largest impacts are relative to where Tom's Cove is, relative to where Fishing Point is on those figures, you will see that for Shoal A they're shifted to the fishing point area, whereas in the impacts to Shoal B are a little more focused on the Tom's Cove area.

I didn't do any kind of statistical analysis up and down the beach saying where the biggest impacts were. I was -- the origin of that comment was just from looking at those figures, basically, okay?

MR. BUNDICK: And here they are, Dave.

DR. KING: I can hold them up, but

that's -- yeah, just the squiggly lines that are adjacent to the pictures on the left-hand side of those three pictures.

MS. SCHUPP: Right. And conceptually that makes sense, but I was wondering for -- you know, from a land management perspective if that -- you know, how big a grain of salt to take it with, you know, if I should really be concerned about a 20-mile stretch or if it's really safer say to Dredge A versus B.

DR. KING: There is probably not going to be a lot of impact. The guidelines that Mineral Management Services provided that they give us that coefficient, that was the basis for that line that I present in the report. It's a fairly conservative number, result to get.

They could have given other guidelines that would have allowed more leeway, I think. I'm not sure it's necessarily in the guideline I would have chosen if I were -- if I were presenting that, but that's not me.

But your question is a good one, and I think that you're probably getting to the limits of the modeling capability. I don't want to speak in very dogmatic terms about the details of that. You're at about the limit of what the models are capable of telling us. I shouldn't be leaning back here.

Yeah, to get to a more detailed understanding, you're going to very rapidly get to the point of saying that we just don't know, don't have the capability of saying where the zero impact is, where the real minimal impact is, and where you draw the line between what is an acceptable impact and an unacceptable impact.

The -- what the -- this figure -- and I'm sure that most of you are thoroughly lost on this subject -- shows is -- compares the changes in the transport rate that you get on the beach from modeling -- from dredging each of these different shoals compared with what the normal year-to-year variability in the wave climate is.

It's not reasonable to say that if there's one more grain of sand or less, more or less transported because of the offshore dredging, that that's an unacceptable site.

But, okay, well, if one grain is more or less than -- then will get moved is okay, is two grains okay? Is five or ten grains? Well, all of those, sure. But a hundred gazillion grains where you have huge cutbacks in the beach is not.

And there is no obvious line that you can draw and say that this is a significant impact and something a little bit less is an insignificant impact. And, frankly, you're also at about the limit of how much you want to trust the modeling effort.

I'm not sure that's the best answer or the answer that you would like to hear, but that's pretty much the state of modeling of where we are.

Now, did that go into it enough?

MS. SCHUPP: Yes, thank you.

DR. KING: More than enough?

MR. BUNDICK: Now, just to add one thing to Dr. Dave's response was that -- just for everybody else: The modeling, the analysis that he did assumed that all the sediment required for the 50-year life of the project was all removed in one fell swoop, which, of course, would not be the case in reality; it was just, again, designed that way so that we could provide a conservative analysis to make up for some of the uncertainties.

MR. WOLFF: Ron Wolff. The question that I would have, this year being a very different year as far as storms that have affected the island, with this 50-year project in mind, is this year and the number of northeast storms that have affected the island, is this something that is unique or is this something that is usual in your 50-year analysis?

Do you plan for these type of storms on a more frequent basis or less frequent basis? I know, you know, this one is kind of unusual, but --

MR. BULL: That's why I asked Shari to put us on this slide. This is the data set that Dr. King worked from. Nor'easters, we had 39 between '54 and 2003. Of course, what we're having this year is not modeled, but I can't say, and maybe -- we don't have a meteorologist here, but I can't say any years within that time period had the same kind of veracity of storms that we had this year.

I don't know if you want to add a little bit to that.

DR. KING: Yeah, just a little bit.

MR. BULL: Just a little bit.

DR. KING: I will try not to be too windy.

Yeah, the modeling is based on historical data sets. And this is the storm data set that was used. There is also a 20-year wave climate that was used between -- the years for that were from 1980 to 1999.

Yeah, this has been a bad winter. How

bad it is is not clear since I know there were big waves out there, but I don't have the actual data on them.

So to really answer your question, we needed to do the modeling work before we got to this winter, so this stuff has not been incorporated into the modeling effort to date.

MR. BULL: I guess to follow up on that, Dave, if this project was already done, we wouldn't have experienced any of the effects to the extent we've experienced this winter. That's pretty much an easy thing to say. If you had 70-foot or a hundred-foot of beach at mean high water out there when we had these storms, the impact would have been minimal.

MR. BUNDICK: The fact that the crashing waves would not have been on our seawall, it would have been a hundred, a hundred five feet seaward would be the benefit of having the beach out in front.

MR. KOEHLER: Any more questions? Any more comments from you guys?

MR. BULL: I don't think so.

MR. KOEHLER: At this point then, we will go into the official comment period. If anybody would like to make an official comment, just raise your hand, I will come by with the mike.

MR. SEYBOLT: Someone has to speak. Again, my name -- for the recorder, my name is Ace Seybolt. I spoke last, I guess that was April or whenever. As I said before, I own the farms behind Assawoman Island and I used to own Assawoman Island.

As a taxpayer and a citizen of the county, I appreciate all the work you have done, especially since this winter you were probably looking over your shoulder holding a life jacket some of the time.

As before, my comment deals with the groin and the detached breakwater. They do not seem to have been foreclosed as an option in the report, and to a layman nothing in the report seemed to incorporate all the negative impacts or studies concerning groins.

And, actually, you seem to be saying there would be no impact on Assawoman. So that is my comment. Thank you.

MR. CHESSER: I'm Grayson Chesser, and I'm the supervisor for Accomack County representing District 3. And before I spoke and I spoke against the seawall. Now -- not the seawall but the groin.

And I'm really happy to see that -- I'm

kind of unhappy to see it's still on the list, but I'm very happy to see that it's dropped down to Number 2. And because I think it would be disastrous for you if you go to that option.

And, you know, Wallops is very important to us. Some people I think think because I express my concerns about Wallops that I am somehow opposed to it. But a large part of my closest family members work at Wallops. An awful lot of my friends, former classmates work at Wallops.

It's absolutely, you know, vital to the county that you succeed, and I wish you-all the best. The reason I spoke against the groin is because I think it would be detrimental not only to you but to all of us who depend on you.

You know, we have a lot riding on you and your success, and we want you to be successful, and I hope that -- hope that you are, and I think you have made the right choice.

Like I said, I would rather see the groin completely eliminated because I've spent an awful lot of time out there in the winter. Almost all these slides you can see show places that I hunt, and so I see a lot of what's going on. And I think I started going out there in the '50s and, you know, seeing all the changes, and it's very dynamic, and I think the choice that you have made is the only logical one to make. Thank you.

MR. PARKER: For the lady with the flying fingers, I have this in writing again. My name is Steve Parker. I'm director of The Nature Conservancy's Virginia Coast Reserve.

This globally important natural area consists of 14 barrier islands and several mainland properties owned and managed for conservation purposes south of Wallops Island. The Nature Conservancy is a nonprofit organization with operations in 50 states and 35 foreign countries. Our mission is to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

We help with the protection of over 100 million acres globally. The Virginia Coast Reserve is one of our most important preserves.

I wish to thank NASA for conducting an open, participatory NEPA process and for listening carefully to the comments of scientists, stakeholders, and this community.

And in completion of our internal review of the PEIS, the Conservancy is in agreement with the preferred alternative. Our concurrence, as well as our concerns with Alternative 2 and other comments and suggestions will be stated in writing during the present public comment period.

NASA Wallops has a mission that's very important to this country and to our community. The Nature Conservancy looks forward to continuing to work with NASA in the future, and thank you again for the opportunity to participate in this very important process.

MR. KOEHLER: Any further comments? Okay. Seeing no further comments, we thank everybody for coming out tonight, and, again, any written comments you need to provide, do so by April the 19th. Okay. Thank you.

(The hearing was concluded at 6:44 p.m.)

Independent Technical Review Team Comments

Please note that Independent Technical Review Team Memoranda 1 and 2, dated August 31, 2009 and December 21, 2009, respectively, are not included in this Appendix as they were based upon reviews of preliminary working drafts of the SRIPP DPEIS. The focus of Technical Memorandum 3, included in this Appendix, is the DPEIS that was available for public review and comment.

Technical Memorandum #3

Independent Technical Review of the Draft Programmatic Environmental Impact Statement: Wallops Flight Facility Shoreline Restoration and Infrastructure Protection Program

Michael S. Fenster, Laura J. Moore, Robert G. Dean, Robert Dolan

April 5, 2010

Table of Contents

Minor technical comments contained in a previous version of TM #3.

Introduction

This review represents the third Technical Memorandum (TM) developed by an Independent Technical Review (ITR) Panel tasked to review and evaluate the Shoreline Restoration and Infrastructure Protection Program (SRIPP) Draft Programmatic Environmental Impact Statement (EIS). The specific tasks for this TM include:

- outline the findings from a review of the Draft Programmatic EIS;
- identify strengths and weaknesses of the document, with comments focusing primarily on the status/resolution of previously identified issues from past reviews; and
- provide recommendations to any deficiencies identified.

Below, we provide our review in sections:

- Resolution of Previously Identified Issues
- Level I Technical Comments and Recommendations: Highest Priority
- Level II Technical Comments and Recommendations: High Priority

We ranked our technical comments and recommendations into two priority categories based on the ITR team's professional judgment as to their importance in addressing deficiencies or improving the overall quality of the SRIPP and the PEIS. Level I technical comments and recommendations are of greatest concern and should be addressed with the highest priority during the editing period. Level II technical comments and recommendations are also of concern and we strongly recommend addressing these comments as well.

Although not included in the comments below, the ITR Panel remains concerned about the southern groin option in Alternative Two and the southern breakwater option in Alternative Three. While the ITR recognizes that the initial plans (Alternative One) will not include construction of the southern groin or breakwater, we strongly recommended in TM #1 (Section 2.4.1) and the ITR Panel continues to recommend that Alternative Two, which calls for a south terminal structure as an adaptive design option, be removed from the PEIS. Similar consideration should be given to abandoning Alternative Three (with a single south nearshore breakwater) given that the impacts can be expected to be similar to those of the south groin.

As discussed in more detail later, we strongly recommend an "adaptive design" approach to addressing the uncertainties attending the complex sediment transport system in the vicinity of Wallops Island. This would both recognize the real uncertainties and pave the way for valuable flexibility in future actions where needed. Additionally, the Corps of Engineers has recommended adaptive design approaches where warranted.

Assuming that NASA will integrate an adaptive design approach, the ITR Team advocates the following reprioritizing of Alternatives:

Alternative One: Seawall and beach nourishment (current Alternative One)
Alternative Two: Seawall, beach nourishment, and north groin
Alternative Three: Seawall, beach nourishment, and a north breakwater

Current Alternative Two: Seawall, beach nourishment, and south groin - ELIMINATE
Current Alternative Three: Seawall, beach nourishment, and south breakwater - ELIMINATE

Finally, the ITR encourages statements in the EIS as to the options available after this project has fulfilled its life. For example, if the site is abandoned, will the structures be removed? Might the Project be extended beyond the 50-years currently planned? Answers to these questions will provide valuable information to the public as they contemplate the next generation charged with managing infrastructure protection projects and natural environments.

Resolution of Previously Identified Issues

Many of the issues identified previously by the ITR and described in Technical Memoranda #1 and #2 have been completely or partially addressed thereby strengthening the current version of the document. We note that improvements include:

- Increased emphasis on possibility of recycling sand from the north.
- More complete analysis and discussion of a relocation alternative.
- More complete geologic and geomorphic background provided along with more appropriate citations of original work.
- Enhanced discussion of sea-level rise within Chapter 3.
- More transparent presentation of uncertainty in the position of the nodal point via identification of 95% confidence limits in net transport rates and notation of a “nodal zone.”

Level I Technical Comments and Recommendations

Level I Comment #1: Adaptive Design

It would seem appropriate to introduce the concept of "Adaptive Design" more explicitly in regard to the determination of whether or not a structure is needed, and if so, the location of the structure. The Adaptive Design concept acknowledges that uncertainty exists in the magnitudes and directions of net transport and, in particular, in the location of the nodal point. Under Adaptive Design, design alterations or a decision to implement an alternative design in the future would be based on the understanding gained from the monitoring results. At this stage, defining the groin location to within a 5 m longshore location conveys an unwarranted understanding of the sediment transport system. We suggest adding text to section 2.5 along the lines of that which appears at the beginning of Chapter 5. The text currently at the beginning of Chapter 5 discusses an adaptive management strategy whereby mitigation measures are optimized. Our suggestion is to apply the same principles to project *design* in Chapter 2, by explicitly discussing the intention to adapt any future project design modifications/additions based on results of monitoring efforts. A logical order in which to frame this discussion could include: (1) Adaptive Management and Design; (2) Uncertainty; (3) Alternatives; and (4) the need for a supplemental EA or EIS after a monitoring period.

Level I Comment #2: Most Effective Location of a Structural Alternative

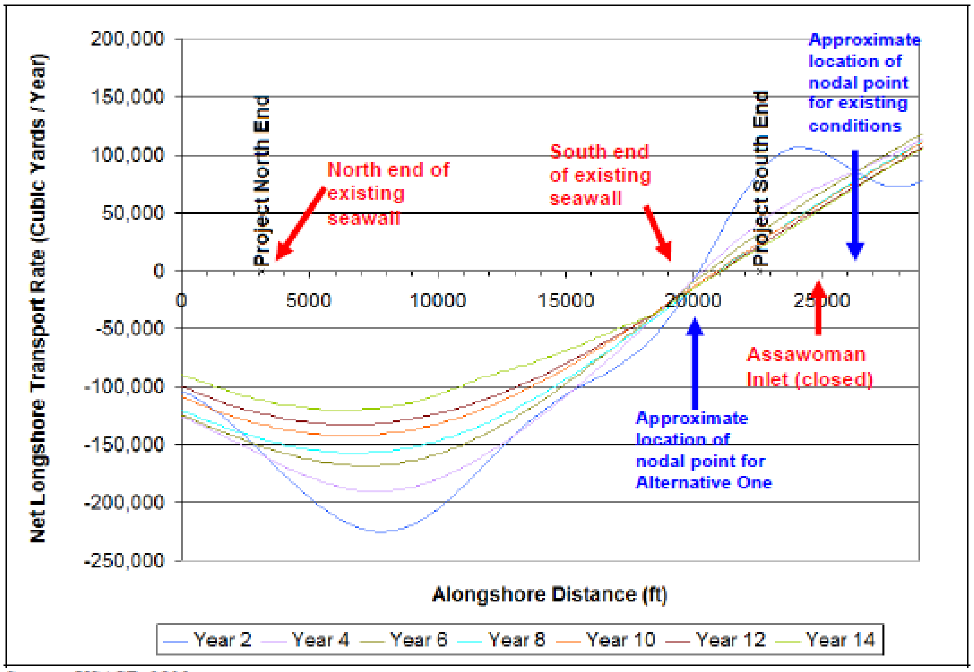
With the present design, there is confusion associated with the groin and offshore breakwater alternatives. Page ES-2 states:

> "Construction of the groin would result in more sand being retained along the Wallops Island beach, so less fill would be required for both the initial nourishment and renourishment volumes compared to Alternative One."

Figure 42 (reproduced below as Figure 1) which applies for the case of no structures (Alternative One), shows that the groin would be installed at about the location[1] of the nodal zone. According to this figure, during a five-year period, the north end of the project would lose more sand (by a factor of approximately 1.8) than the south end. The ITR Team questions the amount of total sand loss (north loss + south loss) used in determining anticipated 5-year fill volumes. We note a potentially greater total loss of approximately 1.5 times over the first 5 years than reported in the PEIS on p. ES-2, p. 57, p. 61 (Table 6), and p. 223 (by our calculations, approximately 1,165,000 cy compared to 806,000 cy). It appears that the last two present alternatives are, to some degree, an artifact of the original design when the net transport was believed to be strongly

[1] The groin would be installed 445 m north of the boundary between Wallops Island and Assawoman Island.

south at the south end of Wallops Island. Though the ITR continues to endorse the preferred alternative (no structure), substantial advantages may exist in changing Alternatives Two and Three to include a structure at the **north end** of the project, rather than at the south end, as discussed below.



Source: USACE, 2010a

Figure 42: Net Sediment Transport Rates over Time for Alternative One

Figure 1. Net Longshore Transport Estimates for Alternative One (No Structures).

A structure at the south end has the potential of either causing erosion or being perceived as causing erosion on Assawoman Island whereas a structure at the north end of the project would retain any impact on Wallops Island. The lack of a structure at the south end would benefit Assawoman Island.

A structure at the north end of the project would maintain the area north of the north structure as an "environmental preserve" which would not be disturbed by back passing and would guarantee that backpassed material from south of the north structure would be the same quality as placed in the initial nourishment. The material collected by the structure could be backpassed on a more-or-less continuous basis "in the dry" by earth moving equipment operating on the beach. This would have several advantages including at least doubling or tripling the renourishment intervals from offshore sources and the ability to address localized "erosional hot spots" without the need for dredge mobilization, thereby reducing project costs and environmental impacts due to large emplacements and removals from the offshore shoal(s). Also, prevention of the transport of the material placed to the extreme north end of Wallops Island would have advantage of not increasing shoaling pressure on Chincoteague Inlet. This Alternative would provide a "conservation of sand approach" without impacting the existing ecology farther north on Wallops Island.

In summary, the benefits of a northern groin - in lieu of the southern groin for Alternative Two - include:

- Reducing the perceived or real adverse impact on downdrift islands;
- Recapturing sand of same quality as initial nourishment;
- Reducing shoaling pressure on Chincoteague Inlet;
- Retaining all potential adverse impacts within Wallops Island;
- Extending renourishment intervals from offshore sources by factor of 2-3;
- Lowering costs;
- Providing a capability to address erosional hot spots as they occur;
- Recycling sediment on a more continuous basis thereby reducing adverse impacts due to large volume placements; and
- Creating an "environmental preserve" north of the groin.

Also, on Figures 42 and 43, why not include a corresponding plot of shoreline change rate? These rates can be calculated from these figures by a specialist, but not the layperson.

Level I Comment #3: Dredging Plan

It seems that the plan is, for each nourishment or renourishment, to dredge uniformly the designated areas in Shoal A and/or Shoal B. To minimize disturbance, wouldn't it be better to dredge a smaller area deeper each time, thereby disturbing less biota since the majority of the biota live in the upper 15 cm or so? We recommend examining several candidate dredging scenarios, determining which is most advantageous to the biological system and detailing to a greater degree, this preferred dredging scenario.

Additionally, in discussing the disruption to the sea bottom due to dredging, if trawling for shrimp and/or clams occurs on these sand ridges, it would be appropriate to discuss this trawling to put the disruption due to dredging in perspective.

Level I Comment #4: Mean Grain Sizes

It is still not possible, from the information provided, to ascertain how the mean grain sizes reported from Unnamed Shoals A and B were derived. This issue is of importance in substantiating claims of sand compatibility and renourishment volumes. Why not clarify sample analysis and calculations of mean grain sizes? For example, p. 43 states, "The mean grain size in the top layer of Unnamed Shoal A is calculated to be 0.42 mm while the top layer of Unnamed Shoal B has a mean grain size of 0.34 mm." How were these means calculated and what is the standard deviation? Providing some measure of spread in mean grain size would be useful. Appendix A provides insufficient information to assess these questions and no other source of documentation is provided. Are the means calculated from the composite values provided for each core?[2] Are they an average of all grain size measurements taken in each core? Are they volumetric averages? Further, Appendix A appears incomplete without inclusion of information summarizing grain size calculations and sampling procedures associated with the table provided. For example, each upper, mid and lower core position is associated with a single analysis of grain size. Grain size can (and does) vary significantly with depth such that selection of a single sample from a section of core that is several feet long may not be representative of the average grain size across that section. How were the samples within each depth range selected and what criteria were used to determine the depth ranges analyzed? In summary, transparent reporting of procedures is advisable and would improve the reader's confidence in the summary values reported. We also suggest including standard deviations for individual grain size analyses as well as for the mean grain sizes used in modeling and analysis of renourishment volumes. The effect of data spread on model results should also be addressed (see also TM #1, section 2.3 and TM #2, section 2.3).

Level I Comment #5: Use of Historical Aerial Photographs

Use of historical aerial photos as evidence for temporal shifts in longshore transport directions is misleading. For example, p., 99 states, "Northerly sediment transport is evidenced by the accumulation of sediment on the southern side of the previously existing groins (Photo 8, taken in 1994), and evidence of southerly sediment transport in the past is shown in Photo 9 (taken in 1969). As discussed in the ITR TM #1 and TM #2, aerial photos often capture seasonal trends in longshore sediment transport that are not indicative of long-term net transport direction. In TM #1 we suggested that an analysis of historical aerial photographs be carried out. In TM #2 we recommended that the document at least acknowledge the appearance of southerly trends in photographs beyond the one shown in Photo 7 of the previous draft of chapter 3. Currently, a single historical photo showing transport to the south has been added to the document. The implication is now that transport was always to the south historically (e.g., Photo 9) and is now always to the north (e.g., Photo 8). This implication is misleading and has the potential to be interpreted as an attempt to selectively present data that supports a desired conclusion.

[2] Composite values would be most appropriate as the dredge and placement operation will thoroughly mix the sediments removed.

We strongly suggest either:

1. removing the aerial photographs and associated text from the document completely,
2. adding a statement following presentation of the two photographs that clearly acknowledges the possibility for aerial photographs to capture seasonal reversals thereby making it difficult to conclusively determine net long-term transport directions from aerial photographs, or
3. carrying out and presenting an historical photo analysis and adding a statement to the effect of that discussed in 2 above.

Level I Comment #6: Monitoring and Mitigation

Given the importance of mitigation and monitoring in determining project success we suggest a few revisions to this section. Appropriately, the potential for long-term adverse effects on geology (e.g., narrowing and/or lowering of the barrier island landform) due to prevention of overwash has been added to the discussion of impacts earlier in the document. Given the broad scale of such an impact, it seems prudent to address this matter – at least briefly – in section 5.1.1.1. Chapter 5 provides discussion of a shoreline change monitoring program as suggested by earlier ITR TMs, however, we suggest expanding this section to provide additional detail and to address some potential deficiencies in the monitoring plan. Although model results have indicated that there will be little effect of the reduction in shoal volume on Assateague Island, is it worth considering inclusion of Assateague Island in the monitoring program, at least initially, to verify that this determination is likely correct? Additionally, clearer and more complete articulation of the beach monitoring program is necessary to demonstrate that such a program will meet the project needs - especially in light of the adaptive design approach. For example, more detail on data collection and analysis should be provided, along with a few references to existing studies that follow similar established procedures. Examples of areas to be addressed include:

- Will topographic profiles be generated from LiDAR data only or will ground surveys be included? If the latter, how will the two different types of surveys be tied together?
- How will bathymetric profiles be collected?
- How will the gap between topographic and bathymetric surveys be closed? (Actually, some land based survey methods, i.e., rod and level, will be required to establish the profiles in water depths too shallow for fathometer soundings while maintaining adequate "overlap" with the fathometer data for quality control.)

In conjunction with the semi-annual surveys, we recommend collecting sand samples for analysis and comparison through time to aid in tracking beach fill movement. In addition to the semi-annual surveys we suggest that the monitoring plan include a discussion of the desirability of including post-storm surveys following significant events whenever possible. Though we acknowledge that it involves additional expense, we also suggest adding a directional wave gauge and a tide gauge to the monitoring program.[3] Both gauges would provide information that would benefit future modeling efforts greatly. Simple inclusion of statements indicating that monitoring will be carried out by an independent contractor with experience in monitoring, measuring and analyzing patterns of shoreline change would also strengthen this section.

Level I Comment #7: Sea-level Rise

The EIS states that **sea-level rise (SLR)** is "a necessary component of the project design" (p. 194) and Chapter 3 (Physical Environment, p. 78-79) highlights SLR as a process that makes Wallops Island particularly vulnerable to infrastructure damage; i.e., "The shoreline at Wallops Island would experience the effects of future sea-level rise, as coasts and barrier islands are particularly vulnerable to the sea-level rise and intensified storm and wave events attributed to climate change (Nicholls et al., 2007)." Moreover, the SRIPP encompasses a 50 year planning horizon – a time span long enough for SLR to impact the SRIPP. However, the first two chapters make little mention of SLR (first mention of SLR on p. 52) to the exclusion of references to storm damage mitigation and reducing "storm-induced" physical damage (numerous statements in Chapters 1 and 2). For example:

- Abstract – no mention of SLR
- Executive Summary – "storm" used 9 times; "sea level" used 0 times
- Chapter 1 - "storm" used 7 times; "sea level" used 0 times
- Chapter 2 - "storm" used 58 times; "sea level" used 1 time (p. 52)

Given the need for developing justification for the SRIPP, setting the context for the SRIPP, and using SLR scenarios in design selection and engineering models we recommend:

- **including SLR discussion earlier in Chapters 1-2 to provide balance between processes that produce changes over various time scales**. Possibilities include:
  Abstract – could mention possibility of climate change and SLR
  page 1: "This Programmatic Environmental Impact Statement (PEIS) has been prepared to evaluate the potential environmental impacts from the proposed Wallops

[3] In discussions with Corps Field Research Facility personnel, subsequent to the March meeting, we were advised that the initial cost of a directional wave gage was $ 120,000 rather than the $ 375,000 reported at the meeting. The annual maintenance costs were stated to be $ 20,000.

Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP). The SRIPP encompasses a 50-year planning horizon and is intended to reduce-damage to Federal and State infrastructure on Wallops Island" caused by the combination of sea-level rise (SLR) and coastal storms.
page 2: "Two of these tenants, the U.S. Navy and MARS, have facilities on Wallops Island that are at risk from SLR and storm damages and would be protected by the Proposed Action."

- **improving discussions to include and emphasize the links between SLR and storm activity**; Sea-level rise is an important changing background condition that will make protection of NASA facilities increasingly difficult into the future by increasing the effect of storms, i.e., given the same storm today and in 20 years, the effect will be greater in 20 years due to higher water levels. For example, in Chapter 4: Environmental Consequences, no mention is made of the possibility of more frequent wave overtopping as sea level rises; the three brief paragraphs seem to short shrift the possible impacts (p. 194).

- **clarifying the role of sea level on the sediment transport regime**; for example, "As sea level rises, it is anticipated that the beach on Wallops Island would be exposed to increasing rates of sediment transport, and therefore would erode at increasing rates over time…" (p. 200). In addition, state the basis for this claim.

- Though Figure 15 appropriately shows a blue "sea-level rise fill layer" as included in the design, the approach and significance of this layer is not addressed in the main text, rather one must search for it in the appendix. We suggest adding a brief explanation within the description and comparison of alternatives in Chapter 2.

- It would also be useful to report the historical rates of sea-level rise for the study area, for example, from the Hampton Roads tide gauge.

Level I Comment #8: Downdrift Impacts

The downdrift impacts of Alternatives Two and Three are oversimplified and questionable:

- p. 204 (and elsewhere), is the only effect of the groin alternative a 300 m "shadow" area?
- p. 205 (and elsewhere), is the impact of the breakwater (i.e., erosion and LST) no more than 2.5 km?

- What is the principle whereby the breakwater causes an impact over a shoreline segment that is eight times longer than the groin?

Level II Technical Comments and Recommendations

Level II Comment #1: Improve Consistency and Accuracy of Impact Summary

The table summarizing impacts (Table ES-1: Summary of Impacts from Proposed Action Alternatives) should be edited to more accurately reflect main sections of the text that highlight the most important and most significant impacts. In some cases, the table appears inconsistent with, or to exaggerate impacts as described in the text. For example:

- "Over the lifetime of the SRIPP, the seawall extension and beach fill would have long-term direct beneficial impacts on geology and the Wallops Island shoreline by mitigating the current rate of shoreline retreat." This statement deals only with the impacts to the shoreline without treating the impacts to geology. As stated on p. 195, there will likely be long-term adverse impacts on geology because overwash will be prevented thereby causing island narrowing. This impact should be addressed in the summary table as well.

- "The addition of sediment to the longshore transport system would result in accretion at the southern end of Wallops Island and northern end of Assawoman Island" This appears to be a potentially misleading overstatement of text on p. 199 that reads, "In summary, under Alternative One, the rate of erosion on the southern end of Wallops Island and the northern end of Assawoman Island would be reduced due to additional sand available for transport…"

Level II Comment #2: Provide a More Balanced Presentation of Impacts

In general, this version of the PEIS is improved in terms of recognizing the positive aspects of the Project; however, we believe that the positive aspects merit greater emphasis to achieve a better balance.

Level II Comment #3: Justify 50-year Storm Event

Table 1 on p. 32 and the associated text on p. 31 of the PEIS provide a discussion of the initial screening of project alternatives. This table appears useful but is somewhat misleading in that it pairs each alternative with a specific level of storm damage reduction. If this table is to be used it should be clearly indicated in the text and in the table that the level of storm damage reduction provided for each alternative is an estimate and therefore representative only of an *anticipated* level of storm damage reduction. For example, changing the text and second to last column heading to "Anticipated Level of Storm Damage Reduction" would provide clarification. Additionally, exclusively listing impacts on adjacent barrier islands as "positive" or "negative" oversimplifies to the point of confusion. Based on the description, this last criterion seems to be an initial assessment of whether or not the project adds sand to the longshore sediment transport system. We recommend providing a text heading (p. 31) and a column heading (p. 32) that is more reflective of this screening criterion (perhaps "Anticipated Change in Sand Availability for Longshore Transport").

Level II Comment #4: Further Clarify Uncertainty in Nodal Zone Position

Further clarify uncertainty in nodal zone position: The presentation and discussion of nodal zone are improved and better reflect uncertainty in position of the nodal point. However, for consistency and to maintain a consistent level of transparency, we suggest annotating Figure 26 in the same manner as Figure 25, showing the position of the nodal zone and reporting the 95% confidence limits on sediment budget numbers as +/- values rather than reporting only the average. Also recommend noting location of the nodal zone on all other similar figures, e.g., Figures 42-44.

Level II Comment #5: Improve Readability

To increase readability of the document by reducing repetition, is it possible to make some general statements that will avoid repetition? For example, could it be said: "In the following paragraphs, unless stated otherwise, all diesel engines will be required to use low sulfur fuel"?

Also, fixing grammar problems will improve both readability and credibility, e.g.,:

- farther vs. further , p. 75, 93, 99 to name a few (do a global search of entire document)
- data = plural, p. 78, 82, 94 "This data…," should read "These data…." "The data is…" should read, "The data are…." (do a global search throughout the document)
- hyphenate sea-level rise throughout the document, but not "the sea level rises" – only when sea level is used as an adjective, e.g., p. 98

Level II Comment # 6: Clarify Predicted Sediment Transport Patterns

Erosion is expected following the beach fill and GENESIS models have estimated the amounts in "Impact on the Shoreline from Seawall Extension," but where will all of this sand go and what will be the impact of the redistribution of this material? The EIS would benefit from more specific statements than "…once the beach fill is completed, the short-term adverse impacts during Year 1 would be mitigated in the long-term and beneficial impacts on Wallops Island, Assawoman Island, and potentially other islands to the south would occur …."

Level II Comment #7: Address Potential Narrowing of Tom's Cove Isthmus

p. 200, Could changes in wave refraction patterns associated with mining offshore shoals contribute to "Narrowing of Tom's Cove Isthmus?"

Level II Comment #8: Address Impacts on Chincoteague Inlet

p. 203, clarification on the impact of beach fill and mining the north end of Wallops on Chincoteague Inlet is needed. While the EIS mentions eastward migration of Chincoteague Inlet as a function of the accretion at the north end of Wallops, no mention is made in the impacts section on the potential westward migration of the inlet in response to mining the northern end. Major changes to tidal channel bathymetry could be expected.

Level II Comment #9: Discuss Impacts of Historical Large Storms

The discussion of storms skips or omits the Ash Wednesday storm of 1962 and the Halloween Storm of 1989… probably the two key events of the past 60 years in terms of changes to Wallops Island. The EIS may benefit from discussion of specific large storm impacts.

Level II Comment #10: Review Accuracy of Invertebrate Impacts

Some of the information on the impacts on the major invertebrates is questionable. For example, the statement regarding their ability to survive while dredging is underway needs confirmation. Invertebrates cannot dig into or out of dry beach deposits. They require a saturated substrate in order to create a "quick" condition in the upper layers of the beachface. This behavior is discussed extensively in the coastal science literature that we previously submitted (e.g., Peterson *et al*., 2000).

Minor technical comments contained in a previous version of TM #3.

SRIPP ITR Minor Comments and Recommendations (Note: This is only a partial list)

- Edit to remove non-gender neutral language that may be off-putting to some readers (why take the chance of offending readers in this way, when it's so easy to avoid it?). e.g., Man's environment = human environment, man's activities = anthropogenic activities, etc.

- p. 33, second sentence of second paragraph- clarify. Doesn't make sense as written.

- Above Table 35. The ratio above this table should be dimensionless and should be: $0.047/7{,}150 = 6.6\text{x}10^{-6}$.

- p. 52, Year 2 nourishment placement activities to "its equilibrium profile." How known?

- p. 52, 54, explanation of "minimum target fill" unclear and not carried out in the discussion

- p. 57, first mention of "monitoring," but unspecified ("on a regular basis")

- p. 57, the term "beach" used incorrectly twice

- p. 73, define acronym "BMP" at first use in each chapter.

- p. 76, "Nor'easters are difficult to predict because their wind speed is not always related to their wave heights."????

- p. 76 Zhang's paper cited as the only one that demonstrates storminess is not linked to global warming… but hurricanes are! (p. 77)

- p. 76, last paragraph, "…which is most damaging along long areas of coastal zones. Nor'easters are difficult to predict because their wind speed is not always related to their wave heights." These two sentences should be clarified and corrected.

- p. 77, second paragraph, "According to a 30-year study by Komar and Allan (2008), the waves off the east coast of the United States are gradually increasing in height, especially those generated by hurricanes." During the study, a net increase in the occurrence of waves…" The study by Komar and Allan was not 30-years long, rather the study investigated a 30-year wave record. The two sentences should be edited accordingly to correctly convey this information.

- p. 78, first sentence: "…how local historical changes and unique circumstances, like rate of subsidence, shoreline retreat, wave and tidal patterns, and presence of manmade structures, affect the sea-level rise within a particular area." Of the items listed, only subsidence affects relative sea-level rise rate. The other items in the list should be removed.

- p. 81 states: "Bathymetry is the measurement of depth". Isn't bathymetry the product of the measurement of depth?

- Why is section 3.1.3 Previous Erosion Prevention and Shoreline Restoration Efforts in
- Chapter 3: Physical Environment section?

- p. 81 ff. Section on "bathymetry" only addresses Assateague and Fishing Point, but not Wallops.

- p. 93, Fishing Point is a "cape?"

- p. 95, section 3.1.5.4 Offshore Sand Shoals is not as detailed as the "Bathymetry" section on p. 81.

- Redundancies: waves, shoals, geographic setting

- p. 96 reads: "…and 11 seconds apart with an 11 second period." Should read "…with an 11 second period."

- p. 98, How are LST direction known?

- p. 131, How is the inventory of invertebrates known?

- p. 156 states: "Continental shelf edge sightings were generally associated with the 1,000-m depth contour…"The continental shelf edge is usually taken as 200 m.

- p. 167, Figure 33 – PHOTO MISSING

- Typo on Page 174. Should be "218 people per km^2".

- p. 193, Cannot erode an inlet (Assawoman)

- NRC (1987) Report referenced for high/low eustatic SLR? Need newer reference.

- p. 195, accuracy of statement on p. 195 – 1st sentence under "*Impacts on the Shoreline from Seawall Extension?"*

- p. 205, strange terms: "benefit to sediments?" "opposite of the breakwater?"

- p. 195 states: "Construction activities would cause erosion in the short-term.". Please explain the mechanism whereby construction activities cause erosion.

- In Tables 31 through Table 47, why are some of the columns in tons per year and some in metric tons per year?

- Typo on p. 205, Fourth Line: Should read “Three” rather than “Two”.

- pp. 207 and 208. In discussing the effects of the structures, it is stated, for example, that: “…construction of a groin would reduce erosion rates locally.” However, there is the potential that a groin (or breakwater) would either cause or be perceived to cause erosion to occur. Groins can be tricky in their effects and depend on wave characteristics, beach conditions between renourishments, etc.

- p. 209, in discussing infilling of borrow pits. Our understanding is that the infilling of borrow pits is poorly understood and that at least in some cases, borrow areas infill with considerably finer sediments than the native and that this process can take a substantial time.

- p. 209 and elsewhere: “slowing wave energy”. Not standard terminology. “Reduce wave energy”?

- p. 222. In discussing air pollutants emitted it states that “Allowance was made for 10% downtime….” Is the downtime relevant to total emissions released?

- p. 274 states: “Temporary increases in the volume of marine traffic would occur for approximately seven months during initial beach nourishment and approximately six months during each nourishment cycle.” Page 295 states: “In addition, the SRIPP dredging operations would last approximately 7 months during the initial construction phase and approximately 2 months during each renourishment cycle.” Why the disparity?

- Some of the conversions from km to miles are incorrect. For example, p. 274 converts 5 km to 8 mi. Also conversion problems are present elsewhere in the report.

- Table 33 and others. The releases are in terms of annual quantities. Are these averages and thus amortized over the 50 year period. Perhaps we missed this explanation.

- p. 257, wording. “driving the suction through the pipe”.

- p. 267. Should “induced” be “multiplier”?

Commenter Affiliation	Commenter	Comment	Topic	Response
Federal Agencies				
USACE	Robert Cole	The cumulative impacts section lacks sufficient information and detail. Cumulative Impacts assessments should begin when NASA began using Wallops Island and needs to include, not only NASA's impacts, but Navy and any other tenant that has done work on the island, such as the Napalm testing that was accomplished on the Island. I am not familiar with all of the past activities; however the Cumulative Impacts section must address all impacts, past, present, and for the foreseeable future. Future expansion is being planned that is not addressed by the EIS. For Example: NASA is proposing to install an electrical loop on the southern end of the island to facilitate future development. The proposed shoreline stabilization project will protect this area; therefore the proposed expansion must somehow be addressed by the Cumulative Impacts portion of the EIS. In conclusion, the Draft EIS needs to address cumulative impacts in more detail to pass 404(b) requirements.	Cumulative Impacts	Section 4.7 of the PEIS, Cumulative Impacts, has been updated substantially including addition of a comprehensive past activities discussion and maps showing impacts on various resources since NASA's occupation of Wallops Island in the 1940s. More discussion has been added to the potential impacts under various resources.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	Page 102: The text states that saltwater intrusion is not a problem "because the salt water is not hydraulically connected to the groundwater aquifer." The PEIS would benefit from a reference or data to support the contention that the system is not connected. Use of the Barlow (2003) reference that salt water intrusion is most often caused by pumping from coastal wells (not site specific) implies that a hydraulic connection between salt and fresh water might exist. The Barlow (2003) reference is not included in the list of references. Barlow, P.M., 2003, Ground water in freshwater- saltwater environments of the Atlantic coast: U.S. Geological Survey Circular 1262.	Affected Environment	The PEIS text has been revised to state that " Most often, saltwater intrusion is caused by ground-water pumping from coastal wells (Barlow, 2003), or from construction of navigation channels. No such activities are proposed for the SRIPP. Salt water intrusion can also occur as the result of a natural process like a storm surge from a hurricane." The Barlow reference has been included in the reference list.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	Considering the significant cost and impact to the environment that may result, and the partial protection that will result, we recommend that NASA consider other alternatives, provide additional analysis of the effects of the evaluated alternatives, and seek to mitigate the potential effects to the maximum extent practicable. There are ample opportunities to	Alternatives	NASA, in conjunction with its cooperating agencies, feels that the alternatives considered in the PEIS best meet the purpose and need while balancing impacts, costs, and schedule. NASA consulted with NMFS and USFWS and the mitigation measures from the consultation have been incorporated into Chapter 5 of the PEIS. Additionally, NASA would implement a monitoring program and use an adaptive management approach (described

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		incorporate mitigative activities into the proposed action such as timing implementation of project activities to avoid sensitive periods for fish and wildlife, working to improve habitat quality in conjunction with project features, and monitoring and adaptive management to specifically address environmental issues and minimize effects.		in Section 1.4 of the Final PEIS). Future NEPA documentation for renourishment would describe potential environmental impacts, and NASA would consult again with agencies as appropriate.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	There appears to be unexplained discrepancy in the level of detail provided for individual project components. For example, beach fill and sand borrow/mining activities are very loosely defined, yet the analysis only discusses a limited amount and frequency of sand placement. In these cases there is acknowledged uncertainty about the performance of the project, the environmental factor that will affect the project performance and implementation of future renourishment. In contrast, the sand retention structures described in alternative 2 and 3 described in specific detail, including location, size, and material. In addition, several other configurations of these features were apparently considered and dismissed with only cursory mention in the EIS.	Alternatives	The intent of the PEIS is to be programmatic but to also allow for a sufficient level of detail for implementation of the Proposed Action Alternatives. Section 1.5 (Scope of the PEIS) of the Final PEIS has been updated to provide a more detailed description of how NASA plans to use this document to aid in planning for the SRIPP. Appendix A provides additional detail on the design of the Preferred Alternative. The USACE has also advanced the engineering design details of the beachfill since publication of the Draft PEIS and these are reflected in the Final PEIS. Regarding screening of the Alternatives, additional information has been added to Sections 2.3 and 2.4 of the Final PEIS to explain how various project configurations were considered but ultimately dismissed from detailed study.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We recommend revising the alternatives discussed to be more consistent with the implementation and intent of a programmatic EIS.	Alternatives	Due to the immediate need for storm damage reduction measures on Wallops Island, the PEIS has been prepared to analyze programmatic impacts while also providing a sufficient level of detailed analysis to support the project's initial construction phase. Using the best available data and understanding of the sediment transport system at the time the Draft PEIS was developed, all alternatives were modeled very specifically to reflect actual impacts from initial construction. Longer term project options, such as sources and frequency of renourishment fill, were given a more programmatic treatment as details regarding those components are not fully defined. Section 2.1 of the Final PEIS has been revised to clarify NASA's strategy for the SRIPP. As part of NASA's Adaptive Management and Design approach (Section 1.4 of Final PEIS) and based on the results of future monitoring efforts, additional alternatives may be considered. Supplemental NEPA documentation would be prepared at that time.
U.S. Department	Willie Taylor	The migratory birds identified and considered in the	Birds	The Affected Environment (3.2.2.3) and Environmental

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of the Interior, Office of Environmental Policy and Compliance		DPEIS do not sufficiently address or represent the species that may occur in the area or the potential effects on them. … As we recommend in our previous letter on this project, we encourage NASA to develop appropriate monitoring to allow assessment of the effects of dredging on these species.		Consequences (4.3.2.2) sections of the Final PEIS have been updated to include more information regarding birds including migratory birds and sea ducks. NASA would conduct bathymetric monitoring of the shoals that would provide information on the geomorphic changes to the shoals which could provide insight into the effects of dredging on EFH, fish species, and the birds that feed at the shoals.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We are concerned about the potential magnitude and duration of the effects to fish and wildlife resources and conservation lands, including cumulative effects that may result from this project. The long duration of the project, and the large amount and frequency of potential impacts to fish and wildlife and their habitats are the primary reasons for our concern.	Cumulative Impacts	Minimization and mitigation measures proposed for the SRIPP would reduce potential local and regional impacts to fish, wildlife, and conservation lands. Under the No Action Alternative, vegetation associated with the dune and swale zones and the shrub, thicket, and maritime forest areas located at the southern end of the island would continue to be at-risk as the shoreline continues to retreat. Increased overwash events would also impact coastal vegetation on Wallops Island. Over time, because this alternative would not prevent shoreline retreat, vegetation in the dune and shore environments may be adversely affected, thereby also adversely affecting fish and wildlife resources.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	The DPEIS does not sufficiently describe the effects of the project on upland wildlife species and migratory birds in particular. While the cumulative effects discussion does recognize that NASA mission-related disturbance may occur to birds occupying the beaches that are created, it does not describe or characterize the effects.	Cumulative Impacts	The text in Section 4.7.2.2 of the Final PEIS has been updated to reflect the complexity and level of detail needed to determine impacts from the SRIPP.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We recommend providing a more detailed and comprehensive analysis of cumulative effects on all resources beyond stating that cumulative effects will occur.	Cumulative Impacts	NASA has updated the cumulative effects section (4.7) of the Final PEIS to include a more comprehensive list of past actions at Wallops Island, has added new resource sections, and updated existing sections to more fully explain cumulative impacts on specific resources.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We recommend that the Preferred Alternative use site-specific dredging methods that protect existing geomorphologic integrity and wave sheltering properties by following two new MMS guidelines [iii]: (1) Avoid the crests of the two targeted shoals to maximize the shoals' wave attenuation function; to maintain the shallowest water wave-action processes,	Dredging	The dredging plan in Section 2.5.5.2 of the Final PEIS has been developed following the two most recent BOEMRE sponsored studies. Chapters 2 and 5 of the Final PEIS include updated dredging plans based on consultation with NMFS regarding EFH. Appendix J provides additional details regarding NASA's proposed dredging plan.

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		which are likely important for long-term shoal maintenance; and to maintain coarse-grained lag deposits in-place since these may serve to ensure crest stability by increasing resistance to wave erosion v,[vi]. (2) Avoid longitudinal dredging (i.e. dredging from the entire length of the shoal, along the longer axis), which affects the wave focusing processes [vii].		
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	Because of our previously expressed concerns that the proposed dredging will reduce the sheltering effect of the shoals and increase erosion along the already vulnerable Assateague Island shoreline, we support NASA's decision to dredge no deeper than the shoal base or seafloor, because that method will confine dredging to the active portion of the seafloor, and will avoid the creation of pits which could alter physical process patterns [xx].	Dredging	Comment noted.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We recommend that the Preferred Alternative use site-specific dredging methods that minimize impacts to sediment transport processes by following new Minerals Management Service guidelines [xxi] that dredged sediment be taken from the extreme downdrift accreting side of each shoal or, secondarily, from the extreme updrift eroding side of each shoal, to minimize the risk of breaking the sediment transport pathways by interrupting sand recycling and transport patterns and processes [xxii].	Dredging	The dredging plan in Section 2.5.5.2 of the Final PEIS has been revised based on EFH recommendations from NMFS.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	In those non-crest areas, we support NASA's proposal to dredge a thin uniform layer of material from a large area, because this method is likely to cause the least disturbance to existing shoal topography and geometry and, therefore, offers the least likelihood of substantial disturbance to the physical processes that maintain the shoals [xxiii].	Dredging	Comment noted. The dredging plan in Section 2.5.5.2 of the Final PEIS has been developed consistent with the two most recent BOEMRE sponsored studies.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We are concerned that potential dredging impacts on cross-shore sediment transport pathways were not addressed in the Draft PEIS, as we requested during the scoping process. We remain concerned that the removal of such a large volume of either shoal may impact the regional sediment budget and sediment	Dredging	Consistent with the two recently BOEMRE sponsored studies; NASA would employ dredging techniques (avoiding erosional areas, not dredging to excessive depth, etc.) to minimize long-term effects on the offshore sand shoals. As a result, the shoals would continue to dissipate incoming wave energy. In addition, the dredged areas would fill gradually over time from local

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		transport pathways, specifically the sentiment transport from the shoal and nearshore areas to Assateague Island, to the detriment of the island's shoreline, topography, natural coastal processes, and ability to keep pace with sea level rise.		sediment transport. The deep troughs landward of these two shoals would, in effect "isolate" the shoreline and its immediate profile off Assateague Island from the dredging effects. The shoals are detached shoreface ridges are isolated on the inner shelf. As such, these sand bodies have a high preservation potential and consequently, a low cross-shore sediment transport potential. Section 4.2.3.5 of the Final PEIS has been revised to provide additional information that supports this conclusion.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We recommend additional explanation of Figure 33. The identification of plover habitat areas should be explained in the context of the several recent plover nests shown outside of that area.	Editorial	The range of the Piping Plover habitat has been extended to the south to include the area where the 2010 nests were found. Text was added to Section 3.2.10.4 of the Final PEIS to clarify this point.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	In Table 22, we recommend clarifying VDGIF's joint jurisdiction concerning federally listed species that they also identify as threatened or endangered.	Editorial	The table has been clarified to state VDGIF as having joint jurisdiction for the species that have both a state and federal threatened or endangered status.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	The net sand transport direction shown in Figure 7 appears incorrect and inconsistent with discussion and photographs and groins and their function.	Editorial	Figure 7 is correct. The commenter may be misinterpreting the portions of figure depicted as beach versus ocean.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We appreciate NASA's effort to model the potential impacts of shoal dredging on the wave climate and longshore transport off of Assateague Island, but we are concerned about the apparent discrepancy between the modeling results [ii] (Volume II of the Draft PEIS) and the Executive Summary of those modeling results (Table ES-1). Although the modeled Impact Factor is lower than a Minerals Management Service (MMS) threshold of 1.0, it is still higher than 0.75 along portions of the already vulnerable Assateague Island shoreline. … In consideration of the largely unknown consequences of dredging the shoals, and with the	GENESIS model	It is understandable that while the modeling effort has shown that dredging either shoal A or shoal B would produce shoreline impacts that are below the MMS threshold, this does not completely satisfy reviewer concerns. The MMS threshold (Equation 8-1, pg 140 in USACE report attached as Appendix A to the PEIS) is a factor that is not easily interpreted. For example, some value of the factor cannot be interpreted as producing the same shoreline impact as a certain number of additional moderate storms per year. What can be said is that the threshold value of 1 is conservative. That is, given the dynamic nature of beaches, any impacts due to dredging can be expected to not be discernable within the natural variability of

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		recognition that our regional sediment transport pathways are poorly understood, ASIS is concerned about the potential impacts of the project on the wave climate that shapes Assateague Island's shoreline.		the shoreline. The modeling indicates that the largest shoreline impacts from mining either Shoal A or B would be less than the MMS threshold and are therefore marginal. The impacts from dredging either of these shoals is mitigated by the presence of Blackfish Bank and Chincoteague Shoal. In addition, the largest of Shoal A impacts would be south of the vulnerable Tom's Cove area. They will be in the vicinity of Fishing Point, an area which is rapidly accreting.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	The section on the affected environment does not adequately describe the environment on site or the environmental context of the project area. The DPEIS fails to adequately describe the context of the adjacent conservation lands and their significance to regional and national fish and wildlife populations. ... We believe that providing this type of context is necessary to adequately understand and consider the potential environmental effects of the project.	Habitat	Sections 3.2.2 (Wildlife), 3.2.7 (Finfish) and 3.3.1 (Land Use) of the Final PEIS have been updated to reflect the importance of the adjacent conservation lands and the fish and wildlife populations they support.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	The DPEIS indicates that the Assateague National Seashore does not extend into Virginia. While the Virginia portion of the island is owned by The National Wildlife Refuge system, the beach in this area is still within the Assateague National Seashore.	Habitat	The PEIS has been revised and now states that Assateague Island National Seashore extends into Virginia.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We support NASA's decision to avoid Blackfish Bank, which is known as a rich shoal habitat, as a dredge target. Additionally, we recommend that the Preferred Alternative use site-specific dredging methods that avoid the crest of the two targeted shoals to protect habitat value [xxvii,xxviii] for finfish, which preferentially congregate around higher-relief shoals for a variety of reasons including geomorphology, and for pelagic seabirds such as scoters which congregate in waters less than 30 meters deeps such as those above shoal crests.	Habitat	The dredging plan in Section 2.5.5.2 of the Final PEIS has been revised based on EFH recommendations from NMFS, which includes site specific dredging methods. NASA would target Shoal A for the initial fill and dredging would occur in areas that are accreting to the extent practicable. Erosional areas of the shoal would be avoided to the extent practicable. There is no plan to avoid shoal crests as recent studies have indicated that there is potential for recovery of shoal crest height provided the dredging cut depth is not excessive (MMS, 2010; Dibajnia and Nairn, *in press*). In addition, the crests have lower benthic abundance and diversity than the flanks and adjacent troughs (e.g., Cutter and Diaz, 2000; Diaz et al., 2006; Slacum et al., *in press*). Per Dibajnia and Nairn (*in press*) recommendations, NASA would not dredge along the entire length of the shoal.
U.S. Department	Willie Taylor	While the proposed project is expected to result in a	Habitat	Additional analysis has been incorporated into Chapter 4.7 of

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of the Interior, Office of Environmental Policy and Compliance		larger amount of beach habitat, the location of much of this habitat immediately adjacent to NASA facilities including launch pads, the existing UAV runway, and other infrastructure, reduces the value of this habitat, and may effectively result in the creation of an attractive nuisance by providing otherwise suitable habitat in an area where wildlife will be regularly (and potentially significantly) disturbed. In this context, it is not clear that the addition of this habitat is beneficial, except during those times when no NASA activities are under way.		the Final PEIS. NASA in consultation with USFWS recognizes that there is uncertainty of how the beach habitat would be used.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	The proposed action will result in significant degradation or complete removal of all existing beach habitat that is protected from disturbance to create an ephemeral beach proximate to numerous disturbances. We recognize that the use of the northern borrow area would help to reduce the impacts to offshore borrow areas, but as we expressed in our previous letter, we believe that a thorough discussion and evaluation of these tradeoffs and the different impacts to different species is needed.	Habitat	Additional information has been added to Chapter 4 resource sections of the Final PEIS to more clearly describe the potential environmental effects of excavating sand from north Wallops Island. As this component of the SRIPP is only a concept at this point, supplemental NEPA documentation, consultation with appropriate agencies (NMFS, USFWS, VMRC, etc.), and appropriate surveys and mitigation would occur prior to use of this area.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We recommend adding to the account of listed invertebrates that the northeastern beach tiger beetle is not currently known to occur on Atlantic coastal beaches in Virginia.	Invertebrates	The Final PEIS has been revised to incorporate the recommended statement.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	…the proposed action indicates that topography and bathymetry monitoring would occur as part of the project. The description of monitoring proposed indicates the types of information that would result, but does not provide information about how monitoring results will be used to make decisions about renourishment, to evaluate environmental impacts, or to evaluate the performance or efficacy of the proposed action.	Mitigation and Monitoring - General	As described in Section 5.2.2.5, NASA will prepare a semi-annual report that summarizes the data collection and analyses and provides recommendations for future work. It is anticipated that future specific actions will require NEPA documentation that can be tiered from this Programmatic EIS to address potential project-specific environmental impacts.
U.S. Department of the Interior, Office of	Willie Taylor	We also recommend that the Preferred Alternative consider the possibility that future research may identify increased impacts to the Assateague Island	Mitigation and Monitoring - Shoreline	Comment noted. This recommendation is addressed with the Adaptive Management strategy that would be implemented with the SRIPP and is the purpose of monitoring program.

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Environmental Policy and Compliance		shoreline, so subsequent dredging for beach renourishment may need to include mitigation of shoreline impacts on Assateague Island and consideration of alternative dredging locations.		
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	We recommend removing mention of potentially planting vegetation on the beach/dunes from the discussion of mitigation unless there is a commitment to conduct the planting.	Mitigation and Monitoring - Shoreline	NASA is committed to conducting the vegetation planting on the created dune. It would be included as part of the initial beach fill construction contract specifications.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	The north Wallops borrow site description does not appear to adequately express the intent or extent of the proposed activity in the area and use of this material. … We recognize the reasons why it might not be appropriate to delineate or limit an area where sand may be removed, but the extent of effects to the habitats should be described, even if only in a relative sense (e.g. is removal of the entire beach habitat in that generally area under consideration, or will some portion of the beach and beach vegetation be left unaffected).	North Wallops Island Borrow Site	The initial fill phase of the Preferred Alternative does not include use of the north Wallops Island borrow site. If north Wallops Island is selected as a renourishment borrow site, NASA would conduct new analysis including more detailed surveys of habitats in the potentially affected area, would re-initiate consultation with NMFS, USFWS, and DGIF regarding potential impacts and mitigation measures for protected species, and would prepare new NEPA documentation. Chapter 4 of the PEIS has been updated to include more information on impacts from excavation of north Wallops Island.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	The project, as proposed, is not being designed or implemented to prevent loss or damage to infrastructure, but to reduce the likelihood of damage or loss. Based on the design criteria cited, with the implementation of the proposed project, over its full lifetime, there remains nearly a 50 percent chance that the impacts to infrastructure and mission that this project is intended to protect will occur anyway as a result of a storm that exceeds design criteria.	Project Effectiveness	NASA assumes the comment is referring to the 100-year design storm return interval which means there is a one percent chance each year for a storm of the 100-year magnitude to occur. As such, there is not a 50 percent chance that the project would fail. However, NASA realizes that the magnitude of the 100-year storm may increase over time therefore NASA has committed to an adaptive management strategy.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	ASIS (*Assateague Island National Seashore*) is concerned about the potential impacts that the Preferred Alternative may have on the wave climate, cross-shore sediment supply, and pelagic habitat value of ASIS.	Project Impacts - Shoreline	Results of the USACE modeling to evaluate potential impacts from dredging on ASIS indicate that no measurable impacts would occur to the ASIS shoreline. In addition, NASA would follow guidelines recommended in the two most recent BOEMRE sponsored studies. As a result, the shoals would continue to dissipate incoming waves. Also, the dredged areas would fill in gradually over time from local sediment transport. The deep troughs landward of these two shoals would, in effect “isolate” the shoreline and its immediate profile off Assateague

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				Island from the dredging effects. The shoals are detached shoreface ridges are isolated on the inner shelf. As such, these sand bodies have a high preservation potential and consequently, a low cross-shore sediment transport potential. Section 4.2.3.5 of the Final PEIS has been revised to provide additional information that supports this conclusion.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	Recognizing that offshore shoals dissipate incoming wave energy, and thereby help to shelter shorelines from the erosive effects of large waves, ASIS (*Assateague Island National Seashore*) is concerned that the proposed dredging will significantly reduce the volume, height, and associated sheltering effect of the targeted shoals and will ultimately impact the shoreline conditions on Assateague Island.	Project Impacts - Shoreline	Results of the USACE modeling to evaluate potential impacts from dredging on ASIS indicate that no measurable impacts would occur to the ASIS shoreline. In addition, NASA would follow guidelines recommended in the two most recent BOEMRE sponsored studies. As a result, the shoals would continue to dissipate incoming waves. Also, the dredged areas would fill in gradually over time from local sediment transport. The deep troughs landward of these two shoals would, in effect "isolate" the shoreline and its immediate profile off Assateague Island from the dredging effects. The shoals are detached shoreface ridges are isolated on the inner shelf. As such, these sand bodies have a high preservation potential and consequently, a low cross-shore sediment transport potential. Section 4.2.3.5 of the Final PEIS has been revised to provide additional information that supports this conclusion.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	While the DPEIS states that the actual renourishment cycle would be determined by the magnitude and frequency of storm events and would vary throughout the 50-year life of the proposed action, all subsequent discussion references only assumed renourishment of 616,000 m3 of sand every five years, and nine renourishment cycles. This description does not adequately represent the range of reasonably foreseeable outcomes or provide any way to assess whether this estimate of renourishment frequency and projected fill volumes is an average estimate, or what range of variation might be appropriate to expect.	Renourishment	The beach response to the initial fill was modeled using not only average wave conditions, but also the entire hindcasted wave dataset, broken into 20 different 4-year blocks, as described in Appendix A, pgs 95-96. This range of beach responses allowed 95% confidence intervals to be calculated for the initial beach response. This level of modeling effort was not performed for the renourishment fills. Instead, only average wave conditions were modeled which only allowed for an average renourishment volume (616,000 m3) to be calculated. This savings in modeling effort and expense is justified on several grounds. First, the actual renourishment volumes would not based upon this modeled value, but rather upon a value calculated from the monitoring data at the time each renourishment is to occur. This is different than the initial fill, which would not be based upon the monitoring effort. Secondly, the primary use of this modeled renourishment volume value is to estimate the total renourishment volume (616,000 * 9) needed during the 50-year life of the project. The variation in this total renourishment number is much less than 9

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				times the individual variations. That is, some renourishment volumes are expected to be greater than this modeled value, while others are expected to be less and these variations in renourishment volumes are statistically expected to largely cancel each other out. In addition, the monitoring of many past beach fill projects has shown that renourishment volumes have a tendency to decrease over time. The explanation is that early in the project lifecycle, it is relatively easy for waves to carry sand to adjacent beaches, because of the shoreline offsets at the ends of the project. However, as material which is eroded from the project site accumulates on adjacent beaches, there is less shoreline offset at the time of renourishment and the erosion rate at the project site decreases. The modeled renourishment volume is calculated as the first renourishment volume, and as such, is considered conservatively large. Therefore calculations of confidence intervals on the renourishment volume were not deemed to add sufficient value to the modeling effort.
U.S. Department of the Interior, Office of Environmental Policy and Compliance	Willie Taylor	ASIS (*Assateague Island National Seashore*) is concerned that the proposed dredging of shoal habitat will impact pelagic fish and birds that use both shoal areas and the oceanic and estuarine waters within the ASIS boundary.	Wildlife	Comment noted. NASA recognizes that there would be unavoidable localized adverse impacts to fish and wildlife resources from implementation of the SRIPP, however these impacts would not be significant within a regional context. The Final PEIS addresses the following impacts on shoal habitats from dredging: Dredging sand from either offshore shoal would have a significant and immediate adverse impact on the local benthic community of the shoal. The primary direct effect would be the removal of sand and entrainment of the infauna and epifauna that reside within and on the sediment. However, it is expected that there would be a negligible impact on the regional benthic ecosystem because: (1) the benthic assemblages on the sand shoals are not unique and similar to assemblages in adjacent areas and (2) the spatial extent of the dredged area is small compared to the broad area of the nearshore continental shelf. The loss of benthic organisms would create a loss of prey for local wildlife, including some managed fish species, but the effect would be localized and temporary. The hopper dredge would also cause an increase in turbidity which could temporarily disturb the ability of fish, surf clams, and other mollusks to feed; however, this effect would be temporary.
US EPA Region	Jeffrey D. Lapp	<u>Other:</u> Existing underwater noise conditions have not	Affected	As stated in the PEIS, existing underwater noise levels are

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III		been evaluated. Noise monitoring was last conducted in 1992. However, since that time conditions on the island have changed and operations have expanded. EPA recommends updating the 1992 study of baseline noise conditions at WFF.	Environment	unknown. Baseline noise conditions have not changed at Wallops Island with the exception of additional large- and medium-class rocket launches, which result in short-duration high-intensity noise that does not contribute to on-going baseline conditions.
US EPA Region III	Jeffrey D. Lapp	<u>Other:</u> Please discuss facility adaptation and the air emissions of the proposed action with respect to WFF as a whole, such as is directed by CEQ draft NEPA guidance (2010) on Considerations of the Effects of Climate Change and Greenhouse Gas Emissions.	Air Quality	Sections 4.2.7 and 4.7.2.1 of the Final PEIS describe the effects of the project on climate change and greenhouse gas emissions, as well as how climate change considerations were included in project design.
US EPA Region III	Jeffrey D. Lapp	<u>Purpose and Need and Alternatives:</u> The relocation of at risk infrastructure was not carried forward for detailed analysis. Explain why a relocation of pad and support facilities would need to maintain the same general size and layout of the current facilities. Are other configurations possible that may allow some or the entire infrastructure to be relocated? Has the acquisition of additional property been investigated to add to the NASA controlled buffer, which may enable additional Wallops Island infrastructure to be move onto the Mainland or Main Base?	Alternatives	As described in Section 1.2.4.2 of the Final PEIS, the facilities on Wallops Island are not only located to ensure public and employee safety, but are also sited based on interrelationship with other facilities including those at the WFF Main Base and Mainland. The existing configuration would need to be maintained to adequately support the various mission activities and maintain safety buffers. Additional information has been added to Section 2.2.1.1 of the Final PEIS to illustrate the hazards inherent with WFF's launch range operations. Because of the unacceptable impacts on local landowners if facilities are moved, purchasing land and relocating infrastructure inland is not feasible.
US EPA Region III	Jeffrey D. Lapp	<u>Purpose and Need and Alternatives</u>: If facilities are not going to be relocated further on inland, EPA would recommend that further investment into future infrastructure on Wallops Island be avoided. The barrier island is a dynamic and unstable system that is very vulnerable to sea-level rise and intense storms. It may be prudent to consider this dynamic nature when looking at future development projects.	Alternatives	Comment noted. NASA has considered the fact that Wallops Island is a dynamic environment and therefore only locates critical facilities there that are absolutely necessary for launch operations. Refer to Section 2.2.1 of the Final PEIS for additional information.
US EPA Region III	Jeffrey D. Lapp	<u>Purpose and Need and Alternatives</u>: Clarify what level of storm protection has been determined and why this specific level is necessary.	Alternatives	The SRIPP has been designed to provide storm damage reduction from a 100-year storm. Ideally, NASA would provide protection against a much larger storm event; however, in consultation with the USACE, the 100-year storm was used in design based on an optimized approach in which a balance is obtained between initial construction costs and the maintenance costs associated with storm-induced damages.
US EPA Region	Jeffrey D. Lapp	<u>Purpose and Need and Alternatives:</u> Please provide	Alternatives	Section 2.4.2 of the Final PEIS has been updated to include a

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III		more information on rationale for eliminating options during secondary screening, particularly the use of reduced beach fill. Clarify why this alternative was eliminated, the level of storm protection it would provide and how that relates to the purpose and need of the project.		more detailed explanation on the screening of alternatives. Regarding the reduced fill options, there are two basic reasons for their elimination. The first is straightforward – the short fill (between the south camera stand and Building W-65) does not satisfy the project requirements of providing storm damage reduction to the at-risk assets on Wallops Island. The portion of the facility north of Building W-65 would remain mostly unprotected as it is today. The second reason is regarding project costs. Shorter fills cost more to maintain on a per foot of beach basis than longer fills. The theoretical arguments for this are presented in Dean (2002). The following quote is from Dean (2002): In fact, the longevity of a project varies as the square of its length, thus if Project A with a longshore length of one mile "loses" 50% of its material in a period of two years, Project B subjected to the same wave climate and constructed of with sand of the same characteristics but with a length of 4 miles would be expected to lose 50% of its material from the region where it was placed in a period of 32 years! Thus project length is very significant to performance.
US EPA Region III	Jeffrey D. Lapp	<u>Purpose and Need and Alternatives:</u> Page 64 states that if year two or three funding is pulled "the completed portions of the project would be viable projects themselves and wouldn't have negative shoreline consequences." If seawall only and seawall and partial beach fill are considered to be viable, they should both be considered as alternatives for the proposed action. Additionally, funding for the replenishment cycles should be discussed, as well as possibilities for funding not being secured for future cycles.	Alternatives	Due to the availability of funding for the initial phases of the SRIPP, individual elements (seawall, beach fill) are separated. Therefore, they are presented in the PEIS as individual packages based on funding and procurement. However, each individual project element would only partially fulfill the purpose and need and therefore would not be constructed by itself as a long-term solution. Sections 2.1 and 2.6 of the Final PEIS has been revised to clarify this point.
US EPA Region III	Jeffrey D. Lapp	EPA cannot adequately assess the effects of the proposed undertaking on cultural resources since the location(s) of the pump-out station(s) has not been identified by WFF; detailed comments are included in the attachment.	Cultural Resources	Potential impact footprints of the pump-out buoys would be minor and consist of anchor footprints and anchor sweeps. Specific locations and anchoring methods for the pump-out locations have not been determined but would be located approximately at the 9 m (30 ft) depth contour which is about 3 km (2 mi) offshore. NASA consulted with VDHR on this issue in July 2010; additional Section 106 consultation would be required for the areas around the pump-out stations once the

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				locations have been identified.
US EPA Region III	Jeffrey D. Lapp	Cultural Resources: Page 177 states, "In a letter dated December 4, 2003, the Virginia Department of Historic Resources (VDHR) concurred with the recommendations of the CRA and VDHR accepted the predictive model for archaeology at WFF, noting that many of the areas with moderate to high archaeological potential are unlikely to be disturbed by future construction or site use." A copy of the letter dated December 4, 2003 from VDHR should be included in the Appendix. It would also be beneficial to include the *Cultural Resources Assessment for Wallops Flight Facility* in the Appendix of the FEIS to understand VDHR determination concluding that future construction or site use would not disturb potential archaeological areas without knowing the type of project work that could result in the future.	Cultural Resources	NASA strives to maintain brevity in its NEPA documents. As such, it is not practical for NASA to provide all background reports and consultation letters not directly related to the SRIPP PEIS such as the Cultural Resources Assessment for WFF. Any reports prepared specifically for the PEIS (such as the two cultural resources reports, biological and essential fish habitat assessments) that support the statements made, conclusions in the document have been included as appendices. Although not included as an Appendix of the Final PEIS, the Cultural Resources Assessment is available for review at http://sites.wff.nasa.gov/code250/cultural_resources_assessment.html. Other documents referenced in the PEIS are available from NASA WFF upon request. Please contact Randall Stanley, WFF Historic Preservation Officer, at 757-824-1309, to obtain these documents.
US EPA Region III	Jeffrey D. Lapp	Cultural Resources: Page 183, "Since the 2004 report, no additional identification and evaluation of above-ground historic properties has been conducted at WFF." Considering the magnitude of the proposed project and other projects planned for WFF, it would be prudent to update the survey during the planning and environmental analysis phase of the proposed action to consider and evaluate all resources that may have the potential to be impacted. Since the location(s) of the pump-out station(s) has not been identified by WFF, this information would be useful in avoiding sites that may affect a resource.	Cultural Resources	NASA consulted with VDHR for potential impacts on cultural resources from the SRIPP Proposed Action Alternatives; the SHPO concurred with NASA's determination that no historic properties would be affected by the SRIPP. Potential impact footprints of the pump-out buoys would be minor and consist of anchor footprints and anchor sweeps. Specific locations and anchoring methods for the pump-out locations have not been determined but would be located approximately at the 9 m (30 ft) depth contour which is about 3 km (2 mi) offshore. NASA consulted with VDHR on this issue in July 2010; additional Section 106 consultation would be required for the areas around the pump-out stations once the locations have been identified.
US EPA Region III	Jeffrey D. Lapp	Cultural Resources: Page 269 states, "Underwater actions, which include dredging within Unnamed Shoal A or Unnamed Shoal B, pump-out operations in the nearshore environment east of Wallops Island, and the construction of a groin or breakwater, would only affect archaeological resources." Please give more detail as to the archaeological resources that would be impacted. "The location(s) of the pump-out station(s) has not been identified by WFF." Please indicate the possible number of pump-out stations that may be needed and identify potential locations for the pump-	Cultural Resources	Following BOEMRE archaeological standards, NASA surveyed the potential borrow sites and the nearshore zone where sand retention structures could be located and did not identify any significant resources. Only debris typically associated with commercial and/or recreational fishing activities were identified. This debris included anchor chains, wire rope, trawls, and other flotsam. Please see Appendices F and G for additional details regarding the surveys. Potential impact footprints of the pump-out buoys would be minor and consist of anchor footprints and anchor sweeps. Specific locations and anchoring methods for the pump-out locations

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		out stations. "Additional Section 106 consultation would be required for the area(s) around the pump-out station(s) once the location(s) has been identified." It is recommended that the VDHR be consulted early and throughout the planning effort of determining pump-out station locations.		have not been determined but would be located approximately at the 9 m (30 ft) depth contour which is about 3 km (2 mi) offshore. NASA consulted with VDHR on this issue in July 2010; additional Section 106 consultation would be required for the areas around the pump-out stations once the locations have been identified.
US EPA Region III	Jeffrey D. Lapp	Environmental Impacts: It is suggested that a secondary and cumulative effects analysis begin with defining the geographic and temporal limits of the study; this is generally broader than the study area of the project. Geographic boundaries are typically shown on a map; and a historic baseline is often set at a major event changing the local environment. In the case of WFF, this could be the start of the facility in the 1940's. Analysis of the trend of the value and quantity of the resources of interest should be developed and considered as part of cumulative impacts.	Cumulative Impacts	The cumulative effects section (4.7) of the Final PEIS has been updated to include study limits for each resource area. Two new figures have been added to the cumulative impacts section to visually display the geographic area of extent for existing and future projects that are described in the PEIS; one showing land-based projects and the other figure showing ocean-based projects. The past actions that have occurred on Wallops Island (starting in the 1930s) have been summarized in a new subsection of cumulative impacts.
US EPA Region III	Jeffrey D. Lapp	Environmental Impacts: The secondary and cumulative effects analysis should provide the documentation of consultation and coordination with agencies holding expertise. For instance, consultation on marine bathymetry and sand shoal resources should be added to support conclusions. Conclusion on assessment of impacts to turtles should not be presented until consultation with National Marine Fisheries and Fish and Wildlife Service has been finalized.	Cumulative Impacts	Comment noted. NASA has consulted with NMFS regarding effects on EFH as well as listed species under the agency's jurisdiction. Additionally, NASA consulted with USFWS regarding impacts to listed species and migratory birds. The outcomes of these consultations and supporting information have been included in Sections 4.3.11.1 and 4.7.2.2 of the Final PEIS.
US EPA Region III	Jeffrey D. Lapp	Environmental Impacts: The DPEIS does not provide a complete evaluation of activities that are expected to occur within the project timeframe, most notably the proposed cycling of sand. It would benefit the document to evaluate sand replenishment projects (including other replenishment projects, structures, etc.) on the barrier island complex as a whole. A discussion of potential impacts of the follow-up actions to the preferred alternative would be appropriate in the cumulative impacts analysis. The conclusion that WFF projects may contribute, but would not be significant impact to endangered species has not supported; for instance, appropriate studies recommended by Fish and Wildlife Service for bird and bat impacts from the	Cumulative Impacts	The cumulative effects section has been revised and includes a comprehensive analysis of environmental impacts from past, current and foreseeable future activities within the project area.

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		proposed turbines has not been completed.		
US EPA Region III	Jeffrey D. Lapp	Offshore Shoals: The proposed dredge removal method involves contour and plane dredging. What other methods were considered and which method will allow the greatest recovery of the shoal? What is the expected recovery time for shoal A based on the proposed borrow operations? Include recommendations made by resource agencies with this expertise.	Dredging	The plane and contour methods of dredging were use in modeling of wave climate by the USACE; however, actual dredging would be completed by the contour method which would result in the least impacts on shoal recovery. Another method investigated was striping but it was eliminated based on increased area of dredging which would result in more impacts on sea turtles and excessive costs. The dredging plan has been revised based on coordination with NMFS. Specific areas of the shoal would be avoided to maintain its geomorphic integrity and allow the greatest recovery. Benthic recolonization of the area should begin soon after dredging operations end. However, It is anticipated that full benthic community recovery will take several years.
US EPA Region III	Jeffrey D. Lapp	Other: A 25% loss rate of material during sand dredge and placement operations is predicted for this project, which results in. 2-3 million yd3 of additional fill generated over the lifetime of the project. Please provide information supporting the use of this loss rate and what measures will be taken to reduce amounts of sand lost. Discuss any possible impacts that could result from these losses.	Dredging	Based on empirically-derived information provided by BOEMRE, sediment losses from offshore dredging operations due to overflow and placement operations may be up to 25%. NASA used this as a conservative value when estimating actual dredging volumes for the SRIPP. Losses are likely to be less than 25% because of the relatively coarse grain size of the sand and low silt/clay composition at Shoals A and B. A portion of the sand lost during dredging operations is expected to fall back into the dredging footprint. Impacts to the benthic community and fish from sediment falling back through the water column and accumulating on the seafloor are expected to be minimal. The trailer suction hopper dredger(s) would be moving while excavating sand and therefore sand losses from overflow will be distributed throughout the dredged area and nearby adjacent areas. Section 4.2.3 of the Final PEIS describes these impacts.
US EPA Region III	Jeffrey D. Lapp	Purpose and Need and Alternatives: Shoal B was eliminated from consideration for use during the initial beach fill for cost purposes. The environmental effects of sand borrow operations on both shoals should be evaluated prior to eliminating this option. It is not clear which shoal would be environmentally preferable for use in this project. The use of shoal A would require a greater percentage of total volume and total surface area, compared to shoal B. What analysis has been conducted to determine the ability of shoals to rebound after dredging?	Dredging	NASA considered the most recent and appropriate scientific literature in developing the dredging methodology at the offshore shoals. See Section 2.5.5.2 of the Final PEIS for the results of these analyses and more information on NASA's dredging plan and EFH considerations. Environmental effects of both Shoals A and B are considered and presented in the Final PEIS. NASA studied how to minimize impacts from dredging and determined that erosional areas of the shoal would be avoided to the greatest extent practicable to maintain its geomorphic integrity and thereby allow the greatest recovery. Because of their similarity between the two shoals (orientation,

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				depth, benthic habitat, sediment characteristics, etc. - see Chapter 4), the environmental impacts to each shoal would be similar; therefore, NASA does not consider one shoal to be environmentally preferable.
US EPA Region III	Jeffrey D. Lapp	Cultural Resources: Page 177 states, "In anticipation of the need for shoreline restoration measures, NASA conducted a pedestrian survey of 6.2 km (3.85 mi) of beach/coastline on Wallops Island on September 18, 2006 (Appendix C)." Please note that the pedestrian survey referenced is not included in Appendix C.	Editorial	The reference to Appendix C was removed from the sentence about the pedestrian survey.
US EPA Region III	Jeffrey D. Lapp	Cultural Resources: Page 185 states, "The archaeological predictive model presented in the CRA identified the potential to encounter pre-historic and historic sites on WFF (which was approved by VDHR in a letter dated December 3, 2003), including the Atlantic coast shoreline and near shore waters." A copy of the letter from VDHR should be provided in the Appendix. Also, it is assumed that the letter referenced on page 177 and on page 185 from VDHR is one in the same; however, the date quoted is not the same (December 3 versus December 4). Please correct this discrepancy. Again, it would be helpful to include the *Cultural Resources Assessment for Wallops Flight Facility* in the Appendix of the FEIS.	Editorial	It is not practical for NASA to provide all background reports and consultation letters not directly related to the SRIPP PEIS such as the Cultural Resources Assessment for WFF. Any reports done specifically for the PEIS (such as the two cultural resources reports, biological and essential fish habitat assessments) that support the statements made, conclusions in the document have been included as appendices. The discrepancy noted in the date of the VDHR letter (December 3 versus 4) has been corrected in the Final PEIS. The Cultural Resources Assessment is available for review at http://sites.wff.nasa.gov/code250/cultural_resources_assessment.html. Other documents referenced in the PEIS are available from NASA WFF upon request. Please contact Randall Stanley, WFF Historic Preservation Officer, at 757-824-1309, to obtain these documents.
US EPA Region III	Jeffrey D. Lapp	Based on our review of the DPEIS, EPA has rated the environmental impacts of the preferred alternative as "EC" (Environmental Concerns) and the adequacy of the impact statement as "2" (Insufficient Information).	Environmental Impacts - Miscellaneous	Comment noted.
US EPA Region III	Jeffrey D. Lapp	We have rated Alternative One, the Preferred Alternative, as "EC-2" (Environmental Concerns, Insufficient Information). Alternatives other than the preferred are not rated by the EPA, but would likely to be considered to have higher potential environmental impact to adjoining barrier islands.	Environmental Impacts - Miscellaneous	Comment noted.
US EPA Region III	Jeffrey D. Lapp	Additional details on adverse impacts to aquatic resources, cultural resources, threatened and endangered species are needed to determine the full	Environmental Impacts - Miscellaneous	Comment noted. NASA added additional details on potential environmental impacts to the PEIS in Chapter 4.

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		scale of potential impact.		
US EPA Region III	Jeffrey D. Lapp	The immediate actions in the preferred alternative lack the construction of hard structures; however, future replenishment cycles may include hard structures such as ones discussed in alternatives two and three. Since specific detail on future actions were not fully addressed in the DPEIS, specific information on the possible adverse impacts is unavailable.	Environmental Impacts - Miscellaneous	As described in Section 5.2.2.5, NASA would conduct semi-annual monitoring and prepare a semi-annual report that summarizes the data collection and analyses. The report would provide recommendations for future actions such as potential construction of a sand retention structure. It is anticipated that future specific actions would require NEPA documentation that can be tiered from this PEIS to address potential project-specific environmental impacts.
US EPA Region III	Jeffrey D. Lapp	Environmental Justice: A definition of a minority community can be found on page 186 of the DPEIS. An exact definition of what constitutes a minority has not been released by EPA or the EJ Coordinators, this definition is inaccurate. We recommend, along with the removal of this statement, that minority and low income populations be compared to state and local demographics, defining minority and low income populations in relation to the state, county or local averages. More comprehensive demographic information regarding the minority and low-income populations of each community should be supplied along with maps highlighting the localization of those communities in relation to the site and any and all work that will be conducted.	Environmental Justice	The reference statement on page 186 of the Draft PEIS that the minority definition came from EPA has been revised to remove reference to EPA. Section 3.3.8 of the PEIS includes identification of income and poverty statistics as they relate to EJ for the populations relevant to the area surrounding WFF - the residents of Accomack County and the Town of Chincoteague. Additionally, Table 27 of the Draft PEIS shows the census tract information for communities surrounding WFF. Because the Proposed Action would not result in disproportionate impacts on low income or minority populations, NASA did not provide additional detailed background information on all the population areas surrounding WFF.
US EPA Region III	Jeffrey D. Lapp	Environmental Justice: Please describe the efforts to ensure the protection of minority and low-income populations. Describe which communities were identified as potential EJ concern and how these populations are being involved through outreach in the decision making process.	Environmental Justice	NASA does not expect low income and minority populations to be disproportionately affected by the Proposed Action. Additional information has been provided in Chapter 4.4.7 of the Final PEIS regarding NASA's public outreach.
US EPA Region III	Jeffrey D. Lapp	Environmental Justice: Residential displacements are not the only concern that should have been taken into consideration for potential EJ issues. Describe what other types of impacts were considered and include them in the DEIS. Potential concerns that were not included may be noise, air and water quality issues, changes in employment opportunities, and subsistence fishing impacts.	Environmental Justice	The statement about displacement of residences (Draft PEIS stated that displacements would not occur) was removed from this section. Although there are low income and minority populations within Accomack County, the Proposed Action would involve activities similar to those currently conducted at WFF, and the current WFF EJIP found that WFF activities do not disproportionately affect low-income or minority populations (NASA, 1996). Additional information has been provided in Chapter 4.4.7 of the Final PEIS regarding potential

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				impacts on EJ populations.
US EPA Region III	Jeffrey D. Lapp	Environmental Justice: The EJ assessment should assure the protection and appropriate level of consideration for the potential adverse impacts that may have an effect on minority and low income populations living in the area near the site. The document should identify where such populations are located, and what potential impacts may occur.	Environmental Justice	Section 3.3.8 of the PEIS includes identification of income and poverty statistics as they relate to EJ for the populations relevant to the area surrounding WFF - the residents of Accomack County and the Town of Chincoteague. Additionally, Table 27 of the Draft PEIS shows the census tract information for communities surrounding WFF. A new figure (Figure 41) showing the census tracts examined for EJ has been added to the Final PEIS. Because the Proposed Action would not result in disproportionate impacts on low income or minority populations, NASA did not provide additional detailed background information on all the population areas surrounding WFF.
US EPA Region III	Jeffrey D. Lapp	Offshore Shoals: Provide a map showing proposed mined areas. Proposed borrow areas within the shoals should be delineated.	Figures	Figure 18 has been added to the Final PEIS showing specific areas within the 2-square-mile survey blocks that would be targeted for dredging.
US EPA Region III	Jeffrey D. Lapp	EPA is concerned about the unknown effects of future renourishment cycles. Future NEPA documentation for additional phases of the SRIPP may likely warrant the preparation of Environmental Impact Statements. EPA encourages NASA to continue to receive input from interagency teams and continue public involvement in the NEPA process. EPA looks forward to work with NASA as the life of the SRIPP continues.	Future NEPA Documentation and Agency Coordination	Comment noted. NASA looks forward to working with the EPA and other federal agencies on future NEPA documentation for proposed actions at WFF.
US EPA Region III	Jeffrey D. Lapp	Offshore Shoals: Clearly present the sand grain sizes that exist at Wallops, and how this compares to grain sizes found in both shoals A & B. What grain size has been determined to be ideal for this beach nourishment project?	Grain Size	Please refer to Section 2.4.5 of the PEIS for information on sediment grain size. A grain size of 0.29 mm was used in the modeling for the alternatives. Please refer to Appendix A for further details on sediment grain size.
US EPA Region III	Jeffrey D. Lapp	Other: It is not clear how the proposed groin and breakwater structures will impact sand transport and effect neighboring barrier islands. What analysis has been conducted to determine these effects?	Groin or Breakwater	Please refer to modeling information presented in Sections 4.2.2 and 4.2.3 of the Final PEIS and Appendix A for a detailed description of potential impacts from construction of a groin or breakwater.
US EPA Region III	Jeffrey D. Lapp	EPA believes the DPEIS does not adequately provide analysis of secondary and cumulative effects of past, current and foreseeable future activities on the barrier island habitat and resources.	Habitat	The cumulative effects section (4.7) of the Final PEIS has been revised and includes a comprehensive analysis of environmental impacts from past, current and foreseeable future activities within the project area.

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US EPA Region III	Jeffrey D. Lapp	Environmental Impacts: Of further concern is the possibility of expanding plover habitat resulting from initial beach fill. Future nourishment activities may result in the disruption of newly created plover habitat.	Habitat	Comment noted. NASA has added additional information regarding potential effects from renourishment on piping plovers in Section 4.3.10 of the Final PEIS. NASA would conduct monitoring of the future beach as agreed upon with NMFS and USFWS through the Section 7 consultation process for the SRIPP PEIS. Prior to renourishment activities, NASA would consult with USFWS and NMFS regarding potential effects on Threatened and Endangered species including the Piping Plover.
US EPA Region III	Jeffrey D. Lapp	Environmental Impacts: The proposed activity may also result in the development of SAV beds in the project area. These resources should be monitored for and protected.	Habitat	The proposed action would not create conditions for SAV development at the sand placement site. SAV does not exist along the Atlantic-facing beaches due to the wave energy, sediment movement, and low water clarity, among other conditions. Shallow excavation on north Wallops Island for beach renourishment material may have the potential to create conditions suitable for SAV development if the excavated area would be protected from breaking waves. Potential SAV development would be considered as part of a mitigation approach to offset any habitat impacts from excavation.
US EPA Region III	Jeffrey D. Lapp	EPA is concerned that sand borrow and placement operations will have adverse affects on the shoal and beach habitats, wildlife, and other environmental resources. Additional information is also needed to clarify monitoring and mitigation plans.	Mitigation and Monitoring - General	Comment noted. NASA recognizes that there would be unavoidable adverse impacts on environmental resources from implementing the SRIPP. However, NASA is committed to minimizing those impacts. Chapters 2 and 5 of the Final PEIS have been updated to include more information about mitigation and monitoring.
US EPA Region III	Jeffrey D. Lapp	Offshore Shoals: If a sand management plan has been prepared for the proposed action, please include it in the Final PEIS. EPA recommends that a sand management plan be prepared if it has not been done already. What are the monitoring efforts for shoals? How will erosional hotspots be identified?	Mitigation and Monitoring - Shoals	The tools for monitoring and managing the sand resources along the Wallops Island beach are contained within the SRIPP monitoring program, explained in detail in Section 5.2 of the Final PEIS. NASA would conduct pre- and post-dredge bathymetric surveys of the proposed dredge area. Erosional hotspots along the shoreline would be identified during the beach profile monitoring proposed to be conducted twice a year.
US EPA Region III	Jeffrey D. Lapp	Environmental Impacts: Page 255 says that a NMFS-approved observer will be present on board the dredging vessel during certain times of year. The role of the observer on the vessel needs further clarification.	Mitigation and Monitoring - Wildlife	Additional information has been added to Section 5.1.2.2 of the Final PEIS to clarify the role of the observer. In summary, the shipboard endangered species observer would advise the dredge operator to slow the vessel or maneuver safely when sea turtles or marine mammals are spotted. Additionally, the observer would monitor the intake of dredged material for the presence

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				of sea turtles such that any interactions or take is properly documented and reported to NMFS.
US EPA Region III	Jeffrey D. Lapp	Environmental Impacts: For adverse affects on, wildlife and endangered species, a detailed monitoring and mitigation plan is needed. EPA encourages NASA to coordinate with FWS to develop and approve this plan. Additional coordination with FWS and NMFS for potential impacts to birds, threatened and endangered species, and essential fish habitat. Impacts to state listed species should be coordinated with appropriate state agencies.	Mitigation and Monitoring - Wildlife	Comment noted. Chapters 2 and 5 of the Final PEIS have been updated to include more information about mitigation and monitoring.
US EPA Region III	Jeffrey D. Lapp	Other: The DPEIS showed possible locations for MEC on WFF. Have potential shoal borrow areas been examined for possible MECs? Are any other hazardous materials beyond MECs found in the project area or on Wallops Island? Please identify any active or past hazardous sites, CERCLA or RCRA, that are known at WFF. An analysis should be conducted to determine if any of these areas have an adverse environmental effect with respect to the proposed action, as well as an MEC avoidance plan. Figure 29 presents MEC locations at WFF, which appear to cover a significant portion of the study area. Please explain how it is that MECs are not anticipated to be encountered.	Munitions	To minimize the risk of adverse impacts from UXO in from the North Wallops Island borrow site, an MEC Avoidance Plan that addresses the potential hazards would be prepared. A visual and magnetic survey of the area to locate MEC would be completed and potential hazards removed prior to excavation. According to a report prepared by the USACE in 2007 and referenced in the Final PEIS, there is no historical evidence of MEC in the vicinity of the offshore shoals considered for the Proposed Action. Regarding other hazardous materials, the WFF Integrated Contingency Plan, developed to meet the requirements of 40 CFR Part 112 (Oil Pollution Prevention and Response), 40 CFR Part 265 Subparts C and D (Hazardous Waste Contingency Plan), and 9 VAC 25-91-10 (Oil Discharge Contingency Plan), serves as WFF's primary guidance document for the prevention and management of oil, hazardous material, and hazardous waste releases.
US EPA Region III	Jeffrey D. Lapp	Environmental Impacts: EPA is concerned about the potential use of North Wallops Island as a potential borrow area for future nourishment cycles. This area is known piping plover habitat, a federally listed endangered species. Recirculation activities may have an adverse effect on plover habitat and actions should be consulted with FWS. Page 203 of the document states that "short-term adverse impacts to shoreline in the period of a few months to years after excavation activities" would occur. Include a discussion of North Wallops recovery time, the relationship to plover habitat. Additional information on monitoring is needed.	North Wallops Island Borrow Site	Additional information regarding effects of backpassing sand on piping plovers has been added to Section 43.10. To mitigate potential effects, excavation work on north Wallops Island would be limited to the non-nesting season for the piping plover. If, in the future, NASA identifies the need to use this area, and when potential plans are more defined, NASA would consult with USFWS to ensure adequate protection and monitoring of any protected species observed in the area.

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US EPA Region III	Jeffrey D. Lapp	Purpose and Need and Alternatives: All of the alternatives presented in the DPEIS include the extension of the existing seawall by 1400 meters, yet no discussion for why this extension is needed was included. Please explain why the seawall needs to be extended beyond its existing length and what infrastructure it is intending to protect, include existing and future projects. Clarify what is meant by 'critical infrastructure.'	Project Design	The seawall extension is needed to protect existing infrastructure (see Figures 3 and 4) such as launch pads, UAS runway and the south camera stand. Critical infrastructure refers to infrastructure that NASA needs to complete its mission.
State Agencies				
Virginia Institute of Marine Science	Ellie L. Irons	Monitoring project activities will be essential to validate project performance assumptions and to adapt the management strategies as needed over the life of the project.	Adaptive Management	Agreed. The Final PEIS describes the adaptive management strategy for the SRIPP based on periodic monitoring and results.
Virginia Institute of Marine Science	Ellie L. Irons	Reviewers also indicated that there are information gaps and deficiencies in the draft PEIS, which should be remedied in the final PEIS.	Editorial	NASA has addressed comments, data gaps and deficiencies in the Final PEIS that have been identified in the Draft PEIS as necessary.
Virginia Institute of Marine Science	Ellie L. Irons	…VIMS recommends that NASA provide a better explanation as to why multiple containment structures with less frequent and intensive beach nourishment cycles are not acceptable and why alternatives with only one structure at the southern end are acceptable.	Groin or Breakwater	Section 2.4.2 of the Final PEIS has been revised to include a more detailed description of the alternatives selection process, which included analysis of multiple sand retention structures that were eliminated due to high potential cost. NASA is proposing an adaptive management strategy whereby the initial beach fill would be monitored. Based on erosional hot spots, etc., structures may be evaluated to determine, with more certainty, where along the shoreline they should be placed.
Virginia Institute of Marine Science	Ellie L. Irons	The draft PEIS (Section 2.3.3.4) is unclear why multiple off-shore breakwaters with beach fill is not an acceptable alternative at the southern end of the project area. During the planning stages of the proposed project, NASA and the Corps considered offshore containment structures and although not clearly explained in the draft PEIS, this alternative was discounted. VIMS wonders if the alternative was discounted due to excessive initial cost, the level of protection needed, a preference for the on-shore seawall extension, the expected downdrift impacts, a combination of these factors or other reasons.	Groin or Breakwater	Section 2.4.2 of the Final PEIS has been updated to include a more detailed discussion regarding alternatives selection. NASA initially dismissed the construction of multiple offshore breakwaters due to cost considerations and because breakwaters could not be easily relocated if monitoring results indicated a more optimal location(s). However, in the future, NASA may consider additional sand retention structures based on beach monitoring results and an adaptive management approach.

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Virginia Institute of Marine Science	Ellie L. Irons	Monitoring programs will be essential to validate project performance assumptions and to adapt the management strategies as needed over the life of the project. Beach profiles and biological surveys at the Wallops Island borrow area will be particularly important to support using this sand source.	Mitigation and Monitoring - Shoreline	Agreed. The Final PEIS describes the adaptive management strategy for the SRIPP based on periodic monitoring and results.
Virginia Institute of Marine Science	Ellie L. Irons	… it is VIMS' opinion that mining sand from the Wallops Island borrow site could adversely impact beach and dune processes in this natural area. However, VIMS' concerned have been somewhat alleviated by the following: -the sand from the Wallops Island borrow site would not be used for the initial beach fill; -any material excavated from the borrow site would likely originate from the initial beach fill due to the predicted sand transport pattern; -no temporary construction access roads or other improvements will be needed to transfer the material; -sand from the northern end of the Island would only be used as source material for a portion of renourishment events; and –sand from the northern end of the Island would only be used if threatened and endangered species will not be adversely impacted.	North Wallops Island Borrow Site	As noted in the comment, the removal of sediments from north Wallops Island would be mitigated by the re-deposition of sediment that would come from the addition of new sand on the beach. Work on north Wallops Island would be limited to the non-nesting season for the piping plover and other beach nesting shorebirds. NASA would work with USFWS to ensure adequate protection and monitoring of any protected species observed in the area.
Virginia Institute of Marine Science	Ellie L. Irons	Several mitigation measures are included to minimize adverse environmental effects during the dredging and transport process. However, regardless of which alternative is selected, the proposed activities will have reasonably foreseeable effects on coastal resources.	Project Impacts	As disclosed in the PEIS and noted in the comment, all alternatives would result in unavoidable impacts on coastal resources. As noted in the PEIS Chapter 4, NASA prepared a Federal Consistency Determination stating how NASA would comply with the enforceable policies of the Virginia Coastal Resources Management Program and stating how the SRIPP would affect coastal resources. The Federal Consistency Determination and VDEQ's response has been included as an appendix to the Final PEIS.
Virginia Institute of Marine Science	Ellie L. Irons	The main findings of the draft PEIS are well supported with various models, current scientific reference data and professional expert advice. The future effects of sea level rise were accounted for within the 50-year project life. Also, proposed offshore sand mining was thoroughly evaluated and appears to be consistent with the current scientific understanding of potential impacts.	Project Support	Comment noted.

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Virginia Institute of Marine Science	Ellie L. Irons	Given that some type of action is necessary, VIMS generally agrees that the three shoreline restoration alternatives are appropriate and consistent with current guidelines for projects on ocean coasts, even though the proposed project will have significant impacts to the environment. However, each proposed alternative includes multiple mitigation measures to minimize these impacts.	Project Support	Comment noted. In implementing this project, NASA would strive to mitigate potential environmental impacts to the extent practicable.
Virginia Institute of Marine Science	Karen A. Duhring	If relocation of vulnerable infrastructure to the mainland is not a viable option, then we agree that the No Action Alternative is not acceptable. Irregular and unscheduled emergency protection actions are not effective. Some type of additional action is necessary to provide erosion and storm protection for the valuable infrastructure at this facility.	Project Support	Comment noted. As described in Section 2.3.3.1 of the Final PEIS, relocation of the infrastructure on Wallops Island is not feasible, and as such, NASA is proposing the SRIPP.
Virginia Institute of Marine Science	Karen A. Duhring	It is our opinion that the proposed SRIPP activities are consistent to the maximum extent practicable with the enforceable policies of the Virginia Coastal Resources Management Program, as stated in Section 4.2.6, CZM Federal Consistency Determination.	Project Support	Comment noted.
Virginia Department of Conservation and Recreation	Alli Baird, Coastal Zone Locality Liason	DCR continues to recommend exploring the feasibility of inland relocation of existing facilities.	Alternatives	As described in Section 2.3.3.1 the Final PEIS, relocation of the infrastructure on Wallops Island is not feasible.
Virginia Department of Conservation and Recreation	Alli Baird, Coastal Zone Locality Liason	Alternative One would be DCR's preferred alternative provided sand is not taken from the beach on the north end of Wallops Island and the proposed seawall extension is limited to the minimum length absolutely necessary for the protection of the facility. The absence of groin or breakwater for this alternative makes it less likely to disrupt sand transport for resources located to the south of the project area.	Alternatives	Comment noted.
Virginia Department of Conservation and Recreation	Ellie L. Irons	Coordinate with DGIF and the FWS to ensure compliance with protected species legislation due to the legal status of the Piping and Wilson's Plovers.	Birds	NASA is coordinating with both DGIF and the USFWS regarding listed species, as described in the Final PEIS Sections 3.2.10 and 4.3.11.
Virginia	Ellie L. Irons	Coordinate with DCR's Division of Natural Heritage	Future NEPA	Comment noted. If a significant amount of time passes,

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Department of Conservation and Recreation		(telephone, (804)371-2708)) if a significant amount of time passes before the project is implemented, since new and updated information is continually added to Biotics Data System.	Documentation and Agency Coordination	additional NEPA documentation would be prepared as appropriate.
Virginia Department of Conservation and Recreation	Alli Baird, Coastal Zone Locality Liason	DCR also recommends the protection of rare bird habitat (Least tern, Wilson's plover, and Piping Plover) during the nesting season from April 15 to August 15.	Mitigation and Monitoring - Nesting season	Comment noted. North Wallops Island would not be excavated during the shorebird nesting season. Chapter 4 of the PEIS summarizes ESA consultation with NMFS and USFWS and Chapter 5 summarizes the mitigation measures NASA would implement as determined by NMFS and USFWS to protect listed species and their habitats.
Virginia Department of Conservation and Recreation	Ellie L. Irons	Limit the source for beach nourishment to the sand shoals (Unnamed Shoal A or Unnamed Shoal B) located offshore in Federal waters and not from the Piping Plover habitat at the Wallops Island borrow site.	North Wallops Island Borrow Site	As specific details regarding backpassing of sand from north Wallops Island are not currently available, it is difficult to accurately characterize the effects the work would have on shorebird nesting. For example, the north end could potentially be used only for a small volume of sand needed to fix an erosional "hot spot," and therefore impacts would likely be minimal. Conversely, if the entire area were used as a borrow site, impacts would likely be much greater. If and when NASA determines that this area is needed as a source of fill material, additional NEPA documentation would be prepared to consider the effects of the specific action. As resource agencies have expressed concern regarding this aspect of the SRIPP, work on north Wallops Island would be limited to the non-nesting season for shorebirds and sea turtles. Additionally, NASA would work closely with resource agencies to ensure adequate protection and monitoring of any protected species known to inhabit the area.
Virginia Department of Conservation and Recreation	Ellie L. Irons	NASA must prepare and implement erosion and sediment control (ESC) plan to ensure compliance with state law and regulations. The ESC plan is submitted to DCR’s Suffolk Regional Office for review for compliance.	Permitting	Comment noted.
Virginia Department of Conservation and Recreation	Ellie L. Irons	The operator or owner of construction activities involving land disturbing activities equal or greater that 1 acre are required to register for coverage under the General Permit for Discharges of Stormwater from Construction Activities and develop a project specific stormwater pollution prevention plan (SWPPP).	Permitting	Comment noted.

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Virginia Department of Conservation and Recreation	Ellie L. Irons	According to the draft PEIS (page 220) the proposed project does not include any land development within the Chesapeake Bay or its tributaries. Therefore the proposed project is consistent with the coastal lands management enforceable policy of the VCP.	Permitting	Comment noted.
Virginia Department of Conservation and Recreation	Alli Baird, Coastal Zone Locality Liason	Please note, DCR continues to be concerned in regards to the effects of the shoreline hardening on the islands downdrift of the project area including The Nature Conservancy and DCR properties.	Project Impacts	Comment noted. Currently, waves hit the seawall directly for the majority of its length. The intent of the seawall is to be a secondary line of defense in conjunction with beachfill placed along its entire length. In addition, sand would be placed over the seawall to form a dune line inland of the placed beach fill. As a result, the shoreline would not be “hardened," as it is in its current condition, but restored to a sand beach, with the rock seawall only serving as an "insurance policy" during larger storm events.
Virginia Department of Conservation and Recreation	Ellie L. Irons	DCR supports Alternative One as the Preferred Alternative, provided that sand is not taken from the Wallops Island borrow site and the proposed seawall extension is limited to the minimum length absolutely necessary for the protection of facilities. DCR’s selection of Alternative One as the best alternative is based on the belief that sand transport to the south of the project area will be less likely to be disrupted without the construction of a groin or breakwater. However, DCR continues to recommend exploring the feasibility of inland relocation of existing facilities.	Project Support	Comment noted. Section 2.3.3.1 of the Final PEIS explains why relocation of infrastructure is not feasible.
Virginia Department of Conservation and Recreation	Alli Baird, Coastal Zone Locality Liason	[DCR]'s files do not indicate the presence of any State Natural Area Preserves under DCR's jurisdiction in the project vicinity. The current activity will not affect any documented state-listed plants or insects.	Wildlife	Comment noted.
Virginia Department of Environmental Quality	Ellie L. Irons	Several agencies indicate that the relocation of vulnerable infrastructure to the mainland would be the best long-term solution to protect the infrastructure on Wallops Island.	Alternatives	Public safety is NASA’s highest priority when conducting its missions. As described in Section 2.3.3.1 of the Final PEIS, the missions that NASA undertakes are sited on Wallops Island to maintain the strictest possible safety measures. The existing configuration would need to be maintained to adequately support the various mission activities and maintain safety buffers. Therefore, purchasing land and relocating infrastructure inland is not feasible.
Virginia	Ellie L. Irons	Some agencies also agree that irregular and	Alternatives	As disclosed in the Final PEIS and noted in your comment, all

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Department of Environmental Quality		unscheduled emergency protective actions have not been (and would continue to not be) and effective shoreline management strategy. However, since all of the action alternatives propose some type of permanent erosion and storm protection along the Wallops Island shoreline, adverse impacts on coastal resources, including protected species and wildlife and the resources upon which they depend, will occur.		alternatives would result in unavoidable impacts on coastal resources. NASA would comply with the enforceable policies of the Virginia Coastal Resources Management Program and mitigate adverse impacts to the greatest extent practicable.
Virginia Department of Environmental Quality	Ellie L. Irons	In general, the reviewing agencies agree that Alternative One, the preferred alternative, would have the least impacts of all the action alternatives since it no longer includes the installation of a permeable groin, and provided that sand is not taken from the Wallops Island borrow site for beach replenishment and the proposed seawall extension is limited to the minimum length absolutely necessary for the protection of the facilities.	Alternatives	Comment noted.
Virginia Department of Environmental Quality	Ellie L. Irons	The draft PEIS is unclear as to why the selected alternatives with only one containment structure at the south end (either groin or breakwater) qualified for the secondary screening of alternatives.	Groin or Breakwater	Using the best available data and understanding of the sediment transport system at the time the DPEIS was developed, Alternative 2 (beach fill + groin) and Alternative 3 (beach fill + breakwater) modeled specific sand retention structures at the southern end of the project area. The structures were considered to retain sand within the project area and were recommended by USACE as providing the most effective solution within the project budget. Initial project costs for multiple structure alternatives were simply too costly. The Final PEIS has been revised to clarify the alternatives selection process and to state that sand retention structures could be considered elsewhere along the Wallops shoreline as part of NASA's adaptive management approach and based on the results of future monitoring efforts. Consideration of any structures not specifically analyzed in this Final PEIS would be subject to additional NEPA documentation.
Virginia Department of Environmental Quality	Ellie L. Irons	The agencies believe that the construction of a groin would disrupt the southerly longshore transport of sand thereby adversely affecting the islands south of Wallops.	Groin or Breakwater	Comment noted. NASA's Preferred Alternative does not include initial construction of a groin or breakwater.
Virginia Department of	Ellie L. Irons	DEQ advocates that principles of pollution prevention be used in all construction projects as well as in facility	Mitigation and Monitoring -	NASA already has an effective and current EMS in place for WFF which includes the recommendations you have provided.

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Environmental Quality		operations. … We have several pollution prevention recommendations that may be helpful in constructing or operating this project. – Consider development of an effective Environmental Management System (EMS). – Consider environmental attributes when purchasing materials. –Consider contractors' commitment to the environment (such as an EMS) when choosing contractors. –Choose sustainable materials and practices for infrastructure and building construction and design. –Integrate pollution prevention techniques into the facility maintenance and operation.	General	Chapter 1 of the Final PEIS has been updated to include reference to WFF's EMS.
Virginia Department of Environmental Quality	Ellie L. Irons	DEQ's FFR Program staff recommends that during removal, all borrow and dredge material should be thoroughly screened for munitions. … All munitions encountered should be managed in accordance with NASA's established munitions avoidance and disposal procedures.	Munitions	As stated in the PEIS, a MEC Avoidance Plan that addresses the potential hazards would be prepared to minimize the risk of adverse impacts from MEC during excavation of north Wallops Island. Any munitions encountered would be managed in accordance with NASA's established munitions avoidance and disposal procedures.
Virginia Department of Environmental Quality	Ellie L. Irons	Prior to initiating any project activities on Wallops Island or offshore, DEQ's FFR Program recommends that the SRIPP Project Manager contact NASA's WFF Manager of Environmental Restoration for information concerning any CERCLA obligations and the Corps Remediation Project Manager for Wallops FUDS areas for information concerning CERCLA obligations at or near Wallops FUDS sites.	Munitions	Comment noted. NASA's WFF manager of Environmental Restoration as well as the USACE Wallops FUDS Project Manager have been consulted during the preparation of the PEIS.
Virginia Department of Environmental Quality	Ellie L. Irons	DEQ's Federal Facilities Restoration (FFR) Program staff states that the proposed project is the latest in may beach replenishment projects that have occurred on Wallops Island. The history of beach replenishment at Wallops Island was provided in the draft PEIS. One potential consequence of relocating sand from borrow areas on Wallops Island or offshore dredge areas became evident during the winter storms of 2009. Wave action during those storms created breaches in the seawall. Within some of the breaches old munitions were found intermixed with seawall boulders. … However, the draft PEIS does not address the potential for munitions to be encountered during offshore dredging activities at the Unnamed Shoal.	Munitions	To minimize the risk of adverse impacts from MEC in this area, an MEC Avoidance Plan that addresses the potential hazards would be prepared. A visual and magnetic survey of the area to locate MEC would be completed and potential hazards removed prior to excavation. According to a report prepared by the USACE in 2007 and referenced in the Final PEIS, there is no historical evidence of MEC in the vicinity of the offshore shoals considered for the proposed action.

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Virginia Department of Environmental Quality	Ellie L. Irons	DEQ's FFR Program staff states that the Preferred Alternative may impact several Federal Facilities Restoration Program FUDS currently under investigation by the Corps.	Munitions	There is a potential that MEC would be encountered during excavation of the north Wallops Island borrow site. As described in Chapter 3 of the PEIS, historic military activities in that area have resulted in a high probability of encountering MEC in the nearshore environment and on the northern end of Wallops Island. As seen on Figure 34, the sea target impact and the small arms range safety fan overlap the accreting shoreline of north Wallops Island. To minimize the risk of adverse impacts from MEC in this area, an MEC Avoidance Plan that addresses the potential hazards would be prepared. A visual and magnetic survey of the area to locate MEC would be completed and potential hazards removed prior to excavation.
Virginia Department of Environmental Quality	Ellie L. Irons	DEQ recommends that the final PEIS address the potential for munitions to be encountered during offshore dredging activities at the Unnamed Shoals as all potential sources for sand identified in the draft PEIS could contain MECs.	Munitions	According to a report prepared by the USACE in 2007 and referenced in the PEIS, there is no historical evidence of MEC in the vicinity of the offshore shoals considered for the proposed action.
Virginia Department of Environmental Quality	Ellie L. Irons	There are several Federal Facilities Restoration Program formerly used defense sites (FUDS) located along or immediately adjacent to the shoreline and/or the Wallops Island borrow site. Therefore, use of sand from the Wallops Island borrow site could adversely affect the FUDS sites, which are currently under investigation by the Corps.	North Wallops Island Borrow Site	Comment noted. Prior to implementing any activity NASA would coordinate with the FUDS project manager as well as the NASA restoration manager for any survey or removal efforts as necessary.
Virginia Department of Environmental Quality	Cindy Keltner	This project will require a permit from the VWPP program (Virginia Water Protection Permit Program).	Permitting	Comment noted.
Virginia Department of Environmental Quality	Ellie L. Irons	DEQ's Tidewater Regional Office (TRO) states that the proposed project will require a VWP (*VA water protection*) permit from DEQ.	Permitting	Comment noted.
Virginia Department of Environmental Quality	Ellie L. Irons	Provided that all applicable VWP permits are obtained and complied with, the project will be consistent with the wetlands management and point source pollution control enforceable policies of the Virginia Coastal Zone Management Program (VCP) (previously called the Virginia Coastal Resources Management Program).	Permitting	Comment noted.

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Virginia Department of Environmental Quality	Ellie L. Irons	Generally, when a locality does not map CBPAs on federal lands, they are still subject to the requirements of the Bay Act Regulations as they contain lands analogous to Resource Protection Areas and/or Resource Management Areas. However, Wallops Island is located in a part of Accomack County outside the Bay watershed and therefore, Wallops Island is not required to be included as part of a Chesapeake Bay Preservation Area and is not subject to the requirements of the regulations.	Permitting	Comment noted.
Virginia Department of Environmental Quality	Ellie L. Irons	The draft PEIS (page 220) states that construction equipment will result in air emissions, but NASA would implement BMPs to minimize impacts. The project would not violate Federal or state air quality standards. Provided that NASA complies with all applicable air regulations, the proposed project would be consistent with the air pollution control enforceable policy of the VCP.	Permitting	Comment noted.
Virginia Department of Environmental Quality	Ellie L. Irons	The draft PEIS includes a federal consistency determination and accompanying analysis of the enforceable policies of the VCP (page 219). The consistency determination states that the proposed project would have no effect on the wetlands management, point source pollution control, coastal lands management and shoreline sanitation management enforceable policies of the VCP. The reviewing agencies generally agree with NASA's determination. However, NASA must ensure that the proposed action is also consistent with the aforementioned policies. Also, DEQ recommends that NASA consider the advisory policies of the VCP.	Permitting	Comment noted.
Virginia Department of Environmental Quality	Ellie L. Irons	DEQ concurs that the proposal is consistent to the maximum extent practicable with the VCP provided all applicable permits and approvals are obtained.	Permitting	Comment noted. NASA would obtain all requisite permits and approvals before implementing the SRIPP.
Virginia Department of Environmental Quality	Ellie L. Irons	DEQ's Office of Waste Permitting and Compliance in the Tidewater Regional Office states that although the proposed project appears to enhance protection of the hazardous waste open burn/open detonation (OB/OD)	Project Impacts	Groundwater is not discussed in detail in the PEIS because the Proposed Action would not be expected to have measurable effects on groundwater. The SRIPP construction would not

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		Resource Conservation and Recovery Act (RCRA) permitted unit, the draft PEIS does not discuss potential alternation of and/or impacts to the existing groundwater monitoring network and potential changes to groundwater flow.		directly impact the open burning (OB) area and would not be expected to change existing groundwater flow such that it would affect OB monitoring. To put this in perspective, the beach would be restored to approximately the same dimensions as it was when OB monitoring began in 1999 (assuming a shoreline loss of approximately 3 meters [10 feet] per year). Over the past eleven years of monitoring, there have not been measurable differences in OB sample results that would suggest changes in the beach profile measurably affect groundwater flow at the site. As the commenter mentions, the beach fill and sand dune would afford the OB area an additional level of protection from storm damage.
Virginia Department of Environmental Quality	Ellie L. Irons	DEQ recommends that all efforts should be taken to ensure that surface waters, including wetlands, are not adversely affected by the proposed activities.	Project Impacts	Comment noted. NASA would strive to mitigate all impacts on surface waters, including wetlands. Chapter 5 of the Final PEIS describes mitigation measures.
Virginia Department of Environmental Quality	Cindy Keltner	There has been multiple petroleum releases reported at the Wallops Flight Facility. One of the closed cases is adjacent to the proposed shoreline restoration, PC# 1993-0913. This release, associated with regulated USTs and ASTs at Buildings X-5 and X-15, should not impact the proposed restoration project. If evidence of a petroleum release is discovered during construction of this project, it must be reported to DEQ.	Solid and/or Hazardous Materials/Waste	Comment noted.
Virginia Department of Environmental Quality	Ellie L. Irons	The DEQ-Waste Division states that the draft PEIS addresses both solid and hazardous waste issues, but does not include a search of waste-related databases.	Solid and/or Hazardous Materials/Waste	Comment noted. NASA is aware of the history of hazardous materials and hazardous waste sites at WFF through its own recordkeeping; therefore, searching waste databases is not necessary.
Virginia Department of Environmental Quality	Ellie L. Irons	All construction and demolition debris, including excess soil, must be characterized in accordance with the Virginia Hazardous Waste Management Regulations prior to disposal at an appropriate facility.	Solid and/or Hazardous Materials/Waste	Any debris (that would most likely include extracted remnants of previous storm damage reduction measures) would be characterized in accordance with Virginia regulations prior to disposal.
Virginia Department of Environmental Quality	Ellie L. Irons	According to the DEQ-TRO, there have been multiple [petroleum storage tanks] releases reported at the WFF. … Therefore, if evidence of a petroleum release is discovered during project activities, it must be reported to DEQ, as authorized by Virginia Code 62.1-44.34.8	Solid and/or Hazardous Materials/Waste	Comment noted. Section 4.2.9 of the Final PEIS reflects this information.

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		through 9 by the Virginia Administrate Code 9 VAC 25-580/10 et seq. Also, all petroleum contaminated soils and groundwater generated during construction must be characterized and disposed of properly.		
Virginia Department of Environmental Quality	Paul Kohler	Also, all structures being demolished/renovated/removed should be checked for asbestos-containing materials (ACM) and lead-based paint prior to demolition.	Solid and/or Hazardous Materials/Waste	There are no structures being demolished or removed under the SRIPP Proposed Action.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	The draft PEIS does not include a plan of action should the SRIPP fail within the project's life time (i.e. it does not adequately protect the physical assets on the beach and/or it significantly interrupts the natural geologic processes on the islands to the south of the project area)... The draft PEIS does not explain what actions would be taken….and/or if the availability of beach compatible sane from offshore sources becomes depleted. We also requested that the PEIS include a discussion on the availability of funding for continuous beach renourishment since it is being presented as a key element to the project's success.	Adaptive Management	NASA, as with all Federal agencies, is subject to appropriations from Congress, so there is no guarantee that the project would be continually funded over the 50-year planning horizon. However, for 2012 construction of facilities budget, the SRIPP was NASA's highest priority project. As such, NASA would continue to advocate for continued funding throughout the lifecycle of the project. If funding for future SRIPP actions was not available, NASA would re-evaluate existing conditions and determine appropriate actions at that time.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Develop a contingency plan detailing the steps to be taken if the proposed project is not undertaken.	Alternatives	The equivalent of a contingency plan is the No Action Alternative. Refer to impacts discussed for the No Action Alternative in the PEIS. The past emergency actions undertaken by NASA have not been effective in reducing storm damage on Wallops Island and thereby does not meet the purpose and need of the project.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	Alternatives Two and Five. While the breakwaters may attenuate wave action and thereby reduce beach erosion to some degree, the stable seawall, which will inhibit the natural movement of sand and water, will likely negate any benefits the breakwaters may provide.	Alternatives	After beach fill is completed, the seawall would be located inland of the water line and therefore is not designed to affect sand transport. Additionally, the seawall would be contained within the sand dune system (dune would be constructed over the seawall).
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We recommend a thorough analysis and discussion of a seventh alternative that involved the installation of detached breakwaters to attenuate wave action, but excludes the seawall extension and beach fill options, and considers limited retreat or removal of infrastructure that does not require a beachfront	Alternatives	NASA conducted an alternatives screening analysis that originally included alternatives with multiple sand retention structures including breakwaters. Please refer to Section 2.4.2 of the Final PEIS for an explanation of why multiple sand retention structures were eliminated for detailed evaluation.

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		location.		
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We recommend discussion in the EIS on: A detailed description of the beach fill design (i.e. targeted beach slope, elevation and width to be maintained over the long term).	Alternatives	Please refer to Section 2.5.1 of the Final PEIS for a detailed description of the beach fill design.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We do not consider Alternatives 3 and 6, which are limited to beach fill, to be viable options since both will likely result in the rapid loss of sand placed on the beach.	Alternatives	Comment noted. As described in Section 2.4.2 of the Final PEIS, reduced beach fill was dismissed as a project alternative due to the limited benefit that it would provide. The greater frequency of beach renourishment likely needed in the reduced beach fill scenario would result in higher costs compared to other alternatives including the Preferred Alternative (full beach fill). That is one of the reasons this alternative was dismissed and not carried forward in the EIS analysis.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	Any beach restoration activities that attempt to stop the natural movement of an island, counter storm-generated disturbances, or disrupt the longshore transport of sand may result in widespread loss of suitable nesting habitat for avian beach nesting species.	Birds	Natural processes may also result in suitable nesting habitat loss as the shoreline erodes. However, restoring the beach on Wallops Island would provide new shoreline habitat for avian species compared to existing conditions. Because it is not possible to know exactly which protected species would use the newly created beach in the future, NASA would re-initiate consultation with USFWS/NMFS as appropriate prior to renourishment activities
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Conduct a cost/benefit analysis which includes a threshold at which NASA considered the environmental costs of the project to outweigh the benefits to its mission and goals (for more information, see DGIF's attached letter) due to the potential impacts this project may have on wildlife resources beyond the project area. The cost/benefit analysis should not only examine monetary costs, but also take into account costs to fish and wildlife resources, the physical integrity of the barrier island chain, and other stakeholder interests. …the PEIS (*should*) include a discussion on the availability of funding for continuous beach renourishment since it is being presented as a key element to the projects success. DGIF does not believe that either request was adequately addressed, making it far more difficult to assess the project's risk to the broader environment over the life time of the project.	Cost/Benefit Analysis	The planning process for USACE Civil Works projects requires that a Cost-Benefit Analysis (CBA) be performed to ensure that the benefits of a proposed project outweigh the costs, thereby providing a justification for implementation. As the SRIPP is not a USACE project but would rather be funded through NASA appropriations, conducting a CBA using a standard USACE methodology was not required prior to project implementation and was therefore not performed. However, in planning the SRIPP, NASA worked closely with USACE to consider the costs of each alternative and whether the benefit realized (storm damage reduction) would outweigh the monetary expenses. Section 1.4 of the Final PEIS includes a discussion of availability of funding and NASA's adaptive management approach. NASA consulted with DGIF to obtain methodology for conducting a cost/benefit analysis that would include wildlife values; however, no example methodology was provided. Due to the extent of the effort and degree of speculation to assign costs associated with all of the various

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				environmental impacts of the SRIPP, this effort was not undertaken. NASA feels that appropriate decisions about implementation of the SRIPP can be made based on the current information provided in the Final PEIS. For more information on project costs see Sections 2.6.2 and 2.6.3 of the Final PEIS.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	Alternative Four. The reduced beach fill will likely require more frequent beach renourishment, therefore Alternative 4 does not appear to offer any cost benefits or reduce barrier island ecosystem impacts over the long term.	Cost/Benefit Analysis	The greater frequency of beach renourishment likely needed in the reduced beach fill scenario would result in higher costs compared to other alternatives including the Preferred Alternative (full beach fill). That is one of the reasons this alternative was dismissed and not carried forward in the EIS analysis.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	The draft PEIS should consider cumulative effects upon wildlife, not just direct effects resulting from specific construction activities.	Cumulative Impacts	The cumulative effects section of the Final PEIS (4.7) has been revised.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	Based on information included in the draft PEIS, it appears that no effort was made to measure the density, abundance and species composition of infaunal organisms at the two offshore borrow *sites* during the benthic habitat survey (Appendix B). Various species of seaducks including white-winged scoters, surf scoters, black scoters and long-tailed ducks forage primarily on mollusks and crustaceans on marine wintering grounds (Bellrose 1978) in water depths ranging from 1–60 meters (SDJV 2010). Sea ducks occur in high densities within 12 nautical miles off of Virginia's coastline in areas with sandy shoals during the winter (Forsell 2003). Therefore, it is possible that the two unnamed shoals A and B, proposed for sand mining, are utilized by these birds as forging sites. Conduct a minimum of three aerial offshore transect surveys before beginning dredging activities over the course of at least one winter season (one in mid-December, one in mid-January, and one in mid-February) along the entire barrier island chain and out to 15 nautical miles. This would establish the relative use of the two unnamed shoals by sea ducks, which would assist DGIF in assessing the impact of dredging activities on these avian species. We recommend [the survey] data be used to analyze what, if any, impacts	Dredging	The benthic habitat survey consisted of video collected at approximately 40 stations on each shoal. The benthic habitat was determined to be unconsolidated sand. There is a relatively extensive amount of existing information on benthic community composition in this region of the mid-Atlantic which was used to characterize the benthic communities in conjunction with the video results. In performing the impact analysis in this PEIS, NASA used the most current available USFWS data (Forsell et al., 2003) regarding shoal use by sea ducks in and around the project area. NASA acknowledges that sea ducks may utilize these shoals, as well as the other shoals in the region to forage and have addressed potential impacts in the Final PEIS. Impacts to sea ducks are not anticipated to be significant within a regional context. Because impacts would be temporary and benthic habitats are expected to regenerate over the course of several years, NASA does not feel that additional studies are justified. The PEIS text in Section 4.3.3 Birds (Offshore Borrow Sites) has been revised to include more detailed information regarding impacts on seabirds and specifically on seaducks.

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		the removal of shoal material will have upon these species. We further recommend that based on the results of these studies, a plan to mitigate any impacts upon sea ducks be developed.		
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We recommend discussion in the EIS on: Results from a compatibility analysis that examine how well the sand on the two offshore shoals matches the existing sand on the barrier islands (i.e. grain size, color, etc.).	Grain Size	Section 2.4.4, 2.4.5, and 2.4.6 of the Final PEIS describe the sediment sampling conducted by USACE to determine grain size suitability of the potential borrow areas. Only compatible sand (that which is adequately similar in grain size to that currently on Wallops Island beach) would be used for beach nourishment. The potential borrow sites were chosen based on the grain size evaluation. Several borrow sites were dismissed because they did not meet the criteria listed below for a useable source of sand.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Alternative One. Moreover, it will reduce the island's value to beach and marsh-dependent wildlife through the loss of beach seaward of the seawall if renourishment efforts are not able to keep up with erosion rates, and the loss of marshes behind the island should significant island narrowing occur.	Habitat	It is NASA's intent to ensure that renourishment efforts would keep up with erosion rates. The goal of Alternative One is to create and maintain beach seaward of the seawall. The topography and bathymetry of the beach would be monitored on a regular basis to determine sand movement patterns and plan when renourishment is needed. The absence of sand retention structures would result in a larger amount of sand being available for erosion and longshore transport. Over the 50-year project life, the exact frequency of beach nourishment would be determined by the amount of fill placed each time, amount of sea-level rise, and by the number and severity of storm events.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Benthic communities. The draft PEIS acknowledges that repeated dredging activities at intervals of three years of less, may not allow sufficient time for benthic communities to recover between dredging cycles.	Invertebrates	Comment noted. The current SRIPP beach fill design contains a 5 year renourishment interval, which would better allow for benthic community recovery. Additional information has been added to Section 2.5.1.3 of the Final PEIS to explain that an additional margin of safety (the overfill volume) is included in the beach fill design to reduce the likelihood of having to renourish at more frequent intervals.
Virginia Department of Game and Inland Fisheries	Amy Ewing	We contend that avoidance could better be achieved by timing construction activities outside of shorebird nesting season. In addition, we recommend some mention in this section about mitigation for possible impacts upon sea turtles.	Mitigation and Monitoring - Nesting season	Due to the length of time required to complete the initial fill (approximately 7 months), it is not feasible to completely avoid work during shorebird and sea turtle nesting season. NASA consulted with NMFS and USFWS and received terms and conditions for SRIPP initial fill activities. During sand placement operations and work on the seawall, NASA would conduct regular monitoring of the beach for potential sea turtle

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				and shorebird nesting activity using a qualified biologist during construction activities if these activities take place during nesting season. If a nest is detected within the proposed work area, that area would be avoided until NMFS/USFWS are notified and site-specific measures developed. To mitigate impacts during renourishment cycles, NASA would avoid excavation on north Wallops Island during sea turtle or shorebird nesting season. NASA would conduct surveys for the presence of sea turtle and shorebird nests along the newly created beach and in consultation with resource agencies would determine timing of renourishment cycles. Additional details regarding mitigation and monitoring are located within Section 5 of the Final PEIS.
Virginia Department of Game and Inland Fisheries	Amy Ewing	..we recommend that all sand removal, if performed, occur outside of the nesting season for Piping Plover and sea turtles. … Adverse impacts upon the listed species may occur as a result of habitat impacts in addition to possible direct impacts associated with construction activities. We recommend consideration of indirect and cumulative impacts.	Mitigation and Monitoring - Nesting season	The Final PEIS has been revised as follows: To avoid impacts to nesting Piping Plovers and sea turtles, work in the proposed north Wallops Island borrow site area would be limited to the non-nesting season. (March 15 through November 30 or the last date of potential sea turtle hatchling emergence based on when the last eggs were laid).
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	The proposed mitigation measures for sand removal at the Wallops Island borrow site listed in Table 11 (PEIS, pages 73-74) state that a qualified biologist would closely monitor excavation activities to ensure that impacts to any listed species and their nests would be avoided or minimized. This statement appears to imply that the work would be conducted during the breeding season. However, the draft PEIS also states (page 302) that work in the proposed Wallops Island borrow site would be limited to the non-nesting season for the Piping Plover (September-March). This contradiction in the draft PEIS needs to be addressed. Also, DGIF notes that if the work is timed to be completed outside of the nesting season, then an on-site biologist would not be necessary.	Mitigation and Monitoring - Nesting season	This contradiction has been corrected in the Final PEIS. No excavation of north Wallops Island would occur during sea turtle or shorebird nesting season.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	DGIF has the following recommendations to ensure protection of Bald Eagles under its jurisdiction: No large machinery should be used within 660 feet of any bald eagle nest from December 15 through July 15 of any year to ensure protection of bald eagles during	Mitigation and Monitoring - Nesting season	As stated in the Final PEIS, no impacts on the bald eagle are anticipated primarily because their habitats would not be disrupted by SRIPP activities. However, as a safeguard, prior to removing sand from north Wallops Island, NASA would conduct a nest survey to determine if any new nests are present

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		excavation activities. Also DGIF recommends that prior to each excavation cycle, the Wallops Island borrow site should be surveyed to determine if any new nests are build within 660 feet of the excavation area and that the same excavation time-of-year restriction should be applied to any new or alternate nest sites.		and would establish buffers as needed. If any nests are identified, NASA would consult with USFWS and VDGIF regarding potential mitigation measures.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	DGIF has the following recommendations to ensure protection of shorebirds under its jurisdiction: The removal of any sand from the Wallops Island borrow site should occur outside of the breeding and nesting seasons for shorebirds (work should occur from November-March of any year), to prevent potential adverse impacts upon these species as a result of habitat impacts and possible direct impacts associated with construction activities.	Mitigation and Monitoring - Nesting season	The EIS states that a trained observer would closely monitor the beach during sand placement activities to ensure that impacts to any listed species and their nests would be avoided or minimized. If a nest is detected within the proposed work area, that area would be avoided until USFWS is notified and site-specific mitigation measures developed.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	DGIF has the following recommendations to ensure protection of sea turtles under its jurisdiction: The removal of any sand from the Wallops Island borrow site should occur outside of the sea turtle (work should occur from November-March of any year).	Mitigation and Monitoring - Nesting season	North Wallops Island would not be excavated during sea turtle nesting season (November to March). Chapter 4 of the Final PEIS summarizes ESA consultation with NMFS and USFWS and Chapter 5 summarizes the mitigation measures NASA would implement as determined by NMFS and USFWS to protect listed species and their habitats. If north Wallops Island is selected as a renourishment borrow site, NASA would conduct new analysis including more detailed surveys of habitats in the potentially affected area, would re-initiate consultation with NMFS, USFWS, and DGIF regarding potential impacts and mitigation measures for protected species, and would prepare new NEPA documentation.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	We recommend discussion in the EIS on: A detailed description of post-construction beach monitoring plan. This plan should present methods for measuring changes to island shorelines over time. Conduct beach profile monitoring on Metompkin and Cedar islands at a frequency that allows for an accurate assessment to be made regarding project impacts further south along the barrier island chain.	Mitigation and Monitoring - Shoreline	As described in the Final PEIS, the greatest physical effects from the project would be closest to the site. Based on USACE modeling in Section 4.2.2.1 and the extent of project effects, monitoring on islands south of Assawoman (Metompkin and Cedar Islands) is not warranted. Given that the net sediment transport is generally toward the north along the Wallops Island shoreline, effects would be expected to be minimal immediately south of the project site, and they would continually decrease with distance from the Wallops Island project site. As such, NASA does not expect that monitoring such a large geographic distance from the project site would provide meaningful data that would allow project-related changes to be discerned from

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				natural variability in the wave climate. NASA's monitoring plan could be modified based on the adaptive management strategy and monitoring results. The monitoring survey of the shoreline in the vicinity of Wallops Island would be conducted twice a year. The first monitoring event would be conducted along the entire lengths of Wallops and Assawoman Islands, from Chincoteague Inlet in the north to Gargathy Inlet in the south, a distance of approximately 13.7 km (8.5 mi). The second of the two annual survey events would be limited to the length of shoreline from Chincoteague Inlet on the north to 0.8 km (0.5 mi) south of the former Assawoman Inlet which defines the south end of Wallops Island. NASA, USACE and BOEMRE agree that this proposed area of shoreline monitoring is appropriate to determine effects from the SRIPP and the data used in the adaptive management decisions. A detailed description of the beach profile monitoring has been added in Section 5.2.2 of the Final PEIS.
Virginia Department of Game and Inland Fisheries	Amy Ewing	Offshore Dredging Activities. We support the recommendations provided in this section regarding the protection of sea turtles and recommend continued coordination with the NMFS regarding their protection and the protection of sea mammals.	Mitigation and Monitoring - Wildlife	NASA has coordinated with NMFS and the USFWS regarding the protection of sea turtles and mammals under Section 7 of the Endangered Species Act; a summary of the consultation is provided in Section 4.3.11 of the Final PEIS. Both NMFS and USFWS Biological Opinions are includes as appendices to the Final PEIS.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	DGIF recommends that the 'Mitigation and Monitoring' section of the draft PEIS address mitigation measures for potential impacts to sea turtles.	Mitigation and Monitoring - Wildlife	Section 5.1.2 in the Final PEIS describes the mitigation measures that have been agreed upon through Section 7 consultation with NMFS and USFWS regarding protection of sea turtles.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Provide a more detailed explanation of the types of wildlife habitats at the northern end of the island that would be avoided during excavation activities.	North Wallops Island Borrow Site	If north Wallops Island is selected as a renourishment borrow site, NASA would conduct new analysis including more detailed surveys of habitats in the potentially affected area, would re-initiate consultation with NMFS, USFWS, and DGIF regarding potential impacts and mitigation measures for protected species, and would prepare site-specific NEPA documentation. To avoid impacts to nesting Piping Plovers and sea turtles, excavation of sand for future renourishment would be conducted outside of plover and sea turtle nesting season (March 15 through November 30 or the last date of potential sea turtle hatchling emergence based on when the last eggs were laid). The wildlife habitat constraints referred to in the Draft PEIS are regarding the identification and avoidance of the

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				most active areas of piping plover and sea turtle nesting. Over the past several years, these areas have generally been south of the Wallops beach off road vehicle access road and therefore Figure 13 in the Final PEIS presents the potential area for sand removal as such. However, it should be noted that these areas are subject to change upon placement of the new beach and would be better defined at the time this option is considered in more detail. The Final PEIS has been revised to clarify this point.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Consider conducting an analysis of the actual recovery time and the sustainability of beaches at the northern end of Wallops Island.	North Wallops Island Borrow Site	NASA would create and implement a monitoring plan that would be modified based on the adaptive management strategy and monitoring results. Chapter 5 of the Final PEIS has been updated to provide additional details that are known at this time.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	The draft PEIS states that the Wallops Island borrow area was developed in consideration of "wildlife habitat constraints," but this statement is not further explained. DGIF states that the draft PEIS does not include any measurement of the density, abundance or species composition of benthic invertebrates in the proposed sand excavation area. The draft PEIS also does not address the potential effects that sand removal to a depth of 1 meter will have on the benthic community and the species that forage on these organisms. DGIF believes that the omission in analysis of environmental consequences represents a serious oversight and a discussion of such analysis should be included in future iterations of the document. DGIF believes that the combination of sand excavation in the northern end of the island and beach renourishment activities to the south may substantially reduce the benthic invertebrate prey base at Wallops Island for unknown periods of time, which will diminish the quality of the island's shorebird foraging (and breeding) habitat.	North Wallops Island Borrow Site	Given the current level of uncertainty regarding the extent and magnitude of how north Wallops Island would be excavated, NASA assessed impacts from this option in a more programmatic manner, relying on the best available data from studies within the region. Additional information regarding potential impacts has been added to Chapter 4 of the Final PEIS. As north Wallops Island would not be used for the initial fill cycle, and as the newly placed fill material would likely be transported onto north Wallops Island, the physical parameters of the beach (namely grain size and beach geometry) would change accordingly. These parameters would likely have a direct effect on the infauna that would inhabit the area. As such, it would be more appropriate to conduct sampling of infaunal densities of the proposed excavation area when preparing a site-specific analysis. If north Wallops Island is selected as a borrow site, NASA would conduct new NEPA analysis including more detailed surveys of habitats in the potentially affected area, would prepare the appropriate level of NEPA documentation, and would re-initiate consultation with NMFS, USFWS, and DGIF regarding potential impacts and mitigation measures for protected species.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Alternative One. DGIF states that the sacrifice of important and unique wildlife habitat along the only section of undeveloped beach on Wallops Island to acquire fill material at the lowest cost possible is not	North Wallops Island Borrow Site	As described in the Draft PEIS, the northern part of Wallops Island may be considered for potential beach renourishment material. However, sand would not be excavated from unique wildlife habitats. NASA would conduct further detailed

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		appropriate. Moreover, the use of sand which is not the optimal grain size is in opposition to the mitigation criteria developed by NASA for sand placement activities (page 300).		coordination with the USFWS on potential areas for excavation as well as to prepare appropriate NEPA documentation to evaluate potential impacts from use of north Wallops Island as a sand source. The mean grain size of samples of native sand on Wallops Island was found to be between 0.20 and 0.21 mm. The mean composite grain size of sand from north Wallops Island was found to be 0.20 mm. Although the grain size of sand from Shoals A and B is preferable as material for nourishment due to its larger grain size (0.42 and 0.34 respectively), the sand from north Wallops Island is still appropriate to supplement renourishment needs, especially once it mixes with the coarser offshore sand.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	DGIF is strongly opposed to NASA's using the Wallops Island borrow site for beach fill during renourishment cycles due to the presence of the federally-listed threatened Piping Plover and sea turtle nesting sites.	North Wallops Island Borrow Site	To avoid impacts to nesting Piping Plovers and sea turtles, excavation of sand for future renourishment would be conducted outside of plover and sea turtle nesting season (March 15 through November 30 or the last date of potential sea turtle hatchling emergence based on when the last eggs were laid). Additionally, prior to using this site as a sand source, NASA would conduct additional NEPA analysis and consult with the appropriate federal and state wildlife management agencies to better assess the potential for implementation prior to making a final decision. NASA would work closely with NMFS and USFWS for avoidance and mitigation of protected species and to avoid any nesting sites.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Alternative One. Over the long term (i.e. beyond the 50-year life span of the project), a reduction in land mass may seriously affect the island's natural function as the first line of protection against storm surge and other weather related events for the marshes and mainland that lie west of the island.	North Wallops Island Borrow Site	Comment noted. Section 4.2.2.1 of the Final PEIS provides additional detail regarding potential indirect effects of the SRIPP, including island narrowing. The goal of Alternative One is to create and maintain beach seaward of the seawall, which would increase the land mass of Wallops Island compared to existing conditions. The topography and bathymetry of the beach would be monitored on a regular basis to determine sand movement patterns and plan when renourishment is needed. The absence of sand retention structures would result in a larger amount of sand being available for erosion and longshore transport.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	DGIF believes that, even with intervention, the Wallops Island shoreline is likely to continue to retreat landward and any attempts to delay or alter the shoreline retreat may be futile over the long term. … This sand capture (*referring to the growing caps of	Project Effectiveness	Comment noted. NASA has been located on Wallops Island since the 1940s and its mission requirements have grown since then. There are over $1 billion of public assets on the island. Chapter 1 provides details on the purpose and need for the program. The SRIPP is designed to provide infrastructure

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		Fishing Point*) is a further indication that Wallops Island will continue to retreat, thereby necessitating continual and costly efforts to slow the natural movement of the island over the long term. In light of this information, we caution that the shoreline along Wallops Island is likely to continue to shift under natural conditions and that attempts to delay or alter these natural fluctuations in shoreline may be futile over the long term.		protection for a term of 50 years. At that point, NASA would re-evaluate appropriate protection measures.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We recommend discussion in the EIS on: What level of protection each alternative will realistically offer and a full presentation of the analyses conducted to determine these protection levels. We recommend the analyses take into account sea level rise and the potential for future increases in storm activity and intensity.	Project Effectiveness	According to current USACE design methodology, all alternatives of the SRIPP have been designed to provide storm damage reduction from a 100-year storm. Additionally, the USACE beach fill and seawall design did take into account sea-level rise, as explained in Section 2.5.1.3 of the Final PEIS.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Discuss in the final PEIS the assertion that any negative impacts from the seawall would be mitigated following beach fill placement.	Project Impacts	As described in further detail in the USACE's modeling and design report in Appendix A, the modeling of the seawall extension showed that the seawall would have only minor impacts on the adjacent shoreline, particularly if the seawall is set back at least 10 yards from the shoreline. The average shoreline change rate at Assawoman Inlet attributed to seawall construction would be less that the variability in the change rate caused by yearly changes in the wave climate. Any negative impacts (e.g., change in shoreline position) from the seawall extension would be negated following the placement of additional sand to the beach and the nearshore sediment transport system. he new sand would effectively replace any sediments lost as a result of fixing the shoreline position with the seawall.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	<u>Alternative One.</u> DGIF is concerned that the extension and increase in height of the existing seawall will prevent natural island overwash processes from occurring over a large area of the island. As mentioned in the draft PEIS (chapter 4, page 195, third paragraph), this would likely result in a greater loss of surface area on the landward side of the seawall and enhance island narrowing with the rise of sea level-Over the long term (i.e., beyond the 50-year life span of the project), a reduction in land mass may seriously	Project Impacts	The potential impacts to overwash processes have been addressed in Sections 4.2.1.1 and 4.7.2 of the Final PEIS. The seawall is one component of the SRIPP. Beach fill is the other major component. The addition of beach fill (both initially and during renourishment cycles) will, at least temporarily, reduce the narrowing of Wallops Island during the 50-year project lifetime. Predictions of changes extending past the 50-year horizon are not addressed in the PEIS. As part of its Adaptive Management and Design strategy, NASA would continually monitor and manage for changes throughout the program

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		affect the island's natural function as the first line of protection against storm surge and other weather-related events for the marshes and mainland that lie west of the island.		lifetime.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Alternative Three. DGIF is concerned that the reduction in beach erosion resulting from wave attenuation performed by the breakwaters will be negated by the newly constructed seawall extension and that this structure may also result in shoreline erosion to the south.	Project Impacts	Sand would be placed in front and on top of the seawall extension under all three alternatives. Therefore, waves would break on the constructed sand beach and would only interact with the seawall in the most extreme storm events. The rock seawall can be thought of as an insurance policy that would only be needed during rare occasions. Section 4.2.2.1 of the Final PEIS and Section 10 of Appendix A describe the minor impacts on the shoreline from construction of the seawall extension prior to placing the beach fill in front of it. It is expected that this condition would only exist for a short period of time (less than one year) and that any resulting shoreline changes would be mitigated by the beach fill.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	<u>Alternative One.</u> Lastly, the results from the models presented in Appendix A of the draft PEIS suggest that the seawall extension will have less of an impact on Assawoman Island’s shoreline over the long term than the current changes in shoreline incurred by yearly variation in wave climate and storms.	Project Impacts	Your comment is correct. As presented in the Final PEIS and USACE modeling report (Appendix A of the Final PEIS), the seawall extension would have less of an impact on Assawoman Island compared to storms and the existing variability in wave climate.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	<u>Alternative One.</u> ..we are concerned that the extension of the seawall will further accelerate sand loss seaward of the seawall, particularly during periods of frequent storm events.	Project Impacts	Although the seawall extension would cause a temporary reduction of sand available to the longshore transport system during the year between completion of seawall construction and completion of initial beach nourishment, there would be an overall net gain of sand introduced to the system by the beach fill.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We recommend discussion in the EIS on: The impacts of sand mining at Blackfish Bank Shoal and unnamed shoal on erosion rates at Assateague Island and islands to the south including results from studies on this topic.	Project Impacts - Shoreline	Because of the potentially adverse impacts on the Assateague Island shoreline and the public perception of negative impacts on commercial and recreational fishing communities, Blackfish Bank Shoal was removed from consideration as a borrow site option. See Sections 2.4.5.3 and 2.4.7 for details. Potential impacts to the Virginia Barrier Island system including modeling results are discussed in Section 4.2.2.1 of the Final PEIS.
Virginia Department of	Raymond Fernald	We recommend discussion in the EIS on: A thorough analysis and discussion of potential impacts each	Project Impacts - Shoreline	Potential impacts to the Virginia Barrier Island system, including modeling results, are discussed in Section 4.2.2.1 of

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Game and Inland Fisheries		alternative poses on the islands to the south of the project area, with a special focus on Assawoman, Metompkin and Cedar islands.		the Final PEIS.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	DGIF is concerned about the adverse effects of Alternative Two on islands located south of Wallops Island as it may reduce the naturally occurring transport of sands to those areas. … Although DGIF understands NASA's need to protect its assets, DGIF does not support any action that could adversely affect other barrier islands, which provide important habitat for shorebirds, sea turtle nesting areas and other wildlife.	Project Impacts - Shoreline	As discussed in detail in Appendix A, the nodal zone of sediment transport is located at approximately the Wallops and Assawoman boundary. Under current conditions, Alternative Two proposes a groin approximately at the location of the nodal zone. The sediment transport diverges at this location. As a result, a groin placed at the southern portion of the project area would not result in erosion to the south.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	<u>Alternative One.</u> We are concerned that the proposed jetty may impede existing longshore transport of sand to Assawoman, Metompkin and Cedar Islands, especially if funding cannot be secured for the anticipated 5-7 year renourishment cycle.	Project Impacts - Shoreline	The following text has been added to Section 4.2.2.1 of the Final PEIS: The groin would be specifically designed to let some sand pass through the structure and was modeled as such. If there were no beach fill, the groin would exacerbate the downdrift erosion on Assawoman Island; however, because the SRIPP includes a beach fill component, overall, more sand would be moving onto the north end of Assawoman Island than is occurring at present. According to the modeling results, the combination of the groin with beach fill would result in accretion of sand on the north end of Assawoman Island. The greatest amount of erosion and accretion would occur immediately adjacent to the groin and would exponentially decrease with distance from the groin. However, it should be noted that NASA share's DGIF's concern regarding the effects of the groin if renourishment funding cannot be secured, and as such, the Beach Fill Only alternative is NASA's preferred alternative for the SRIPP.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	DGIF does not fully support any of the alternatives presented in the draft PEIS. DGIF believe that all of the alternatives are likely to result in adverse impacts upon wildlife and/or the resources upon which they depend. However, DGIF agrees with the selection of Alternative One as the Preferred Alternative, since it no longer includes the installation of a permeable groin. The groin would reduce the southerly longshore transport of sand thereby adversely affecting the islands south of Wallops.	Project Support	Comment noted.

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Virginia Department of Game and Inland Fisheries	Raymond Fernald	Alternative One. Lastly, regular beach renourishment is very costly and may negatively affect local wildlife habitats in the short term, especially if non-compatible sand is used. This practice may also threaten the biological integrity of the two shoals from where sand will be obtained and may reduce the overall sand budget in the nearshore system, accelerating erosion of nearby beaches.	Renourishment	Section 2.4.4, 2.4.5, and 2.4.6 of the Final PEIS describes the nearshore, offshore, and north Wallops Island sediment sampling conducted by USACE to determine grain size suitability of the potential borrow areas. Only compatible sand (that which is adequately similar in grain size to that currently on Wallops Island beach) would be used for beach nourishment. The potential borrow sites were chosen based on the grain size evaluation. Several borrow sites were dismissed because they did not meet the criteria listed below for a useable source of sand. The dredging plan was formulated with recommendations from NMFS and is described in detail in Section 2.5.5.2 of the PEIS. Section 4.3.6 outlines anticipated impacts on benthos from dredging. Dredging sand from either offshore shoal would have a significant and immediate adverse impact on the local benthic community of the shoal. However, it is expected that there would be a negligible impact on the regional benthic ecosystem.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	While the draft PEIS acknowledges that the shoreline at Wallops Island will certainly experience the effects of future sea level rise, sea level rise was not included as a variable in the models used to design SRIPP. Moreover, the Storm Damage Reduction Project Design for Wallops Island Virginia report (Appendix A) offered a very limited discussion on climate change and sea level rise and the only concession it made to address the problem is to follow current Corps' policy. …there was no discussion about what steps would be taken to account for sea level rise within the projects lifetime if renourishment at the required volume and frequency is no longer possible due to lack of funding or availability of beach compatible sand.	Sea-level Rise	The SRIPP project design and modeling was performed according to current USACE policy. In addition, Appendix A and Section 4.2.2.1 of the PEIS states that sea-level rise would be appropriately compensated for at each renourishment event. If renourishment were stopped before the end of the project lifetime due to funding limitations, the result would be that the infrastructure on Wallops Island would become increasingly vulnerable to storm damage and erosion as time goes on. This would happen whether the projected sea-level rise occurs or not; with sea-level rise, the vulnerability would be exacerbated.
Virginia Department of Game and Inland Fisheries	Ellie L. Irons	Offshore Dredging Activities. DGIF is concerned that the proposed project could impact sea turtles and other mammals.	Wildlife	NASA is coordinating with NMFS and the USFWS regarding the protection of sea turtles and mammals. Mitigation measures that have been developed for the project are explained in Section 5.1 of the Final PEIS.
Virginia Department of Game and Inland Fisheries	Amy Ewing	Currently, management of Virginia's barrier island chain is minimal and basically allows nature to take its course. This management scheme has proven, over time, to benefit the fish and wildlife that inhabit these areas. All of the alternative presented in the draft PEIS	Wildlife	Comment noted. NASA recognizes that the SRIPP would have unavoidable adverse impacts on fish and wildlife resources and is committed to mitigating those impacts to the extent practicable.

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		directly counter this management scheme. Based on this and the scope and location of the activities proposed to stabilize the shoreline at WFF, we cannot fully support any of the alternatives presented in the draft PEIS as they are all likely to result in adverse impacts upon wildlife under our jurisdiction and/or impact the resources upon which they depend.		It should be noted that NASA's management of Wallops Island is based on its mission requirements as an aerospace research range which differ from those of the organizations that manage the other Virginia barrier islands. For additional information about NASA's mission see Chapter 1 of the PEIS.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We recommend discussion in the EIS on: All potential sand mining impacts on the aforementioned shoals' avifauna and to fishes and other wildlife species that forage on the shoals' benthos.	Wildlife	The potential impacts on benthos at the shoals which is associated with dredging is discussed in several sections of the Final PEIS, including 4.3.3 Birds, 4.3.8 Finfish, and 4.3.9 Essential Fish Habitat. Removal of sand from the shoal(s) would alter the topography of the shoal and, as described in Section 4.3.2.5 (Finfish), may adversely affect fish populations in the area. As a result, dredging may indirectly affect seabird populations that prey on fish at the shoal by altering fish distribution and populations. However, since the shoals do not present a unique habitat and there are numerous other suitable shoals nearby, the adverse impacts would be temporary, localized and not significant.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We recommend discussion in the EIS on: Consultations with National Marine Fisheries Service regarding potential impacts of hopper dredging on sea turtles.	Wildlife	Section 4.3.11.1 of the Final PEIS now includes a discussion regarding consultation with NMFS.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	Seawall Extension - According to the draft PEIS, impacts upon wildlife associated with extension of the seawall would he avoided through on site monitoring to ensure that Red Knots and Piping Plovers are not directly affected during the construction of the wall. We contend that avoidance could better he achieved by timing construction activities outside of shorebird nesting season. In addition, we recommend discussion in this section about potential impacts upon sea turtles.	Wildlife	The entire seawall extension would not occur at once; it would likely take place as funding allows. As the 435 m (1,430 ft) initial seawall extension is expected to require seven months of construction time, it is not possible to efficiently complete that work outside of nesting season. Additionally, the area that would be affected by seawall extension is currently intertidal (with little suitable nesting beach behind it), so direct effects on nesting birds or sea turtles are not expected to be substantial. However, if additional seawall extension (up to the maximum length of 1,400 m [4,600 ft]) takes place following the initial beach fill, the potential exists for direct impacts to nesting species. As such, NASA would conduct regular monitoring of the beach for potential nesting activity if these activities take place during shorebird or sea turtle nesting season. If a nest is detected, buffers would be established around the nest(s) where no work would occur until site-specific mitigation measures are formulated in conjunction with USFWS and VDGIF.

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				Given the availability of adjacent foraging habitat that would be available to non-nesting beach birds (including Red Knots), any startle effects from construction noise also would not present a substantial impact. As requested, additional information regarding potential impacts on sea turtles has been added to Section 4.3.10 of the Final PEIS.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We recommend further explanation of possible adverse impacts resulting from any of the proposed activities and how such impacts may be mitigated.	Environmental Impacts - Miscellaneous	Potential environmental impacts from all alternatives are detailed in Chapter 4 of the PEIS and mitigation is addressed in Chapter 5.
Virginia Department of Game and Inland Fisheries		We are concerned about the adverse effects placement of a groin at the south end of Wallops may have on islands south of Wallops as it may reduce naturally occurring transport of sands to those areas. Although we recognize NASA's need to protect its assets, we do not support any action to do so that adversely affect other harrier islands that provide important shorebird and sea turtle nesting areas and other wildlife habitats.	Groin or Breakwater	Comment noted. NASA shares DGIF's concern regarding the potential effects of a south terminal groin, and as such has identified the Beach Fill Only project as its preferred alternative.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	VDGIF agrees with the decision to designate Alternative 1 as the Preferred Alternative since it no longer includes installation of a permeable groin, which would reduce the southerly longshore transport of sand thereby adversely affecting the islands south of Wallops. We continue, though, to have concerns about several aspects of the activities proposed in the Preferred Alternative. We offer the following comments and recommendations about the three alternatives presented in the draft PEIS .	Project Support	Comment noted.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	There was no discussion about what steps would be taken to account for sea level rise within the project's lifetime if renourishment at the required volume and frequency is no longer possible due to lack of funding or availability of beach compatible sand. This omission in the PEIS makes it difficult to fully assess the scope and breadth of the project's risk to the environment over the next 50 years.	Sea-level Rise	If funding for future SRIPP actions was not available, NASA would re-evaluate existing conditions and determine appropriate actions at that time. NASA would advocate to remove a groin or breakwater; however, NASA, as with all Federal agencies, is subject to appropriations from Congress, so there is no guarantee that the project would be continually funded over the 50-year planning horizon. However, for 2012 construction of facilities budget, the SRIPP was NASA's

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				highest priority project.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We have similar concerns with Alternative 4 as we do with Alternative 1 because it involves the same actions, only less beach fill will be used. The reduced beach fill will likely require more frequent beach renourishment; therefore Alternative 4 does not appear to offer any cost benefits or reduce barrier island ecosystem impacts aver the long term.	Alternatives	The greater frequency of beach renourishment likely needed in the reduced beach fill scenario would result in higher costs compared to other alternatives including the Preferred Alternative (full beach fill). That is one of the reasons this alternative was dismissed and not carried forward in the EIS analysis.
Virginia Department of Game and Inland Fisheries	Raymond Fernald	We do not consider Alternatives 3 and 6, which are limited to beach fill, to be viable options since both will likely result in the rapid loss of sand placed on the beach.	Alternatives	Comment noted. The greater frequency of beach renourishment likely needed in the reduced beach fill scenario would result in higher costs compared to other alternatives including the Preferred Alternative (full beach fill). That is one of the reasons this alternative was dismissed and not carried forward in the EIS analysis.
Virginia Department of Health	Ellie L. Irons	The VDH-ODW (Virginia Department of Health, Office of Drinking Water) states that there are no apparent impacts to public drinking water sources due to the proposed project. There are no groundwater wells within a 1-mile radius and no surface water intakes located within a 5-mile radius of the project site. The project site is not located within Zone 1 or Zone 2 of any public surface water sources. The VDH-ODW states that potential impacts to public water distribution systems or sanitary sewage collection systems must be verified by the local utility.	Project Support	Comment noted.
Virginia Department of Historic Resources	Ronald Grayson	Based upon the information provided, we concur with your determination that the Proposed Alternatives 1, 2 and 3 will not adversely affect any historic properties. In the event that previously unrecorded historic properties are discovered during project activities, stop work in the area and contact DHR immediately.	Project Support	Comment noted.
Virginia Marine Resources Commission	Ellie L. Irons	It appears that the project would require authorization from the VMRC. However, any dredging that occurs more than 3 miles offshore will not require authorization from the VMRC.	Permitting	Comment noted. As the preferred borrow site for the initial fill cycle would be in Federal waters, NASA would apply and receive authorization from BOEMRE prior to dredging.
Virginia Marine Resources	Ellie L. Irons	Provided that all VMRC regulations are complied with, the project will be consistent with the subaqueous	Permitting	Comment noted. NASA would comply with all VMRC regulations.

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Commission		lands management enforceable policy of the VCP.		
Virginia Marine Resources Commission	Ellie L. Irons	For any development that involves encroachments on primary sand dunes, a JPA must be submitted to VMRC for review and approval.	Permitting	Comment noted. NASA would submit a Joint Permit Application and obtain all necessary authorizations from VMRC prior to implementing either alternative.
Virginia Marine Resources Commission	Ellie L. Irons	Also, VMRC supports Alternative One, as this alternative would have less impact to the existing longshore transport of sand to Assawoman Island in the event that funding for the proposed 5-year beach nourishment cycles cannot be secured.	Project Support	Comment noted. NASA shares VMRC's concern regarding the potential effects of the project on neighboring islands, and as such has identified the Beach Fill Only project as its preferred alternative.
Local Government				
Accomack County Wetlands Board	David Fluhart	As there was no local Wetlands Board jurisdiction, the Accomack County Wetlands Board took no action on the project and offered no comments regarding the Draft PEIS. It was noted that parts of this project will require approval from the Virginia Marine Resources Commission.	Permitting	Comment noted.
Accomack-Northampton Planning District Commission	Eastern Shore Groundwater Committee	The Ground Water Committee would like to voice its support for the [SRIPP] at the Wallops Flight Facility on Wallops Island, Virginia. The Committee found your summary of the [DPEIS] at its last meeting to be very informative. The Ground Water Committee greatly supports the SRIPP.	Project Support	Comment noted.
Accomack County Supervisor, Grayson Chesser	Grayson Chesser	I'm the supervisor of Accomack County representing District 3. Before I spoke against the seawall. Now - not the seawall but the groin. I'm kind of unhappy to see [the groin] still on the list, but I'm very happy to see that it's dropped down to Number 2 because I think it would be disastrous for you if you go to that option. Its absolutely vital to the county that you succeed and I wish you all the best. The reason I spoke against the groin is because I think it would be detrimental not only to you but to all of us who depend on you. I would rather see the groin completely eliminated because I've spent an awful lot of time out there in the winter..I started going out there in the 50s and seeing all the changes its very dynamic and I think the choice you have made [beach fill only as preferred alternative]	Groin or Breakwater	Comment noted. Modeling results indicate that the groin would not have substantial negative impacts. However, it is always possible that conditions could occur that are outside the range that were considered in the modeling effort. Uncertainty in the groin impacts on the shoreline is one of the reasons that this alternative is not the preferred alternative. NASA would determine the future need for sand retention structure(s) based on shoreline monitoring results using an adaptive management strategy.

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		if the only logical one to make.		
Accomack County Supervisor, Grayson Chesser		You know, we have a lot riding on you and your success, and we want you to be successful, and I hope that -- hope that you are, and I think you have made the right choice.	Groin or Breakwater	Comment noted. NASA concurs that the Preferred Alternative (no sand retention structure) is the most appropriate solution for storm damage reduction on Wallops Island.
Other Organizations and Individuals				
Assateague Coastal Trust	Kathy Phillips	ACT is concerned that destruction of shoal habitat will impact the complex food web of these shoals, and the marine communities that depend on it. Therefore, we support NASA's decision not to dredge Blackfish Bank, which is known to support a rich biological community.	Alternatives	Comment noted.
Assateague Coastal Trust	Kathy Phillips	ACT is concerned that dredging either of the proposed shoals, located 7 and 11 miles offshore of Assateague Island, will reduce the shoal's ability to shelter Assateague Island from large waves and resulting shoreline erosion. Any dredging with the potential to increase erosion or wave energy impact on the barrier islands should follow a detailed dredging plan that is included in the EIS. That plan should describe site-specific dredging methods that minimize impacts on island shorelines, such as maintaining the existing shoal crest height (to maintain shallow water processes and crest stability) and avoiding longitudinal (along-axis) dredging (to minimize wave focusing), as per new draft dredging guidelines currently in review by Minerals Management Service. We agree with NASA's decision to dredge no deeper than the seafloor or base of the shoals; dredging pits could alter physical processes.	Dredging	Additional details regarding NASA's dredging plan has been added to Section 2.5.7.2 of the Final PEIS. Results of the USACE modeling to evaluate potential impacts from dredging on ASIS indicate that no measurable impacts would occur to the ASIS shoreline. In addition, NASA would follow guidelines recommended in the two most recent BOEMRE sponsored studies. As a result, the shoals would continue to dissipate incoming waves. Also, the dredged areas would fill in gradually over time from local sediment transport. The deep troughs landward of these two shoals would, in effect "isolate" the shoreline and its immediate profile off Assateague Island from the dredging effects. The shoals are detached shoreface ridges are isolated on the inner shelf. As such, these sand bodies have a high preservation potential and consequently, a low cross-shore sediment transport potential. Section 4.2.3.5 of the Final PEIS has been revised to provide additional information that supports this conclusion.
Assateague Coastal Trust	Kathy Phillips	ACT remains concerned that dredged sediments placed on Wallops Island, and from there transported to Assawoman and Metompkin Islands, will be incompatible with native sediments, which would in turn alter the terrestrial surface texture, the shoreface slope, and the sediment transport processes driven both by wind and by overwash. Such changes in sediments would affect the nesting and foraging behavior of	Grain Size	Sections 2.4.4, 2.4.5, and 2.4.6 of the Final PEIS describe the sediment sampling conducted by USACE to determine grain size suitability of the potential borrow areas. Only compatible sand (that which is adequately similar in grain size to that currently on Wallops Island beach) would be used for beach nourishment. The potential borrow sited were chosen based on the grain size evaluation. Several borrow sites were dismissed because they did not meet the criteria listed below for a useable

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		shorebirds on those islands. In consideration of these potential impacts, the Preferred Alternative should include guidance on ensuring the compatibility of shoal sediments with the native sediments of Wallops Island and downdrift nearshore and beach areas.		source of sand.
Assateague Coastal Trust	Kathy Phillips	Because these islands are geologically fragile and biologically important, we strongly support NASA's decision not to build shore-perpendicular sand retention structures. Groins are well known to cause erosion on their downdrift side and the impacts to alongshore sediment transport would be unacceptable.	Groin or Breakwater	Comment noted.
Assateague Coastal Trust	Kathy Phillips	We support NASA's Wallops Flight Facility as part of our community and hope to work both towards the success of the Facility and the protection of our region's coastal ecosystem. However, as expressed in our letter during the Scoping Process, ACT remains concerned that the Shoreline Restoration and Infrastructure Protection Project will impact many of the natural resources that our organization works hard to protect, including barrier island habitats, coastal waters, shorebirds, sea birds, fish, and marine mammals.	Project Impacts	Comment noted. NASA recognizes that there would be unavoidable adverse impacts to coastal resources, and as such, is committed to mitigating those impacts to the greatest extent practicable.
Assateague Coastal Trust	Kathy Phillips	ACT is also concerned that removal of a significant volume of either shoal will reduce the volume of sediment currently being transported to the barrier islands, thereby accelerating erosion and impacting the islands' natural coastal processes and resilience to the ongoing effects of climate change including sea level rise and storm intensity. As noted in our comments during the Scoping Process, multiple mid-Atlantic coast studies indicate that offshore shoals are an important component of the regional sediment budget and sediment transport pathways. We are disappointed that the Draft EIS did not address potential impacts of sediment removal on cross-shore sediment transport, and we recommend that the Preferred Alternative include new studies to map and quantify cross-shore sediment transport in the area, including geophysical and hydrodynamic data collection in the nearshore and offshore regions of Assateague and Wallops Islands. In	Project Impacts - Shoreline	Results of the USACE modeling to evaluate potential impacts from dredging on ASIS indicate that no measurable impacts would occur to the ASIS shoreline. In addition, NASA would follow guidelines recommended in the two most recent BOEMRE sponsored studies. As a result, the shoals would continue to dissipate incoming waves. Also, the dredged areas would fill in gradually over time from local sediment transport. The deep troughs landward of these two shoals would, in effect "isolate" the shoreline and its immediate profile off Assateague Island from the dredging effects. The shoals are detached shoreface ridges are isolated on the inner shelf. As such, these sand bodies have a high preservation potential and consequently, a low cross-shore sediment transport potential. Section 4.2.3.5 of the Final PEIS has been revised to provide additional information that supports this conclusion.

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		the meantime, to minimize potential impacts of dredging on the poorly-understood sediment transport processes in this region, we also recommend that sediment be dredged from as far offshore as possible, where it is less likely to contribute to onshore sediment transport; that it be dredged from the downdrift accreting side of each shoal, to minimize interruption to sediment transport pathways; and that it be dredged in a thin uniform layer from non-crest areas, to minimize disturbance to shoal topography and geometry and associated shoal-maintenance processes.		
Hampton Roads Military & Federal Facilities Alliance (HRMFFA)		We fully support the planned SRIPP proposal as economically, environmentally, and operationally sound. We find the PEIS to be exhaustive in its research and in its attention to preserving the rich environment unique to the Eastern Shore. We believe NASA has done a superb j ob of balancing the concerns of preserving both the environment and the NASA, U.S. Navy and Mid-Atlantic Regional Spaceport assets which would be enormously expensive to replicate should they be damaged or destroyed from wave impacts associated with storm events.	Project Support	Comment noted.
Self, Calvert Seybolt	Calvert Seybolt	My comment deals with the groin and detached breakwater. They do not seem to have been foreclosed as an option in the report, and to a layman nothing in the report seemed to incorporate all the negative impacts or studies concerning groins. And, actually, you seem to be saying there would be no impact on Assawoman.	Groin or Breakwater	Comment noted. Modeling results indicate that the breakwater or groin would not have substantial negative impacts on Assawoman Island. However, it is always possible that conditions could occur that are outside the range that were considered in the modeling effort. Uncertainty in the breakwater impacts on the shoreline is one of the reasons that this alternative is not the preferred alternative. NASA would determine the future need for sand retention structure(s) based on shoreline monitoring results using an adaptive management strategy.
The Nature Conservancy	Steve Parker	I wish to thank NASA for conducting an open, participatory NEPA process and for listening carefully to the comments of scientists, stakeholders, and this community. The Conservancy is in agreement with the preferred alternative.	Alternatives	Comment noted.
Virginia Nature		In addition, we believe it is imperative that NASA	Adaptive	Comment noted. Please refer to Section 2.3.3.1 of the Final

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Conservancy		begin to take steps to evaluate rigorously the costs and benefits of various adaptation strategies, including phased relocation to the mainland and corresponding efforts to promote the resiliency of the barrier island system. From our conversations with NASA, we understand that those evaluations are beyond the scope of this PEIS. We also appreciate that any relocation effort would pose enormous operational, engineering and financial challenges. While not at all disregarding those challenges, we do respectfully submit that those challenges are likely to increase over time, as are the impacts from rising sea levels and more intense storm events. Given the billions of dollars invested in WFF and its laudable plans to expand operations and its role in the nation's public and private spaceflight programs, starting these planning and analysis efforts earlier rather than later seems to be the most prudent course.	Management	PEIS which describes why relocating infrastructure is not a feasible or acceptable option for NASA WFF.
Virginia Nature Conservancy		If obtaining more accurate and actionable information for the PEIS were simply a matter of correcting a few parameters on the GENESIS model run or using a different model, the Nature Conservancy would certainly make that request for the Final PEIS. Unfortunately, we believe that the flaws in the GENESIS model are instead symptomatic of the underlying limitations of sediment transport models on complex and dynamic real-world environments. Especially when the stakes are so high (both the protection of WFF and the preservation of the larger barrier islands system) we submit that the construction of large scale structures or new engineered approaches is simply not appropriate without robust, long-term, and large-scale real world monitoring results to guide and direct future management actions. With the selection of Alternative One, NASA has taken steps that generally align with this precautionary approach, and again, we commend this decision.	GENESIS model	Comment Noted.
Virginia Nature Conservancy	Robert S. Young. PhD, PG	The modeling used to examine the benefits and impacts of a proposed groin is critically flawed. See Dr. Young's paper for more details.	GENESIS model	As with all mathematical models, the models used in this study have limitations. They do not exactly mimic nature. While they do provide significant insights, the fact that they do have limitations is one of the principle reasons for adopting an

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				adaptive management strategy for the SRIPP. The advice and guidance found in ASBPA 2008, Kraus, Hanson and Blomgren 1994, National Research Council 1995, and Basco, D.R. 2002, all of which are USACE standards was followed in the design of the south terminal groin. NASA and the design engineer, USACE, disagrees with the statement that the methodology is critically flawed.
Virginia Nature Conservancy		As Dr. Young states very clearly in his report (enclosed)˝ "the modeling used to examine the benefits and impacts of the proposed groin is critically flawed. All references in the PEIS to any increased durability of the re-nourishment project, cost savings, or potential downdrift impacts resulting from the construction of the proposed groin are therefore flawed and should not be used for consideration of alternative two" Ultimately, Dr. Young calls into question the use of the Generalized Model for Simulating Shoreline Change (GENESIS), stating that it results in "incorrect representation of shoreline change and sedimentary processes" since the calibrated model was not successfully verified and does not account for the influence of antecedent geology on the sediment budget at Wallops.	GENESIS model	As with all mathematical models, the models used in this study have limitations. They do not exactly mimic nature. While they do provide significant insights, the fact that they do have limitations is one of the principle reasons for adopting an adaptive management strategy. USACE employed globally standardized models to aid in the coastal engineering for the WFF SRIPP.
Virginia Nature Conservancy	Robert S. Young. PhD, PG	All references in the PEIS to any increased durability of the renourishment project, cost savings, or potential downdrift impacts resulting from the construction of the proposed groin are therefore flawed and should not be used for consideration of Alternative Two.	Groin or Breakwater	As with all mathematical models, the models used in this study have limitations. They do not exactly mimic nature. While they do provide significant insights, the fact that they do have limitations is one of the principle reasons for adopting an adaptive management strategy. USACE employed globally standardized models to aid in the coastal engineering for the WFF SRIPP.
Virginia Nature Conservancy		Requests that any future actions considered by NASA for short-term protection of WFF should be based on robust landscape-scale monitoring of the sediment dynamics and shoreline change at Wallops; See Letter dated April 19, 2010	Mitigation and Monitoring - Shoreline	As described in the Final PEIS, NASA would implement an Adaptive Design and Management strategy for the SRIPP. This approach would put into place a thorough monitoring program that would assess shoreline changes on Wallops and adjacent areas. Based on the results of the monitoring program, NASA would assess the need for future actions.
Virginia Nature Conservancy	Robert S. Young. PhD, PG	USACE (2010) seriously underestimates the closure depth along this shoreline leading to a significant underestimation of the amount of nourishment sand	Project Design	The closure depth was determined by a combination of using standard equations for its calculation and from interpreting the local geology. Additional fill was added to the nourishment

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		required, the storm benefits of the project, and project durability.		volume specifically to address any potential underestimation.
Virginia Nature Conservancy		In addition, Dr. Young raises serious concerns regarding the USACE's selection of a four-meter closure depth. Dr. Young submits that this depth is too shallow, and its selection yields incorrect conclusions on the project durability, impacts from storm events, and the overall movement of sand within the project area.	Project Design	The closure depth was determined by a combination of using standard equations for its calculation and from interpreting the local geology. Additional fill was added to the nourishment volume specifically to address any potential underestimation.
Virginia Nature Conservancy		First and foremost, The Nature Conservancy applauds NASA for its selection of Alternative One (seawall extension and beach re-nourishment) as the Preferred Alternative in the SRIPP PEIS. The Nature Conservancy believes that the Preferred Alternative will provide short-term protection benefits to the WFF without creating significant deleterious impacts to the barrier islands owned by the Conservancy and other conservation partners to the north and south of Wallops Island.	Project Support	Comment noted.
Virginia Nature Conservancy	Robert S. Young. PhD, PG	The impacts of rising sea level along Wallops Island over the next 50 years are also greatly underestimated.	Sea-level Rise	Current USACE policy was followed in the beach fill modeling to account for impacts from sea level rise. This has been primarily accomplished by providing an additional sediment volume during each renourishment event that would raise the level of the entire beach fill by an amount necessary to keep pace with the projected rate of sea-level rise.
Virginia Nature Conservancy		Given the reality of rising sea levels and stronger storms, strongly recommends that NASA form an advisory team of partners and experts to help develop an adaptation strategy that ensures the long-term protection of NASA's operations at Wallops and the conservation of the larger barrier island system. The harsh reality is that Wallops Island will remain extremely vulnerable to sea level rise and storm surges. We agree with Dr. Young's assessment that NASA must "entertain the very real possibility that the WFF will not be maintainable as is, in situ, over the next 50 years, even if the Preferred Alternative performs as designed. The Conservancy submits that in order for the PEIS to evaluate accurately any one Alternative's	Sea-level Rise	Comment noted. Sea-level rise has been accounted for in the project design. Section 4.2.1.1 of the Final PEIS has been updated to include the following: The renourishment fill includes the advanced fill volume and a sea-level rise volume. The sea-level rise fill volume was accounted for by including an additional amount of material at each renourishment event that would raise the entire beach profile by an amount equal to the projected amount of sea-level rise, as estimated by King et al. (USACE, 2010a) in the USACE analysis and design. Additional consideration on the impacts of sea-level rise has been added to Section 4.7.2 of the Final PEIS.

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		likely success in protecting the infrastructure and operations of WFF over the 50-year lifespan of the SRIPP, it must more comprehensively consider the implications of rising sea levels within the PEIS.		
The Nature Conservancy	Steve Parker	The Nature Conservancy looks forward to continuing to work with NASA in the future, and thank you again for the opportunity to participate in this very important process.	Project Support	Comment noted.
Internal Technical Review Team (ITR)				
ITR	ITR	Finally, the ITR encourages statements in the EIS as to the options available after this project has fulfilled its life. For example, if the site is abandoned, will the structures be removed? Might the Project be extended beyond the 50-years currently planned? Answers to these questions will provide valuable information to the public as they contemplate the next generation charged with managing infrastructure protection projects and natural environments.	Adaptive Management	This type of analysis is beyond the scope of the PEIS. If Wallops Island is abandoned by NASA, any structures along the shoreline would be evaluated for removal. Prior to future actions, NASA would complete NEPA documentation that would fully evaluate potential alternatives using an adaptive management approach based on monitoring results. As such, NASA would notify the public and consult with appropriate agencies regarding potential alternatives (such as removing structures if warranted) and impacts.
ITR	ITR	As discussed in more detail later, we strongly recommend an “adaptive design” approach to addressing the uncertainties attending the complex sediment transport system in the vicinity of Wallops Island. This would both recognize the real uncertainties and pave the way for valuable flexibility in future actions where needed. Additionally, the Corps of Engineers has recommended adaptive design approaches where warranted.	Adaptive Management	The PEIS has been revised to incorporate a new section (1.4) that addresses adaptive design and management.
ITR	ITR	Level I Comment #1: Adaptive Design. It would seem appropriate to introduce the concept of “Adaptive Design” more explicitly in regard to the determination of whether or not a structure is needed, and if so, the location of the structure. The Adaptive Design concept acknowledges that uncertainty exists in the magnitudes and directions of net transport and, in particular, in the location of the nodal point. Under Adaptive Design, design alterations or a decision to implement an alternative design in the future would be based on the understanding gained from the monitoring results. At	Adaptive Management	The PEIS has been revised to incorporate a new section (1.4) that addresses adaptive design and management.

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		this stage, defining the groin location to within a 5 m longshore location conveys an unwarranted understanding of the sediment transport system. We suggest adding text to section 2.5 along the lines of that which appears at the beginning of Chapter 5. The text currently at the beginning of Chapter 5 discusses an adaptive management strategy whereby mitigation measures are optimized. Our suggestion is to apply the same principles to project design in Chapter 2, by explicitly discussing the intention to adapt any future project design modifications/additions based on results of monitoring efforts. A logical order in which to frame this discussion could include: (1) Adaptive Management and Design; (2) Uncertainty; (3) Alternatives; and (4) the need for a supplemental EA or EIS after a monitoring period.		
ITR	ITR	Offshore Sand Shoals is not as detailed as the "Bathymetry" section on p. 81.	Affected Environment	The Bathymetry section (Section 3.1.3) provides more detailed information regarding the bathymetry in the SRIPP project area, including a map showing the bathymetry of both Unnamed Shoals A and B from data collected by NASA during a 2009 survey of the shoals. Since the shoals are a part of the geomorphology of the project area, the shoals are also discussed under "Offshore Sand Shoals" discussion in Section 3.1.4.4. A reference is made back to section 3.1.3 in Section 3.1.4.4 rather than repeating the level of detail provided in Section 3.1.3.
ITR	ITR	Zhang's paper cited as the only one that demonstrates storminess is not linked to global warming… but hurricanes are!	Affected Environment	The PEIS has been revised to state that increased hurricane activity/intensity is linked to increased seawater temperatures and global warming.
ITR	ITR	Further clarify uncertainty in nodal zone position: The presentation and discussion of nodal zone are improved and better reflect uncertainty in position of the nodal point. However, for consistency and to maintain a consistent level of transparency, we suggest annotating Figure 26 in the same manner as Figure 25, showing the position of the nodal zone and reporting the 95% confidence limits on sediment budget numbers as +/- values rather than reporting only the average. Also recommend noting location of the nodal zone on all other similar figures, e.g., Figures 42-44.	Affected Environment	Figure 26 has been revised to show position of nodal zone and 95% confidence values as suggested. For Figures 42-44, the location of the nodal point and the width of the nodal zone shifts slightly from year to year. Additional figures (ADD NUMBERS) have been added to the Final PEIS that show the Year 5 net longshore transport rates with 95% confidence intervals for Alternatives 1-3.

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ITR	ITR	The discussion of storms skips or omits the Ash Wednesday storm of 1962 and the Halloween Storm of 1989… probably the two key events of the past 60 years in terms of changes to Wallops Island. The EIS may benefit from discussion of specific large storm impacts.	Affected Environment	Mention of these two storms has been included.
ITR	ITR	Level 1 Comment #5: Use of Historical Aerial Photographs. Use of historical aerial photos as evidence for temporal shifts in longshore transport directions is misleading. For example, p., 99 states, "Northerly sediment transport is evidenced by the accumulation of sediment on the southern side of the previously existing groins (Photo 8, taken in 1994), and evidence of southerly sediment transport in the past is shown in Photo 9 (taken in 1969). As discussed in the ITR TM #1 and TM #2, aerial photos often capture seasonal trends in longshore sediment transport that are not indicative of long-term net transport direction. In TM #1 we suggested that an analysis of historical aerial photographs be carried out. In TM #2 we recommended that the document at least acknowledge the appearance of southerly trends in photographs beyond the one shown in Photo 7 of the previous draft of chapter 3. Currently, a single historical photo showing transport to the south has been added to the document. The implication is now that transport was always to the south historically (e.g., Photo 9) and is now always to the north (e.g., Photo 8). This implication is misleading and has the potential to be interpreted as an attempt to selectively present data that supports a desired conclusion. We strongly suggest either: 1. removing the aerial photographs and associated text from the document completely, 2. adding a statement following presentation of the two photographs that clearly acknowledges the possibility for aerial photographs to capture seasonal reversals thereby making it difficult to conclusively determine net long-term transport directions from aerial photographs, or 3. carrying out and presenting an historical photo	Affected Environment	The discussion in the Draft PEIS explains the direction of net sediment transport and the photos are merely presented for visual understanding to the reader of what the net sediment transport north and south looks like along the shoreline - the photographs are not intended to represent direct evidence of net sediment transport over many years because they are only a snapshot in time. As recommended, a statement has been added to Section 3.1.5.4 of the Final PEIS noting that the photographs may be capturing seasonal reversals thereby making it difficult to conclusively determine net long-term transport directions from aerial photographs.

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		analysis and adding a statement to the effect of that discussed in 2 above.		
ITR	ITR	Cannot erode an inlet (Assawoman)	Affected Environment	Assawoman Inlet is completely filled in with sediment currently; therefore although it is still referred to as an inlet, it is erodible at the present time.
ITR	ITR	In discussing air pollutants emitted it states that “Allowance was made for 10% downtime….” Is the downtime relevant to total emissions released?	Air Quality	An assumption of downtime was used in estimating the amount of time that equipment would be operating to complete the air emission calculations. It is a practical assumption that allows for weather conditions, refueling, and mechanical problems. If downtime wasn't allowed for, then emissions would have been slightly higher.
ITR	ITR	Assuming that NASA will integrate an adaptive design approach, the ITR Team advocates the following reprioritizing of Alternatives: Alternative One: Seawall and beach nourishment (current Alternative One); Alternative Two: Seawall, beach nourishment, and north groin; Alternative Three: Seawall, beach nourishment, and a north breakwater. Current Alternative Two: Seawall, beach nourishment, and south groin - ELIMINATE, Current Alternative Three: Seawall, beach nourishment, and south breakwater - ELIMINATE	Alternatives	Using the best available data and understanding of the sediment transport system at the time the DPEIS was developed, Alternative 2 (w/ groin) and Alternative 3 (w/ breakwater) modeled specific sand retention structures at the southern end of the project area. The PEIS has been revised to clarify that sand retention structures may be considered elsewhere along the Wallops shoreline as part of NASA's Adaptive Management and Design approach and based on the results of future monitoring efforts. Prior to implementing any measures outside of what has been analyzed in this PEIS, additional NEPA documentation would be prepared.
ITR	ITR	Level I Comment #2: With the present design, there is confusion associated with the groin and offshore breakwater alternatives. Page ES-2 states: “Construction of the groin would result in more sand being retained along the Wallops Island beach, so less fill would be required for both the initial nourishment and renourishment volumes compared to Alternative One.” Figure 42 (reproduced below as Figure 1) which applies for the case of no structures (Alternative One), shows that the groin would be installed at about the location1 of the nodal zone. According to this figure, during a five-year period, the north end of the project would lose more sand (by a factor of approximately 1.8) than the south end. The ITR Team questions the amount of total sand loss (north loss + south loss) used in determining anticipated 5-year fill volumes. We note	Alternatives	We concur that the ITR puts forth a strong case for a groin at the north end of the project area. NASA's initial alternatives analyses included evaluation of sand retention structures at both the north and south ends of Wallops Island. Although a southern sand retention structures are presented for analysis and comparison in the PEIS, NASA's preferred alternative is not to initially construct a sand retention structure but instead to collect data and use an adaptive management approach to determine the need for and location of a sand retention structure. If the data supports construction of a sand retention structure, supplemental NEPA documentation (and consultation with cognizant stakeholder groups) would be prepared during the planning process.

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		a potentially greater total loss of approximately 1.5 times over the first 5 years than reported in the PEIS on p. ES-2, p. 57, p. 61 (Table 6), and p. 223 (by our calculations, approximately 1,165,000 cy compared to 806,000 cy). It appears that the last two present alternatives are, to some degree, an artifact of the original design when the net transport was believed to be strongly south at the south end of Wallops Island. Though the ITR continues to endorse the preferred alternative (no structure), substantial advantages may exist in changing Alternatives Two and Three to include a structure at the north end of the project, rather than at the south end, as discussed below. A structure at the south end has the potential of either causing erosion or being perceived as causing erosion on Assawoman Island whereas a structure at the north end of the project would retain any impact on Wallops Island. The lack of a structure at the south end would benefit Assawoman Island. A structure at the north end of the project would maintain the area north of the north structure as an "environmental preserve" which would not be disturbed by back passing and would guarantee that backpassed material from south of the north structure would be the same quality as placed in the initial nourishment. The material collected by the structure could be backpassed on a more-or-less continuous basis "in the dry" by earth moving equipment operating on the beach. This would have several advantages including at least doubling or tripling the renourishment intervals from offshore sources and the ability to address localized "erosional hot spots" without the need for dredge mobilization, thereby reducing project costs and environmental impacts due to large emplacements and removals from the offshore shoal(s). Also, prevention of the transport of the material placed to the extreme north end of Wallops Island would have advantage of not increasing shoaling pressure on Chincoteague Inlet. This Alternative would provide a "conservation of sand		

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		approach" without impacting the existing ecology farther north on Wallops Island. In summary, the benefits of a northern groin - in lieu of the southern groin for Alternative Two - include: · Reducing the perceived or real adverse impact on downdrift islands; · Recapturing sand of same quality as initial nourishment; · Reducing shoaling pressure on Chincoteague Inlet; · Retaining all potential adverse impacts within Wallops Island; · Extending renourishment intervals from offshore sources by factor of 2-3; · Lowering costs; · Providing a capability to address erosional hot spots as they occur; · Recycling sediment on a more continuous basis thereby reducing adverse impacts due to large volume placements; and · Creating an "environmental preserve" north of the groin.		
ITR	ITR	"Bathymetry is the measurement of depth". Isn't bathymetry the product of the measurement of depth?	Bathymetry	The term "bathymetry" can refer to either the measurement of water depth at various places in a body of water, or to the information obtained from such measurements. The sentence in Section 3.1.3 of the PEIS has been revised to read "Bathymetry is the measurement of depth at various places in a body of water".
ITR	ITR	Section on "bathymetry" only addresses Assateague and Fishing Point, but not Wallops.	Bathymetry	A description of nearshore bathymetry has been added to the PEIS.
ITR	ITR	"Continental shelf edge sightings were generally associated with the 1,000-m depth contour…" The continental shelf edge is usually taken as 200 m.	Bathymetry	Sentence has been revised to read: Sightings were generally associated with the 1,000-m (3,280-ft) depth contour during all times of the year (CeTAP, 1982).
ITR	ITR	p. 274 states: "Temporary increases in the volume of marine traffic would occur for approximately seven months during initial beach nourishment and approximately six months during each nourishment cycle." Page 295 states: "In addition, the SRIPP dredging operations would last approximately 7	Dredging	Page 274 of the Draft PEIS incorrectly stated the duration of dredging. The renourishment dredging cycle would take approximately 2 months as stated in Chapter 2 (Implementation Schedule). The transportation section of the Final PEIS has been revised accordingly.

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		months during the initial construction phase and approximately 2 months during each renourishment cycle." Why the disparity?		
ITR	ITR	Level I Comment #3: Dredging Plan. It seems that the plan is, for each nourishment or renourishment, to dredge uniformly the designated areas in Shoal A and/or Shoal B. To minimize disturbance, wouldn't it be better to dredge a smaller area deeper each time, thereby disturbing less biota since the majority of the biota live in the upper 15 cm or so? We recommend examining several candidate dredging scenarios, determining which is most advantageous to the biological system and detailing to a greater degree, this preferred dredging scenario. Additionally, in discussing the disruption to the sea bottom due to dredging, if trawling for shrimp and/or clams occurs on these sand ridges, it would be appropriate to discuss this trawling to put the disruption due to dredging in perspective.	Dredging	Information on the proposed dredging plan has been added to Section 2.5.2.2 of the Final PEIS. Shallow dredging has been recommended in two recent MMS-funded studies examining dredging on shoals offshore of DE, MD, and VA (CSA International Inc et al., 2009; Dibajnia and Nairn [*in press*]). While a relatively shallow excavation over a broader area results in more surface area disturbance and greater short-term biological impacts, sediment reworking and site infilling in general proceed more rapidly than would occur with deeper, more spatially restricted dredging (CSA International Inc., 2009; Byrnes et al., 1999). In turn, benthic recovery would follow the recovery of the physical habitat. A deep dredging footprint would result in increased benthic recovery time as well as potential permanent changes to the geomorphic integrity of a shoal. Section 4.7.2.2 of the Cumulative Effects section addresses benthic impacts from trawling. Trawling disturbs the sediment and associated benthic community however unlike dredging it does not remove sediment and disturbs a shallow depth than dredging.
ITR	ITR	Our understanding is that the infilling of borrow pits is poorly understood and that at least in some cases, borrow areas infill with considerably finer sediments than the native and that this process can take a substantial time.	Dredging	The proposed dredging depth will be relatively shallow (2 to 3 meters) and will not create pits. It is expected that bedload transport will move sediment from adjacent undredged areas into the dredge footprint.
ITR	ITR	Fishing Point is a "cape?"	Editorial	Fishing Point shares features with other shoreline locations that are called capes, such as the three large North Carolina Capes (Hatteras, Lookout, and Fear), most prominently because of the 90 degree convex change in shoreline orientation. There are also certainly differences between Fishing Point and the three North Carolina capes, such as in size and longevity.
ITR	ITR	The table summarizing impacts (Table ES-1: Summary of Impacts from Proposed Action Alternatives) should be edited to more accurately reflect main sections of the text that highlight the most important and most significant impacts. In some cases, the table appears inconsistent with, or to exaggerate impacts as	Editorial	Changes have been made to the Executive Summary table to better reflect the most important impacts, and for clarity.

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		described in the text. For example: · “Over the lifetime of the SRIPP, the seawall extension and beach fill would have long-term direct beneficial impacts on geology and the Wallops Island shoreline by mitigating the current rate of shoreline retreat.” This statement deals only with the impacts to the shoreline without treating the impacts to geology. As stated on p. 195, there will likely be long-term adverse impacts on geology because overwash will be prevented thereby causing island narrowing. This impact should be addressed in the summary table as well. · “The addition of sediment to the longshore transport system would result in accretion at the southern end of Wallops Island and northern end of Assawoman Island” This appears to be a potentially misleading overstatement of text on p. 199 that reads, “In summary, under Alternative One, the rate of erosion on the southern end of Wallops Island and the northern end of Assawoman Island would be reduced due to additional sand available for transport…”		
ITR	ITR	Additionally, exclusively listing impacts on adjacent barrier islands as “positive” or “negative” oversimplifies to the point of confusion. Based on the description, this last criterion seems to be an initial assessment of whether or not the project adds sand to the longshore sediment transport system. We recommend providing a text heading (p. 31) and a column heading (p. 32) that is more reflective of this screening criterion (perhaps “Anticipated Change in Sand Availability for Longshore Transport”).	Editorial	The text heading referred to (page 31 of Draft PEIS) and the last column of Table 1 (page 32 of Draft PEIS) has been revised to "Anticipated Change in Sand Availability for Longshore Transport" as recommended.
ITR	ITR	To increase readability of the document by reducing repetition, is it possible to make some statements that will avoid repetition? For example, could it be said: “In the following paragraphs, unless stated otherwise, all diesel engines will be required to use low sulfur fuel”? Also, fixing grammar problems will improve both readability and credibility, e.g.,: · farther vs. further , p. 75, 93, 99 to name a few (do a global search of entire document)	Editorial	The recommended changes have been made to the Final PEIS.

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		· data = plural, p. 78, 82, 94 “This data…,” should read “These data….” “The data is…” should read, “The data are….” (do a global search throughout the document) · hyphenate sea-level rise throughout the document, but not “the sea level rises” – only when sea level is used as an adjective, e.g., p. 98		
ITR	ITR	Edit to remove non-gender neutral language that may be off-putting to some readers (why take the chance of offending readers in this way, when it’s so easy to avoid it?). e.g., Man’s environment = human environment, man’s activities = anthropogenic activities, etc.	Editorial	Language has been changed to be gender neutral.
ITR	ITR	Second sentence of second paragraph- clarify. Doesn’t make sense as written.	Editorial	The sentence has been re-written for clarity.
ITR	ITR	Define acronym “BMP” at first use in each chapter.	Editorial	BMP has been spelled out in the acronym list and at first usage in text.
ITR	ITR	Second paragraph, “According to a 30-year study by Komar and Allan (2008), the waves off the east coast of the United States are gradually increasing in height, especially those generated by hurricanes.” During the study, a net increase in the occurrence of waves…” The study by Komar and Allan was not 30-years long, rather the study investigated a 30-year wave record. The two sentences should be edited accordingly to correctly convey this information.	Editorial	Paragraph has been re-written for clarity.
ITR	ITR	Reads: “…and 11 seconds apart with an 11 second period.” Should read “…with an 11 second period.”	Editorial	The error has been corrected in the Final PEIS.
ITR	ITR	Figure 33 – PHOTO MISSING	Editorial	In the versions of the Draft PEIS that were distributed, Figure 33 is not missing.
ITR	ITR	Should be “218 people per km2”.	Editorial	The error has been corrected in the Final PEIS.
ITR	ITR	Fourth Line: Should read “Three” rather than “Two”.	Editorial	The error has been corrected in the Final PEIS.
ITR	ITR	“slowing wave energy”. Not standard terminology. “Reduce wave energy”?	Editorial	The text has been changed from "slow" to "reduce" where found throughout the Final PEIS.

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ITR	ITR	Some of the conversions from km to miles are incorrect. For example, p. 274 converts 5 km to 8 mi. Also conversion problems are present elsewhere in the report.	Editorial	The error on page 274 of the Draft PEIS was corrected - the value of miles and kilometers was mistakenly interchanged. Other conversions may not appear to be exact because rounding was used to remain consistent with the level of precision presented. For example, if 25 miles is shown, then the value presented for kilometers was 40 instead of 40.2. If the conversion was originally done from miles to kilometers and rounding occurred to present the correct level of precision in the document, if the reader then tried to convert kilometers to miles the values would appear incorrect. Using the 40 kilometer (25 mile) example from above, if you convert 40 kilometers back to miles you get 24.8 miles. The conversions in the Final PEIS were checked again for accuracy and changes made as needed.
ITR	ITR	“Nor’easters are difficult to predict because their wind speed is not always related to their wave heights.” ????	Editorial	Sentence has been re-written for clarity.
ITR	ITR	Last paragraph, “…which is most damaging along long areas of coastal zones. Nor’easters are difficult to predict because their wind speed is not always related to their wave heights.” These two sentences should be clarified and corrected.	Editorial	Sentence has been re-written for clarity.
ITR	ITR	First mention of “monitoring,” but unspecified (“on a regular basis”)	Editorial	The concept of monitoring is introduced in this paragraph, but is not intended to specify monitoring intervals. That level of detail is presented in Section 5.2 Monitoring.
ITR	ITR	p. 57, the term “beach” used incorrectly twice	Editorial	The term "beach" has been replaced by the term "shoreline" in the two instances.
ITR	ITR	Redundancies: waves, shoals, geographic setting	Editorial	Although some repetition will occur in a document of this nature and complexities, the Final PEIS has been edited for redundancies in the sections referred to in the comment.
ITR	ITR	Strange terms: “benefit to sediments?” “opposite of the breakwater?”	Editorial	The sentence regarding benefit to sediments has been revised to read: Minor losses of sediments are anticipated in the immediate vicinity of the breakwater during the construction period. The term "opposite" has been replaced by "perpendicular."
ITR	ITR	wording. “driving the suction through the pipe”.	Editorial	The sentence has been revised to read: "the sound of suction through the pipe".

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ITR	ITR	Should “induced” be “multiplier”?	Editorial	The term "induced effect" has been replaced by the term" ripple effect". The text in question has been revised as follows: In turn, the labor force would re-spend a portion of their salary and wage earnings on various consumer expenditures, producing a “ripple effect”. This effect is observed as indirect economic activities, such as demand for goods and services, respond to the direct economic stimulus. Some non-local construction workers and vessel operators and crew are anticipated to require lodging in local motels and hotels.
ITR	ITR	Level II Comment #3: Justify 50-year storm event. Table 1 on p. 32 and the associated text on p. 31 of the PEIS provide a discussion of the initial screening of project alternatives. This table appears useful but is somewhat misleading in that it pairs each alternative with a specific level of storm damage reduction. If this table is to be used it should be clearly indicated in the text and in the table that the level of storm damage reduction provided for each alternative is an estimate and therefore representative only of an anticipated level of storm damage reduction. For example, changing the text and second to last column heading to “Anticipated Level of Storm Damage Reduction” would provide clarification.	Editorial	The column header has been changed to "Anticipated Level of Storm Damage Reduction" as suggested.
ITR	ITR	Above Table 35. The ratio above this table should be dimensionless and should be: 0.047/7,150 = 6.6x10-6.	Editorial	The comment refers to the following statement: "These data show the ratio of CO_2e emissions resulting from Alternative 1 to all sources in the United States is approximately 0.047/7,150 million metric tonnes. CO_2e emissions from this alternative would amount to approximately 6.62x10-4 percent of the total GHG emissions generated by the United States". While the commenter is correct that 0.047/7,150 = 6.6x10-6, the statement as written, as a percentage, is correct.
ITR	ITR	Table 33 and others. The releases are in terms of annual quantities. Are these averages and thus amortized over the 50 year period. Perhaps we missed this explanation.	Editorial	The emissions shown in Table 33 and other related tables are not averaged over a 50-year time period and instead show estimated emissions for 1) initial dredging/placement emissions, and 2) renourishment emissions for one renourishment event. In theory the reader could multiply the renourishment emissions times the 9 renourishment events and add that to the initial dredging emissions to come up with a 50-year total emissions;' however, this methodology is not consistent with the Clean Air Act because regulatory thresholds

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				are provided on an annual basis. Also, emissions are going to dissipate over the region annually so adding them cumulatively does not provide useful environmental impact information.
ITR	ITR	Why is section 3.1.3 Previous Erosion Prevention and Shoreline Restoration Efforts in Chapter 3: Physical Environment section?	Editorial	Section 3.1.3 of the Draft PEIS "Previous Erosion Prevention and Shoreline Restoration Efforts" has been moved from Chapter 3: Physical Environment to Chapter 1: Introduction/Background in the Final PEIS as recommended.
ITR	ITR	In Tables 31 through Table 47, why are some of the columns in tons per year and some in metric tons per year?	Editorial	Both English and metric units of measure were provided in the air emissions results because U.S. (EPA) air emissions are regulated/permitted in English units (tons) and greenhouse gas (GHG) emissions are considered on a global scale and the accepted unit of measure when presenting GHG emissions is metric.
ITR	ITR	Explanation of “minimum target fill” unclear and not carried out in the discussion	Editorial	Additional explanation of minimum target fill was added to Section 2.5 (Proposed Action Alternatives) of the Final PEIS. The concept is now given several sentences of explanation/summary; if the reader wants to follow up on details of how each component within the minimum target fill was derived by USACE modeling, they can read Dr. King's report in Appendix A.
ITR	ITR	“Construction activities would cause erosion in the short-term..”. Please explain the mechanism whereby construction activities causes erosion.	Environmental Impacts - Miscellaneous	Construction activities such as grading, clearing, and use of heavy equipment result in removal of vegetation and disturbance of the ground surface which often result in wind and water erosion because the soil particles are exposed to the weather and easily become dislodged and transported (erosion) whereas typically they would be protected by vegetation.
ITR	ITR	Also, on Figures 42 and 43, why not include a corresponding plot of shoreline change rate? These rates can be calculated from these figures by a specialist, but not the layperson.	Figures	Plots of shoreline change rate have been added to Section 4.2.3.4 of the Final PEIS as suggested (Figures 49, 52, and 53 in the Final PEIS). These show the projected Year 5 shoreline positions with confidence limits, the projected accretion adjacent to each end of the project and continued erosion further to the south on Assawoman Island.
ITR	ITR	Level II Comment #6: Clarify predicted sediment transport patterns. Erosion is expected following the beach fill and GENESIS models have estimated the amounts in “Impact on the Shoreline from Seawall Extension,” but where will all of this sand go and what	GENESIS model	Some of the beach fill material will pass to the south, which will help alleviate the erosion problem on Assawoman Island. The majority is expected to pass to the north and accumulate on the north end of Wallops Island. The PEIS has been updated to include this information.

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		will be the impact of the redistribution of this material? The EIS would benefit from more specific statements than "…once the beach fill is completed, the short-term adverse impacts during Year 1 would be mitigated in the long-term and beneficial impacts on Wallops Island, Assawoman Island, and potentially other islands to the south would occur …."		
ITR	ITR	Level I Comment #4: Mean Grain Sizes. It is still not possible, from the information provided, to ascertain how the mean grain sizes reported from Unnamed Shoals A and B were derived. This issue is of importance in substantiating claims of sand compatibility and renourishment volumes. Why not clarify sample analysis and calculations of mean grain sizes? For example, p. 43 states, "The mean grain size in the top layer of Unnamed Shoal A is calculated to be 0.42 mm while the top layer of Unnamed Shoal B has a mean grain size of 0.34 mm." How were these means calculated and what is the standard deviation? Providing some measure of spread in mean grain size would be useful. Appendix A provides insufficient information to assess these questions and no other source of documentation is provided. Are the means calculated from the composite values provided for each core?2 Are they an average of all grain size measurements taken in each core? Are they volumetric averages? Further, Appendix A appears incomplete without inclusion of information summarizing grain size calculations and sampling procedures associated with the table provided. For example, each upper, mid and lower core position is associated with a single analysis of grain size. Grain size can (and does) vary significantly with depth such that selection of a single sample from a section of core that is several feet long may not be representative of the average grain size across that section. How were the samples within each depth range selected and what criteria were used to determine the depth ranges analyzed? In summary, transparent reporting of procedures is advisable and would improve the reader's confidence in the summary values reported. We also suggest including standard	Grain Size	The USACE report in Appendix A of the Final PEIS has been updated to include more information on how grain size samples were taken and the analysis was conducted.

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		deviations for individual grain size analyses as well as for the mean grain sizes used in modeling and analysis of renourishment volumes. The effect of data spread on model results should also be addressed (see also TM #1, section 2.3 and TM #2, section 2.3).		
ITR	ITR	...the ITR Panel remains concerned about the southern groin option in Alternative Two and the southern breakwater option in Alternative Three. While the ITR recognizes that the initial plans (Alternative One) will not include construction of the southern groin or breakwater, we strongly recommended in TM #1 (Section 2.4.1) and the ITR Panel continues to recommend that Alternative Two, which calls for a south terminal structure as an adaptive design option, be removed from the PEIS. Similar consideration should be given to abandoning Alternative Three (with a single south nearshore breakwater) given that the impacts can be expected to be similar to those of the south groin.	Groin or Breakwater	Using the best available data and understanding of the sediment transport system at the time the DPEIS was developed, Alternative 2 (w/ groin) and Alternative 3 (w/ breakwater) modeled specific sand retention structures at the southern end of the project area. The PEIS has been revised to clarify that sand retention structures may be considered elsewhere along the Wallops shoreline as part of NASA's Adaptive Management and Design approach and based on the results of future monitoring efforts. NASA would conduct additional analysis and prepare NEPA documentation if this alternative would be pursued.
ITR	ITR	In discussing the effects of the structures, it is stated, for example, that: "…construction of a groin would reduce erosion rates locally." However, there is the potential that a groin (or breakwater) would either cause or be perceived to cause erosion to occur. Groins can be tricky in their effects and depend on wave characteristics, beach conditions between renourishments, etc.	Groin or Breakwater	Comment noted. Modeling results indicate that the groin would not have substantial negative impacts. However, it is always possible that conditions could occur that are outside the range that were considered in the modeling effort. Uncertainty in the groin impacts on the shoreline is one of the reasons that this alternative is not the preferred alternative. NASA would determine the future need for sand retention structure(s) based on shoreline monitoring results using an adaptive management strategy.
ITR	ITR	How is the inventory of invertebrates known?	Invertebrates	This section, like other affected environment sections, was based off of the NASA 2008 Environmental Resources Document. A statement indicating this has been added to the introduction of the Affected Environment chapter.
ITR	ITR	Level II Comment #10: Review accuracy of invertebrate impacts. Some of the information on the impacts on the major invertebrates is questionable. For example, the statement regarding their ability to survive while dredging is underway needs confirmation. Invertebrates cannot dig into or out of dry beach deposits. They require a saturated substrate	Invertebrates	In Section 4.3.6 Benthos, Alternative One, we state that "Due to the handling and pumping activities, the dredged sand itself would also be devoid of live benthos." The statement concerning the mobility of the benthos at the sand placement site has been clarified.

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		in order to create a "quick" condition in the upper layers of the beachface. This behavior is discussed extensively in the coastal science literature that we previously submitted (e.g., Peterson et al., 2000).		
ITR	ITR	Level I Comment #6: Monitoring and Mitigation. Given the importance of mitigation and monitoring in determining project success we suggest a few revisions to this section. Appropriately, the potential for long-term adverse effects on geology (e.g., narrowing and/or lowering of the barrier island landform) due to prevention of overwash has been added to the discussion of impacts earlier in the document. Given the broad scale of such an impact, it seems prudent to address this matter – at least briefly – in section 5.1.1.1. Chapter 5 provides discussion of a shoreline change monitoring program as suggested by earlier ITR TMs, however, we suggest expanding this section to provide additional detail and to address some potential deficiencies in the monitoring plan. Although model results have indicated that there will be little effect of the reduction in shoal volume on Assateague Island, is it worth considering inclusion of Assateague Island in the monitoring program, at least initially, to verify that this determination is likely correct? Additionally, clearer and more complete articulation of the beach monitoring program is necessary to demonstrate that such a program will meet the project needs - especially in light of the adaptive design approach. For example, more detail on data collection and analysis should be provided, along with a few references to existing studies that follow similar established procedures. Examples of areas to be addressed include: Will topographic profiles be generated from LiDAR data only or will ground surveys be included? If the latter, how will the two different types of surveys be tied together? · How will bathymetric profiles be collected? · How will the gap between topographic and bathymetric surveys be closed? (Actually, some land based survey methods, i.e., rod and level, will be required to establish the profiles in water depths too	Mitigation and Monitoring - General	Chapter 5 has been updated to include more information regarding the monitoring of physical coastal processes. NASA's monitoring plan would be modified based on the adaptive management strategy and monitoring results. Chapter 5 of the Final PEIS includes all details that are known at this time. As funding allows, NASA would conduct as many recommended monitoring procedures as practicable. NASA would follow standard USACE bathymetric survey procedures as stated in USACE survey manual publication number EM 1110-2-1003.

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		shallow for fathometer soundings while maintaining adequate “overlap” with the fathometer data for quality control.)		
ITR	ITR	In conjunction with the semi-annual surveys, we recommend collecting sand samples for analysis and comparison through time to aid in tracking beach fill movement. In addition to the semi-annual surveys we suggest that the monitoring plan include a discussion of the desirability of including post-storm surveys following significant events whenever possible. Though we acknowledge that it involves additional expense, we also suggest adding a directional wave gauge and a tide gauge to the monitoring program. Both gauges would provide information that would benefit future modeling efforts greatly. Simple inclusion of statements indicating that monitoring will be carried out by an independent contractor with experience in monitoring, measuring and analyzing patterns of shoreline change would also strengthen this section.	Mitigation and Monitoring - General	NASA would create and implement a monitoring plan that would be modified based on the adaptive management strategy and monitoring results. Chapter 5 of the Final PEIS has been updated to provide additional details that are known at this time. As funding allows, NASA would conduct as many recommended monitoring procedures as practicable.
ITR	ITR	How are Longshore Sediment Transport direction known?	Project Design	Wave data were used in USACE modeling to determine longshore sediment transport directions on Wallops Island. Chapter 5 of the USACE report (Appendix A of the PEIS) details what data was used and how it was applied into the models. The Longshore Sediment Transport section of Chapter 3 in the PEIS includes the following discussion: "Waves coming from the southeast have roughly the same height everywhere along the shoreline, but waves coming from the northeast have dramatically decreasing height (and thus energy) the further north they are along Wallops Island. This means that they have less ability to transport sand to the south. The wave sheltering from Fishing Point and the offshore shoals is the primary reason that the net sediment transport in most years along Wallops Island is to the north."
ITR	ITR	Year 2 nourishment placement activities to “its equilibrium profile.” How known?	Project Design	Chapter 2 of the EIS has been updated to provide a better explanation of what an "equilibrium profile" is and that the USACE modeling determined that in Year 2 under the Preferred Alternative it would be reached. A detailed explanation of the modeling and USACE analysis that were done to reach this conclusion are provided in the USACE report

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				which is Appendix A of the Final PEIS.
ITR	ITR	Level II Comment #7: Address potential narrowing of Tom's Cove isthmus. p. 200, Could changes in wave refraction patterns associated with mining offshore shoals contribute to "Narrowing of Tom's Cove Isthmus?"	Project Impacts	The isthmus separating Tom's Cove from the Atlantic Ocean is narrowing primarily because the Atlantic Ocean shoreline is eroding. This is expected to continue whether offshore shoals are mined or not. The modeling of the shoal mining impacts on the shoreline specifically addressed this issue. The modeling results indicated that mining either shoal A or shoal B would not produce significant changes from the current conditions. Furthermore, mining shoal A (the preferred alternative) would produce the fewest changes in the Tom's Cove area.
ITR	ITR	Level II Comment #8: Address Impacts on Chincoteague Inlet. p. 203, clarification on the impact of beach fill and mining the north end of Wallops on Chincoteague Inlet is needed. While the EIS mentions eastward migration of Chincoteague Inlet as a function of the accretion at the north end of Wallops, no mention is made in the impacts section on the potential westward migration of the inlet in response to mining the northern end. Major changes to tidal channel bathymetry could be expected.	Project Impacts	The north end of Wallops Island accumulates sand from both the south (northward transport along Wallops Island) and east (westward transport across Chincoteague ebb shoal). This accumulation of material at the north end of Wallops Island is causing the inlet to migrate to the east. The amount of material proposed to be mined from the north end of Wallops Island is intended to be equal to this excess that is being deposited. This is expected to help stabilize the location of Chincoteague Inlet and is not expected to provide a force that helps shift the inlet to the west. While it is recognized that inlets are dynamic features, removal of this sand is expected to (if anything) help stabilize the inlet.
ITR	ITR	Accuracy of statement – 1st sentence under "Impacts on the Shoreline from Seawall Extension?"	Project Impacts	The sentence in question, "The fact that sand behind the seawall extension would be retained instead of eroded (erosion in the area of the seawall extension would occur under No Action Alternative) would lead to the potential to exacerbate the erosion on the adjacent shoreline south of the extension" was provided by Dr. David King, which he determined via modeling (see Appendix A of the Final PEIS). Because sand would be retained behind the newly built portion of the seawall instead of remaining available for sediment transport, more erosion would occur on the shoreline south of the seawall extension only if it was constructed and the beach fill was not implemented. The statement is accurate.
ITR	ITR	Level I Comment #8: Downdrift Impacts. The downdrift impacts of Alternatives Two and Three are oversimplified and questionable: What is the principle whereby the breakwater causes an impact over a shoreline segment that is eight times	Project Impacts - Shoreline	The groin and detached breakwater are located in the vicinity of a divergent nodal zone. The beach responses at this type of location can be expected to be substantially different than what would occur along a more typical shoreline where the transport is predominantly in one direction. The modeling effort requires

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		longer than the groin?		the assignment of a permeability to each groin and a transmission coefficient to each detached breakwater. While these two parameters are somewhat analogous, there are significant differences in how the model treats them. In the initial modeling effort, these parameters were varied to help understand their impacts, but there was never an attempt to adjust them so that the two different structures would produce similar downdrift impacts. For the final modeling effort, reasonable values (0.2 for the groin permeability and 0.3 for the breakwater transmission coefficient) were used.
ITR	ITR	Level I Comment #8: Downdrift Impacts. The downdrift impacts of Alternatives Two and Three are oversimplified and questionable: p. 204 (and elsewhere), is the only effect of the groin alternative a 300 m "shadow" area?	Project Impacts - Shoreline	The comment deals with the following statement from the PEIS: "There would be an accumulation of sediment on the updrift side of the groin, and it is possible that groin would function as a "shadow," causing an increase in erosion downdrift of the area within the groin shadow. If the nodal zone is on Wallops Island, the groin could result in erosion within a 300-m (1,000-ft) "shadow" area south of the structure." The groin is specifically designed to allow sand to pass through the structure and was modeled as such. If there were no beach fill, the groin would exacerbate the downdrift erosion on Assawoman Island. However, because the beach fill would be in place, more sand would be moving onto the north end of Assawoman Island than is occurring at present. This would reduce the erosion rate on the north end of Assawoman Island. In fact, sand would be supplied at a rate that the models indicate that the north end of Assawoman Island will begin accreting. The greatest impacts will be immediately adjacent to the project and exponentially decrease with distance from the project. Over time, the effects would continue to grow. If the groin is built as designed and if the models are not inaccurate, then there would be no "shadow" zone south of the groin where there would be an increase in erosion. The quoted statement in the PEIS has been removed and the discussion above added to Section 4.2.2.1.
ITR	ITR	Level I Comment #8: Downdrift Impacts. The downdrift impacts of Alternatives Two and Three are oversimplified and questionable: p. 205 (and elsewhere), is the impact of the breakwater (i.e., erosion and LST) no more than 2.5 km?	Project Impacts - Shoreline	The comment deals with the following statement from the SRIPP (pg 205): "The extent of the erosion would depend on the rate of longshore sediment transport in the breakwater area, but based on the results of the USACE modeling (presented on Figure 41), the direct effects would not likely occur more than 2.5 km (1.5 mi) downdrift of the breakwater." As with the

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				groin, the detached breakwater is an inherently leaky structure. Modeling results indicate that with the breakwater and the beach fill, more sand would be moving onto the north end of Assawoman Island that is occurring presently. This would not just slow the rate of erosion currently occurring on the north end of Assawoman Island, it would cause accretion to occur. The greatest impacts would be immediately adjacent to the project and exponentially decrease with distance from the project. Over time, the effects would continue to grow. If the breakwater is built as designed and if the models are not inaccurate, then there would be no "shadow" zone south of the structure where there would be an increase in erosion. The quoted statement in the PEIS has been removed and the discussion above added to Section 4.2.2.1.
ITR	ITR	In general, this version of the PEIS is improved in terms of recognizing the positive aspects of the Project; however, we believe that the positive aspects merit greater exposure to achieve a better balance.	Project Support	Comment noted. NASA has added more text and content regarding benefits of the SRIPP to Section 2 of the Final PEIS.
ITR	ITR	The EIS states that sea-level rise (SLR) is "a necessary component of the project design" (p. 194) and Chapter 3 (Physical Environment, p. 78-79) highlights SLR as a process that makes Wallops Island particularly vulnerable to infrastructure damage; i.e., "The shoreline at Wallops Island would experience the effects of future sea-level rise, as coasts and barrier islands are particularly vulnerable to the sea-level rise and intensified storm and wave events attributed to climate change (Nicholls et al., 2007)." Moreover, the SRIPP encompasses a 50 year planning horizon – a time span long enough for SLR to impact the SRIPP. However, the first two chapters make little mention of SLR (first mention of SLR on p. 52) to the exclusion of references to storm damage mitigation and reducing "storm-induced" physical damage (numerous statements in Chapters 1 and 2). For example: o Abstract – no mention of SLR o Executive Summary – "storm" used 9 times; "sea level" used 0 times o Chapter 1 - "storm" used 7 times; "sea level" used 0 times	Sea-level Rise	Sea-level rise has been incorporated into more sections of the Final PEIS as suggested.

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		o Chapter 2 - “storm” used 58 times; “sea level” used 1 time (p. 52) Given the need for developing justification for the SRIPP, setting the context for the SRIPP, and using SLR scenarios in design selection and engineering models we recommend: · including SLR discussion earlier in Chapters 1-2 to provide balance between processes that produce changes over various time scales. Possibilities include: Abstract – could mention possibility of climate change and SLR page 1: “This Programmatic Environmental Impact Statement (PEIS) has been prepared to evaluate the potential environmental impacts from the proposed Wallops Flight Facility (WFF) Shoreline Restoration and Infrastructure Protection Program (SRIPP). The SRIPP encompasses a 50-yearplanning horizon and is intended to reduce damage to Federal and State infrastructure on Wallops Island” caused by the combination of sea-level rise (SLR) and coastal storms. page 2: “Two of these tenants, the U.S. Navy and MARS, have facilities on Wallops Island that are at risk from SLR and storm damages and would be protected by the Proposed Action.”		
ITR	ITR	Given the need for developing justification for the SRIPP, setting the context for the SRIPP, and using SLR scenarios in design selection and engineering models we recommend: improving discussions to include and emphasize the links between SLR and storm activity; Sea-level rise is an important changing background condition that will make protection of NASA facilities increasingly difficult into the future by increasing the effect of storms, i.e., given the same storm today and in 20 years, the effect will be much greater in 20 years due to higher water levels. For example, in Chapter 4: Environmental Consequences, no mention is made of the possibility of more frequent wave overtopping as sea level rises; the three brief paragraphs seem to short shrift the possible impacts.	Sea-level Rise	Sea-level rise has been incorporated into more sections of the Final PEIS as suggested.

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ITR	ITR	Given the need for developing justification for the SRIPP, setting the context for the SRIPP, and using SLR scenarios in design selection and engineering models we recommend: clarifying the role of sea level on the sediment transport regime; for example, "As sea level rises, it is anticipated that the beach on Wallops Island would be exposed to increasing rates of sediment transport, and therefore would erode at increasing rates over time…" In addition, state the basis for this claim.	Sea-level Rise	An increase in the mean water level on a beach can be expected to cause an increase in erosion of the upper beach face (the portion of the beach profile above zero elevation) for two reasons. First, as the waves approach the shoreline, the waves are in deeper water than they would be without the sea level rise, so less of their energy is dissipated by breaking and thus more energy reaches the vicinity of the shoreline. Secondly, beaches typically have concave (upward) profiles. Waves break higher up on the profile than before where the profile is steeper (out of equilibrium). The profile adjusts to this new condition by flattening out, which means removing (additional) material from the upper shoreface. However, for this project it is planned that additional material will be provided at each renourishment interval which will act to raise the entire profile by an amount equal to the amount of sea level rise. It is not clear whether the quoted statement refers to increased longshore or cross-shore sediment transport. This response deals mainly with cross-shore transport. For longshore transport to increase, either wave heights need to increase or wave angles need to change in appropriate ways (or both). Global warming may not only cause sea-level rise, but also an increase in the frequency and intensity of storms. Increased storminess could increase wave heights along Wallops Island; however, the increased storminess is an even murkier issue than sea-level rise. Increased water levels will affect wave refraction, but not much and it is not clear that the overall change in wave angle would be in the appropriate direction to increase the longshore transport. The bottom line is that sea-level rise would have an unquantifiable but probably minimal impact on erosion rates for the SRIPP. Due to the confusion about the quoted statement, it has been removed from the Final PEIS.
ITR	ITR	It would also be useful to report the historical rates of sea-level rise for the study area, for example, from the Hampton Roads tide gauge.	Sea-level Rise	The Final PEIS has been revised to include the following information: Data gathered from long-term tidal gauges in Hampton Roads, Virginia indicate that between 1930 and 1960 the average relative sea-level rise for this location was 4.2 mm per year (NOAA, 2004).
ITR	ITR	First sentence: "…how local historical changes and unique circumstances, like rate of subsidence, shoreline retreat, wave and tidal patterns, and presence of manmade structures, affect the sea-level rise within	Sea-level Rise	Suggested change has been made.

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		a particular area." Of the items listed, only subsidence affects relative sea-level rise rate. The other items in the list should be removed.		
ITR	ITR	NRC (1987) Report referenced for high/low eustatic SLR? Need newer reference.	Sea-level Rise	Dr. King utilized the USACE 2009 document "Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs" (http://140.194.76.129/publications/eng-circulars/ec1165-2-211/entire.pdf) in formulating the methodology for his report. The NRC 1987 reference comes directly from 2009 USACE guidance.
ITR	ITR	Though Fig. 15 appropriately shows a blue "sea-level rise fill layer" as included in the design, the approach and significance of this is not addressed in the main text, rather one must search for it in the appendix. Suggest adding an explanation within the description and comparison of alternatives in Chapter 2.	Sea-level Rise	A brief explanation of the sea-level rise fill volume has been added to Chapter 2 Preferred Alternative.