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FEASIBILITY REPORT

AND

ENVIRONMENTAL IMPACT STATEMENT

COASTAL STORM DAMAGE REDUCTION PROJECT

SURF CITY AND NORTH TOPSAIL BEACH

NORTH CAROLINA

Appendix E

Sand Compatibility Analysis

Appendix E: Sand Compatibility Analysis

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Appendix E: Sand Compatibility Analysis

1. Introduction. Sands making up the native beach are generally hydraulically sorted with the coarser grain sizes concentrated in the foreshore region, where wave energy is the greatest, and the finer grain sizes located in the offshore areas seaward of the surf zone. In order for the borrow material to be compatible with the native beach sand, the borrow material must contain essentially all of the same grain sizes that exist on the active beach profile of the project area. In this regard, the active beach profile is generally defined in engineering terms as the portion of the profile from the top of the beach berm seaward to depths where significant sand transport by wave energy is negligible. At Topsail Island, the active beach profile appears to end in a water depth of approximately 25 feet below National American Vertical Datum (NAVD). Note that sediment movement in water depths greater than 25 feet below NAVD is known to occur. However, the rate of sediment movement in these deeper depths is relatively small compared to rate of movement in the shallower depths and are therefore of minor importance in the day to day and year to year behavior of the beach profile.

2. Definitions. Definitions are included to provide better understanding of the terminology used in this appendix.

Active zone. The zone that extends from the top of the beach berm seaward to depths where sediment transport induced by waves is negligible.

Beach berm. A nearly horizontal part of the beach or backshore formed by the deposit of material by wave action.

Datum. Any permanent line, plane, or surface, used as a reference datum to which reference datums are referred.

Foreshore. The part of the shore, lying between the crest of the seaward berm (or upper limit of wave wash at high tide) and the ordinary low water mark, that is ordinarily traversed by the uprush and backrush of the waves as the tides rise and fall.

Grain size. Refers to the mean or effective diameter of individual mineral grains or particles. Grain size analysis passes particles through a series of sieves with known mesh sizes to determine the grain size based on the amount of particles retained or passing a sieve.

Mean high water (MHW). The average height of high waters over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value.

Mean low water (MLW). The average height of low waters over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value.

Mean sea level (MSL). The average height of the surface of the sea for all the stages of the tide over a 19-year period, usually determined from hourly height readings. Not necessarily equal to mean tide level. It is also the average water level that would exist in the absence of tides.

Offshore. The zone extending from the shoreface to the edge of the continental shelf.

Overfill ratio. Used to evaluate the compatibility of sediments and to relate the volume of borrow site sediment required for a project to perform comparably with native beach sand.

Phi scale. A common method to represent grain size distribution. The scale is a logarithmic transformation of the Wentworth grade scale for size classifications of sediment grains based on the negative logarithm to the base 2 of the particle diameter. A phi value is dimensionless and has equivalent millimeter values.

Vibracore. A drill machine driven by a vibrating head assembly to collect sediment samples. Ocean sediment samples are collected by lowering the machine from a floating vessel to the ocean floor.

3. **Grain Size Nomenclature.** Note that the mean grain sizes of the native and borrow area materials are reported in both millimeters (mm) and phi (φ) units in this report where phi is related to the grain size as follows:

$$\varphi = -\ln(d)/\ln(2)$$

where:
d = grain size in millimeters (mm)
ln = natural log

Since the distribution of the sand samples can generally be represented as log-normal distributions, the standard deviations and variances of the particle size distributions are reported in phi units.

4. **Native Beach Sampling and Results.** The characteristics of the native beach material at Topsail Island were determined through an extensive sampling program conducted by the USACE in 2003. Samples were collected from the beach along transects approximately 5,000 feet apart (see figure A-1). Only transects 7 through 16 exist within the boundaries for the Surf City/North Topsail Beach project and were evaluated to determine the native beach characteristics. Grab samples were collected by the USACE in 2003 from the along each transect at the surface at the following elevations: Toe of the Dune, Crest of the Berm, Mean High Water (MHW), Mean Sea Level (MSL), Mean Low Water (MLW), and twelve (12) samples collected seaward of MLW starting at elevation -3 feet and continuing at 2 foot depth increments from -4 to -24 feet.

The State of North Carolina implemented new rules in 2007 governing sediment compatibility for beach nourishment. The rules are titled "Technical Standards for Beach Fill Projects" and are found in 15A North Carolina Administrative Code (NCAC) 07H.0312. These rules specify that characterization of the native beach material requires a minimum of thirteen (13) samples be collected along each transect with an equal number of samples collected landward and seaward of mean low water (MLW). Because this rule was implemented after the sampling program at Topsail Island was conducted by USACE, the current data set for transects 7 through 12 contain only four landward samples of MLW. In 2007, Coastal Planning & Engineering of North Carolina, Inc. (CPE-NC) collected two (2) additional samples landward of the MLW from the dune and mid-berm (~ +3 to +5 ft NAVD) along each transect line 13 through 16 to meet this requirement for the North Topsail Beach non-Federal Shore Protection Project. The CPE-NC data for transect lines 13 through 16 has been incorporated into this evaluation performed for the Surf City/North Topsail Beach Federal Shore Protection Project. To comply with the beach fill standard, two (2) additional samples will be required to be collected landward of MLW for each transect line 7 through 12 prior to construction of this project. To be consistent with the samples collected by CPE-NC along transect lines 13 through 16, these additional samples along transect lines 7 through 12 will be collected from the dune and mid-berm (~ +3 to +5 ft NAVD).

To comply with the beach fill standards, only 6 of the 12 samples collected seaward of MLW were combined with the MLW sample and samples landward of MLW to develop the composite characteristics of the native beach material to be used in the compatibility analysis of the borrow material. The grain size distribution of each sample was determined by standard sieve analysis, from which the mean and standard deviation of the grain size distribution of each sample were determined. The samples at each transect line were combined to develop the composite characteristics of the native beach material to be used in the compatibility analysis of the borrow material.

Active Beach Profile Zone

The vertical datum used for the collection of the native beach samples by USACE in 2003 was the National Geodetic Vertical Datum of 1929 (NGVD ’29). The beach fill standards implemented by North Carolina in 2007 adopted the North American Vertical Datum of 1988 (NAVD ’88) as the vertical datum. Therefore, the vertical elevation for near shore samples collected by USACE has been converted to NAVD for consistency in this appendix. The mean grain size and standard deviation of the native samples collected along the transect lines in regards to depth is illustrated on figure E-1. The mean grain size variation with depth is typical of other beaches in North Carolina where coarser material is present in the foreshore area ranging from mean high water (+1.1 NAVD) to around -4 to -5 feet NAVD. The mean grain size gradually decreases seaward from this point. The standard deviation of the particle size distribution is larger at the same depths where the coarser material is present in the foreshore to around -4 to -5 feet NAVD. The standard deviation is gradually smaller seaward of this point.

Composite Characteristics of Native Beach Material

The grain size distribution of each of the samples collected from the transect lines were combined and the average grain size distribution and standard deviation for each transect determined. The individual transect line characteristics are summarized in table E-1. The average grain size distribution and standard deviation for the 10 transect lines (7-16) were then combined to determine the composite grain size distribution and standard deviation for the Surf City/North Topsail Beach study area, which are summarized in table E-2. The composite mean grain size for the Surf City/North Topsail Beach study area is 2.15 phi (0.23 mm) with a standard deviation of 0.71 phi (0.61 mm).

The mean grain size and standard deviation of each transect line is plotted on figure E-2. The mean grain size for each transect is relatively similar with the exception of transect line 8, which is slightly coarser and the largest percentage of shell present. The standard deviation is also largest at transect line 8 indicating the material is less sorted in this area than along the other transects. Generally, the material appears to be relatively well sorted throughout the study area as illustrated by the small standard deviation with the exception of transect line 8.

5. **Borrow Material Sampling and Results.** The search for borrow material was concentrated in the ocean waters off Topsail Island beginning approximately 1 mile offshore and in water depths of 33 feet Mean Lower Low Water (MLLW) and extending seaward to approximately 6 miles offshore. Details of this offshore search for beach compatible material is described in Appendix C, Geotechnical Analyses, and consisted of a combination of seismic and sonar surveys followed by the collection of vibracores at 369 locations. Boring logs were developed for each vibracore based on visual classifications of the material in the cores. The sand layers in each vibracore were sampled for grain size analysis. The results of the grain size analysis of the vibracore material combined with the seismic bottom profile data, was used to delineate the boundaries of potential offshore borrow areas. Composite grain size characteristics of the material in each of these potential borrow areas were computed for comparison with the composite characteristics of the native beach material.

Borrow Material Vibracores

The investigation was conducted in two major phases. Phase one consisted of the collection of over 315 miles of seismic subbottom profiles performed offshore of

Topsail Island, with 173 miles of these miles for the Surf City/North Topsail Beach project. Phase 2 involved the collection of 369 vibracores offshore of Topsail Island, with 208 of these vibracores for the Surf City/North Topsail Beach project. The search area and the seismic lines surveyed in this effort for the entire Topsail Island are discussed in detail in the Geophysical Report in Attachment 1 to Appendix C, Geotechnical Analyses. The seismic survey data was analyzed to determine areas where beach quality material of sufficient depth appeared likely.

Based on the interpretation of the seismic data, a vibracore drilling plan was developed to determine the characteristics of the subbottom material. In this regard, the seismic data only provides information on the layering of material and does not provide information of the granular characteristics of the material. The vibracores consist of vibrating a 20-foot long plastic core into the ocean bottom. The plastic core is then split and the material characteristics in the core visually classified. Material collected in the core was sampled and the size distribution of that material was determined through standard sieve analysis. In general, the cores were sampled in two-foot intervals or more frequently if a significant difference in the character of the material was visually apparent. The locations of the vibracores collected for the Topsail Beach study area are shown on figure A-1. Logs of each of the vibracores are provided in Attachment 2 to Appendix C, Geotechnical Analyses. In addition, laboratory data for grain size analysis from each sample is provided in Attachment 3 to Appendix C.

Borrow Site Vibracore Analysis

An initial compatibility analysis was conducted of the vibracore logs and sample lab data in 2004. This analysis identified fourteen preliminary borrow areas (G, H, I, J, K, L, M, N, O, P, Q, R, S, and T) for the Surf City/North Topsail Beach project (See Appendix A, Figure A-1). Mid-Atlantic Technology and Environmental Research, Inc completed an archeological resources survey (magnetometer and side-scan sonar) of the preliminary borrow areas in 2005. The survey identified the presence of hard bottom in and around several of the preliminary borrow areas. Due to the presence of significant hard bottom in borrow areas I, K, and M, these borrow areas were eliminated as potential borrow sources.

The grain size characteristics of all of the samples collected from each of the cores within the remaining potential borrow areas are given in tables E-3 through E-18. The grain size characteristics of the borrow area samples were used to develop weighted average composite grain size distribution representative of all of the material in each of the borrow areas. The weighting was based on the thickness of the core represented by a particular sample in each core from which a weighted composite distribution for each core was determined. The weighted average core distributions were used to compute the overall composite characteristics for the entire borrow area. To comply with the NC beach fill standards, tables E-3 through E-18 also identify the amount of fine-grained sediment, defined as smaller than 0.062 mm (#230 sieve), the amount of granular sediment, defined as smaller than 4.76 mm (#4 sieve) and greater than or equal to 2.0 mm (#10 sieve), and the amount of gravel, defined as greater than or equal to 4.76 mm (#4 sieve). The final weighted composite characteristics for each of the borrow areas are given in tables E-19 to E-34.

6. Overfill Ratio. The suitability of the borrow material for placement on the beach is based on the overfill ratio. The overfill ratio is computed by numerically comparing the size distribution characteristics of the native beach sand with that in the borrow area and includes an adjustment for the percent of fines in the borrow area. The overfill ratio is primarily based on the assumption that the borrow material will undergo sorting and winnowing once exposed to waves and currents in the littoral zone, with the resulting sorted distribution approaching that of the native sand.

Since borrow material will rarely match the native material exactly, the amount of borrow material needed to result in a net cubic yard of beach fill material will generally be greater than one cubic yard. The excess material needed to yield one net cubic yard of material in place on the beach profile is the overfill ratio. The overfill ratio is defined as the ratio of the volume of borrow material needed to yield one net cubic yard of fill material. For example, if 1.5 cubic yards of fill material is needed to yield one net yard in place, the overfill factor would equal 1.5. The numerical procedure for computing the overfill ratio is contained in a suite of computer programs contained in the Automated Coastal Engineering System (ACES) produced by the U.S. Army Coastal Engineering Research Center. The procedure is also described in the U.S. Army Coastal Engineering Manual EM-1110-2-1100 Part V (July 2003). A summary of the native beach and borrow characteristics, as well as, the computed overfill ratios is shown in table E-35.

7. Compatibility and Borrow Sources. The compatibility analysis compares the grain size of the “native or reference beach” with the material in the proposed borrow material. The overfill ratio is the primary indicator of the compatibility of the borrow material to the beach material, with a value of 1.00 indicating that one cubic yard of borrow material is needed to match one cubic yard of beach material. An overfill ratio of up to 1.5 is generally considered acceptable as a match of compatibility. Table E-35 illustrates the overfill ratios for potential borrow areas for the Surf City/North Topsail Beach project.

Prior to implementation of the NC beach fill rules in 2007, eleven (11) offshore borrow areas were identified for the Surf City/North Topsail Beach project and included G, H, J, L, N, O, P, Q, R, S, and T. After re-evaluation of the borrow areas using the new beach fill standards, borrow area R was determined to be well above the silt criteria and was not evaluated further. Excluding borrow area R, the compatibility analysis indicated the overfill ratio for the remaining 10 borrow areas were all below 1.5. Because additional characterization for all borrow areas will be conducted during the design phase, borrow area R has not been included in the volume calculations for material available for the project, but has been retained for future evaluation. With the exclusion of borrow area R, the total estimated volume in the remaining ten borrow areas (G, H, J, L, N, O, P, Q, S, and T) is approximately 27.59 million cubic yards (yd^3), which is insufficient to meet the required volume for the NED plan of 32.3 million yd^3.

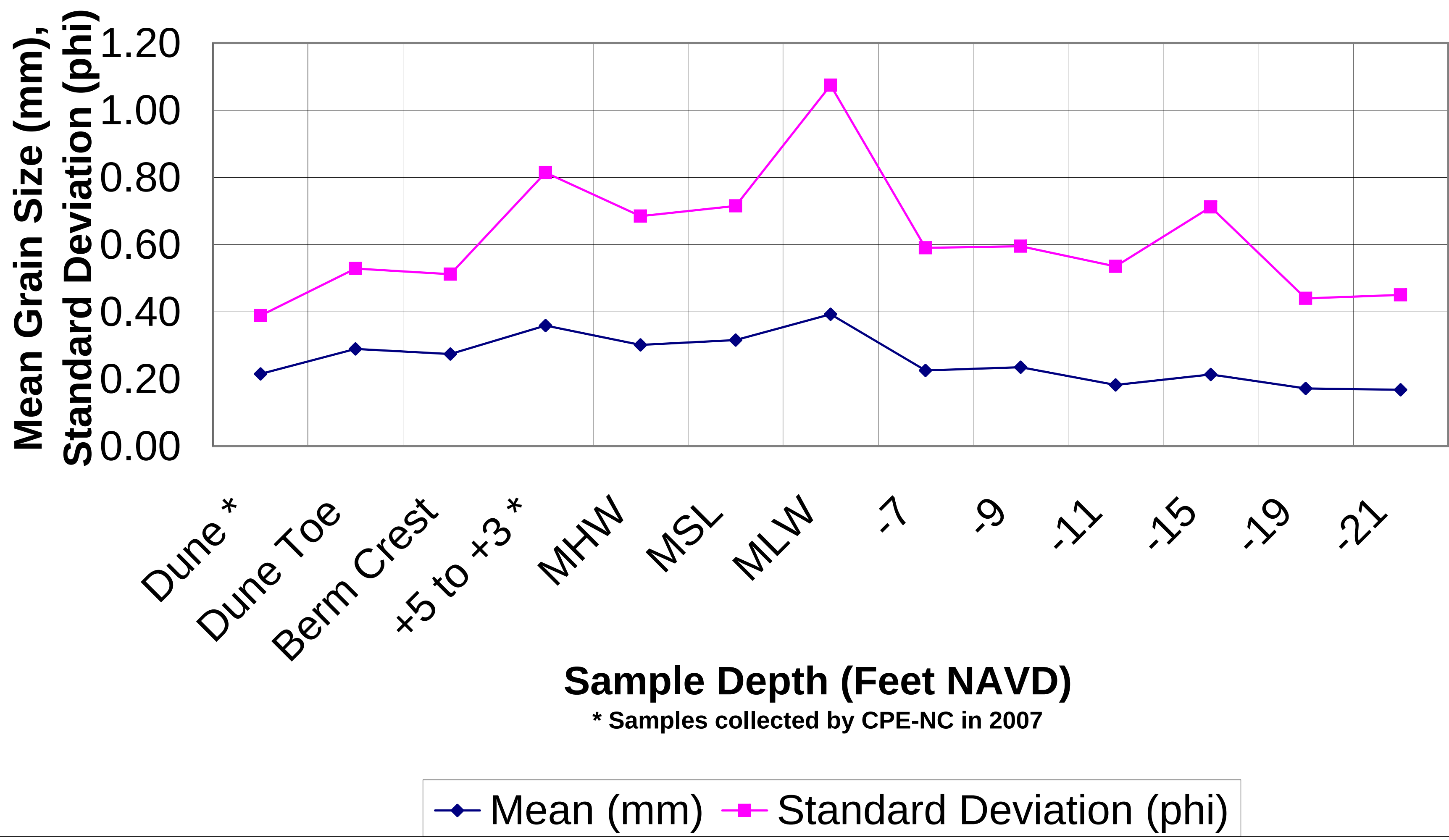
To address the deficiency of available material for the Surf City/North Topsail Beach project, the six borrow areas identified for the Topsail Beach Federal shore protection project (A, B, C, D, E, and F) were considered. The estimated amount of compatible material in these borrow areas exceeds the Topsail Beach Federal and non-Federal project requirements by approximately 9.68 million yd^3. Therefore, these borrow areas have been included in the compatibility analysis conducted for the Surf City/North Topsail Beach project in this appendix. The overfill ratios for these six borrow areas are also all below 1.5 with the exception of borrow area C., which was 1.56. Because the overfill ratio for borrow area C was only slightly above 1.5, it has been retained for further evaluation when additional characterization is conducted during the design phase. The additional estimated amount of compatible material in the Topsail Beach borrow areas (A, B, C, D, E, and F) which exceeds the Topsail Beach project requirements (approximately 9.29 million yd^3) combined with the estimated volume (27.59 million yd^3) in borrow areas G, H, J, L, N, O, P, Q, S, and T meets the NED project requirements (32.3 million yd^3).

The composite mean grain size of material in the native beach material and borrow areas is illustrated in table E-35. The composite mean grain size for the borrow areas is typically within 0.03 millimeters of the native beach sand (0.23 mm), with the exceptions of borrow areas F, N, S, and T. The mean grain size for these borrow areas is larger than the native beach material with mean grain sizes of 0.47 mm, 0.28 mm, 0.32 mm, and 0.29 mm respectively.

The NC beach fill standards require compatibility of the native beach with borrow sources in regards to the percentage of silt (< 0.062 mm), granular sediment, (< 4.76 mm and ≥ 2.0 mm), gravel (≥ 4.76 mm), and calcium carbonate. A visual estimate of shell content can be used in lieu of carbonate weight percent for samples collected prior to the effective date of beach fill rules which applies to the Surf City/North Topsail Beach project. The standards require that percent silt, granular sediment, and gravel in borrow material not exceed the amount found in the native beach plus 5% and the percent carbonate in borrow material not exceed the amount found in the native beach plus 15%. These characteristics for the native beach and borrow material are illustrated in table E-35. The analysis for the native beach material indicates the silt, granular sediment, and gravel content are 1.2%, 1.1%, and 0.5% respectively. The visual shell content for the native beach is 9%. After incorporating the tolerance permitted by the beach fill standards, the silt, granular sediment, gravel, and shell content permitted for borrow areas to be used for the Surf City/North Topsail Beach are less than 6.2%, 6.1%, 5.5%, and 24% respectively.

All of the borrow areas comply with the beach fill standards in regards to the percentage of silt with the exception of borrow areas A (6.6%) and L (6.3%). Both of these borrow areas exceed the standard slightly by 0.4 and 0.1% respectively. All of the borrow areas comply with the beach fill standards in regards to the percentage of granular sediment with the exception of borrow areas F (7.0%) and S (6.6%), which exceed the standard by 0.9 and 0.5% respectively. All of the borrow areas comply with the beach fill standards in regards to the percentage of gravel sediment with the exception of borrow areas F (8.5%) and P (6.6%), which exceed the standard by 3 and 1.1% respectively. All of the borrow areas comply with the beach fill standards in regards to the percentage of shell content (carbonate). Because all borrow areas will be further characterized during the design phase of this project, borrow areas in which the standards were exceeded for the various characteristic (A, F, L, S, and P) have been retained. Additional vibracores will be performed to comply with the beach fill standards of 1 core/acre or 1,000 foot spacing. This additional data will be incorporated into the existing borrow area data to produce the final characteristics of each borrow source, which will be evaluated using the NC beach fill standards to determine compliance.

Figure E-1: Average Mean and Standard Deviation Versus Sample Depth



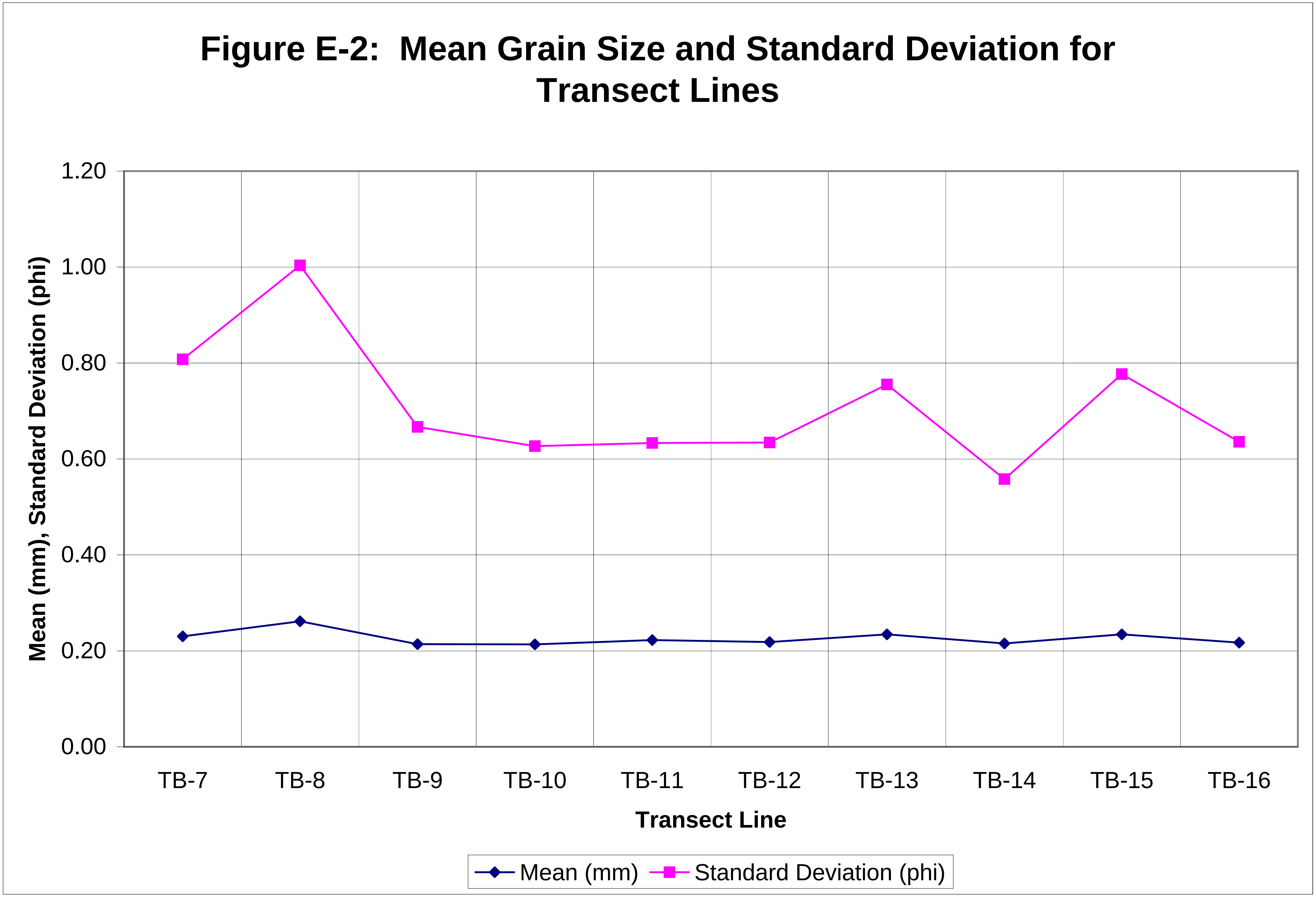


Figure E-2: Mean Grain Size and Standard Deviation for Transect Lines
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Mean (mm), Standard Deviation (phi)
TB-7
TB-8
TB-9
TB-10
TB-11
TB-12
TB-13
TB-14
TB-15
TB-16
Transect Line
Mean (mm)
Standard Deviation (phi)

Table E-1
Native Beach Samples

Sample Description	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TRANSECT LINE TB-7								
TB-7-TOE	1.89	0.27	0.69	0.62	7.0	0.3	0.9	17
TB-7-CREST	1.53	0.35	0.89	0.54	0.9	0.3	0.0	24
TB-7-MHW	1.61	0.33	0.72	0.61	0.5	0.2	0.0	22
TB-7-MSL	1.47	0.36	1.00	0.50	1.1	0.1	0.0	32
TB-7-MLW	1.37	0.39	1.23	0.43	1.0	3.5	0.2	19
TB-7-6	2.52	0.17	0.41	0.76	1.3	0.1	0.0	5
TB-7-8	2.62	0.16	0.40	0.76	1.0	0.1	0.0	13
TB-7-12	2.43	0.19	0.46	0.73	1.1	0.6	0.1	8
TB-7-14	2.57	0.17	0.47	0.72	1.8	2.0	0.1	5
TB-7-18	2.52	0.17	0.42	0.75	1.3	0.0	1.0	5
TB-7-20	2.61	0.16	0.42	0.75	2.1	0.0	0.0	2
TRANSECT LINE TB-8								
TB-8-TOE	0.93	0.52	0.59	0.67	0.5	0.1	0.0	35
TB-8-CREST	1.50	0.35	0.40	0.76	1.2	4.4	1.4	20
TB-8-MHW	1.59	0.33	0.92	0.53	1.3	3.1	0.2	17
TB-8-MSL	1.53	0.35	0.81	0.57	0.6	0.2	0.0	20
TB-8-MLW	0.52	0.70	1.97	0.26	0.8	18.3	7.9	30
TB-8-6	2.01	0.25	0.65	0.64	1.0	0.3	0.0	13
TB-8-8	2.54	0.17	0.47	0.72	0.8	0.2	0.0	7
TB-8-12	2.49	0.18	0.44	0.74	1.4	0.1	0.0	6
TB-8-14	2.52	0.17	0.46	0.73	1.2	2.4	0.2	4
TB-8-18	2.57	0.17	0.41	0.75	1.7	0.0	0.0	6
TB-8-20	2.64	0.16	0.44	0.74	2.0	0.1	0.0	7
TRANSECT LINE TB-9								
TB-9-TOE	2.08	0.24	0.42	0.75	0.8	0.1	0.0	5
TB-9-CREST	2.17	0.22	0.40	0.76	0.9	0.0	0.0	6
TB-9-MHW	1.72	0.30	0.81	0.57	1.4	3.0	0.0	15
TB-9-MSL	1.44	0.37	1.19	0.44	0.7	2.3	0.0	18
TB-9-MLW	0.52	0.70	2.08	0.24	0.9	27.3	6.1	20
TB-9-6	2.43	0.19	0.44	0.74	1.3	0.1	0.0	9
TB-9-8	2.51	0.17	0.45	0.73	1.0	0.1	0.0	8
TB-9-12	2.48	0.18	0.55	0.68	1.6	2.2	0.0	9
TB-9-14	2.53	0.17	0.44	0.74	1.3	0.5	0.4	5
TB-9-18	2.57	0.17	0.43	0.74	1.9	0.1	0.0	3
TB-9-20	2.64	0.16	0.41	0.75	2.3	0.1	0.0	3
TRANSECT LINE TB-10								
TB-10-TOE	1.36	0.39	1.04	0.49	0.6	2.8	0.0	13
TB-10-CREST	1.87	0.27	0.55	0.68	0.8	0.0	0.0	12
TB-10-MHW	2.04	0.24	0.44	0.74	1.2	0.0	0.0	7
TB-10-MSL	2.04	0.24	0.47	0.72	1.1	0.1	0.0	6
TB-10-MLW	1.79	0.29	0.90	0.54	1.0	0.5	0.2	16
TB-10-6	2.59	0.17	0.39	0.76	1.4	0.0	0.0	5
TB-10-8	2.61	0.16	0.49	0.71	1.6	0.1	0.0	4
TB-10-12	2.52	0.17	0.51	0.70	1.8	0.2	0.0	5
TB-10-14	2.41	0.19	0.53	0.69	1.8	2.1	0.7	7
TB-10-18	2.45	0.18	0.42	0.75	2.2	0.5	0.3	4
TB-10-20	2.49	0.18	0.44	0.74	2.8	0.1	0.1	5

Table E-1
Native Beach Samples (continued)

Sample Description	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TRANSECT LINE TB-11								
TB-11-TOE	1.98	0.25	0.40	0.76	0.6	0.1	0.0	5
TB-11-CREST	2.10	0.23	0.39	0.76	0.3	0.0	0.0	5
TB-11-MHW	1.45	0.37	1.07	0.48	0.8	1.6	0.0	13
TB-11-MSL	1.35	0.39	1.08	0.47	0.6	0.1	0.2	30
TB-11-MLW	1.79	0.29	0.74	0.60	1.3	0.3	0.0	15
TB-11-6	2.34	0.20	0.46	0.72	1.1	0.3	0.0	6
TB-11-8	1.53	0.35	0.47	0.72	0.6	0.3	0.0	5
TB-11-12	1.62	0.32	0.53	0.69	1.3	0.4	0.1	7
TB-11-14	1.63	0.32	0.43	0.74	1.4	2.1	0.2	8
TB-11-18	1.70	0.31	0.42	0.75	1.5	0.3	0.1	4
TB-11-20	1.67	0.31	0.42	0.75	1.2	0.2	0.9	6
TRANSECT LINE TB-12								
TB-12-TOE	1.98	0.25	0.43	0.74	0.5	0.0	0.0	4
TB-12-CREST	2.10	0.23	0.43	0.74	0.1	0.0	0.0	6
TB-12-MHW	2.01	0.25	0.51	0.70	0.7	0.0	0.0	10
TB-12-MSL	1.92	0.26	0.43	0.74	0.5	0.0	0.0	7
TB-12-MLW	1.29	0.41	1.19	0.44	1.7	3.2	1.1	31
TB-12-6	2.43	0.19	0.44	0.74	0.8	0.4	0.0	5
TB-12-8	2.44	0.18	0.41	0.75	0.0	1.0	0.0	6
TB-12-12	2.47	0.18	0.48	0.72	1.6	0.6	0.8	7
TB-12-14	0.89	0.54	2.71	0.15	0.9	4.3	17.8	28
TB-12-18	2.60	0.16	0.41	0.75	2.2	0.0	0.0	4
TB-12-20	2.52	0.17	0.46	0.73	1.6	0.7	0.1	6
TRANSECT LINE TB-13								
TB-13-DUNE *	2.17	0.22	0.42	0.75	0.3	0.0	0.0	0
TB-13-TOE	1.99	0.25	0.48	0.72	0.8	0.1	0.0	10
TB-13-CREST	1.65	0.32	0.70	0.61	1.1	0.0	0.1	14
TB-13 +5 *	1.06	0.48	1.04	0.49	0.6	0.0	2.4	0
TB-13-MHW	1.71	0.31	0.68	0.63	0.5	0.0	0.1	12
TB-13-MSL	1.72	0.30	0.68	0.63	0.0	0.0	0.0	15
TB-13-MLW	1.92	0.26	0.58	0.67	1.2	0.0	0.0	12
TB-13-6	2.48	0.18	0.49	0.71	0.9	0.3	0.0	5
TB-13-8	2.43	0.19	0.56	0.68	1.0	0.3	0.0	6
TB-13-12	2.50	0.18	0.52	0.70	2.3	0.6	0.1	6
TB-13-14	2.53	0.17	0.57	0.67	2.7	0.4	0.0	6
TB-13-18	2.54	0.17	0.50	0.71	2.0	0.4	0.0	4
TB-13-20	2.60	0.17	0.50	0.70	2.6	0.1	0.0	5
TRANSECT LINE TB-14								
TB-14-DUNE *	2.35	0.20	0.36	0.78	0.21	0.0	0.0	0
TB-14-TOE	2.11	0.23	0.37	0.77	0.4	0.2	0.0	5
TB-14-CREST	1.76	0.30	0.64	0.64	0.4	0.2	0.0	9
TB-14 +3 *	2.28	0.21	0.32	0.80	0.8	0.0	0.0	0
TB-14-MHW	1.99	0.25	0.43	0.74	0.5	0.0	0.0	6
TB-14-MSL	1.94	0.26	0.44	0.74	0.4	0.0	0.0	6
TB-14-MLW	1.78	0.29	0.63	0.65	1.4	0.0	0.0	13
TB-14-6	2.40	0.19	0.51	0.70	1.0	0.2	0.0	6
TB-14-8	2.35	0.20	0.53	0.69	0.3	0.1	0.0	5
TB-14-12	2.38	0.19	0.57	0.67	1.2	0.4	0.6	5
TB-14-14	2.43	0.19	0.44	0.74	0.8	0.3	0.0	4
TB-14-18	2.50	0.18	0.44	0.74	1.7	0.3	0.0	2
TB-14-20	2.59	0.17	0.46	0.73	2.3	0.3	0.0	3

* Samples were collected by CPE-NC Inc for the North Topsail Non-Federal Shore Protection Project in 2007.

Table E-1
Native Beach Samples (continued)

Sample Description	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TRANSECT LINE TB-15								
TB-15-DUNE *	2.28	0.21	0.35	0.79	0.2	0.0	0.0	0
TB-15-TOE	2.10	0.23	0.48	0.72	0.5	0.0	0.0	6
TB-15-CREST	2.19	0.22	0.32	0.80	0.1	0.0	0.0	2
TB-15 +3 *	0.86	0.55	1.58	0.33	0.5	0.1	0.0	0
TB-15-MHW	1.87	0.27	0.56	0.68	0.4	0.0	0.0	3
TB-15-MSL	1.82	0.28	0.65	0.64	0.9	0.0	0.0	6
TB-15-MLW	1.77	0.29	0.86	0.55	0.9	0.2	0.0	10
TB-15-6	2.52	0.17	0.47	0.72	1.0	0.1	0.0	3
TB-15-8	0.58	0.67	1.23	0.43	1.1	8.5	2.7	28
TB-15-12	2.55	0.17	0.57	0.67	2.2	0.5	0.4	4
TB-15-14	2.56	0.17	0.53	0.69	1.9	1.3	0.8	3
TB-15-18	2.63	0.16	0.47	0.72	2.5	0.0	0.0	1
TB-15-20	2.65	0.16	0.46	0.73	2.3	0.0	0.0	3
TRANSECT LINE TB-16								
TB-16-DUNE *	2.08	0.24	0.43	0.74	0.2	0.0	0.0	0
TB-16-TOE	2.10	0.23	0.38	0.77	0.2	0.0	0.0	4
TB-16-CREST	2.09	0.24	0.40	0.76	0.1	0.0	0.0	4
TB-16 +4 *	2.31	0.20	0.32	0.80	0.5	0.0	0.0	0
TB-16-MHW	1.79	0.29	0.71	0.61	0.1	0.6	0.0	9
TB-16-MSL	2.00	0.25	0.42	0.75	0.6	0.0	0.0	5
TB-16-MLW	2.00	0.25	0.56	0.68	1.1	2.7	0.5	7
TB-16-6	0.84	0.56	1.63	0.32	0.4	10.5	0.4	27
TB-16-8	2.02	0.25	0.96	0.51	0.9	1.1	0.5	12
TB-16-12	2.42	0.19	0.71	0.61	1.5	1.5	0.3	7
TB-16-14	2.64	0.16	0.55	0.68	1.8	1.5	0.0	4
TB-16-18	2.67	0.16	0.48	0.72	1.1	0.0	0.0	3
TB-16-20	2.71	0.15	0.49	0.71	2.2	0.0	0.0	3

* Samples were collected by CPE-NC Inc for the North Topsail Non-Federal Shore Protection Project in 2007.

Table E-2

Composite Characteristics for Native Beach

Transect Line	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TB-7	2.12	0.23	0.81	0.57	1.7	0.7	0.2	14
TB-8	1.93	0.26	1.00	0.50	1.1	2.7	0.9	15
TB-9	2.22	0.21	0.67	0.63	1.3	3.2	0.6	9
TB-10	2.23	0.21	0.63	0.65	1.8	0.6	0.1	8
TB-11	2.17	0.22	0.63	0.64	1.0	0.5	0.1	9
TB-12	2.20	0.22	0.63	0.64	1.0	0.9	1.8	10
TB-13	2.09	0.23	0.76	0.59	1.2	0.4	1.2	7
TB-14	2.22	0.22	0.56	0.68	0.9	0.1	0.0	5
TB-15	2.09	0.23	0.78	0.58	1.1	0.8	0.3	5
TB-16	2.20	0.22	0.64	0.64	0.8	1.4	0.1	7
Native Beach Composite Data	**2.15**	**0.23**	**0.71**	**0.61**	**1.2**	**1.1**	**0.5**	**9**

Table E-3

Borings for Borrow Area G

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-254	1	-49	-51	2	2.45	0.18	0.43	0.74	1.6	0.3	0.0	3
	2	-51	-53	2	1.81	0.29	1.59	0.33	14.0	5.7	5.1	9
	3	-53	-54	1	1.33	0.40	1.62	0.33	6.8	5.4	8.8	1
		EL -49 to -54		D= 5	2.09	0.23	0.90	0.54	7.6	3.5	3.8	5
TI-03-V-256	1	-47.3	-48.8	1.5	2.09	0.23	0.62	0.65	1.0	0.8	1.6	7
	2	-48.8	-49.3	0.5	2.08	0.24	0.63	0.65	1.1	0.9	3.0	7
		EL -47.3 to -49.3		D=2	2.09	0.23	0.62	0.65	1.1	0.8	2.0	7
TI-03-V-257	1	-47.5	-50	2.5	1.92	0.26	1.09	0.47	2.4	3.2	8.4	15
	2	-50	-50.5	0.5	2.48	0.18	0.96	0.52	11.1	1.7	1.1	6
		EL -47.5 to -50.5		D= 3	2.04	0.24	0.97	0.51	3.9	2.9	7.2	14
TI-03-V-258	1	-46.5	-47.8	1.3	1.31	0.40	1.83	0.28	1.2	3.4	12.4	18
	2	-47.8	-49.3	1.5	0.75	0.60	2.70	0.15	4.2	10.0	18.5	37
		EL -46.5 to -49.3		D= 2.8	0.89	0.54	2.48	0.18	2.8	6.9	15.7	28
TI-03-V-275	1	-47.7	-50	2.3	2.65	0.16	0.60	0.66	9.3	0.9	2.9	6
	2	-50	-53.2	3.2	2.57	0.17	0.40	0.76	4.2	0.0	0.0	2
	3	-53.2	-55.5	0	2.87	0.14	0.71	0.61	14.4	0.2	0.0	2
	4	-55.5	-56	0	2.37	0.19	1.82	0.28	16.2	5.4	5.5	7
		EL -47.7 to -53.2		D=5.5	2.58	0.17	0.43	0.74	6.3	0.4	1.2	4

Table E-4

Borings for Borrow Area H

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-260	**1**	**-44.4**	**-46**	**1.6**	**1.85**	**0.28**	**0.99**	**0.50**	**1.3**	**2.7**	**5.9**	**14**
	2	**-46**	**-46.6**	**0.6**	**2.61**	**0.16**	**0.55**	**0.68**	**9.6**	**0.8**	**0.6**	**3**
		EL -44.4 to -46.6		**D= 2.2**	**2.07**	**0.24**	**0.87**	**0.55**	**3.6**	**2.2**	**4.5**	**11**
TI-03-V-273	**1**	**-45.2**	**-47.5**	**2.3**	**2.23**	**0.21**	**0.60**	**0.66**	**2.2**	**2.0**	**1.8**	**7**
	2	**-47.5**	**-50**	**2.5**	**2.30**	**0.20**	**0.52**	**0.70**	**2.0**	**0.6**	**0.0**	**4**
	3	-50	-52	0	2.56	0.17	0.39	0.76	4.4	0.6	0.1	3
	4	-52	-54	0	2.76	0.15	0.23	0.86	2.7	0.0	0.0	1
	5	-54	-55.7	0	2.58	0.17	0.36	0.78	2.1	0.0	0.0	1
	6	-55.7	-56.2	0	2.56	0.17	0.37	0.77	2.4	0.0	0.0	0
		EL -45.2 to -50		**D=4.8**	**2.27**	**0.21**	**0.55**	**0.68**	**2.1**	**1.3**	**0.9**	**5**

Table E-5
Borings for Borrow Area J

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-98	**1**	**-45.5**	**-48.3**	**2.8**	**2.13**	**0.23**	**0.73**	**0.60**	**5.2**	**1.3**	**0.5**	**11**
	2	-48.3	-51	0	4.28	0.05	3.78	0.07	22.1	5.2	1.5	15
	3	-51	-53	0	2.67	0.16	0.79	0.58	15.6	3.0	0.4	10
	4	-53	-55.5	0	3.63	0.08	2.09	0.23	18.6	1.5	0.6	6
	5	-55.5	-58	0	2.48	0.18	0.45	0.73	9.4	2.2	0.4	7
	6	-58	-61	0	2.50	0.18	0.40	0.76	6.6	0.1	0.0	3
	7	-61	-64	0	2.50	0.18	0.41	0.75	8.0	0.5	0.0	4
	8	-64	-65.5	0	2.57	0.17	0.48	0.71	12.6	0.1	0.0	2
		EL -45.5 to -48.3		**D= 2.8**	**2.13**	**0.23**	**0.73**	**0.60**	**5.2**	**1.3**	**0.5**	**11**
TI-03-V-99	**1**	**-46.7**	**-50**	**3.3**	**2.46**	**0.18**	**0.44**	**0.73**	**9.6**	**1.3**	**0.1**	**6.0**
	2	**-50**	**-53**	**3**	**2.45**	**0.18**	**0.47**	**0.72**	**11.4**	**2.1**	**0.3**	**8.0**
	3	**-53**	**-55**	**2**	**2.43**	**0.18**	**0.40**	**0.76**	**6.2**	**0.4**	**0.2**	**4.0**
	4	-55	-58.5	0	3.05	0.12	1.33	0.40	16.8	2.2	0.9	9.0
	5	-58.5	-61	0	2.48	0.18	0.40	0.76	6.4	0.3	0.0	3.0
	6	-61	-63	0	2.53	0.17	0.42	0.75	10.7	0.1	0.0	2.0
	7	-63	-66.2	0	2.49	0.18	0.40	0.76	7.6	0.0	0.0	2.0
	8	-66.2	-66.7	0	2.50	0.18	0.41	0.75	8.8	0.1	0.0	1.0
		EL -46.7 to -55		**D=8.3**	**2.45**	**0.18**	**0.44**	**0.74**	**9.5**	**1.4**	**0.2**	**6.2**
TI-03-V-102	**1**	**-45**	**-47**	**2**	**1.70**	**0.31**	**1.23**	**0.43**	**2.4**	**5.8**	**1.7**	**19**
	2	**-47**	**-48**	**1**	**2.22**	**0.21**	**0.63**	**0.65**	**2.3**	**1.9**	**0.4**	**11**
	3	-48	-51	0	2.51	0.18	0.78	0.58	14.4	3.4	0.8	12
	4	-51	-54	0	2.52	0.17	0.42	0.75	9.7	0.4	0.1	3
	5	-54	-57	0	2.52	0.17	0.42	0.75	10.1	0.0	0.0	2
	6	-57	-59.3	2.3	2.60	0.17	0.51	0.70	12.6	0.1	0.0	2
		EL -45 to -48		**D=3**	**1.86**	**0.27**	**1.05**	**0.48**	**2.3**	**4.5**	**1.3**	**16**

Table E-5
Borings for Borrow Area J (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Layer Depth (ft) Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-103	**1**	**-47.4**	**-50**	**2.6**	**2.29**	**0.20**	**0.58**	**0.67**	**2.8**	**1.6**	**0.2**	**10**
	2	-50	-53	0	2.57	0.17	0.59	0.67	13.5	1.7	0.6	8
	3	-53	-55	0	3.17	0.11	1.40	0.38	18.0	0.4	0.0	3
	4	-55	-57	0	2.42	0.19	4.39	0.05	26.0	4.6	15.2	1
	5	-57	-59	0	3.65	0.08	1.66	0.32	32.8	3.5	1.7	2
	6	-59	-59.7	0	3.45	0.09	0.97	0.51	26.9	1.2	0.0	4
		EL -47.4 to -50		**D=2.6**	**2.29**	**0.20**	**0.58**	**0.67**	**2.8**	**1.6**	**0.2**	**10**
TI-03-V-270A	**1**	**-46.3**	**-48.3**	**2**	**2.00**	**0.25**	**0.81**	**0.57**	**1.5**	**3.0**	**1.1**	**9**
	2	-48.3	-50.5	0	3.19	0.11	0.78	0.58	17.7	0.1	0.1	1
	3	-50.5	-52.5	0	3.28	0.10	0.73	0.60	18.6	0.1	0.0	1
	4	-52.5	-54.8	0	3.21	0.11	0.72	0.61	16.9	0.5	0.0	1
		EL -46.3 to -48.3		**D=2**	**2.00**	**0.25**	**0.81**	**0.57**	**1.5**	**3.0**	**1.1**	**9**
TI-03-V-281	**1**	**-44**	**-45.5**	**1.5**	**1.73**	**0.30**	**0.99**	**0.50**	**1.5**	**4.4**	**1.9**	**15**
	2	**-45.5**	**-47.4**	**1.9**	**2.20**	**0.22**	**0.54**	**0.69**	**1.1**	**1.0**	**0.2**	**6**
	3	-47.4	-49	0	1.95	0.26	1.94	0.26	15.6	8.2	3.3	19
	4	-49	-51	0	3.29	0.10	2.55	0.17	19.1	5.9	1.8	13
	5	-51	-53	0	2.38	0.19	1.02	0.49	14.7	3.4	6.1	11
	6	-53	-55.2	0	3.27	0.10	1.69	0.31	18.4	2.8	1.7	11
	7	-55.2	-55.7	0	3.06	0.12	1.36	0.39	17.5	3.0	1.5	10
		EL -44 to -47.4		**D=3.4**	**2.02**	**0.25**	**0.72**	**0.61**	**1.2**	**2.5**	**1.0**	**10**
TI-03-V-283	**1**	**-42.4**	**-44**	**1.6**	**1.58**	**0.34**	**1.16**	**0.45**	**2.2**	**5.3**	**2.8**	**10**
	2	**-44**	**-45.6**	**1.6**	**2.15**	**0.22**	**0.57**	**0.67**	**2.0**	**2.1**	**0.8**	**7**
	3	-45.6	-48.5	0	1.87	0.27	1.82	0.28	15.3	8.4	3.1	17
	4	-48.5	-51	0	3.35	0.10	1.75	0.30	18.8	2.2	0.2	3
	5	-51	-53.5	0	2.64	0.16	0.72	0.61	14.7	2.9	2.6	8
	6	-53.5	-54.6	0	2.55	0.17	0.56	0.68	12.9	2.6	0.5	5
		EL -42.4 to -45.6		**D=3.2**	**1.87**	**0.27**	**0.88**	**0.54**	**2.1**	**3.7**	**1.8**	**9**

Table E-5
Borings for Borrow Area J (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-286	**1**	**-42**	**-44.2**	**2.2**	**1.89**	**0.27**	**0.90**	**0.53**	**2.6**	**1.8**	**3.3**	**11**
	2	**-44.2**	**-46**	**1.8**	**1.26**	**0.42**	**2.24**	**0.21**	**12.3**	**7.0**	**11.7**	**17**
	3	-46	-49	0	2.15	0.23	2.00	0.25	16.1	5.7	7.4	12
	4	-49	-51.5	0	-0.21	1.15	4.86	0.03	15.8	9.6	33.4	1
	5	-51.5	-54	0	1.98	0.25	3.62	0.08	23.1	16.3	10.6	1
	6	-54	-55	0	-0.39	1.31	4.71	0.04	15.3	5.3	41.3	1
		EL -42 to -46		**D=4**	**1.85**	**0.28**	**1.15**	**0.45**	**7.0**	**1.8**	**3.3**	**14**

Table E-6
Borings for Borrow Area L

Boring Number	Layer Number	Layer Depth (ft) Top	Layer Depth (ft) Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-91	1	-46.8	-48	1.2	2.00	0.25	0.78	0.58	1.4	1.8	1.1	7
	2	-48	-50.3	2.3	1.26	0.42	2.61	0.16	10.1	5.7	14.1	26
		EL -46.8 to -50.3		D= 3.5	1.61	0.33	1.69	0.31	7.1	4.4	9.6	19
TI-03-V-93	1	-46.7	-49	2.3	2.15	0.23	0.83	0.56	8.5	3.8	0.8	15
	2	-49	-51	0	2.45	0.18	0.96	0.51	14.7	3.7	0.6	11
	3	-51	-53	0	2.54	0.17	0.49	0.71	11.8	0.9	0.3	4
	4	-53	-54.2	0	2.52	0.17	0.44	0.74	9.5	1.1	0.1	5
	5	-54.2	-57	0	2.62	0.16	0.56	0.68	12.7	0.4	0.0	3
	6	-57	-60	0	3.63	0.08	2.03	0.24	19.6	1.2	0.4	7
	7	-60	-63	0	3.66	0.08	2.08	0.24	20.3	1.1	0.4	2
	8	-63	-65.2	0	3.84	0.07	2.31	0.20	23.2	4.0	0.0	2
		EL -46.7 to -49		D=2.3	2.15	0.23	0.83	0.56	8.5	3.8	0.8	15
TI-03-V-95	1	-47	-50	3	2.49	0.18	0.45	0.73	9.8	1.6	0.3	8
	2	-50	-53	3	2.49	0.18	0.45	0.73	10.2	1.6	0.5	9
	3	-53	-56	3	2.49	0.18	0.41	0.75	7.4	0.7	0.0	5
	4	-56	-58	2	2.53	0.17	0.38	0.77	4.7	0.1	0.0	3
	5	-58	-60.8	2.8	2.54	0.17	0.42	0.75	8.8	0.2	0.0	3
	6	-60.8	-63.5	0	3.74	0.07	2.23	0.21	22.1	2.8	3.5	2
	7	-63.5	-64.3	0	2.33	0.20	4.41	0.05	23.8	9.6	15.1	1
		EL -47 to -60.8		D=13.8	2.50	0.18	0.42	0.75	8.4	0.9	0.2	6
TI-03-V-341	1	-44.2	-46.5	2.3	1.97	0.26	0.96	0.51	5.1	3.0	0.5	7
	2	-46.5	-48.5	2	2.31	0.20	0.71	0.61	7.8	1.9	1.0	5
	3	-48.5	-51	0	2.60	0.16	0.65	0.64	13.4	2.2	6.7	1
	4	-51	-53.5	0	2.54	0.17	0.45	0.73	10.5	1.2	1.4	2
	5	-53.5	-56	0	2.59	0.17	0.57	0.68	12.8	1.4	4.8	3
	6	-56	-58.2	0	0.61	0.65	3.20	0.11	10.7	5.6	26.3	5
		EL -44.2 to -48.5		D=4.3	2.12	0.23	0.88	0.54	6.3	2.5	0.7	6

Table E-6
Borings for Borrow Area L (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-342	**1**	**-44.3**	**-46.3**	**2**	**1.89**	**0.27**	**1.04**	**0.49**	**3.8**	**5.6**	**2.8**	**15**
	2	-46.3	-48.5	0	1.97	0.26	1.46	0.36	12.7	6.4	1.4	14
	3	-48.5	-51.5	0	3.52	0.09	3.28	0.10	23.1	5.6	1.8	17
	4	-51.5	-54.5	0	1.92	0.26	1.81	0.28	14.5	7.8	1.6	11
	5	-54.5	-57	0	1.52	0.35	2.44	0.18	14.5	8.5	9.9	11
	6	-57	-59.1	0	2.78	0.15	1.28	0.41	16.4	4.5	3.6	4
	7	-59.1	-61	0	2.69	0.16	0.64	0.64	13.8	1.3	0.2	2
	8	-61	-63.5	0	2.63	0.16	0.49	0.71	10.5	1.5	0.1	3
	9	-63.5	-64.3	0	-1.18	2.27	3.63	0.08	7.6	6.8	48.4	2
		EL -44.3 to -46.3		**D=2**	**1.89**	**0.27**	**1.04**	**0.49**	**3.8**	**5.6**	**2.8**	**15**
TI-03-V-343	**1**	**-46**	**-48**	**1.5**	**2.37**	**0.19**	**0.48**	**0.72**	**2.3**	**0.7**	**0.0**	**2**
	2	**-48**	**-50**	**1.5**	**2.23**	**0.21**	**0.62**	**0.65**	**1.3**	**1.7**	**0.8**	**5**
	3	**-50**	**-51**	**0**	**2.53**	**0.17**	**0.43**	**0.74**	**9.2**	**0.4**	**0.4**	**1**
	4	-51	-54	0	2.65	0.16	0.55	0.68	12.7	0.2	0.0	2
	5	-54	-56.3	0	2.73	0.15	0.63	0.65	14.2	0.8	0.0	4
		EL -46 to -51		**D=5**	**2.37**	**0.19**	**0.50**	**0.71**	**3.3**	**1.0**	**0.4**	**3**
TI-03-V-344	**1**	**-45.7**	**-47.5**	**1.8**	**0.74**	**0.60**	**2.31**	**0.20**	**1.4**	**8.2**	**14.4**	**22**
	2	**-47.5**	**-48**	**0.5**	**1.36**	**0.39**	**1.44**	**0.37**	**2.3**	**2.9**	**11.5**	**23**
		EL -45.7 to -48		**D=2.3**	**0.81**	**0.57**	**2.23**	**0.21**	**1.6**	**7.0**	**13.8**	**22**
TI-03-V-345	**1**	**-42.3**	**-44.5**	**2.2**	**1.70**	**0.31**	**0.93**	**0.52**	**1.6**	**2.0**	**1.1**	**14**
	2	**-44.5**	**-45.3**	**0.8**	**1.42**	**0.37**	**1.35**	**0.39**	**2.2**	**5.0**	**4.9**	**18**
		EL -42.3 to -45.3		**D=3**	**1.65**	**0.32**	**1.01**	**0.50**	**1.8**	**2.8**	**2.1**	**15**
TI-03-V-346	**1**	**-42.5**	**-44**	**1.5**	**1.74**	**0.30**	**1.14**	**0.45**	**3.6**	**3.8**	**3.9**	**13**
	2	**-44**	**-45.5**	**1.5**	**2.25**	**0.21**	**0.79**	**0.58**	**11.7**	**2.9**	**5.9**	**13**
	3	-45.5	-47	0	2.56	0.17	0.58	0.67	13.0	1.6	2.0	1
	4	-47	-48.5	0	2.66	0.16	0.58	0.67	12.9	0.9	1.5	2
	5	-48.5	-51	0	0.77	0.59	2.92	0.13	13.7	5.8	20.0	1
	6	-51	-52	0	0.67	0.63	3.42	0.09	13.4	7.4	29.1	3
		EL -42.5 to -45.5		**D=3**	**1.93**	**0.26**	**1.09**	**0.47**	**7.6**	**3.4**	**4.9**	**13**

Table E-6
Borings for Borrow Area L (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-351	**1**	**-44.5**	**-45.5**	**1**	**-0.43**	**1.34**	**2.67**	**0.16**	**2.2**	**14.6**	**27.9**	**28**
	2	**-45.5**	**-47.3**	**1.8**	**2.60**	**0.16**	**0.58**	**0.67**	**10.1**	**3.4**	**0.8**	**10**
	3	-47.3	-49.5	0	3.08	0.12	1.28	0.41	17.7	2.0	0.4	5
	4	-49.5	-51.5	0	2.66	0.16	1.01	0.50	15.3	1.7	8.0	1
		EL -44.5 to -47.3		**D=2.8**	**1.31**	**0.40**	**2.13**	**0.23**	**7.3**	**7.4**	**10.5**	**16**

Table E-7
Borings for Borrow Area N

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-63	1	-45.9	-47	1.1	2.18	0.22	0.52	0.70	0.7	0.5	0.3	6
	2	-47	-48.9	1.9	1.82	0.28	0.99	0.50	1.5	3.2	7.5	18
		EL -45.9 to -48.9		D= 3	2.08	0.24	0.63	0.65	1.2	2.2	4.9	14
TI-03-V-65	1	-45.7	-47	1.3	2.29	0.20	0.47	0.72	1.2	0.3	0.0	6
	2	-47	-48.5	1.5	2.38	0.19	0.46	0.73	1.3	0.9	0.3	6
	3	-48.5	-50.5	2	2.39	0.19	0.40	0.76	2.0	0.6	1.5	9
	4	-50.5	-51.2	0.7	2.41	0.19	0.42	0.75	1.3	0.2	0.0	4
		EL -45.7 to -51.2		D=5.5	2.37	0.19	0.43	0.74	1.5	0.5	0.6	7
TI-03-V-68	1	-46.7	-48.5	1.8	2.38	0.19	0.46	0.73	1.4	0.9	0.2	5
	2	-48.5	-50.5	2	1.55	0.34	1.20	0.43	7.5	4.8	4.9	3
	3	-50.5	-52	1.5	0.24	0.85	2.86	0.14	10.0	4.9	19.5	1
	4	-52	-52.7	0.7	1.73	0.30	0.85	0.55	6.0	2.7	5.7	1
		EL -46.7 to -52.7		D=6	1.71	0.31	1.20	0.44	6.1	3.4	4.8	3
TI-03-V-69	1	-43.6	-45	1.4	2.05	0.24	0.73	0.60	0.7	2.3	3.3	13
	2	-45	-46.8	1.8	0.97	0.51	1.96	0.26	1.2	8.2	10.4	30
	3	-46.8	-47.3	0.5	0.61	0.66	2.67	0.16	2.1	6.0	18.5	34
		EL -43.6 to -47.3		D=3.7	1.31	0.40	1.71	0.31	1.1	5.7	8.8	24
TI-03-V-70	1	-44.8	-47	2.2	1.27	0.42	1.36	0.39	4.6	4.2	7.1	19
	2	-47	-47.8	0.8	1.06	0.48	1.99	0.25	10.6	11.3	6.4	29
	3	-47.8	-49.3	1.5	1.74	0.30	0.98	0.51	5.0	1.3	11.4	1
	4	-49.3	-49.8	0.5	1.74	0.30	1.32	0.40	10.5	3.6	8.7	8
		EL -44.8 to -49.8		D=5	1.33	0.40	1.46	0.36	6.3	4.4	8.4	14

Table E-7
Borings for Borrow Area N (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-72	1	-43.6	-45.5	1.9	0.71	0.61	1.29	0.41	0.9	6.5	6.7	21
	2	-45.5	-46.4	0.9	0.04	0.97	2.63	0.16	1.5	7.7	19.9	15
		EL -43.6 to -46.4		D=2.8	0.54	0.69	1.64	0.32	1.1	6.9	10.9	19
TI-03-V-74	1	-46.2	-48	1.8	2.31	0.20	0.48	0.71	1.1	1.4	0.1	5
	2	-48	-50	2	2.38	0.19	0.50	0.71	2.3	0.9	0.3	7
	3	-50	-51.7	1.7	1.08	0.47	2.17	0.22	6.9	8.3	10.8	18
		EL -46.2 to -51.7		D=5.5	2.20	0.22	0.67	0.63	3.3	3.4	3.5	10
TI-03-V-77	1	-45.7	-48	2.3	2.23	0.21	0.57	0.67	1.4	1.5	0.9	7
	2	-48	-49.2	0	-0.30	1.23	2.82	0.14	8.8	15.4	26.8	16
		EL -45.7 to -48		D=2.3	2.23	0.21	0.57	0.67	1.4	1.5	0.9	7
TI-03-V-78	1	-44.8	-46.8	2	1.41	0.38	1.82	0.28	3.3	6.9	8.1	15
	2	-46.8	-48.3	1.5	2.73	0.15	0.42	0.75	7.5	0.1	0.0	2
	3	-48.3	-48.8	0.5	2.53	0.17	0.38	0.77	2.3	0.0	0.0	2
		EL -44.8 to -48.8		D=4	2.38	0.19	0.65	0.64	4.8	3.5	4.1	9
TI-03-V-79	1	-44.1	-46.4	2.3	2.03	0.24	0.60	0.66	1.6	0.5	0.1	8
	2	-46.4	-47.5	0	-0.44	1.35	2.27	0.21	6.4	15.5	38.4	2
		EL -44.5 to -46.4		D=2.3	2.03	0.24	0.60	0.66	1.6	0.5	0.1	8
TI-03-V-86	1	-44.3	-46.5	2.2	1.75	0.30	1.03	0.49	1.0	4.9	4.2	17
	2	-46.5	-48.5	2	2.36	0.20	0.46	0.72	2.0	0.7	1.2	6
	3	-48.5	-51	2.5	2.29	0.21	0.56	0.68	2.7	1.1	1.0	5
	4	-51	-53	2	1.77	0.29	0.76	0.59	2.1	3.0	0.3	8
	5	-53	-55.5	2.5	1.80	0.29	0.73	0.60	2.6	3.2	1.0	9
	6	-55.5	-58	2.5	0.92	0.53	1.82	0.28	8.0	8.0	8.8	6
	7	-58	-59.1	1.1	1.80	0.29	0.97	0.51	6.4	3.8	3.9	0
		EL -44.3 to -59.1		D=14.8	1.88	0.27	0.91	0.53	3.4	3.6	3.0	8

Table E-7
Borings for Borrow Area N (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Layer Depth (ft) Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-87	**1**	**-46.7**	**-49**	**2.3**	**2.06**	**0.24**	**0.84**	**0.56**	**7.9**	**1.4**	**0.0**	**3**
	2	**-49**	**-51**	**2**	**2.22**	**0.21**	**0.66**	**0.63**	**3.1**	**2.3**	**3.7**	**10**
	3	**-51**	**-52.5**	**1.5**	**0.40**	**0.76**	**3.00**	**0.12**	**6.0**	**3.9**	**24.8**	**2**
	4	-52.5	-54	0	0.52	0.70	2.25	0.21	8.2	7.9	14.9	2
	5	-54	-55.2	0	-0.33	1.25	3.22	0.11	5.6	3.8	35.8	0
	EL -46.7 to -52.5			**D=5.8**	**1.88**	**0.27**	**1.09**	**0.47**	**5.8**	**2.4**	**7.7**	**5**

Table E-8

<u>Borings for Borrow Area O</u>

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-83B	**1**	**-42.9**	**-45**	**2.1**	**0.33**	**0.80**	**3.06**	**0.12**	**8.7**	**8.7**	**24.6**	**45**
	2	**-45**	**-48**	**3**	**0.36**	**0.78**	**2.89**	**0.13**	**8.0**	**9.0**	**23.2**	**46**
	3	-48	-50	0	2.59	0.17	0.61	0.65	13.5	0.5	0.0	3
	4	-50	-51.4	0	2.57	0.17	0.59	0.66	12.8	0.6	1.4	1
	5	-51.4	-55	0	2.68	0.16	0.78	0.58	15.2	0.6	6.5	1
	6	-55	-58	0	2.49	0.18	0.44	0.74	9.1	0.5	0.1	4
	7	-58	-61	0	2.53	0.17	0.45	0.73	12.2	0.2	0.0	1
	8	-61	-62.9	0	2.56	0.17	0.54	0.69	12.8	0.5	7.4	4
		EL -42.9 to -48		**D= 5.1**	**0.33**	**0.80**	**2.99**	**0.13**	**8.2**	**8.9**	**24.6**	**46**
TI-03-V-85	**1**	**-43.9**	**-46**	**2.1**	**2.10**	**0.23**	**0.79**	**0.58**	**7.4**	**3.0**	**1.4**	**5**
	2	**-46**	**-48.4**	**2.4**	**2.05**	**0.24**	**0.70**	**0.61**	**2.6**	**1.8**	**5.1**	**11**
	3	-48.4	-51	0	1.95	0.26	1.15	0.45	9.0	1.6	10.2	1
	4	-51	-53	0	2.54	0.17	0.59	0.67	11.3	1.3	0.0	1
	5	-53	-56	0	2.67	0.16	0.70	0.62	14.5	0.4	0.2	1
	6	-56	-56.9	0	2.47	0.18	0.41	0.75	9.1	0.1	0.0	2
		EL -43.9 to -48.4		**D= 4.5**	**2.07**	**0.24**	**0.74**	**0.60**	**4.8**	**2.4**	**3.5**	**8**
TI-03-V-322	**1**	**-41.9**	**-45**	**3.1**	**2.51**	**0.18**	**0.44**	**0.74**	**7.1**	**0.3**	**0.4**	**3**
	2	-45	-48	0	2.70	0.15	0.48	0.72	11.2	0.6	0.0	3
	3	-48	-50	0	2.78	0.15	0.62	0.65	14.1	2.0	0.3	5
	4	-50	-52.7	0	3.03	0.12	1.12	0.46	16.9	3.4	1.6	9
	5	-52.7	-54	0	2.90	0.13	0.76	0.59	14.5	1.5	0.2	4
	6	-54	-55.4	0	0.14	0.91	4.27	0.05	9.1	3.1	25.4	3
		EL -41.9 to -45		**D=3.1**	**2.51**	**0.18**	**0.44**	**0.74**	**7.1**	**0.3**	**0.4**	**3**
TI-03-V-323	**1**	**-40.6**	**-43.1**	**2.5**	**1.58**	**0.33**	**1.02**	**0.49**	**1.8**	**4.1**	**2.9**	**14**
	2	**-43.1**	**-45.5**	**2.4**	**2.46**	**0.18**	**0.43**	**0.74**	**8.0**	**0.4**	**0.5**	**3**
	3	**-45.5**	**-48**	**2.5**	**2.52**	**0.17**	**0.42**	**0.75**	**9.3**	**0.1**	**0.0**	**2**
	4	**-48**	**-50.5**	**2.5**	**2.55**	**0.17**	**0.42**	**0.75**	**8.6**	**0.6**	**0.1**	**2**
	5	**-50.5**	**-53**	**2.5**	**2.63**	**0.16**	**0.41**	**0.75**	**9.7**	**0.3**	**0.0**	**2**
	6	-53	-53.7	0	2.73	0.15	0.59	0.66	13.2	1.0	0.3	4
		EL -40.6 to -53		**D=12.4**	**2.46**	**0.18**	**0.46**	**0.73**	**7.5**	**1.1**	**0.7**	**5**

Table E-8
Borings for Borrow Area O (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-324	**1**	**-41.6**	**-43.4**	**1.8**	**-0.79**	**1.73**	**3.30**	**0.10**	**1.4**	**8.7**	**38.2**	**24**
	2	**-43.4**	**-45**	**1.6**	**2.27**	**0.21**	**0.58**	**0.67**	**1.6**	**1.5**	**2.2**	**7**
	3	**-45**	**-47**	**2**	**2.48**	**0.18**	**0.40**	**0.76**	**7.1**	**0.3**	**0.0**	**2**
	4	**-47**	**-48.6**	**1.6**	**2.53**	**0.17**	**0.44**	**0.74**	**11.6**	**0.3**	**0.0**	**2**
		EL -41.6 to -48.6		**D=7**	**1.85**	**0.28**	**1.22**	**0.43**	**5.4**	**2.7**	**10.3**	**9**
TI-03-V-325	**1**	**-42.7**	**-44.7**	**2**	**2.31**	**0.20**	**0.59**	**0.66**	**4.5**	**2.7**	**1.9**	**9**
	2	-44.7	-47	0	2.67	0.16	0.58	0.67	12.8	1.4	0.1	4
	3	-47	-49	0	2.64	0.16	0.57	0.67	11.8	3.2	0.0	8
	4	-49	-51.5	0	2.24	0.21	1.46	0.36	13.5	5.9	1.7	12
	5	-51.5	-53.5	0	2.78	0.15	0.60	0.66	11.4	0.1	0.1	1
	6	-53.5	-55.7	0	2.63	0.16	0.47	0.72	5.0	0.3	0.0	1
		EL -42.7 to -44.7		**D=2**	**2.31**	**0.20**	**0.59**	**0.66**	**4.5**	**2.7**	**1.9**	**9**
TI-03-V-326	**1**	**-42.3**	**-44**	**1.7**	**2.29**	**0.20**	**0.56**	**0.68**	**3.2**	**0.9**	**0.4**	**6**
	2	**-44**	**-45.3**	**1.3**	**2.55**	**0.17**	**0.47**	**0.72**	**9.7**	**0.1**	**0.0**	**0**
	3	**-45.3**	**-48**	**2.7**	**2.52**	**0.17**	**0.44**	**0.74**	**7.0**	**0.1**	**0.0**	**0**
	4	**-48**	**-50.5**	**2.5**	**2.57**	**0.17**	**0.41**	**0.75**	**4.1**	**0.0**	**0.0**	**0**
	5	**-50.5**	**-52.3**	**1.8**	**2.56**	**0.17**	**0.42**	**0.75**	**4.3**	**0.0**	**0.0**	**1**
	6	**-52.3**	**-55**	**2.7**	**2.59**	**0.17**	**0.40**	**0.76**	**4.4**	**0.1**	**0.0**	**1**
	7	-55	-57.5	0	3.05	0.12	0.54	0.69	10.6	0.0	0.0	1
	8	-57.5	-58.3	0	2.94	0.13	0.47	0.72	8.9	0.0	9.4	1
		EL -42.3 to -55		**D=12.7**	**2.54**	**0.17**	**0.43**	**0.74**	**5.3**	**0.2**	**0.1**	**1**
TI-03-V-327	**1**	**-41**	**-43**	**2**	**1.48**	**0.36**	**1.62**	**0.33**	**1.9**	**6.4**	**6.2**	**18**
	2	**-43**	**-45**	**2**	**2.56**	**0.17**	**0.52**	**0.70**	**9.8**	**0.5**	**0.2**	**4**
	3	-45	-47	0	2.81	0.14	0.77	0.58	15.0	0.6	0.2	2
	4	-47	-49.2	0	-0.79	1.72	3.20	0.11	6.6	11.6	42.7	2
	5	-49.2	-51	0	2.40	0.19	2.37	0.19	21.4	5.1	8.7	4
	6	-51	-53.5	0	3.42	0.09	1.03	0.49	25.8	0.9	0.2	2
	7	-53.5	-57	0	3.24	0.11	0.73	0.60	17.9	0.1	0.0	1
	8	-57	-57.5	0	3.21	0.11	0.75	0.59	17.2	0.3	0.0	3
		EL -41 to -45		**D=4**	**2.22**	**0.22**	**0.76**	**0.59**	**5.9**	**3.4**	**3.2**	**11**

Table E-9
Borings for Borrow Area P

Boring Number	Layer Number	Layer Depth (ft) Top	Layer Depth (ft) Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-317	**1**	**-39.5**	**-40.8**	**1.3**	**-0.83**	**1.78**	**3.30**	**0.10**	**1.8**	**9.7**	**38.7**	**25**
	2	**-40.8**	**-44**	**3.2**	**1.94**	**0.26**	**1.25**	**0.42**	**8.3**	**1.0**	**0.0**	**6**
	3	-44	-47	0	2.04	0.24	1.61	0.33	13.4	1.0	0.4	5
	4	-47	-50	0	1.99	0.25	1.67	0.31	11.7	3.7	1.3	11
	5	-50	-53	0	1.88	0.27	1.43	0.37	7.7	0.6	0.1	3
	6	-53	-55.5	0	1.88	0.27	1.42	0.37	6.5	0.1	0.0	2
		EL -39.5 to -44		**D= 4.5**	**1.52**	**0.35**	**1.75**	**0.30**	**6.4**	**3.5**	**11.2**	**11**
TI-03-V-318	**1**	**-40.5**	**-42.5**	**2**	**1.99**	**0.25**	**0.72**	**0.61**	**1.4**	**1.4**	**0.6**	**8**
	2	-42.5	-45.3	0	2.96	0.13	1.00	0.50	16.3	0.5	0.1	3
	3	-45.3	-47	0	2.45	0.18	0.52	0.70	6.2	0.1	0.0	1
	4	-47	-49.8	0	2.10	0.23	0.81	0.57	7.7	1.6	0.0	2
	5	-49.8	-50.5	0	4.18	0.06	3.09	0.12	42.8	0.5	0.0	2
	6	-50.5	-53	0	0.68	0.63	-0.17	1.12	2.2	0.5	0.0	1
	7	-53	-54.5	0	1.75	0.30	-0.84	1.80	5.9	0.1	0.0	1
		EL -40.5 to -42.5		**D= 2**	**1.99**	**0.25**	**0.72**	**0.61**	**1.4**	**1.4**	**0.6**	**8**
TI-03-V-320	**1**	**-40.5**	**-42.4**	**1.9**	**-0.56**	**1.47**	**2.84**	**0.14**	**1.3**	**13.0**	**32.0**	**21**
	2	**-42.4**	**-45**	**2.6**	**2.34**	**0.20**	**0.49**	**0.71**	**7.7**	**0.9**	**0.0**	**4**
	3	**-45**	**-48**	**3**	**2.46**	**0.18**	**0.38**	**0.77**	**5.2**	**0.1**	**0.0**	**2**
	4	**-48**	**-51**	**3**	**2.52**	**0.17**	**0.41**	**0.75**	**8.0**	**0.1**	**0.3**	**2**
	5	-51	-54	3	2.55	0.17	0.39	0.76	5.5	0.1	0.0	1
	6	-54	-54.5	0.5	2.59	0.17	0.40	0.76	8.2	0.9	0.0	3
		EL -40.5 to -51		**D=10.5**	**2.23**	**0.21**	**0.66**	**0.63**	**5.9**	**2.0**	**5.9**	**5**

Table E-10
Borings for Borrow Area Q

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-161	1	-35.4	-37.5	2.1	2.21	0.22	0.57	0.67	1.8	0.7	0.3	8
	2	-37.5	-39	1.5	2.00	0.25	1.00	0.50	6.1	3.4	6.9	11
	3	-39	-39.6	0.6	2.46	0.18	0.41	0.75	6.8	0.2	0.0	3
		EL -35.4 to -39.6		D= 4.2	2.23	0.21	0.61	0.65	4.1	1.6	2.6	8

Boring Number	Layer Number	Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-162	1	-35.2	-37.5	2.3	1.60	0.33	1.58	0.33	4.0	6.0	5.1	19
	2	-37.5	-39.7	2.2	2.76	0.15	0.57	0.67	10.6	1.5	0.3	8
	3	-39.7	-41.2	1.5	2.41	0.19	0.40	0.76	7.0	0.2	0.0	1
		EL -35.2 to -41.2		D=6	2.35	0.20	0.70	0.62	7.2	2.9	2.1	10

Table E-11
Borings for Borrow Area S

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-46	**1**	**-44.7**	**-47**	**2.3**	**0.17**	**0.89**	**2.09**	**0.23**	**3.3**	**15.6**	**12.7**	**47**
	2	-47	-48	0	2.01	**0.25**	2.22	**0.21**	16.7	6.5	0.4	8
	3	-48	-50	0	-0.13	1.10	2.42	0.19	9.2	22.1	18.1	3
	4	-50	-53	0	-1.41	2.66	2.95	0.13	6.1	21.0	39.5	1
		EL -44.7 to -47		**D= 2.3**	**0.17**	**0.89**	**2.09**	**0.23**	**3.3**	**15.6**	**12.7**	**47**

Boring Number	Layer Number	Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-47	**1**	**-44.5**	**-45.5**	**1**	**1.98**	**0.25**	**0.93**	**0.53**	**4.0**	**5.0**	**0.2**	**22**
	2	**-45.5**	**-47.3**	**1.8**	**-0.02**	**1.01**	**2.50**	**0.18**	**6.8**	**22.0**	**17.2**	**58**
	3	-47.3	-50	0	0.67	0.63	3.18	0.11	16.4	23.7	12.6	14
	4	-50	-52	0	-0.20	1.15	2.51	0.18	8.3	21.7	19.4	2
	5	-52	-54	0	0.19	0.87	2.50	0.18	12.0	19.6	16.4	1
	6	-54	-55.7	0	-0.99	1.98	2.56	0.17	5.8	22.4	34.5	1
		EL -44.5 to -47.3		**D=2.8**	**0.82**	**0.57**	**2.28**	**0.21**	**5.8**	**16.0**	**11.1**	**45**

Boring Number	Layer Number	Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-48	**1**	**-44.2**	**-46.4**	**2.2**	**1.63**	**0.32**	**1.12**	**0.46**	**3.9**	**6.2**	**2.0**	**18**
	2	-46.4	-48.2	0	1.93	0.26	2.82	0.14	17.3	10.6	5.2	27
	3	-48.2	-50	0	0.36	0.78	2.55	0.17	10.8	17.3	17.0	1
	4	-50	-52	0	-0.01	1.01	2.69	0.15	13.5	24.1	18.5	0
	5	-52	-54	0	0.15	0.90	2.39	0.19	10.3	21.9	14.7	1
	6	-54	-55.2	0	0.41	0.75	2.48	0.18	11.3	19.3	14.9	1
		EL -44.2 to -46.4		**D=2.2**	**1.63**	**0.32**	**1.12**	**0.46**	**3.9**	**6.2**	**2.0**	**18**

Boring Number	Layer Number	Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-49	**1**	**-43.8**	**-46.1**	**2.3**	**2.22**	**0.21**	**0.53**	**0.69**	**1.3**	**0.9**	**0.1**	**8**
	2	-46.1	-47.7	0	2.68	0.16	1.05	0.48	14.3	1.3	1.4	8
	3	-47.7	-49.3	0	3.52	0.09	1.26	0.42	33.1	0.1	0.0	1
	4	-49.3	-51.5	0	2.63	0.16	0.64	0.64	7.9	0.2	0.0	2
	5	-51.5	-54.1	0	1.50	0.35	1.67	0.31	11.7	5.4	7.6	2
	6	-54.1	-55	0	-0.13	1.09	2.74	0.15	7.6	14.7	23.9	1
		EL -43.8 to -46.1		**D=2.3**	**2.22**	**0.21**	**0.53**	**0.69**	**1.3**	**0.9**	**0.1**	**8**

Table E-11
Borings for Borrow Area S (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-51	**1**	**-44.1**	**-46.7**	**2.6**	**2.01**	**0.25**	**0.67**	**0.63**	**1.8**	**2.8**	**0.5**	**16**
	2	-46.7	-50	0	3.57	0.08	2.30	0.20	27.2	3.6	3.0	12
	3	-50	-52	0	2.25	0.21	0.70	0.61	13.3	3.0	0.7	2
	4	-52	-54	0	2.28	0.21	0.69	0.62	13.1	1.2	0.2	2
	5	-54	-56	0	1.44	0.37	1.78	0.29	11.7	4.5	10.2	2
	6	-56	-57.6	0	-0.66	1.58	3.46	0.09	7.6	9.7	34.5	1
		EL -44.1 to -46.7		**D=2.6**	**2.01**	**0.25**	**0.67**	**0.63**	**1.8**	**2.8**	**0.5**	**16**
TI-03-V-52	**1**	**-44.2**	**-46**	**1.8**	**1.96**	**0.26**	**0.58**	**0.67**	**1.4**	**1.0**	**0.9**	**9**
	2	**-46**	**-47.7**	**1.7**	**2.40**	**0.19**	**0.41**	**0.75**	**2.1**	**1.0**	**1.7**	**6**
		EL -44.2 to -47.7		**D=3.5**	**2.18**	**0.22**	**0.56**	**0.68**	**1.8**	**1.0**	**1.3**	**8**
TI-03-V-53	**1**	**-44.8**	**-46.3**	**1.5**	**2.31**	**0.20**	**0.43**	**0.74**	**1.2**	**0.1**	**0.0**	**6**
	2	**-46.3**	**-47.5**	**1.2**	**1.30**	**0.41**	**1.98**	**0.25**	**11.2**	**12.4**	**1.7**	**32**
		EL -44.8 to -47.5		**D=2.7**	**1.98**	**0.25**	**0.93**	**0.52**	**5.6**	**5.6**	**1.7**	**18**

Table E-11
Borings for Borrow Area S

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-46	**1**	**-44.7**	**-47**	**2.3**	**0.17**	**0.89**	**2.09**	**0.23**	**3.3**	**15.6**	**12.7**	**47**
	2	-47	-48	0	2.01	**0.25**	2.22	**0.21**	16.7	6.5	0.4	8
	3	-48	-50	0	-0.13	1.10	2.42	0.19	9.2	22.1	18.1	3
	4	-50	-53	0	-1.41	2.66	2.95	0.13	6.1	21.0	39.5	1
		EL -44.7 to -47		**D= 2.3**	**0.17**	**0.89**	**2.09**	**0.23**	**3.3**	**15.6**	**12.7**	**47**
TI-03-V-47	**1**	**-44.5**	**-45.5**	**1**	**1.98**	**0.25**	**0.93**	**0.53**	**4.0**	**5.0**	**0.2**	**22**
	2	**-45.5**	**-47.3**	**1.8**	**-0.02**	**1.01**	**2.50**	**0.18**	**6.8**	**22.0**	**17.2**	**58**
	3	-47.3	-50	0	0.67	0.63	3.18	0.11	16.4	23.7	12.6	14
	4	-50	-52	0	-0.20	1.15	2.51	0.18	8.3	21.7	19.4	2
	5	-52	-54	0	0.19	0.87	2.50	0.18	12.0	19.6	16.4	1
	6	-54	-55.7	0	-0.99	1.98	2.56	0.17	5.8	22.4	34.5	1
		EL -44.5 to -47.3		**D=2.8**	**0.82**	**0.57**	**2.28**	**0.21**	**5.8**	**16.0**	**11.1**	**45**
TI-03-V-48	**1**	**-44.2**	**-46.4**	**2.2**	**1.63**	**0.32**	**1.12**	**0.46**	**3.9**	**6.2**	**2.0**	**18**
	2	-46.4	-48.2	0	1.93	0.26	2.82	0.14	17.3	10.6	5.2	27
	3	-48.2	-50	0	0.36	0.78	2.55	0.17	10.8	17.3	17.0	1
	4	-50	-52	0	-0.01	1.01	2.69	0.15	13.5	24.1	18.5	0
	5	-52	-54	0	0.15	0.90	2.39	0.19	10.3	21.9	14.7	1
	6	-54	-55.2	0	0.41	0.75	2.48	0.18	11.3	19.3	14.9	1
		EL -44.2 to -46.4		**D=2.2**	**1.63**	**0.32**	**1.12**	**0.46**	**3.9**	**6.2**	**2.0**	**18**
TI-03-V-49	**1**	**-43.8**	**-46.1**	**2.3**	**2.22**	**0.21**	**0.53**	**0.69**	**1.3**	**0.9**	**0.1**	**8**
	2	-46.1	-47.7	0	2.68	0.16	1.05	0.48	14.3	1.3	1.4	8
	3	-47.7	-49.3	0	3.52	0.09	1.26	0.42	33.1	0.1	0.0	1
	4	-49.3	-51.5	0	2.63	0.16	0.64	0.64	7.9	0.2	0.0	2
	5	-51.5	-54.1	0	1.50	0.35	1.67	0.31	11.7	5.4	7.6	2
	6	-54.1	-55	0	-0.13	1.09	2.74	0.15	7.6	14.7	23.9	1
		EL -43.8 to -46.1		**D=2.3**	**2.22**	**0.21**	**0.53**	**0.69**	**1.3**	**0.9**	**0.1**	**8**

Table E-11
Borings for Borrow Area S (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-51	**1**	**-44.1**	**-46.7**	**2.6**	**2.01**	**0.25**	**0.67**	**0.63**	**1.8**	**2.8**	**0.5**	**16**
	2	-46.7	-50	0	3.57	0.08	2.30	0.20	27.2	3.6	3.0	12
	3	-50	-52	0	2.25	0.21	0.70	0.61	13.3	3.0	0.7	2
	4	-52	-54	0	2.28	0.21	0.69	0.62	13.1	1.2	0.2	2
	5	-54	-56	0	1.44	0.37	1.78	0.29	11.7	4.5	10.2	2
	6	-56	-57.6	0	-0.66	1.58	3.46	0.09	7.6	9.7	34.5	1
		EL -44.1 to -46.7		**D=2.6**	**2.01**	**0.25**	**0.67**	**0.63**	**1.8**	**2.8**	**0.5**	**16**
TI-03-V-52	**1**	**-44.2**	**-46**	**1.8**	**1.96**	**0.26**	**0.58**	**0.67**	**1.4**	**1.0**	**0.9**	**9**
	2	**-46**	**-47.7**	**1.7**	**2.40**	**0.19**	**0.41**	**0.75**	**2.1**	**1.0**	**1.7**	**6**
		EL -44.2 to -47.7		**D=3.5**	**2.18**	**0.22**	**0.56**	**0.68**	**1.8**	**1.0**	**1.3**	**8**
TI-03-V-53	**1**	**-44.8**	**-46.3**	**1.5**	**2.31**	**0.20**	**0.43**	**0.74**	**1.2**	**0.1**	**0.0**	**6**
	2	**-46.3**	**-47.5**	**1.2**	**1.30**	**0.41**	**1.98**	**0.25**	**11.2**	**12.4**	**1.7**	**32**
		EL -44.8 to -47.5		**D=2.7**	**1.98**	**0.25**	**0.93**	**0.52**	**5.6**	**5.6**	**1.7**	**18**

Table E-12
Borings for Borrow Area T

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-14	1	-37.2	-39.5	2.3	2.18	0.22	0.54	0.69	1.4	2.0	0.5	8
	2	-39.5	-40.4	0.9	1.12	0.46	1.50	0.35	1.4	4.0	10.5	24
		EL -37.2 to -40.4		D= 3.2	1.97	0.26	0.74	0.60	1.4	2.6	3.3	13
TI-03-V-17	1	-40.6	-43	2.4	1.97	0.25	0.66	0.63	1.2	1.5	0.6	14
	2	-43	-45	2	2.16	0.22	0.54	0.69	2.6	0.6	0.4	7
	3	-45	-47	2	1.40	0.38	1.46	0.36	2.9	4.6	7.5	25
	4	-47	-49.2	2.2	1.78	0.29	0.82	0.57	2.6	2.5	75.3	21
		EL -40.6 to -49.2		D=8.6	1.91	0.27	0.78	0.58	2.3	2.3	2.9	17
TI-03-V-22	1	-41.6	-42.1	0.5	1.29	0.41	1.73	0.30	4.8	9.6	5.0	9
	2	-42.1	-43.8	1.7	2.38	0.19	0.53	0.69	10.5	0.0	0.0	2
		EL -41.6 to -43.8		D=2.2	2.26	0.21	0.62	0.65	9.2	2.2	1.1	4
TI-03-V-23	1	-41.4	-43	1.6	1.80	0.29	0.65	0.64	1.6	0.5	0.0	10
	2	-43	-45	2	0.14	0.91	2.55	0.17	2.1	12.7	21.5	44
	3	-45	-45.9	0.9	2.51	0.18	0.42	0.75	4.9	0.5	0.3	4
	4	-45.9	-48.2	0	0.16	0.90	3.55	0.09	15.3	12.0	31.1	1
		EL -41.4 to -45.9		D=4.5	1.18	0.44	1.74	0.30	2.5	5.9	9.6	24
TI-03-V-27	1	-42	-43.9	1.9	1.77	0.29	0.69	0.62	1.1	0.8	0.1	19
	2	-43.9	-44.4	0.5	1.79	0.29	0.75	0.60	1.3	2.0	2.2	19
		EL -42.7 to -44.7		D=2.4	1.78	0.29	0.70	0.62	1.2	1.1	0.6	19

Table E-13

Borings for Borrow Area A

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-124	**1**	**-38.5**	**-40.5**	**2**	**1.72**	**0.30**	**1.59**	**0.33**	**9.0**	**8.5**	**2.1**	**22**
	2	-40.5	-42.5	0	2.37	0.19	0.54	0.69	18.2	3.2	1.0	11
	3	-42.5	-45	0	2.79	0.14	0.42	0.75	5.6	0.1	0.0	3
	4	-45	-48	0	2.84	0.14	0.58	0.67	12.7	0.0	0.0	1
	5	-48	-51	0	2.73	0.15	0.67	0.63	13.9	0.0	0.0	1
	6	-51	-53.5	0	2.61	0.16	0.47	0.72	11.2	0.0	0.0	1
		EL -38.5 to -40.5		**D= 2**	**1.72**	**0.30**	**1.59**	**0.33**	**9.0**	**8.5**	**2.1**	**22**

Boring Number	Layer Number	Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-125	**1**	**-38.9**	**-40.9**	**2**	**2.31**	**0.20**	**0.98**	**0.51**	**8.4**	**4.5**	**2.6**	**17**
	2	-40.9	-43	0	2.71	0.15	0.58	0.67	11.3	2.8	0.3	9
	3	-43	-46	0	2.94	0.13	0.42	0.75	11.8	0.1	0.0	1
	4	-46	-48	0	2.93	0.13	0.44	0.74	11.7	0.0	0.0	1
	5	-48	-50.5	0	2.95	0.13	0.55	0.68	13.2	0.0	0.0	1
	6	-50.5	-51	0	2.88	0.14	0.67	0.63	13.4	0.0	0.0	1
		EL -38.9 to -40.9		**D=2**	**2.31**	**0.20**	**0.98**	**0.51**	**8.4**	**4.5**	**2.6**	**17**

Boring Number	Layer Number	Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-126	**1**	**-38.7**	**-41**	**2.3**	**1.00**	**0.50**	**2.20**	**0.22**	**8.7**	**14.9**	**6.5**	**43**
	2	**-41**	**-43.5**	**2.5**	**2.77**	**0.15**	**0.38**	**0.77**	**6.0**	**0.5**	**0.1**	**3**
	3	-43.5	-45.5	0	3.06	0.12	0.64	0.64	16.4	1.1	0.0	2
	4	-45.5	-47.5	0	2.75	0.15	0.57	0.67	12.7	0.4	0.0	2
	5	-47.5	-49.2	0	3.28	0.10	1.32	0.40	21.7	1.2	0.7	1
	6	-49.2	-49.7	0	2.81	0.14	0.61	0.66	14.2	0.2	0.1	2
		EL -38.7 to -43.5		**D=4.8**	**1.76**	**0.30**	**1.79**	**0.29**	**7.3**	**7.4**	**3.2**	**22**

Boring Number	Layer Number	Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-127	**1**	**-39.8**	**-42.3**	**2.5**	**1.41**	**0.38**	**1.91**	**0.27**	**3.8**	**6.6**	**8.5**	**28**
	2	**-42.3**	**-44**	**1.7**	**2.86**	**0.14**	**0.36**	**0.78**	**6.9**	**0.1**	**0.0**	**1**
	3	**-44**	**-44.7**	**0.7**	**2.90**	**0.13**	**0.36**	**0.78**	**6.2**	**0.2**	**0.0**	**1**
		EL -39.8 to -44.7		**D=4.9**	**2.19**	**0.22**	**1.11**	**0.46**	**5.2**	**3.4**	**4.3**	**15**

Table E-13

Borings for Borrow Area A (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-129	**1**	**-40.9**	**-42.5**	**1.6**	**1.48**	**0.36**	**1.25**	**0.42**	**1.2**	**5.5**	**0.9**	**24**
	2	**-42.5**	**-43.4**	**0.9**	**2.41**	**0.19**	**0.54**	**0.69**	**1.8**	**2.1**	**0.3**	**9**
	3	-43.4	-44.3	0.9	ND	ND	ND	ND	37.3	1.8	0.0	7
	4	-44.3	-47.6	3.3	1.59	0.33	1.16	0.45	7.4	2.7	0.5	6
	5	-47.6	-49.2	1.6	ND	ND	ND	ND	70.7	0.1	0.0	1
		EL -40.9 to -43.4		**D=2.5**	**1.84**	**0.28**	**1.09**	**0.47**	**1.4**	**4.2**	**0.7**	**19**
TI-03-V-130	**1**	**-42.6**	**-45.1**	**2.5**	**2.62**	**0.16**	**0.51**	**0.70**	**8.0**	**2.3**	**0.1**	**7**
	2	**-45.1**	**-47**	**1.9**	**2.82**	**0.14**	**0.32**	**0.80**	**4.9**	**0.2**	**0.0**	**2**
	3	**-47**	**-49**	**2**	**2.82**	**0.14**	**0.29**	**0.82**	**3.6**	**0.1**	**0.0**	**1**
	4	**-49**	**-50.9**	**1.9**	**2.65**	**0.16**	**0.44**	**0.74**	**3.8**	**0.0**	**0.0**	**1**
		EL -42.6 to -50.9		**D=8.3**	**2.71**	**0.15**	**0.42**	**0.75**	**5.3**	**0.7**	**0.0**	**3**
TI-03-V-182	**1**	**-44.7**	**-46**	**1.3**	**2.30**	**0.20**	**0.63**	**0.65**	**2.5**	**1.8**	**0.5**	**7**
	2	**-46**	**-47**	**1**	**1.88**	**0.27**	**1.26**	**0.42**	**2.2**	**6.4**	**2.1**	**11**
	3	**-47**	**-49**	**2**	**2.90**	**0.13**	**0.44**	**0.74**	**11.2**	**0.1**	**0.0**	**1**
	4	-49	-52.3	3.3	2.93	0.13	0.42	0.75	12.2	0.1	0.0	0
		EL -44.7 to -49		**D=4.3**	**2.55**	**0.17**	**0.49**	**0.71**	**6.5**	**2.1**	**0.6**	**5**
TI-03-V-187	**1**	**-42.5**	**-44.5**	**2**	**2.40**	**0.19**	**0.65**	**0.64**	**2.9**	**3.5**	**1.3**	**11**
	2	**-44.5**	**-46.5**	**2**	**2.81**	**0.14**	**0.55**	**0.68**	**9.1**	**1.9**	**0.3**	**7**
	3	-46.5	-49	2.5	2.92	0.13	0.40	0.76	8.9	0.1	0.0	1
	4	-49	-52	3	2.92	0.13	0.42	0.75	9.4	0.0	0.0	1
	5	-52	-54	2	2.81	0.14	0.56	0.68	10.6	0.0	0.0	1
	6	-54	-55.5	1.5	3.37	0.10	1.27	0.41	20.4	0.0	0.0	1
		EL -42.5 to -46.5		**D=4**	**2.63**	**0.16**	**0.56**	**0.68**	**6.0**	**2.7**	**0.8**	**9**

Table E-13

Borings for Borrow Area A (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-188	**1**	**-44.2**	**-47.8**	**3.6**	**1.74**	**0.30**	**1.51**	**0.35**	**3.2**	**5.2**	**6.2**	**19**
	2	**-47.8**	**-50**	**2.2**	**2.97**	**0.13**	**0.46**	**0.73**	**12.2**	**0.2**	**0.0**	**2**
	3	**-50**	**-52**	**2**	**3.07**	**0.12**	**0.52**	**0.70**	**11.6**	**0.0**	**0.0**	**0**
	4	-52	-54.2	2.2	2.93	0.13	0.48	0.72	12.0	0.1	0.0	1
		EL -44.2 to -52		**D=7.8**	**2.69**	**0.15**	**0.65**	**0.64**	**7.9**	**2.5**	**2.9**	**9**
TI-03-V-189	**1**	**-45.5**	**-47.5**	**2**	**2.36**	**0.20**	**0.60**	**0.66**	**2.9**	**1.8**	**0.9**	**8**
	2	**-47.5**	**-51**	**3.5**	**2.06**	**0.24**	**1.16**	**0.45**	**7.6**	**5.6**	**3.8**	**16**
	3	**-51**	**-54.8**	**3.8**	**2.81**	**0.14**	**0.60**	**0.66**	**11.6**	**1.8**	**1.1**	**8**
	4	-54.8	-57	2.2	2.91	0.13	0.46	0.73	10.5	1.5	0.7	5
	5	-57	-59	2	3.04	0.12	0.55	0.68	12.1	0.1	0.0	3
	6	-59	-59.5	0.5	2.92	0.13	0.47	0.72	11.8	0.1	0.0	2
		EL -45.5 to -54.8		**D=9.3**	**2.46**	**0.18**	**0.77**	**0.59**	**8.2**	**3.3**	**2.1**	**11**
TI-03-V-197	**1**	**-45.5**	**-47**	**1.5**	**2.23**	**0.21**	**0.64**	**0.64**	**1.6**	**2.1**	**3.2**	**8**
	2	**-47**	**-49.5**	**2.5**	**2.88**	**0.14**	**0.43**	**0.74**	**10.1**	**0.5**	**0.6**	**3**
	3	-49.5	-52	2.5	3.35	0.10	0.77	0.59	26.7	0.2	0.1	1
	4	-52	-52.9	0.9	ND	ND	ND	ND	73.5	0.0	0.0	0
	5	-52.9	-55	2.1	3.61	0.08	1.03	0.49	40.5	0.0	0.0	1
	6	-55	-56.7	1.7	3.71	0.08	1.18	0.44	42.0	0.1	0.0	1
	7	-56.7	-57.5	0.8	ND	ND	ND	ND	72.4	0.1	0.0	0
		EL -45.5 to -49.5		**D=4**	**2.61**	**0.16**	**0.51**	**0.70**	**6.9**	**1.1**	**1.6**	**5**
TI-03-V-202	**1**	**-46.3**	**-48**	**1.7**	**2.24**	**0.21**	**0.75**	**0.59**	**1.8**	**3.5**	**1.5**	**9**
	2	**-48**	**-50**	**2**	**2.70**	**0.15**	**0.79**	**0.58**	**12.6**	**2.8**	**0.7**	**9**
	3	-50	-52	2	2.99	0.13	1.09	0.47	18.3	2.4	0.6	10
	4	-52	-53.9	1.9	2.92	0.13	0.69	0.62	15.3	2.3	0.8	9
		EL -46.3 to -50		**D=3.7**	**2.44**	**0.18**	**0.77**	**0.59**	**7.6**	**3.2**	**1.1**	**9**

Table E-13
Borings for Borrow Area A (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-203	1	-43.4	-45.5	2.1	0.93	0.52	2.03	0.25	2.3	9.9	9.4	25
	2	-45.5	-46.6	1.1	2.28	0.21	0.64	0.64	1.8	2.1	3.1	10
		EL -43.4 to -46.6		D=3.2	1.34	0.39	1.78	0.29	2.1	7.2	7.2	20
TI-03-V-208	1	-49	-51	2	2.61	0.16	0.42	0.75	4.6	1.4	0.4	6
	2	-51	-52.2	1.2	2.88	0.14	0.41	0.75	9.6	0.8	0.1	3
		EL -49 to -52.2		D=3.2	2.70	0.15	0.44	0.74	6.5	1.2	0.3	5
TI-03-V-216	1	-48.2	-49	0.8	1.15	0.45	2.12	0.23	1.9	10.4	9.3	23
	2	-49	-50.3	1.3	1.75	0.30	1.94	0.26	12.3	7.9	4.6	18
		EL -48.2 to -50.3		D=2.1	1.45	0.36	1.95	0.26	8.3	8.9	6.4	20

Table E-14
Borings for Borrow Area B

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-132	**1**	**-42.2**	**-43.8**	**1.6**	**0.58**	**0.67**	**2.04**	**0.24**	**1.5**	**12.3**	**9.4**	**44**
	2	**-43.8**	**-46**	**2.2**	**2.64**	**0.16**	**0.44**	**0.74**	**5.3**	**0.9**	**0.1**	**5**
	3	**-46**	**-47.6**	**1.6**	**2.86**	**0.14**	**0.37**	**0.77**	**6.7**	**0.1**	**0.0**	**2**
		EL -42.2 to -47.6		**D= 5.4**	**2.09**	**0.23**	**1.16**	**0.45**	**4.6**	**4.0**	**2.8**	**16**

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-205	**1**	**-43.2**	**-45.2**	**2**	**2.39**	**0.19**	**0.56**	**0.68**	**2.2**	**0.9**	**0.1**	**6**
	2	-45.2	-47.2	0	ND	ND	ND	ND	64.2	0.0	0.0	0
	3	-47.2	-50	0	3.73	0.08	1.02	0.49	36.3	0.1	0.0	1
	4	-50	-53	0	3.74	0.08	1.09	0.47	37.8	0.0	0.0	1
	5	-53	-55.2	0	3.32	0.10	0.84	0.56	21.5	0.0	0.0	1
		EL -43.2 to -45.2		**D=2**	**2.39**	**0.19**	**0.56**	**0.68**	**2.2**	**0.9**	**0.1**	**6**

Table E-15

Borings for Borrow Area C

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-174	**1**	**-45.5**	**-47.8**	**2.3**	**2.43**	**0.18**	**0.53**	**0.69**	**2.4**	**2.5**	**2.1**	**9**
	2	-47.8	-49.5	0	ND	ND	ND	ND	68.4	0.1	0.0	3
	3	-49.5	-50.5	0	ND	ND	ND	ND	80.8	0.6	0.4	3
	4	-50.5	-51.3	0	3.53	0.09	1.27	0.41	24.4	1.0	0.3	2
		EL -45.5 to -47.8		**D= 2.3**	**2.43**	**0.18**	**0.53**	**0.69**	**2.4**	**2.5**	**2.1**	**9**

Boring Number	Layer Number	Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-178	**1**	**-46.3**	**-48.5**	**2.2**	**2.58**	**0.17**	**0.53**	**0.69**	**7.0**	**0.9**	**4.9**	**9**
	2	-48.5	-50.5	0	2.95	0.13	0.43	0.74	9.5	0.2	0.3	2
	3	-50.5	-52	0	2.52	0.17	0.81	0.57	8.5	1.8	5.2	11
	4	-52	-54.5	0	2.59	0.17	0.49	0.71	7.2	0.0	0.0	2
	5	-54.5	-57	0	2.50	0.18	0.44	0.74	3.6	0.1	0.0	3
	6	-57	-60	0	2.06	0.24	0.87	0.55	3.6	0.8	0.1	9
	7	-60	-62.5	0	2.01	0.25	0.87	0.55	2.1	0.4	0.0	2
	8	-62.5	-63.3	0	2.69	0.15	0.31	0.81	3.0	0.0	0.0	1
		EL -46.3 to -48.5		**D=2.2**	**2.58**	**0.17**	**0.53**	**0.69**	**7.0**	**0.9**	**4.9**	**9**

Boring Number	Layer Number	Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-185	**1**	**-46.5**	**-48.5**	**2**	**2.38**	**0.19**	**0.53**	**0.69**	**1.2**	**1.4**	**0.5**	**5**
	2	**-48.5**	**-51**	**2.5**	**2.73**	**0.15**	**0.63**	**0.65**	**11.7**	**1.2**	**1.2**	**8**
	3	-51	-53	0	3.12	0.11	0.68	0.62	15.1	0.8	0.5	8
	4	-53	-55	0	ND	ND	ND	ND	49.9	0.3	0.2	1
	5	-55	-58	0	ND	ND	ND	ND	82.3	0.0	0.0	0
	6	-58	-61	3	ND	ND	ND	ND	84.5	0.0	0.0	0
	7	-61	-64.3	0	3.32	0.10	0.81	0.57	22.0	0.1	0.0	1
	8	-64.3	-64.8	0	3.06	0.12	0.72	0.61	14.9	0.0	0.0	1
		EL -46.5 to -51		**D=4.5**	**2.54**	**0.17**	**0.49**	**0.71**	**7.0**	**1.3**	**0.9**	**7**

Table E-15
Borings for Borrow Area C (cont.)

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-186	**1**	**-47.7**	**-49.5**	**1.8**	**2.42**	**0.19**	**0.49**	**0.71**	**2.6**	**1.5**	**1.1**	**7**
	2	**-49.5**	**-51**	**1.5**	**2.48**	**0.18**	**0.43**	**0.74**	**4.5**	**0.9**	**4.0**	**7**
	3	-51	-53.9	2.9	2.73	0.15	0.51	0.70	7.9	0.2	0.0	2
	4	-53.9	-56	2.1	ND	ND	ND	ND	54.1	0.2	0.0	2
	5	-56	-57	1	ND	ND	ND	ND	65.6	0.1	0.0	0
	6	-57	-60	3	3.28	0.10	0.84	0.56	21.8	0.2	0.1	2
	7	-60	-63	3	2.93	0.13	0.45	0.73	10.8	0.1	0.0	2
	8	-63	-65.5	2.5	3.18	0.11	0.76	0.59	16.8	0.1	0.0	1
		EL -47.7 to -51		**D=3.3**	**2.46**	**0.18**	**0.44**	**0.73**	**3.4**	**1.2**	**2.4**	**7**
TI-03-V-192	**1**	**-47**	**-49**	**2**	**2.10**	**0.23**	**0.69**	**0.62**	**1.5**	**1.2**	**0.1**	**7**
	2	-49	-50	1	ND	ND	ND	ND	35.1	1.2	0.0	1
		EL -47 to -49		**D=2**	**2.10**	**0.23**	**0.69**	**0.62**	**1.5**	**1.2**	**0.1**	**7**
TI-03-V-198	**1**	**-46.5**	**-48.5**	**2**	**1.35**	**0.39**	**1.75**	**0.30**	**1.5**	**5.3**	**9.8**	**20**
	2	**-48.5**	**-49.5**	**1**	**2.33**	**0.20**	**0.56**	**0.68**	**2.3**	**1.7**	**1.5**	**7**
	3	-49.5	-50.5	1	3.29	0.10	1.05	0.48	23.9	0.1	0.0	1
	4	-50.5	-52.5	2	2.43	0.18	0.60	0.66	6.1	0.0	0.0	0
	5	-52.5	-54.5	2	3.05	0.12	0.48	0.72	7.8	0.0	0.0	0
		EL -46.5 to -49.5		**D=3**	**1.84**	**0.28**	**1.14**	**0.45**	**1.7**	**4.1**	**7.1**	**16**
TI-03-V-199	**1**	**-46.6**	**-48.8**	**2.2**	**2.14**	**0.23**	**0.70**	**0.62**	**1.4**	**0.7**	**0.5**	**7**
	2	-48.8	-51.1	2.3	3.11	0.12	0.68	0.63	14.2	0.1	0.0	2
	3	-51.1	-51.6	0.5	2.97	0.13	0.73	0.60	13.8	0.1	0.0	2
		EL -46.6 to -48.8		**D=2.2**	**2.14**	**0.23**	**0.70**	**0.62**	**1.4**	**0.7**	**0.5**	**7**

Table E-16
Borings for Borrow Area D

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-223	**1**	**-43.5**	**-45**	**1.5**	**2.12**	**0.23**	**0.63**	**0.65**	**0.9**	**1.3**	**1.1**	**8**
	2	**-45**	**-46.5**	**1.5**	**1.85**	**0.28**	**0.90**	**0.54**	**1.3**	**4.4**	**4.5**	**16**
	3	-46.5	-47.2	0	3.00	0.13	1.15	0.45	19.4	3.3	1.1	8
		EL -43.5 to -46.5		**D= 3**	**2.00**	**0.25**	**0.75**	**0.59**	**1.1**	**2.9**	**2.8**	**12**
TI-03-V-224	**1**	**-46.4**	**-48.4**	**2**	**2.23**	**0.21**	**0.54**	**0.69**	**1.5**	**2.1**	**1.4**	**7**
	2	-48.4	-50.5	0	3.63	0.08	1.46	0.36	32.5	0.5	0.0	2
	3	-50.5	-52.6	0	3.38	0.10	0.86	0.55	28.0	0.2	0.0	1
		EL -46.4 to -48.4		**D=2**	**2.23**	**0.21**	**0.54**	**0.69**	**1.5**	**2.1**	**1.4**	**7**
TI-03-V-228	**1**	**-46.9**	**-47.9**	**1**	**2.10**	**0.23**	**0.68**	**0.63**	**1.6**	**2.0**	**0.5**	**6**
	2	**-47.9**	**-50.6**	**2.7**	**1.29**	**0.41**	**2.08**	**0.24**	**7.4**	**12.8**	**5.2**	**18**
	3	**-50.6**	**-52.5**	**1.9**	**2.93**	**0.13**	**0.44**	**0.73**	**11.3**	**0.9**	**0.1**	**3**
	4	**-52.5**	**-53.6**	**1.1**	**2.92**	**0.13**	**0.46**	**0.73**	**11.0**	**2.2**	**1.7**	**5**
		EL -46.9 to -53.6		**D=6.7**	**2.16**	**0.22**	**1.23**	**0.43**	**8.2**	**6.1**	**2.5**	**10**

Table E-17

Borings for Borrow Area E

Boring Number	Layer Number	Layer Depth (ft) Top	Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-240	**1**	**-50**	**-52**	**2**	**1.78**	**0.29**	**0.74**	**0.60**	**1.0**	**1.7**	**3.5**	**9**
	2	**-52**	**-52.8**	**0.8**	**2.56**	**0.17**	**0.42**	**0.75**	**5.7**	**0.6**	**0.2**	**3**
		EL -50 to -52.8		**D= 2.8**	**2.00**	**0.25**	**0.82**	**0.57**	**2.3**	**1.4**	**2.5**	**7**
TI-03-V-241	**1**	**-49**	**-51.2**	**2.2**	**2.01**	**0.25**	**0.50**	**0.71**	**0.8**	**0.5**	**0.5**	**4**
	2	**-51.2**	**-53**	**1.8**	**2.55**	**0.17**	**0.45**	**0.73**	**7.6**	**0.7**	**0.1**	**3**
	3	-53	-54	0	3.87	0.07	1.27	0.42	42.6	0.1	0.0	1
	4	-54	-56.1	0	3.62	0.08	1.39	0.38	36.0	0.1	0.0	1
		EL -49 to -53		**D=4**	**2.25**	**0.21**	**0.61**	**0.66**	**3.9**	**0.6**	**0.3**	**4**

Table E-18
Borings for Borrow Area F

Boring Number	Layer Number	Layer Depth (ft) Top	Layer Depth (ft) Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-245	1	-47.2	-48.5	1.3	0.50	0.71	1.47	0.36	1.8	9.6	6.6	18
	2	-48.5	-49.7	1.2	1.55	0.34	1.37	0.39	1.4	4.5	8.0	18
		EL -47.2 to -49.7		D= 2.5	0.96	0.51	1.64	0.32	1.6	7.2	7.3	18

Boring Number	Layer Number	Layer Depth (ft) Top	Layer Depth (ft) Bottom	Layer Thickness (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-369	1	-48	-49	1	1.73	0.30	1.25	0.42	7.3	3.6	0.3	2
	2	-49	-51	2	0.82	0.56	2.34	0.20	4.7	8.4	14.1	3
	3	-51	-53	2	-0.08	1.06	2.64	0.16	6.2	13.4	20.6	1
		EL -48 to -51		D=3	1.20	0.44	1.90	0.27	5.6	6.8	9.5	2

Table E-19
Composite Characteristics for Borrow Area G

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-254	5.0	2.09	0.23	0.90	0.54	7.6	3.5	3.8	5
TI-03-V-256	2.0	2.09	0.23	0.62	0.65	1.1	0.8	2.0	7
TI-03-V-257	3.0	2.04	0.24	0.97	0.51	3.9	2.9	7.2	14
TI-03-V-258	2.8	0.89	0.54	2.48	0.18	2.8	6.9	15.7	28
TI-03-V-275	5.5	2.58	0.17	0.43	0.74	6.3	0.4	1.2	4

Borrow Area G Composite Data

Mean	**2.0**
Mean (mm)	**0.24**
Std Dev (phi)	**1.0**
Std Dev (mm)	**0.51**
% Silt	**5.2**
% Granular	**2.7**
% Gravel	**5.2**
% Shell	**10**

Table E-20
Composite Characteristics for Borrow Area H

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-260	2.2	2.07	0.24	0.87	0.55	3.6	2.2	4.5	11
TI-03-V-273	4.8	2.27	0.21	0.55	0.68	2.1	1.3	0.9	5

Borrow Area H Composite Data

Mean	**2.21**
Mean (mm)	**0.22**
Std Dev (phi)	**0.65**
Std Dev (mm)	**0.64**
% Silt	**2.6**
% Granular	**1.6**
% Gravel	**2.0**
% Shell	**7**

Table E-21
Composite Characteristics for Borrow Area J

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-98	2.8	2.13	0.23	0.73	0.60	5.2	1.3	0.5	11
TI-03-V-99	8.3	2.45	0.18	0.44	0.74	9.5	1.4	0.2	6
TI-03-V-102	3.0	1.86	0.27	1.05	0.48	2.3	4.5	1.3	16
TI-03-V-103	2.6	2.29	0.20	0.58	0.67	2.8	1.6	0.2	10
TI-03-V-270A	2.0	2.00	0.25	0.81	0.57	1.5	3.0	1.1	9
TI-03-V-281	3.4	2.02	0.25	0.72	0.61	1.2	2.5	1.0	10
TI-03-V-283	3.2	1.87	0.27	0.88	0.54	2.1	3.7	1.8	9
TI-03-V-286	4.0	1.85	0.28	1.15	0.45	2.6	1.8	3.3	14

Borrow Area J Composite Data

Mean	**2.12**
Mean (mm)	**0.23**
Std Dev (phi)	**0.75**
Std Dev (mm)	**0.60**
% Silt	**4.5**
% Granular	**2.3**
% Gravel	**1.1**
% Shell	**10**

Table E-22
Composite Characteristics for Borrow Area L

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-91	3.5	1.61	0.33	1.69	0.31	7.1	4.4	9.6	19
TI-03-V-93	2.3	2.15	0.23	0.83	0.56	8.5	3.8	0.8	15
TI-03-V-95	13.8	2.50	0.18	0.42	0.75	8.4	0.9	0.2	6
TI-03-V-341	4.3	2.12	0.23	0.88	0.54	6.3	2.5	0.7	6
TI-03-V-342	2.0	1.89	0.27	1.04	0.49	3.8	5.6	2.8	15
TI-03-V-343	5.0	2.37	0.19	0.50	0.71	3.3	1.0	0.4	3
TI-03-V-344	2.3	0.81	0.57	2.23	0.21	1.6	7.0	13.8	22
TI-03-V-345	3.0	1.65	0.32	1.01	0.50	1.8	2.8	2.1	15
TI-03-V-346	3.0	1.93	0.26	1.09	0.47	7.6	3.4	4.9	13
TI-03-V-351	2.8	1.31	0.40	2.13	0.23	7.3	7.4	10.5	16

Borrow Area L Composite Data

Mean	**2.05**
Mean (mm)	**0.24**
Std Dev (phi)	**0.94**
Std Dev (mm)	**0.52**
% Silt	**6.3**
% Granular	**2.8**
% Gravel	**3.1**
% Shell	**10**

Table E-23
Composite Characteristics for Borrow Area N

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-63	3.0	2.08	0.24	0.63	0.65	1.2	2.2	4.9	14
TI-03-V-65	5.5	2.37	0.19	0.43	0.74	1.5	0.5	0.6	7
TI-03-V-68	6.0	1.71	0.31	1.20	0.44	4.6	3.4	2.7	3
TI-03-V-69	3.7	1.31	0.40	1.71	0.31	1.1	5.7	8.8	24
TI-03-V-70	5.0	1.33	0.40	1.46	0.36	6.3	4.4	8.4	14
TI-03-V-72	2.8	0.54	0.69	1.64	0.32	1.1	6.9	10.9	19
TI-03-V-74	5.5	2.20	0.22	0.67	0.63	3.3	3.4	3.5	10
TI-03-V-77	2.3	2.23	0.21	0.57	0.67	1.4	1.5	0.9	7
TI-03-V-78	4.0	2.38	0.19	0.65	0.64	4.8	3.5	4.1	9
TI-03-V-79	2.3	2.03	0.24	0.60	0.66	1.6	0.5	0.1	8
TI-03-V-86	14.8	1.88	0.27	0.91	0.53	3.4	3.6	3.0	8
TI-03-V-87	5.8	1.88	0.27	1.09	0.47	5.8	2.4	7.7	5

Borrow Area N Composite Data

Mean	**1.86**
Mean (mm)	**0.28**
Std Dev (phi)	**0.96**
Std Dev (mm)	**0.51**
% Silt	**3.6**
% Granular	**3.2**
% Gravel	**4.8**
% Shell	**9**

Table E-24
Composite Characteristics for Borrow Area O

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-83B	5.1	0.33	0.80	2.99	0.13	8.2	8.9	24.6	46
TI-03-V-85	4.5	2.07	0.24	0.74	0.60	4.8	2.4	3.5	8
TI-03-V-322	3.1	2.51	0.18	0.44	0.74	7.1	0.3	0.4	3
TI-03-V-323	12.4	2.46	0.18	0.46	0.73	7.5	1.1	0.7	5
TI-03-V-324	7.0	1.85	0.28	1.22	0.43	5.4	2.7	10.3	9
TI-03-V-325	2.0	2.31	0.20	0.59	0.66	4.5	2.7	1.9	9
TI-03-V-326	12.7	2.54	0.17	0.43	0.74	5.3	0.2	0.1	1
TI-03-V-327	4.0	2.22	0.22	0.76	0.59	5.9	3.4	3.2	11

Borrow Area O Composite Data

Mean	**2.12**
Mean (mm)	**0.23**
Std Dev (phi)	**0.86**
Std Dev (mm)	**0.55**
% Silt	**6.2**
% Granular	**2.0**
% Gravel	**4.7**
% Shell	**9**

Table E-25
Composite Characteristics for Borrow Area P

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-317	4.5	1.52	0.35	1.75	0.30	6.4	3.5	11.2	11
TI-03-V-318	2.0	1.99	0.25	0.72	0.61	1.4	1.4	0.6	8
TI-03-V-320	10.5	2.23	0.21	0.66	0.63	5.9	2.0	5.9	5

Borrow Area P Composite Data

Mean	**2.01**
Mean (mm)	**0.25**
Std Dev (phi)	**0.96**
Std Dev (mm)	**0.52**
% Silt	**5.5**
% Granular	**2.4**
% Gravel	**6.6**
% Shell	**7**

Table E-26
Composite Characteristics for Borrow Area Q

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-161	4.2	2.23	0.21	0.61	0.65	4.1	1.6	2.6	8
TI-03-V-162	6.0	2.35	0.20	0.70	0.62	7.2	2.9	2.1	10

Borrow Area Q Composite Data

Mean	**2.30**
Mean (mm)	**0.20**
Std Dev (phi)	**0.66**
Std Dev (mm)	**0.63**
% Silt	**5.9**
% Granular	**2.4**
% Gravel	**2.3**
% Shell	**10**

Table E-27
Composite Characteristics for Borrow Area S

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-46	2.3	0.17	0.89	2.09	0.23	3.3	15.6	12.7	47
TI-03-V-47	2.8	0.82	0.57	2.28	0.21	5.8	16.0	11.1	45
TI-03-V-48	2.2	1.63	0.32	1.12	0.46	3.9	6.2	2.0	18
TI-03-V-49	2.3	2.34	0.20	0.30	0.81	1.3	0.9	0.1	8
TI-03-V-51	2.6	2.01	0.25	0.67	0.63	1.8	2.8	0.5	16
TI-03-V-52	3.5	2.18	0.22	0.56	0.68	1.8	1.0	1.3	8
TI-03-V-53	2.7	1.98	0.25	0.93	0.52	5.6	5.6	1.7	18

Borrow Area S Composite Data

Mean	**1.62**
Mean (mm)	**0.32**
Std Dev (phi)	**1.12**
Std Dev (mm)	**0.46**
% Silt	**3.3**
% Granular	**6.6**
% Gravel	**4.1**
% Shell	**21**

Table E-28
Composite Characteristics for Borrow Area T

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-14	3.2	1.97	0.26	0.74	0.60	1.4	2.6	3.3	13
TI-03-V-17	8.6	1.91	0.27	0.78	0.58	2.3	2.3	2.9	17
TI-03-V-22	2.2	2.26	0.21	0.62	0.65	9.2	2.2	1.1	4
TI-03-V-23	4.5	1.18	0.44	1.74	0.30	2.5	5.9	9.6	24
TI-03-V-27	2.4	1.78	0.29	0.70	0.62	1.2	1.1	0.6	19

Borrow Area T Composite Data

Mean	**1.78**
Mean (mm)	**0.29**
Std Dev (phi)	**0.95**
Std Dev (mm)	**0.52**
% Silt	**2.8**
% Granular	**3.0**
% Gravel	**3.9**
% Shell	**16.5**

Table E-29
Composite Characteristics for Borrow Area A

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-124	2.0	1.72	0.30	1.59	0.33	9.0	8.5	2.1	22
TI-03-V-125	2.0	2.31	0.20	0.98	0.51	8.4	4.5	2.6	17
TI-03-V-126	4.8	1.76	0.30	1.79	0.29	7.3	7.4	3.2	22
TI-03-V-127	4.9	2.19	0.22	1.11	0.46	5.2	3.4	4.3	15
TI-03-V-129	2.5	1.84	0.28	1.09	0.47	1.4	4.2	0.7	19
TI-03-V-130	8.3	2.71	0.15	0.42	0.75	5.3	0.7	0.0	3
TI-03-V-182	4.3	2.55	0.17	0.49	0.71	6.5	2.1	0.6	5
TI-03-V-187	4.0	2.63	0.16	0.56	0.68	6.0	2.7	0.8	9
TI-03-V-188	7.8	2.69	0.15	0.65	0.64	7.9	2.5	2.9	9
TI-03-V-189	9.3	2.46	0.18	0.77	0.59	8.2	3.3	2.1	11
TI-03-V-197	4.0	2.61	0.16	0.51	0.70	6.9	1.1	1.6	5
TI-03-V-202	3.7	2.44	0.18	0.77	0.59	7.6	3.2	1.1	9
TI-03-V-203	3.2	1.34	0.39	1.78	0.29	2.1	7.2	7.2	20
TI-03-V-208	3.2	2.70	0.15	0.44	0.74	6.5	1.2	0.3	5
TI-03-V-216	2.1	1.45	0.36	1.95	0.26	8.3	8.9	6.4	20

Borrow Area A Composite Data

Mean	**2.36**
Mean (mm)	**0.20**
Std Dev (phi)	**0.88**
Std Dev (mm)	**0.54**
% Silt	**6.6**
% Granular	**3.4**
% Gravel	**2.2**
% Shell	**11**

Table E-30
Composite Characteristics for Borrow Area B

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-132	5.4	2.09	0.23	1.16	0.45	4.6	4.0	2.8	16
TI-03-V-205	2.0	2.39	0.19	0.56	0.68	2.2	0.9	0.1	6

Borrow Area B Composite Data

Mean	**2.17**
Mean (mm)	**0.22**
Std Dev (phi)	**0.99**
Std Dev (mm)	**0.50**
% Silt	**4.0**
% Granular	**1.7**
% Gravel	**0.8**
% Shell	**13**

Table E-31
Composite Characteristics for Borrow Area C

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-174	2.3	2.43	0.18	0.53	0.69	2.4	2.5	2.1	9
TI-03-V-178	2.2	2.58	0.17	0.53	0.69	7.0	0.9	4.9	9
TI-03-V-185	4.5	2.54	0.17	0.49	0.71	7.0	1.3	0.9	7
TI-03-V-186	3.3	2.46	0.18	0.44	0.73	3.4	1.2	2.4	7
TI-03-V-192	2.0	2.10	0.23	0.69	0.62	1.5	1.2	0.1	7
TI-03-V-198	3.0	1.84	0.28	1.14	0.45	1.7	4.1	7.1	16
TI-03-V-199	2.2	2.14	0.23	0.70	0.62	1.4	0.7	0.5	7

Borrow Area C Composite Data

Mean	**2.32**
Mean (mm)	**0.20**
Std Dev (phi)	**0.63**
Std Dev (mm)	**0.64**
% Silt	**3.9**
% Granular	**1.7**
% Gravel	**2.6**
% Shell	**9**

Table E-32
Composite Characteristics for Borrow Area D

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-223	3.0	2.00	0.25	0.75	0.59	1.1	2.9	2.8	12
TI-03-V-224	2.0	2.23	0.21	0.54	0.69	1.4	2.1	0.6	7
TI-03-V-228	6.7	2.16	0.22	1.23	0.43	8.2	6.1	2.5	10

Borrow Area D Composite Data

Mean	**2.13**
Mean (mm)	**0.23**
Std Dev (phi)	**0.99**
Std Dev (mm)	**0.50**
% Silt	**5.2**
% Granular	**4.6**
% Gravel	**2.2**
% Shell	**10**

Table E-33
Composite Characteristics for Borrow Area E

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-240	2.8	2.00	0.25	0.82	0.57	2.3	1.4	2.5	7
TI-03-V-241	4.0	2.25	0.21	0.61	0.66	3.9	0.6	0.3	4

Borrow Area E Composite Data

Mean	**2.15**
Mean (mm)	**0.23**
Std Dev (phi)	**0.69**
Std Dev (mm)	**0.62**
% Silt	**3.2**
% Granular	**0.9**
% Gravel	**1.2**
% Shell	**5**

Table E-34
Composite Characteristics for Borrow Area F

Boring Number	Depth (ft)	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
TI-03-V-245	2.5	0.96	0.51	1.64	0.32	1.6	7.2	7.3	18
TI-03-V-369	3.0	1.20	0.44	1.90	0.27	5.6	6.8	9.5	2

Borrow Area E Composite Data

Mean	**1.09**
Mean (mm)	**0.47**
Std Dev (phi)	**1.78**
Std Dev (mm)	**0.29**
% Silt	**3.8**
% Granular	**7.0**
% Gravel	**8.5**
% Shell	**10**

Table E-35
Compatibility of Native and Borrow Sand

Native Beach	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell
Surf City/North Topsail Beach	2.15	0.23	0.71	0.61	1.2	1.1	0.5	9

Borrow Site	Mean (phi)	Mean (mm)	Std Dev (phi)	Std Dev (mm)	% Silt (0.062 mm)	% Granular (2 - 4.76 mm)	% Gravel (4.76 mm)	% Shell	Overfill Ratio	Silt Correction Factor	Final Overfill Ratios Corrected for Silt Content
A ^	2.36	0.20	0.88	0.54	6.6	3.4	2.2	11	1.29	1.07	1.38
B ^	2.17	0.22	0.99	0.50	4.0	1.7	0.8	13	1.18	1.04	1.23
C ^	2.32	0.20	0.63	0.64	3.9	1.7	2.6	9	1.50	1.04	1.56
D ^	2.13	0.23	0.99	0.50	5.2	4.6	2.2	10	1.15	1.06	1.21
E ^	2.15	0.23	0.69	0.62	3.2	0.9	1.2	5	1.02	1.03	1.15
F ^	1.09	0.47	1.78	0.23	3.8	7.0	8.5	10	1.14	1.04	1.19
G	2.05	0.24	0.98	0.51	5.2	2.7	5.2	10	1.11	1.05	1.17
H	2.21	0.22	0.65	0.64	2.6	1.6	2.0	7	1.16	1.03	1.19
J	2.12	0.23	0.75	0.60	4.5	2.3	1.1	10	1.01	1.05	1.15
L	2.05	0.24	0.94	0.52	6.3	2.8	3.1	10	1.09	1.07	1.16
N	1.86	0.28	0.96	0.51	3.6	3.2	4.8	9	1.05	1.04	1.15
O	2.12	0.23	0.86	0.55	6.2	2.0	4.7	9	1.08	1.07	1.15
P	2.01	0.25	0.96	0.52	5.5	2.4	6.6	7	1.09	1.06	1.15
Q	2.30	0.20	0.66	0.63	5.9	2.4	2.3	10	1.37	1.06	1.46
S	1.62	0.32	1.12	0.46	3.3	6.6	4.1	21	1.06	1.03	1.15
T	1.78	0.29	0.95	0.52	2.8	3.0	3.9	17	1.03	1.03	1.15

^ These borrow areas have been identified for the Topsail Beach Federal project. The excess material not used for these projects is planned to be available for the Surf City/North Topsail Beach Federal project. This amount is approximately 9.68 million cubic yards.

Final

Integrated

Feasibility Report
and
Environmental Impact Statement

Coastal Storm Damage Reduction Project

Surf City and North Topsail Beach
NORTH CAROLINA

Appendix G

Section 404(b)(1) Guidelines Analysis

SURF CITY AND NORTH TOPSAIL BEACH, NORTH CAROLINA
Preliminary Evaluation of Section 404 (b) (1) Guidelines 40 CFR 230

This evaluation of the placement of any and all fill material into waters and wetlands of the United States required for construction and maintenance of the Surf City and North Topsail Beach, North Carolina, Coastal Storm Damage Reduction Project.

Section 404 Public Notice No. CESAW-TS-PE-XXXXXXX

		Preliminary 1/	Final 2/
1.	Review of Compliance (230.10(a)-(d)) A review of the NEPA Document indicates that:		
a.	The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose	YES|_| NO|_|	YES|X_| NO|_|
b.	The activity does not: 1) violate applicable State water quality standards or effluent standards prohibited under Section 307 of the CWA; 2) jeopardize the existence of federally listed endangered or threatened species or their habitat; and 3) violate requirements of any federally designated marine sanctuary (See Sections 8.01, 8.07 and Appendix I of the Final Integrated Feasibility Report and EIS (Final Report))	YES| _| NO|_|	YES|X_| NO|_|
c.	The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values (See Section 8.0 of the Final Report)	YES| | NO|_|	YES|X_| NO|_|
d.	Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (see Section 8.0 of the Final Report).	YES| _| NO |_|	YES| X | NO|_|

Proceed to Section 2

*, 1, 2/ See page 6.

2. Technical Evaluation Factors (Subparts C-F)

Factor	N/A	Not Significant	Significant*
a. Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)			
(1) Substrate impacts.		X	
(2) Suspended particulates/turbidity impacts.		X	
(3) Water column impacts.		X	
(4) Alteration of current patterns and water circulation.		X	
(5) Alteration of normal water fluctuations/hydroperiod.		X	
(6) Alteration of salinity gradients.	NA		
b. Biological Characteristics of the Aquatic Ecosystem (Subpart D)			
(1) Effect on threatened/endangered species and their habitat.		X	
(2) Effect on the aquatic food web.		X	
(3) Effect on other wildlife (mammals, birds, reptiles, and amphibians).		X	
c. Special Aquatic Sites (Subpart E)			
(1) Sanctuaries and refuges.	NA		
(2) Wetlands.		X	
(3) Mud flats.	NA		
(4) Vegetated shallows.	NA		
(5) Coral reefs.	NA		
(6) Riffle and pool complexes.	NA		
d. Human Use Characteristics (Subpart F)			
(1) Effects on municipal and private water supplies.	NA		
(2) Recreational and commercial fisheries impacts.		X	
(3) Effects on water-related recreation.		X	
(4) Aesthetic impacts.		X	
(5) Effects on parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves.		X	

Remarks: See Section 8.00 and Appendix I of the Final Integrated Feasibility Report and EIS (Final Report), Surf City and North Topsail Beach, North Carolina, dated November 2008 for more information on the above topics.

Proceed to Section 3
*See page 6.

3. Evaluation of Dredged or Fill Material (Subpart G) 3/

a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material. (Check only those appropriate.)

(1) Physical characteristics. . . . . |X|
(2) Hydrography in relation to known or anticipated sources of contaminants . . . . |X|
(3) Results from previous testing of the material or similar material in the vicinity of the project . . . . | |
(4) Known, significant sources of persistent pesticides from land runoff or percolation . . . . |_|
(5) Spill records for petroleum products or designated (Section 311 of CWA) hazardous substances . . . . |_|
(6) Other public records of significant introduction of contaminants from industries, municipalities, or other sources. . . . . |X|
(7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities. . . . . |_|

(8) Other sources (specify). . . . . |_|

Reference: See Sections 2.07.3, 8.03, and Appendices C and E of the Final Report for Surf City and North Topsail Beach, North Carolina, dated November 2008

Remark: Sediments to be dredged consist of beach quality sand. Contaminants do not bind to sand, therefore, contaminant testing of sediments was not required.

b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to result in degradation of the disposal site. YES |X| NO |_|

Proceed to Section 4

*, 3/, see page 6.

4. Disposal Site Determinations (230.11(f)).

a. The following factors as appropriate, have been considered in evaluating the disposal site.

(1) Depth of water at disposal site. . . . . |X|

(2) Current velocity, direction, and variability at disposal site . . . . |X|

(3) Degree of turbulence. . . . . |X|

(4) Water column stratification . . . . |X|

(5) Discharge vessel speed and direction . . . . |X|

(6) Rate of discharge . . . . |X|

(7) Dredged material characteristics (constituents, amount and type of material, settling velocities). . . . . |X|

(8) Number of discharges per unit of time. . . . . |X|

(9) Other factors affecting rates and patterns of mixing (specify) . . . . |_|

Reference: See Final Integrated Feasibility Report and EIS, Surf City and North Topsail Beach, North Carolina, dated November 2008

b. An evaluation of the appropriate factors in 4a above indicates that the disposal site and/or size of mixing zone are acceptable. YES |X| NO |__|*

5. Actions to Minimize Adverse Effects (Subpart H).

All appropriate and practicable steps have been taken, through application of recommendations of 230.70-230.77, to ensure minimal adverse effects of the proposed discharge. YES |X| NO |__|*

See Section 8.01 of Final Report for Marine Environment
See Section 8.07 of Final Report for Water Resources
See Appendix I of the Final Report for threatened and endangered species

Return to section 1for final stage of compliance review.
See also note 3/, page 6.
*See page 6.

6. Factual Determinations (230.11).

A review of appropriate information as identified in items 2-5 above indicates that there is minimal potential for short- or long-term environmental effects of the proposed discharge as related to:

a. Physical substrate at the disposal site (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

b. Water circulation, fluctuation, and salinity (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

c. Suspended particulates/turbidity (review sections 2a, 3, 4, and 5). YES |X| NO |_|*

d. Contaminant availability (review sections 2a, 3, and 4). YES |X| NO |_|*

e. Aquatic ecosystem structure and function (review sections 2b and c, 3, and 5). YES |X| NO |_|*

f. Disposal site (review sections 2, 4, and 5). YES |X| NO |_|*

g. Cumulative impact on the aquatic ecosystem. YES |X| NO |_|*

h. Secondary impacts on the aquatic ecosystem. YES |X| NO |_|*

Remark: More detailed information on the topics above may be found in Sections 2.07.3, 8.03, and Appendices C, E, and J of the Final Report for Surf City and North Topsail Beach, North Carolina, dated June 2010..

7. Findings.

a. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines. . . . . |X|

b. The proposed disposal site for discharge of dredged or fill material complies with the Section 404(b)(1) guidelines with the inclusion of the following conditions:. . . . . |_|

c. The proposed disposal site for discharge of dredged or fill material does not comply with the Section 404(b)(1) guidelines for the following reasons(s):

(1) There is a less damaging practicable alternative . . . . |_|

(2) The proposed discharge will result in significant degradation of the aquatic ecosystem . . . . |_|

(3) The proposed discharge does not include all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem. . . . . |_|

*See page 6.

8.

____

Jefferson Ryscavage
Colonel, U.S. Army
District Engineer

Date: ____________________

*A negative, significant, or unknown response indicates that the permit application may not be in compliance with the Section 404(b)(1) Guidelines.

1/ Negative responses to three or more of the compliance criteria at this stage indicate that the proposed projects may not be evaluated using this "short form procedure." Care should be used in assessing pertinent portions of the technical information of items 2 a-d, before completing the final review of compliance.

2/ Negative response to one of the compliance criteria at this stage indicates that the proposed project does not comply with the guidelines. If the economics of navigation and anchorage of Section 404(b)(2) are to be evaluated in the decision-making process, the "short form evaluation process is inappropriate."

3/ If the dredged or fill material cannot be excluded from individual testing, the "short-form" evaluation process is inappropriate.

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SURF CITY AND NORTH TOPSAIL BEACH, NORTH CAROLINA

Appendix H

Correspondence

Appendix H

Correspondence

This appendix includes correspondence received from the sponsors and other agencies. Other correspondence from the NEPA scoping process is contained in Appendix K. Correspondence regarding Public Review [will be / is] contained in Appendix T.

April 27, 2001 - Letter from North Topsail Beach Mayor to District Engineer supporting Feasibility Study and confirming understanding cost sharing for the study and construction phases.

May 8, 2001 - Letter from Surf City Mayor to District Engineer supporting Feasibility Study and confirming understanding cost sharing for the study and construction phases. August 3, 2005 – Letter from NC State Historic Preservation Office concurring that no additional archaeological survey of borrow areas are recommended.

November 7, 2007 – Letter from Wilmington District to DOI Minerals Management Service requesting MMS to serve as a cooperating agency on this project.

February 7, 2008 – Letter from MMS to Wilmington District agreeing to serve as cooperating agency.

July 1, 2010 – Letter from Surf City Mayor to District Engineer supporting the proposed Project

June 9, 2010 – Self Certification of Financial Capability by Town of Surf City

June 4, 2010 - Letter from Surf City Mayor to District Engineer assuring compliance by town in obtaining required parking and access.

July 1, 2010 – Letter from North Topsail Beach Mayor to District Engineer supporting the proposed project

June 11, 2010 – Self Certification of Financial Capability by Town of North Topsail Beach

June 11, 2010 - Letter from North Topsail Beach Mayor to District Engineer assuring compliance by town in obtaining required parking and access.

Dec 13, 2010 – Letter from NCDENR to District Engineer indicating support by the State of North Carolina for the Proposed Project

Town Of North Topsail Beach

Routed: 07 May 01
Action: PM
CF: DE
DD
DP
DX

April 27, 2001

Colonel James W. DeLony
U.S. Army Corps of Engineers
Wilmington District
P.O. Box 1890
Wilmington, NC 28402-1890

Dear Colonel DeLony:

We have been participating in the Corps of Engineers' Reconnaissance Study for shore protection and related purposes for North Topsail Beach and Surf City, North Carolina.

We are concerned about the unprecedented erosion of the berm and dune along North Topsail Beach and Surf City, and the high vulnerability of our towns to the predicted increase in hurricanes, and appreciate your work on our behalf. We believe that further study of possible shore protection and related purposes can be a valuable contribution toward protecting our citizens. We support your continuing work on the Reconnaissance Study and seeking funding for the cost shared Feasibility Study.

North Topsail Beach is prepared to participate in development of the Project Study Plan (PSP), and to be a co-sponsor with the Town of Surf City of a Feasibility Study for this shore protection and related purposes at North Topsail Beach and Surf City. We understand that the preliminary estimated cost of the Feasibility Study indicates the total non-federal funding obligation for fifty percent of the cost would be approximately $1,500,000. The Town of North Topsail Beach is prepared to negotiate a Feasibility Cost Sharing Agreement (FCSA), along with the Town of Surf City, with the Wilmington District at the proper time. We understand that the amount of non-federal funds required from North Topsail Beach and Surf City is initially estimated to be $750,000 from each Town. We also are prepared to negotiate the terms of the non-federal funding for thirty-five percent of the cost for initial construction and 50 percent for future nourishment of any agreed upon project.

2008 LOGGERHEAD COURT NORTH TOPSAIL BEACH, NC 28460 PHONE (910) 328-1349 FAX (910) 328-4508

The Town of North Topsail Beach expects to obtain fifty percent of the funds it must provide for these activities from the State of North Carolina, Division of Water Resources. The remaining funds are to be provided by the Town of North Topsail Beach from property tax revenues, proceeds from passage of bond referendum, flood control assessments or other Town or Onslow County action.

Mr. John J. Flynn will serve as representative from the North Topsail Beach Board of Aldermen and Mr. Tony Hammond is designated as the North Topsail Beach Town staff point-of-contact for shore protection and related programs for North Topsail Beach and Surf City. Other staff members may be designated to participate in the Feasibility Study.

We look forward to working with you further on this effort to improve shore protection along North Topsail Beach and Surf City, North Carolina.

Sincerely,

Marlow F. Bostic, Jr.
Mayor

MFB/lmc

SURF CITY
NORTH CAROLINA 28445

A.D. (Zander) GUY, JR., MAYOR
NELVA R. ALBURY, COUNCIL MEMBER
DEXTER BLIZZARD, COUNCIL MEMBER
DONALD R. HELMS, COUNCIL MEMBER
DONALD H. LUTHER, COUNCIL MEMBER
DOUGLAS C. MEDLIN, COUNCIL MEMBER

Routed: 14 May 01
Action: PM
CF: DE
DD
DX
DP
TS
OC

May 8, 2001

Colonel James W. DeLony
U.S. Army Corps of Engineers
Wilmington District
Post Office Box 1890
Wilmington, North Carolina 28402-1890

Dear Colonel DeLony:

We have been participating in the Corps of Engineers' Reconnaissance Study for shore protection and related purposes for North Topsail Beach and Surf City, North Carolina.

We are concerned about the unprecedented erosion of the berm and dune along North Topsail Beach and Surf City, and the high vulnerability of our towns to the predicted increase in hurricanes, and appreciate your work on our behalf. We believe that further study of possible shore protection and related purposes can be a valuable contribution toward protecting our citizens. We support your continuing work on the Reconnaissance Study and seeking funding for the cost shared Feasibility Study.

Surf City is prepared to participate in development of the Project Study Plan (PSP), and to be a co-sponsor with the Town of North Topsail Beach of a Feasibility Study for this shore protection and related purposes at North Topsail Beach and Surf City. We understand that the preliminary estimated cost of the Feasibility Study indicates the total non-federal funding obligation for fifty percent of the cost would be approximately $1,500,000. The Town of Surf City is prepared to negotiate a Feasibility Cost Sharing Agreement (FCSA), along with the Town of North Topsail Beach, with the Wilmington District at the proper time. We understand that the amount of non-federal funds required from North Topsail Beach and Surf City is initially estimated to be $750,000 from each town. We also are prepared to negotiate the terms of the non-federal funding for thirty-five percent of the cost for initial construction and 50 percent of future nourishment of any agreed upon project.

The Town of Surf City expects to obtain fifty percent of the funds it must provide for these activities from the State of North Carolina, Division of Water Resources. The remaining funds are to be provided by the Town of Surf City from property tax revenues, proceeds from passage of bond referendum, flood control assessments or other Town action.

P.O. Box 2475 • 214 N. New River Drive • Telephone (910) 328-4131 • FAX: (910) 328-4132

Patrick Thomas, Surf City town manager, will be Surf City's lead representative for the study of shore protection and related purposes for North Topsail Beach and Surf City. He may designate other staff members to participate in the Study in various ways.

We look forward to working with you further on this effort to improve shore protection along North Topsail Beach and Surf City, North Carolina.

Sincerely,

A. D. (Zander) Guy, Jr.
Mayor

North Carolina Department of Cultural Resources

State Historic Preservation Office

Peter B. Sandbeck, Administrator

Michael F. Easley, Governor
Lisbeth C. Evans, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

August 3, 2005

Richard H. Kimmel
Environmental Resources Section
Department of the Army
Wilmington District, Corps of Engineers
P.O. Box 1890
Wilmington, NC 28402-1890

RE: Draft Report: *An Archaeological Remote Sensing Survey of Surf City-North Topsail Beaches Borrow Areas*, Bib #5524, Pender and Onslow Counties, CH 01-0497

Dear Mr. Kimmel:

We have received the draft report summarizing the remote sensing surveys conducted by Mid-Atlantic Technology and Environmental Research, Inc. (M-AT/ER) in proposed offshore sand borrow areas near Surf City and North Topsail Beaches.

No previously recorded archaeological sites occur within the seven proposed sand borrow areas. M-AT/ER conducted marine magnetometer and side-scan sonar surveys of the proposed borrow areas for the purpose of identifying any potential archaeological resources that might be impacted by the offshore dredging activities. The survey identified no single source magnetic anomalies or acoustic targets with characteristics suggesting significant cultural resources within the proposed sand borrow areas. Because of these findings, we concur with the recommendation for no additional archaeological investigations related to sand mining activities in the seven proposed borrow areas.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919/733-4763. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Peter Sandbeck

	Location	Mailing Address	Telephone/Fax
ADMINISTRATION	507 N. Blount Street, Raleigh NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-4763/733-8653
RESTORATION	515 N. Blount Street, Raleigh NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-6547/715-4801
SURVEY & PLANNING	515 N. Blount Street, Raleigh, NC	4617 Mail Service Center, Raleigh NC 27699-4617	(919)733-6545/715-4801

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1890
WILMINGTON, NORTH CAROLINA28402-1890

IN REPLY REFER TO

November 7, 2007

Environmental Resources Section

Ms. Renee Orr, Chief
Sand and Gravel Program
Minerals Management Service
Mail Stop 4010381 Elden Street
Herndon, Virginia 22071

Dear Ms. Orr:

The U. S. Army Corps of Engineers, Wilmington District is conducting a study to evaluate a shore protection project for the towns of Surf City and North Topsail Beach, North Carolina (Figure 1). As indicated in detail below, the purpose of this letter is to request that Minerals Management Service be a cooperating agency for this project.

Topsail Island is on the southeastern North Carolina coast. From south to north the three towns on the island are Topsail Beach, Surf City and North Topsail Beach. The primary study area for this report includes the Towns of Surf City and North Topsail Beach and the associated offshore borrow sites. The Towns of Surf City and North Topsail Beach are the project sponsors and the results of the study will be documented in a forthcoming integrated Feasibility Report and Draft Environmental Impact Statement.

Ten borrow areas, identified as G, H, J, L, N, 0 , P, 0, Sand T (Figures 2 and 3) have been identified for the 50-year period of analysis for the Surf City/North Topsail Beach Shore Protection Project. As shown in Table 1, borrow areas F, I, M and R have been tentatively omitted from the plan based on the existing, limited subsurface analysis that indicates that these sites may not meet the current Coastal Resource Commission (CRC) regulations for beach compatibility. However, additional subsurface analysis is planned prior to project construction which could determine that these sites meet the CRC compatibility criteria and thus may be used for the project. Site K has been permanently deleted due to its close proximity to hardbottom. With the exception of borrow sites I, 0 , and R, which are less than 3 miles offshore, all other sites (G, H, J, L, N, 0, P, Sand T) are typically between 3 and 6 miles offshore. All borrow areas have bottom depths of less than 66 feet, contain material that has approximately 10% passing the #200 sieve or less, and contain material that is compatible with the native material on the beaches. Borrow areas were identified based on material characteristics and depth of suitable material. Magnetometer and side-scan sonar (acoustic) surveys were used to identify and thus avoid cultural resources as well as hardbottom areas. Borrow area characteristics are summarized below in Table 1.

Location (see Fig 1)	Mean Grain Size (phi)	Standard Deviation (phi)	% Silt (#230 sieve)	% Shell	Final Overfill Ratio	Available Volume MCY
A	2.35	0.86	6.6	11	1.34	*
B	2.17	0.99	6.4	13	1.19	*
C	2.32	0.63	3.9	9	1.59	*
D	2.13	0.99	5.2	6	1.18	*
E	2.15	0.69	3.2	5	1.07	*
F	site omitted					
G	.2.05	0.98	5.2	10	1.14	2.73
H	2.2]	0.65	2.6	7	1.21	0.72
I	site omitted					
.T	2.12	0.75	4.5	10	1.06	3.44
L	1.99	0.97	6.4	10	1.13	6.68
M	site omitted					
N	1.78	103	34	10	1.07	6.00
0	2.28	0.71	6.6	5.3	1.32	3.61
P	2.18	0.76	5.2	7	1.07	3.34
Q	2.33	0.6	5.9	8	1.79	0.81
R	Site omitted					
S	146	1.29	3.3	22	1.10	1.82
T	1.60	1.10	2.8	18	1.06	0.50
Surf City/No Topsail Bch	2.16	0.77	149	12	Native material	
NTB	2.18	0.75	1.32	8	Native material	
SC&NTB	2.17	0.76	1.42	10	Native material	

* Material planned to be used on Topsail Beach project. All of the available material will not be needed for Topsail Beach and may be used for Surf City and North Topsail Beach).

Table 1. Surf City (SC) and North Topsail Beach (NTB) Borrow Area Characteristics.

Although a detailed borrow area use plan has not yet been developed, the project would entail removing sand from the borrow areas listed above. It is anticipated that approximately 31 million cubic yards of material would be needed to construct the Surf City and North Topsail Beach shore protection project. Please be advised that we intend to seek all required approvals from the Minerals Management Service for such sand removal.

Pursuant to 40 CFR 1501, the U.S. Army Corps of Engineers Wilmington District requests that the Minerals Management Service serve as a cooperating agency during the required National Environmental Policy Act process for the Surf City and North Topsail Beach Shore Protection Project. The U.S. Army Corps of Engineers further requests that MMS serve as a cooperating agency on environmental requirements related to the Endangered Species Act, National Historic Preservation Act, Coastal Zone Management Act, and Magnusson-Stevens Fishery Management and Conservation Act. This letter serves as the coordinating request prescribed for ESA Section 7 (50 CFR 402), NHPA Section 106 (36 CFR 800), Subpart C Consistency (15 CFR 930), and Magnusson-Stevens Section 305 (50 CFR 600). pursuant to 50 CFR 402, the U.S. Army Corps of Engineers will notify the U.S. Fish and Wildlife Service and NOAA National Marine Fisheries Service of its lead role and MMS' cooperating role provided your agreement to serve as a cooperating agency.

Please advise us, at your earliest convenience, as to your agency's willingness to serve as a cooperating agency in the NEPA process for this project. Jenny Owens, Environmental Resources Section, will serve as the major point of contact for any MMS involvement in this project, and she can be reached at 910-251-4757 in the event that you would like additional information regarding this matter. We look forward to an efficient and productive relationship with MMS regarding this important shore protection project.

Sincerely,

W. Coleman Long
Chief, Planning and
Environmental Branch

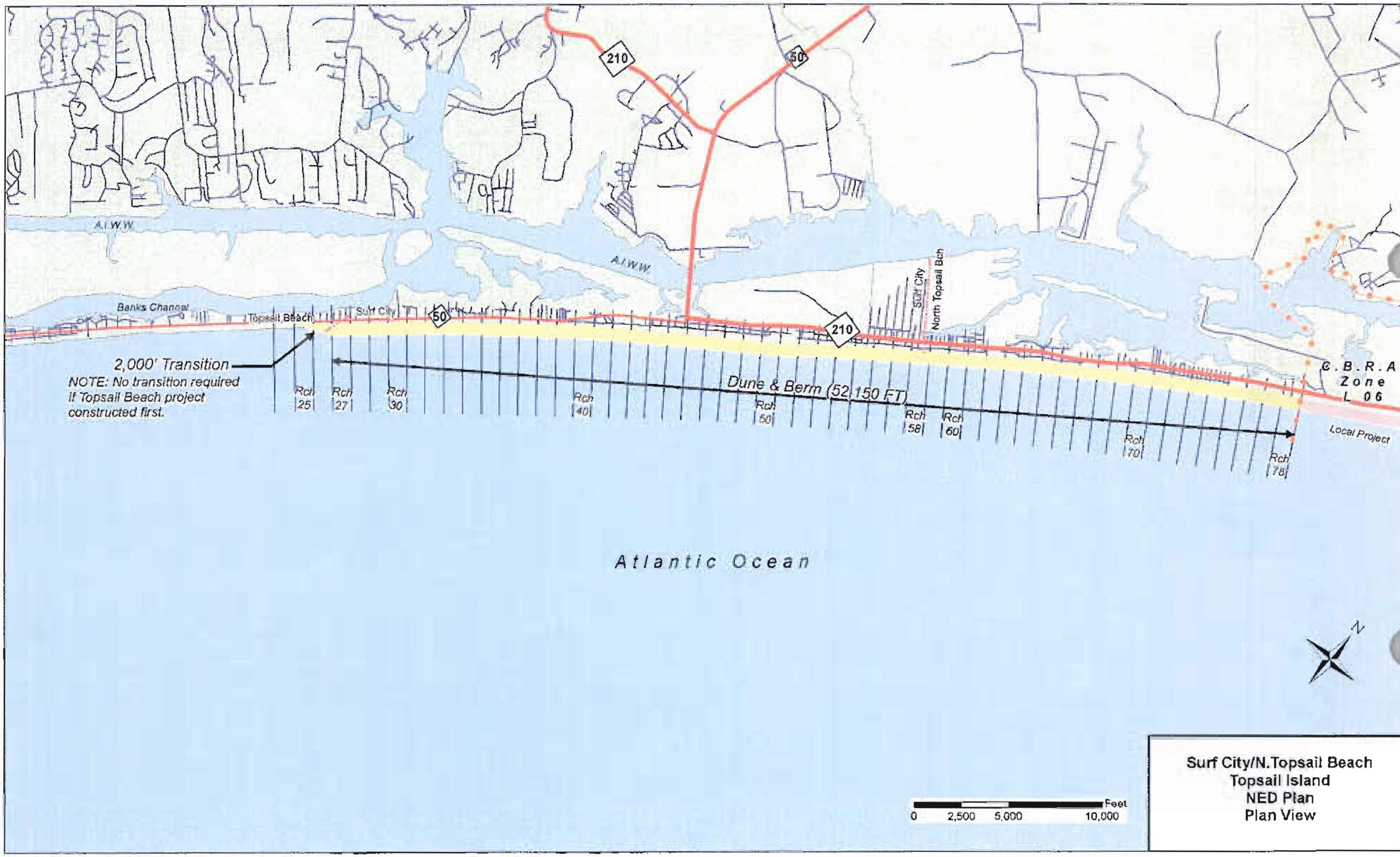


Figure 1. Surf City, North Topsail Beach Project Study Area

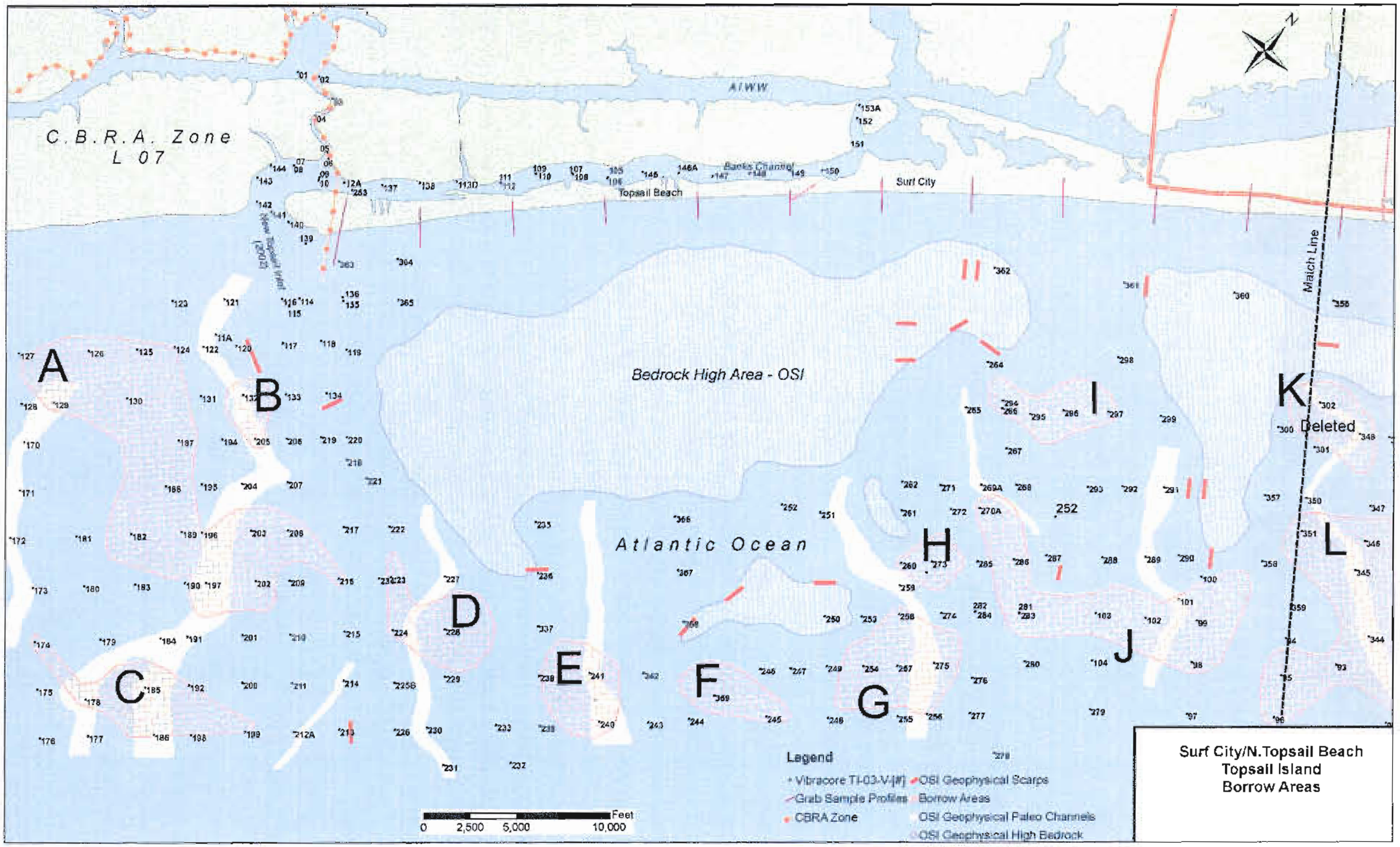


Figure 2. Borrow Areas (1 of 2)

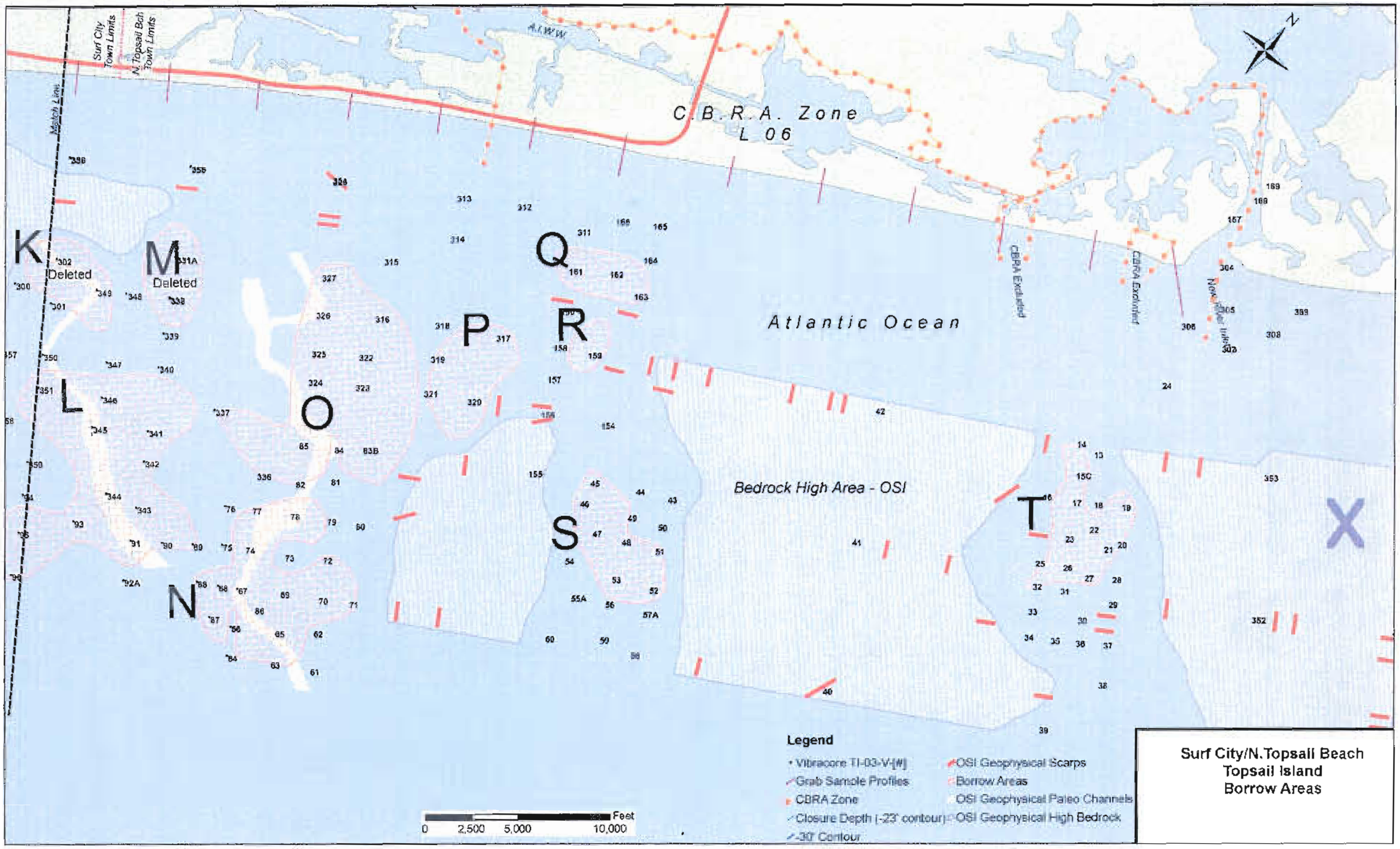


Figure 3. Borrow Areas (2 of 2)

Mr. W. Coleman Long
Chief, Planning and Environmental Branch
Environmental Resources Branch
Department of the Army
Corps of Engineers, Wilmington District
P.O. Box 1890
Wilmington, North Carolina 28402

FEB 0 7 2008

Dear Mr. Long:

Thank you for your November 7,2007, letter requesting Outer Continental Shelf (OCS) sand for the Surf City / North Topsail Beach Shore Protection Project, and that the Minerals Management Service (MMS) become a cooperating agency during the required National Environment Act (NEPA) process. The MMS welcomes the opportunity to participate in the NEPA effort and agrees to serve as a cooperating agency. As a cooperating agency we expect to: participate *in* the NEPA process at the earliest possible time; participate *in* the seeping process; assume, on the request of U.S. Army Corps of Engineers (USACE), responsibility for developing information and preparing environmental analyses for which the MMS has special expertise; make available staff support at the lead agency's request to enhance the interdisciplinary capability of the USACE; and use our own funds to accomplish these responsibilities.

The MMS also agrees to participate in: the required Endangered Species Act (ESA) Section 7 consultation; the Magnuson-Stevens Fishery and Conservation Management Act Essential Fish Habitat consultation (Section 305); the National Historic Preservation Act Section 106 process: and the Coastal Zone Management Act Section 307 consistency determination. As the lead federal agency for ESA Section 7 and the Essential Fish Habitat consultations, the USACE must notify U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) of its lead role and MMS' cooperating role. We would expect to jointly submit with the USACE the ESA Section 7 and Essential Fish Habitat assessments to FWS and NMFS.

The USACE recommended plan requires about 11.5 million cubic yards of borrow material during initial construction. Thereafter, the project maintenance requirements for the 4-year renourishment cycle are about 1.6 million cubic yards of borrow material over the 50-year project. It is MMS policy to negotiate a new agreement for each use of OCS material (or per nourishment event); therefore, this agreement only applies to the NEPA and environmental requirements for initial construction. The final NEPA document, as well as the outcome of the other environmental requirements, may be used to establish stipulations or conditions in the final negotiated agreement.

The MMS looks forward to working with you during this process. We ask that the following staff be included on all communication regarding this project, Geoffrey Wikel, Leasing Division, (703) 787-1283 and Sally Valdes, Environmental Division, (703) 787-1707. If you would like to discuss any of these items further, please contact Sally Valdes at (703) 787-1707.

Sincerely,

James F. Bennett
Chief, Branch of Environmental Assessment
Environmental Division

TOWN OF SURF CITY

P. O. BOX 2475 214 N. NEW RIVER DRIVE SURF CITY, NC 28445
Telephone: (910) 328-4131 Fax: (910) 328-4132
www.townofsurfcity.com

A. D. (Zander) Guy, Jr., Mayor
Douglas C. Medlin, Mayor Pro-tem
Nelva R. Albury, Council Member

Michael H. Curley, Council Member
Donald R. Helms, Council Member
William J. (Buddy) Fowler, Council Member

July 1, 2010

Colonel Jefferson M. Ryscavage, District Commander
Department of the Army
Wilmington District, Corps of Engineers
69 Darlington Avenue
Wilmington, NC 28403-1343

Dear Colonel Ryscavage:

On behalf of Surf City I would like to express and confirm our continued support of the proposed Surf City and North Topsail Beach Coastal Storm Damage Reduction Project. The feasibility study was authorized by two Transportation and Infrastructure Committee resolutions dated February 16, 2000 and April 11, 2000.

Surf City supports the selected National Economic Development Plan (NED) consisting of a sand dune constructed to an elevation of 15 feet above the National Geodetic Vertical Datum (NGVD), fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD with a six-year re-nourishment cycle. The berm and dune project extends along a reach of 52,150 feet.

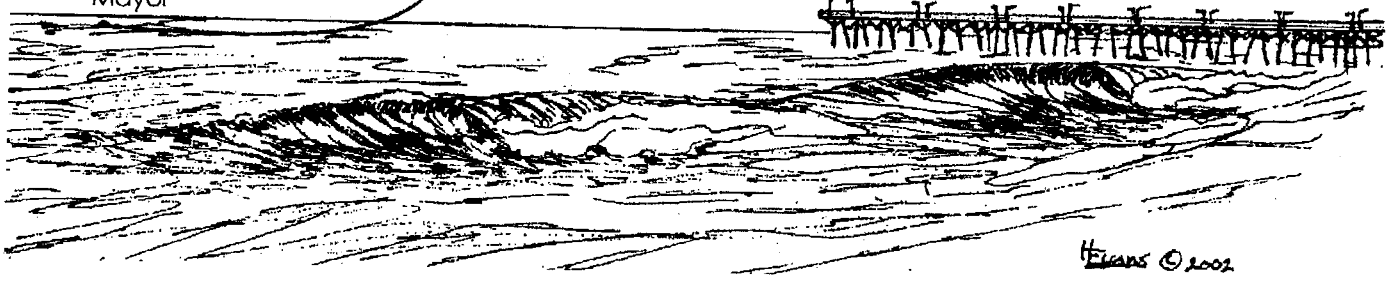
Further, we have been advised that the Initial Construction is $123,135,000, the first renourishment is $20,872,000, and each re-nourishment event from the 2nd to 8th cycle on a 6-year interval is $29,242,000. The estimated costs are based on October 2008 price levels and interest rate of 4.375 percent. The estimated operating and maintenance cost is approximately at $52,000 per year.

We understand the obligation of the local sponsors to cost share the initial construction at a rate of 65% Federal and 35% non-Federal and the obligation to cost share in the post construction re-nourishment costs at a rate of 50% federal and 50% non-Federal. We have been informed by the U.S. Army Corps of Engineers that the sponsors will be required to provide public beach access at a minimum of one access point and associated parking every half mile of the proposed project or the Federal cost sharing percentages will be reduced.

With Warm Personal Regards I am

Sincerely yours,

A.D. (Zander) Guy, Jr.
Mayor



NON-FEDERAL SPONSOR'S
SELF-CERTIFICATION OF FINANCIAL CAPABILITY
FOR DECISION DOCUMENTS

I, J. Michael Moore, do hereby certify that I am the Chief Financial Officer for the Town of Surf City, North Carolina; that I am aware of the financial obligations of the Non-Federal Sponsor for the Surf City and North Topsail Beach Coastal Storm Damage Reduction Project; and that the Non-Federal Sponsor will have the financial capability to satisfy the Non-Federal Sponsor's obligations for the project. I understand that the Government's acceptance of this self-certification shall not be construed as obligating either the Government or the Non-Federal Sponsor to implement a project.

IN WITMESS WHEREOF, I have made and executed this certification this 9th day of June, 2010.

BY: J. Michael Moore

TITLE: Town Manager

DATE: June 9, 2010

TOWN OF SURF CITY

P. O. BOX 2475 214 N. NEW RIVER DRIVE SURF CITY, NC 28445
Telephone: (910) 328-4131 Fax: (910) 328-4132
www.townofsurfcity.com

June 4, 2010

Colonel Jefferson M. Ryscavage, District Commander
Department of the Army
Wilmington District, Corps of Engineers
69 Darlington Avenue
Wilmington, NC 28403-1343

Re: Assurance of Compliance to the Required Public Access and Parking Requirement for Surf City and North Topsail Beach Coastal Reduction Project.

Dear Colonel Ryscavage:

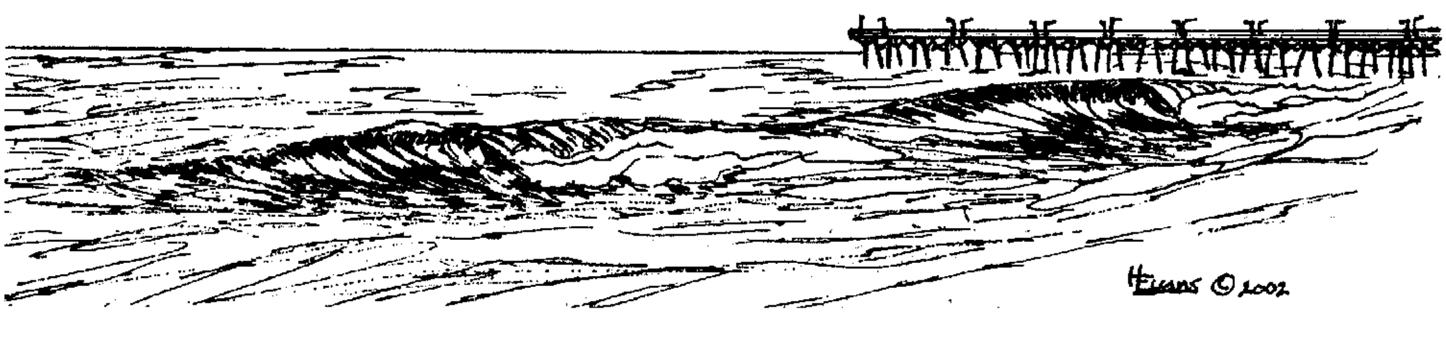
The Surf City Town Council recognizes the parking and public access requirements that are required under Sections 3.04 and 9.02 from the revised Feasibility Report and Environmental Impact Statement. Further this is to verify our Board is committed to provide the required public parking and access as outlined in both sections. The Council further assures that the Town will acquire the property that will provide the required accesses and parking. The one area identified in the Feasibility Report (map attached), shown in red at approximately 1600 South Shore Drive is being worked on by the Town Attorney and will be designated as a Public Beach Access. The Attorney has actually identified 7 accesses between 1600 down to 2500 block of South Shore Drive that will be identified as public beach accesses. The Town is in the process of purchasing a lot at 2303 South Shore Drive and will be designated for public parking. We have identified other lots in the yellow area on the map and are negotiating with property owners in order to purchase and designate for public parking. We understand that the feasibility report states we need 37 additional public parking spots to meet the requirements and will continue to pursue until we can meet the requirements.

The Town understands that the Federal cost share of the project would be decreased if the Town does not comply with the parking and access requirements. The share would decrease from 65% to 51.3% for the initial construction and from 50% to 39% for subsequent maintenance renourishment.

Town Council would like to thank you for all the assistance you and your staff have provided with this most important project and should you have any additional request, please advise.

With Warm Personal Regards I am,
Si~~ncerely yours~~,

A.D. (Zander) Guy, Jr.
Mayor



Town of North Topsail Beach

Daniel Tuman, Mayor
Michael Yawn, Mayor Pro Tem
Aldermen:
Richard Farley
Deborah Lanci
Richard Macartney
Robert Swantek

Steven H. Foster
Town Manager

Carin Z. Faulkner, MPA
Town Clerk

July 1, 2010

Colonel Jefferson M. Ryscavage, District Commander
Department of the Army
Wilmington District, Corps of Engineers
69 Darlington Ave.
Wilmington, NC 28403-1343

Regarding: Surf City and North Topsail Beach Coastal Storm Damage Reduction Project Letter of Support

Dear Colonel Ryscavage,

The purpose of this correspondence is to express and confirm our continued support of the proposed Surf City and North Topsail Beach Coastal Storm Damage Reduction Project. The feasibility study was authorized by two Transportation and Infrastructure Committee resolutions dated February 16, 2000 and April 11, 2000.

We support the selected National Economic Development Plan (NED) consisting of a sand dune constructed to an elevation of 15 feet above the National Geodetic Vertical Datum (NGVD), fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD with a six-year re-nourishment cycle. The berm and dune project extends along a reach of 52,150 feet.

Further, we have been advised that the Initial Construction is $123,135,000, the first renourishment is $20,872,000, and each re-nourishment event from the 2nd to 8th cycle on a 6-year interval is $29,242,000. The estimated costs are based on October 2008 price levels and interest rate of 4.375 percent. The estimated operating and maintenance cost is approximately at $52,000 per year.

We understand the obligation of the local sponsors to cost share the initial construction at a rate of 65% Federal and 35% non-Federal and the obligation to cost share in the post construction re-nourishment costs at a rate of 50% Federal and 50% non-Federal. We have been informed by the U.S. Army Corps of Engineers that the sponsors will be required to provide public beach access at a minimum of one access point and associated parking every half mile of the proposed project or the Federal cost sharing percentages will be reduced.

Sincerely,

p.p. Carin Faulkner
Dan Tuman
Mayor

2008 LOGGERHEAD COURT NORTH TOPSAIL BEACH, NC 28460 PHONE (910) 328-1349 FAX (910) 328-4508
www.north-topsail-beach.org

Town of North Topsail Beach

Daniel Tuman, Mayor
Michael Yawn, Mayor Pro Tem
Aldermen:
Richard Farley
Deborah Lanci
Richard Macartney
Robert Swantek

Steven H. Foster
Town Manager

Carin Z. Faulkner, MPA
Town Clerk

NON-FEDERAL SPONSOR'S SELF-CERTIFICATION OF FINANCIAL CAPABILITY

I, Steven H. Foster, do hereby certify that I am the Town Manager of the Town of North Topsail Beach; that I am aware of the financial obligations of the Non-Federal Sponsor for the Town of North Topsail Beach renourishment project and that the Non-Federal Sponsor has the financial capability to satisfy the Non-Federal Sponsor's obligations under the Surf City and North Topsail Beach Storm Damage Reduction Project.

IN WITNESS WHEREOF, I have made the executed this certification this 11th day of June, 2010.

BY: Steven H. Foster

TITLE: Town Manager

DATE: June 11, 2010

2008 LOGGERHEAD COURT NORTH TOPSAIL BEACH, NC 28460 PHONE (910) 328-1349 FAX (910) 328-4508
www.north-topsail-beach.org

Town of North Topsail Beach

Daniel Tuman, Mayor
Michael Yawn, Mayor Pro Tem
Aldermen:
Richard Farley
Deborah Lanci
Richard Macartney
Robert Swantek

Steven H. Foster
Town Manager

Carin Z. Faulkner, MPA
Town Clerk

June 11, 2010

Colonel Jefferson M. Ryscavage
Department of the Army
Wilmington District, Corps of Engineers
69 Darlington Ave.
Wilmington, NC 28403

Regarding: Surf City and North Topsail Beach Coastal Reduction Project- North Topsail Beach Board of Aldermen Assurance of Compliance to the Required Public Access and Parking Requirement

Dear Colonel Ryscavage,

The purpose of this letter is to state that the Board of Aldermen recognizes the parking and public access requirement that is required under Sections 3.04 and 9.02 from the revised Feasibility Report and Environmental Impact Statement. Further this is to verify the Board is committed to provide the required parking and access as outlined in those sections. The Board further assures that the Town will acquire the property that will provide an additional 20 parking spaces, and an additional access way. (Please find attached a map that will indicate those areas)

The Town understands that the Federal cost share of the project would be decreased if the Town does not comply with the parking and access requirements. That share would decrease from 65% to 51.3% for initial construction and from 50% to 39% for subsequent maintenance renourishment.

Thank you for all of the assistance that you and your staff have provided in this project, and should you have any additional request, please advise.

Sincerely,

Dan Tuman

Mayor Dan Tuman

Enclosure

2008 LOGGERHEAD COURT NORTH TOPSAIL BEACH, NC 28460 PHONE (910) 328-1349 FAX (910) 328-4508
www.north-topsail-beach.org

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Water Resources

Beverly Eaves Perdue
Governor

Thomas A. Reeder
Director

Dee Freeman
Secretary

December 13, 2010

Colonel Jefferson M. Ryscavage, District Commander
Department of the Army
Wilmington District, Corps of Engineers
PO Box 1890
Wilmington, NC 28402-1890

Dear Colonel Ryscavage:

The purpose of this correspondence is to express our continued support of the proposed Surf City and North Topsail Beach Coastal Storm Damage Reduction Project.

The North Carolina General Assembly has previously authorized the Division of Water Resources to use water resource capital improvement funds for the project study to the extent state funds became available. The Division of Water Resources understands that the selected National Economic Development Plan (NED) consists of a sand dune constructed to an elevation of 15 feet above the National Geodetic Vertical Datum (NGVD), fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD with a six-year re-nourishment cycle. The berm and dune project extends along a reach of 52,150 feet.

We have been advised that the Initial Construction cost is $127,973,000, and the total cost for the 7 planned renourishments is $215,525,000. The estimated costs are based on October 2010 price levels and an interest rate of 4.375 percent. The estimated operating and maintenance cost is approximately at $52,000 per year.

We understand the obligation of the local sponsors to cost share the initial construction at a rate of 65% Federal and 35% non-Federal and the obligation to cost share in the post construction re-nourishment costs at a rate of 50% Federal and 50% non-Federal. The State will assist in the financial support of this Project based on availability of state funds and continued authorization by the North Carolina General Assembly. Furthermore, this expression of potential financial support should not be construed as any form of regulatory approval of this project. The execution of this project is still subject to all State regulations and applicable permitting decisions and requirements.

Sincerely,

Thomas A. Reeder

1611 Mail Service Center, Raleigh, North Carolina 27699-1611
Phone: 919-733-4064 \ FAX: 919-733-3558 Internet: www.ncwater.org

Final Feasibility Report
and
Environmental Impact Statement

SURF CITY AND NORTH TOPSAIL BEACH, NORTH CAROLINA

Coastal Storm Damage Reduction Project

Appendix I

Biological Assessment

FINAL
BIOLOGICAL ASSESSMENT

Surf City and North Topsail Beach
Pender and Onslow Counties, North Carolina
Coastal Storm Damage Reduction Project

1.00 PROPOSED PROJECT

The tentatively selected National Economic Development (NED) Plan, consists of a sand dune constructed to an elevation of 15 feet above the National Geodetic Vertical Datum (NGVD), fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD. This plan is identified among the other alternatives as "Plan 1550". The berm and dune project extends along a reach of 52,150 feet. On the north end, the project will adjoin an adjacent non-Federal beachfill project for North Topsail Beach. At the south end, a 2,000-foot long, berm-only transition section would extend from the town boundary along the Topsail Beach shoreline. If the Federal project for Topsail Beach is constructed first, then the transition is not needed. All the proposed dredging will occur within the Atlantic Ocean in offshore borrow areas located approximately 1-6 miles offshore.

2.00 NATIONAL MARINE FISHERIES SERVICE (NMFS): SECTION 7 CONSULTATION HISTORY

Prior to 1991, in accordance with Section 7 requirements under the Endangered Species Act (ESA), each US Army Corps of Engineers (USACE) district within the Corps' South Atlantic Division (SAD) prepared individual project specific biological assessments for dredging activities in the South Atlantic and received subsequent individual biological opinions from the National Marine Fisheries Service (NMFS). Beginning in 1991, NMFS moved away from individual consultations for Corps dredging activities with the development of the 1991 South Atlantic Regional Biological Opinion (SARBO) for dredging of channels in the Southeastern United States from North Carolina through Cape Canaveral, Florida. In order to assess the regional implications of USACE dredging actions, the NMFS extended the use of a Regional Biological Opinion (RBO) in subsequent 1995 and 1997 SARBO consultations. To date, SAD has been implementing its dredging program under the 1997 SARBO. However, since the 1997 consultation, several re-initiation triggers have been met, such as: (1) modification of the proposed activity, (2) listing of a new species and/or critical habitat, (3) the inclusion of Puerto Rico and the U.S. Virgin Islands which had been excluded from previous opinions and (4) the current status of Section 10(a)(1)(A) scientific research permits. Therefore, on April 30, 2007 SAD sent a letter to NMFS formally requesting re-initiation of consultation for dredging activities and other associated actions in the South Atlantic under Section 7 of the ESA.

On 12 September 2008, SAD provided NMFS with the Corps' South Atlantic Regional Biological Assessment (SARBA) for federal, federally permitted, or federally sponsored (funded or partially funded) dredging activities (i.e. hopper, cutterhead, mechanical, bed leveling, and side cast) in the coastal waters, navigation channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and sand mining areas in the South Atlantic Ocean (including OCS sand resources under Minerals Management Service (MMS) jurisdiction) from the North Carolina/Virginia Border through and including Key West, Florida and the Islands of Puerto Rico and the US Virgin Islands (USVI). Dredging methods and other associated actions considered under this assessment include hydraulic dredges (i.e. pipeline and hopper), mechanical dredges, bed leveling, transportation methodology (i.e. hopper, tugs/scows, and barges), and relocation trawling. Federally threatened, endangered, or candidate species considered under this assessment include: six species of marine turtles (leatherback, loggerhead, Kemp's ridley, hawksbill, green, and olive ridley sea turtles), Acroporid corals (staghorn and elkhorn), three large whale species (North Atlantic right whale (NARW), humpback whale, and sperm whale), Johnson's seagrass, and three anadromous or marine fish species (shortnose sturgeon, Atlantic sturgeon, and smalltooth sawfish). Of the species covered under the SARBA, the following are found within the Surf City and North Topsail Beach proposed project area: five species of sea turtles (loggerhead, green, Kemp's ridley, hawksbill, and leatherback), three large whale species (NARW, humpback whale, and sperm whale), and shortnose sturgeon.

In May 2007, during a SARBA scoping meeting at the NMFS Southeast Regional Office in St. Pete, Fl, Corps and NMFS representatives agreed that all dredging activities in the South Atlantic would continue to work under the 1997 SARBO until the new SARBO was developed and finalized. For the purposes of this assessment, all dredging actions will work under the Reasonable and Prudent Measures (RPM's), Terms and Conditions (T&C's), and Incidental Take Statement (ITS) of the 1997 SARBO until a superseding SARBO is completed. Upon completion of the new SARBO by NMFS, all new RPM's, T&C's, and ITS will be adhered to as a component of this project. For those species present within the proposed project vicinity of the Surf City and North Topsail Beach (SCNTB) coastal storm damage reduction project that have already been addressed in the Corps' 12 September 2008 SARBA, an additional species life history analysis and project impact evaluation will not be provided in the ensuing text, but rather reference to the existing NMFS consultation will be made.

In summary, based on a detailed evaluation provided in the 12 September 2008 SARBA of the effects of the proposed action on sea turtle, large whale, and sturgeon species found within the SCNTB project area, Table 1 provides the effect determinations for hopper dredging and associated activities.

Table 1. Effect determination for hopper dredging and associated activities for sea turtle, large whale, and sturgeon species found within the proposed SCNTB project area (No Effect (NE – green); May Affect Not Likely to Adversely Affect (MANLA – orange); May Affect Likely to Adversely Affect (MALAA – red); and Not Likely to Adversely Modify (NLAM – yellow/orange)). (Reference: *USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE, Wilmington District. Submitted to NMFS on 12 September 2008.)*

Proposed Activity	Effect Determination									
	Sea Turtle					Large Whales			Shortnose Sturgeon	Smalltooth Sawfish
	Leatherback	*Loggerhead*	*Green*	*Kemp's Ridley*	*Hawksbill*	*NARW*	*Humpback*	*Sperm*		
Hydraulic Hopper	NE	MALAA	MALAA	MALAA	MALAA	NE	NE	NE	MALAA	NE
Bed Leveling	NE	MANLAA	MANLAA	MANLAA	MANLAA	NE	NE	NE	NE	NE
Transport - Hopper, Tug/Scow, Barge	NE	NE	NE	NE	NE	MANLAA	MANLAA	MANLAA	NE	NE
Trawling	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA				MALAA	NE
Tissue Sampling	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA					
Tagging	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA					
Dredge Lighting	MANLAA	MANLAA	MANLAA	MANLAA	MANLAA					
Critical Habitat	NLAM		NLAM		NLAM	NLAM				

2.00 SPECIES CONSIDERED UNDER THIS ASSESSMENT

Updated lists of endangered and threatened (T&E) species for the project area (Pender and Onslow Counties, NC) were obtained from the NMFS (Southeast Regional Office, St. Petersburg, FL) (http://sero.nmfs.noaa.gov/pr/pdf/North%20Carolina.pdf) and the USFWS (Field Office, Raleigh, NC) (http://www.fws.gov/raleigh/es_tes.html) websites. These lists were combined to develop the following composite list of T&E species that could be present in the area based upon their geographic range. However, the actual occurrence of a species in the area would depend upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance and migratory habits, and other factors.

Table 2. Threatened and Endangered Species Potentially Present in Pender and Onslow Counties, NC.

Species Common Names	Scientific Name	Federal Status
Mammals		
West Indian Manatee	*Trichechus manatus*	Endangered
North Atlantic Right whale	*Eubaleana glacialis*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered
Sperm whale	*Physeter macrocephalus*	Endangered
Finback whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Blue Whale	*Balaenoptera musculus*	Endangered
Birds		
Piping Plover	*Charadrius melodus*	Threatened
Red-cockaded woodpecker	*Picoides borealis*	Endangered
Reptiles		
American alligator	*Alligator mississippiensis*	T (S/A)
Green sea turtle	*Chelonia mydas*	Threatened[1]
Hawksbill turtle	*Eretmochelys imbricata*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Fish		
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Smalltooth sawfish	*Pristis pectinata*	Endangered
Vascular Plant		
Golden sedge	*Carex lutea*	Endangered
Chaffseed	*Schwalbea Americana*	Endangered
Cooley's meadowrue	*Thalictrum cooleyi*	Endangered
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	Endangered
Seabeach amaranth	*Amaranthus pumilus*	Threatened

Status	Definition
Endangered	A taxon "in danger of extinction throughout all or a significant portion of its range."
Threatened	A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

T (S/A)	Threatened due to similarity of appearance (e.g., American alligator)--a species that is threatened due to similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation.

[1]Green turtles are listed as threatened, except for breeding populations in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

3.00 ASSESSMENT OF IMPACTS TO LISTED THREATENED AND ENDANGERED SPECIES

3.01 General Impacts

Dredging and placement of beach quality sand have the potential to affect animals and plants in a variety of ways. The potential for adverse impacts may result from actions of the dredging equipment (i.e. suction, sediment removal, hydraulic pumping of water and sediment); physical contact with dredging equipment and vessels; physical barriers imposed by the presence of dredging equipment (i.e. pipelines); and placement of dredged material on the beach within the proposed construction template (i.e. covering, suffocation). Although beach placement of material, and associated construction operations (i.e. operation of heavy equipment, pipeline route, etc.), may adversely affect some species and their habitat, the resultant constructed beach profile also promotes restoration of important habitat that has been lost or degraded as a result of erosion. Potential impacts vary according to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that could be affected, and the nature of the interaction of a particular species with the dredging activities.

Any potential impacts on federally listed threatened and endangered species would be limited to those species that occur in habitats provided by the project area. Therefore, the proposed work will not affect any listed species, which generally reside in freshwater, forested habitats, or savannas, including the American alligator, red-cockaded woodpecker, golden sedge, chaffseed, Cooley's meadowrue, and rough-leafed loosestrife. Federally listed species which could be present in the project area during the proposed action are the blue whale, finback whale, humpback whale, NARW, sei whale, sperm whale, West Indian manatee, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, shortnose sturgeon, seabeach amaranth, and piping plover.

Dredging methods and placement of beach quality sand associated with the proposed action are similar to current maintenance dredging methods and existing beach nourishment projects. These methods have been addressed in a number of previous environmental documents, including biological assessments and biological opinions rendered regarding endangered and threatened species. The accounts, which follow, will summarize this information as it applies to the proposed action.

3.02 Species Accounts

3.02.1 American Alligator, Red-cockaded Woodpecker, Golden Sedge, Chaffseed, Cooley's Meadowrue, and Rough-leaved Loosestrife.

These are all terrestrial, freshwater, woodland, or savanna species. Since this habitat type is not present in the areas to be affected by the proposed action, these species are unlikely to occur.

Effect Determination. It has been determined that the proposed action is not likely to adversely affect any of these species or their habitat.

3.02.2 Blue Whale, Finback Whale, Humpback Whale, North Atlantic Right Whale (NARW), Sei Whale, and Sperm Whale

a. Status. Endangered

b. Occurrence in Immediate Project Vicinity. These whale species all occur infrequently in the ocean off the coast of North Carolina. Of these, only the NARW and the humpback whale routinely come close enough inshore to encounter the project area. Humpback whales were listed as "endangered" throughout their range on June 2, 1970 under the Endangered Species Act and are considered "depleted" under the Marine Mammal Protection Act. Humpbacks are often found in protected waters over shallow banks and shelf waters for breeding and feeding. They migrate toward the poles in summer and toward the tropics in winter and are in the vicinity of the North Carolina coast during seasonal migrations, especially between December and April. Since 1991, humpback whales have been seen in nearshore waters of North Carolina with peak abundance in January through March (NMFS, 2003). In the Western North Atlantic, humpback feeding grounds encompass the eastern coast of the United States, the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland. Major prey species include small schooling fishes (herring, sand lance, capelin, mackerel, small Pollock, and haddock) and large zooplankton, mainly krill (up to 1.5 tons per day) (http://www.nmfs.noaa.gov). Based on an increased number of sightings and stranding data, the Chesapeake and Delaware Bays and the U.S. mid-Atlantic and southeastern states, particularly along Virginia and North Carolina coasts, have become increasingly important habitat for juvenile humpback whales (Wiley *et al*., 1995).

There are 6 major habitats or congregation areas for the western NARW; these are the coastal waters of the southeastern United States, the Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf. However, the frequency with which NARWs occur in offshore waters in the southeastern U.S. remains unclear (NMFS, 2003). While it usually winters in the waters between Georgia and Florida, the NARW can, on occasion, be found in the waters off North Carolina. NARWs swim very close to the shoreline and are often noted only a few hundred meters offshore (Schmidly, 1981). NARWs have been documented along the North Carolina coast, as close as 250 meters from the beach, between December and April with sightings being most common from mid to late March (Dr. Frank J. Schwartz, personal communication). Sighting data provided by the NARW Program of the New England Aquarium indicates that 93 percent of all North Carolina sightings between 1976 and 1992 occurred between mid-October and mid-April (Slay, 1993). The occurrence of NARWs in the State's waters is usually associated with spring or fall migrations. Due to their occurrence in the nearshore waters, the transport of hopper dredges to and from the offshore borrow areas could result in an encounter with humpback and NARW species.

c. Project Impacts.

(1) Habitat. No critical habitat has been designated for NARWs and humpback whales within the proposed project area.

(2) Food Supply. North Atlantic right whales feed primarily on copepods (*Calanus* sp.) and euphausids (krill) (NMFS, 1991) and humpback whales feed on small fish and krill. The proposed dredging will not diminish productivity of the nearshore ocean; therefore, the food supply of these species should be unaffected.

(3) Relationship to Critical Periods in Life Cycle.

North Atlantic Right Whale (NARW).

Detailed life history information for NARWs and potential effects from dredging activities area provided within the following Section 7 consultation documents:

National Marine Fisheries Service. 1997. Regional Biological Opinion for the Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland

USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE, Wilmington District. Submitted to NMFS on 12 September 2008.

The referenced September 2008 Section 7 consultation document discusses in detail the 26 June, 2006 proposed regulations by NMFS to implement mandatory vessel speed restrictions of 10 knots or less on vessels 65 ft. or greater in overall length in certain locations and at certain times of the year along the east coast of the U.S. Atlantic seaboard. Following the release of the referenced USACE consultation document, NMFS announced the release of the Final Rule and subsequent OMB approval of the collection-of-information requirements. Specifically, on October 10, 2008 NMFS published a final rule implementing speed restrictions to reduce the incidence and severity of ship collisions with North Atlantic right whales (73 FR 60173) with an effective date of December 9, 2008 through December 9, 2013. That final rule contained a collection-of-information requirement subject to the Paperwork reduction Act (PRA) that had not yet been approved by OMB. Specifically, 50 CFR 224.105(c) requires a logbook entry to document that a deviation from the 10-knot speed limit was necessary for safe maneuverability under certain conditions. On October 30, 2008, OMB approved the collection-of-information requirements contained in the October 10, 2008, final rule. On 5 December 2008, NMFS announced that the collection-of-information requirements were approved under Control Number 0648–0580, with an expiration date of April 30, 2009 (15 CFR Part 902).

Humpback Whales.

The overall North Atlantic population of humpback whales is estimated at 10,600 individuals and is increasing (Waring *et al*., 1999); however the minimum population estimates for the Gulf of Maine stock is 647 individuals with a steadily increasing trend (NMFS, 2003). For the period 1993-1997, the total estimated human-caused mortality and serious injury from fishery interactions and vessel collisions is estimated at 4.4 per year (NMFS, 2003). According to Jensen and Silber's (2003) large whale ship strike database, of the 292 records of confirmed or possible ship strikes to large whales, 44 records (15%) were of humpback whales, the second most often reported species next to finback whales (75 records) (26%). Of the 5 documented ship strikes resulting in serious injury or mortality for North Atlantic humpback whales from January 1997-December 2001, 3 where located in North Carolina and South Carolina waters. Though the total level of human-caused mortality and serious injury is unknown, current data indicate that it is significant; furthermore, mortality off the U.S. Mid-Atlantic States continues to increase (NMFS, 2003).

(4) Effect Determination. Of the six species of whales being considered, only the NARW and humpback whale would normally be expected to occur within the project area during the project construction period. Therefore, the proposed project is not likely to adversely affect the blue whale, finback whale, sei whale, and sperm whale. Conditions outlined in previous consultations in order to reduce the potential for accidental collision (i.e. contractor pre-project briefings, large whale observers, slow down and course alteration procedures, etc.) will be implemented as a component of this project. Based on the implementation of these conditions, dredging activities associated with the proposed project may affect but are not likely to adversely affect the NARW and humpback whale species.

3.02.3 West Indian Manatee

a. Status. Endangered.

b. Occurrence in Immediate Project Vicinity. The manatee is an occasional summer resident off the North Carolina coast with presumably low population numbers (Clark, 1987). The species can be found in shallow (5 ft to usually <20 ft), slow-moving rivers, estuaries, saltwater bays, canals, and coastal areas (USFWS, 1991). The West Indian manatee is herbivorous and eats aquatic plants such as hydrilla, eelgrass, and water lettuce (USFWS, 1999a). Manatees are thermally stressed at water temperatures below 18ºC (64.4ºF) (Garrot *et al*., 1995); therefore, during winter months, when ambient water temperatures approach 20ºC (68ºF), the U.S. manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. During the summer months, sightings drop off rapidly north of Georgia (Lefebvre *et al., 2001*) and are rare north of Cape Hatteras (Rathbun *et al., 1982*; Schwartz, 1995). However, they are sighted infrequently in southeastern North Carolina with most records occurring in July, August, and September, as they migrate up and down the coast (Clark, 1993). The Species is considered a seasonal inhabitant of North Carolina with most occurrences reported from June through October (USFWS, 2001). According to Schwartz (1995), manatees have been reported in the state during nine months, with most sightings in the August-September period. Manatee population trends are poorly understood, but deaths have increased steadily. A large percent of mortality is due to collisions with watercrafts, especially of calves. Another closely related factor in their decline has been the loss of suitable habitat through incompatible coastal development, particularly destruction of sea grass beds by boating facilities (USFWS, 2001).

Manatees are rare visitors to the SCNTB Region. According to Schwartz (1995), a total of 68 manatee sightings have been recorded in 11 coastal counties of North Carolina during the years 1919-1994. Therefore, it is likely that manatees transit through the SCNTB region during the warm water months. Manatees are known to infrequently occur within nearly all North Carolina ocean and inland waters (Schwartz, 1995) with four North Carolina records having been from inlet-ocean sites and six from the open ocean (Rathbun, 1982). According to the existing literature, specific numbers of manatees using the region are not known but are presumed to be very low. More research is needed to determine the status of the species in North Carolina and identify areas (containing food and freshwater supplies), which support summer populations.

c. Current Threats to Continued Use of the Area. Current threats to this species in the SCNTB area cannot be clearly assessed due to our lack of knowledge regarding its population, seasonality, distribution, and the habitat components in the project area that may be needed for its use. However, considering that manatees become thermally stressed at water temperatures below 18ºC (64ºF) (Garrot *et al*., 1995), cold winter temperatures keep the species from over wintering in the project area.

d. Project Impacts.

(1) Habitat. Impacts to estuarine and nearshore ocean habitat of the area associated with the placement of sediment on the beach should be minor. With the current state of knowledge on the habitat requirements for the manatee in North Carolina, it is difficult to determine the magnitude of such impacts. Studies currently underway by the USFWS using animals fitted with satellite transmitters will hopefully provide data on the nature of these seasonal movements and habitat requirements during migrational periods.

(2) Food Supply. Foods, which are used by the manatee in North Carolina, are unknown. In Florida, their diet consists primarily of vascular plants. The proposed action will involve minimal change to the physical habitat of the estuary with no known impacts to vascular plants and overall estuarine and nearshore productivity should remain high throughout the project area. Therefore, potential food sources for the manatee should be unaffected.

(3) Relationship to Critical Periods in Life Cycle. Since the manatee is considered to be an infrequent summer resident of the North Carolina coast, the proposed action should have little effect on the manatee since its habitat and food supply will not be significantly impacted. In regards to vessel collisions, the proposed borrow sites are located between 1-6 miles offshore and the hopper dredge pumpout stations will be located within a mile offshore; thus, hopper dredging activities will not occur in the estuarine or inlet habitat area and direct impacts from collision will not occur. Nonetheless, the Corps will implement precautionary measures for avoiding impacts to manatees from associated transiting vessels during construction activities, as detailed in the "Guidelines for Avoiding Impacts to the West Indian Manatee" established by the USFWS.

(4) Effect Determination. Since the habitat and food supply of the manatee will not be significantly impacted, overall occurrence of manatees in the project vicinity is infrequent, all hopper dredging will occur in the offshore environment, and precautionary measures for avoiding impacts to manatees, as established by USFWS, will be implemented for transiting vessels associated with the project, the proposed action may affect by is not likely to adversely affect the manatee.

3.02.4 Sea Turtles.

a. Status.

Loggerhead	*Caretta caretta*	Threatened
Hawksbill	*Eretmochelys imbricata*	Endangered
Kemp's Ridley	*Lepidochelys kempii*	Endangered
Green	*Chelonia mydas*	Threatened[1]
Leatherback	*Dermochelys coriacea*	Endangered

[1]Green turtles are listed as threatened, except for breeding populations in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

b. Critical Habitat. Critical habitat has not been designated in the continental U.S. for the five species of sea turtles identified to occur within the proposed project vicinity. Therefore, the proposed actions would not result in an adverse modification to identified critical habitat.

c. Background. Detailed life history information associated with the in-water life cycle requirements for sea turtles and a subsequent analysis of impacts from the proposed dredging activities is provided within the following NMFS Section 7 consultation documents:

National Marine Fisheries Service. 1997. Regional Biological Opinion for the Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland

USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE, Wilmington District. Submitted to NMFS on 12 September 2008

A summary of project specific information associated with beach and in-water habitat use is provided in the ensuing text.

1.) Occurrence in Immediate Project Vicinity. All five species of sea turtles identified above are known to occur in both the estuarine and oceanic waters of North Carolina. According to Epperly *et al.* (1994), inshore waters, such as Pamlico and Core Sounds, are important developmental and foraging habitats for loggerheads, greens, and Kemp's ridleys. Nearly all sea turtles found within these sounds are immature individuals immigrating into the sounds in the spring and emigrating from the sounds in the late fall and early winter (Epperly et. al, 1995).

Loggerhead, green, and Kemp's ridley sea turtles are known to frequently use coastal waters offshore of North Carolina as migratory travel corridors (Wynne, 1999) and commonly occur at the edge of the continental shelf when they forage around coral reefs, artificial reefs, and boat wrecks.

Hawksbill and leatherback sea turtles infrequently enter inshore waters (Epperly *et al.*, 1995) and are normally associated solely with oceanic waters (Schwartz, 1977). However, Lee and Palmer (1981) document that leatherbacks normally frequent the shallow shelf waters rather than those of the open sea, with the exception of long-range migrants.

Of the five species of sea turtles considered for this project, only the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*), and the leatherback sea turtle (*Dermochelys coriacea*) nest regularly on North Carolina beaches and have the potential to nest within the project area. There are no documented nesting attempts of hawksbill and Kemp's ridley sea turtles on the project beaches; however, Kemp's ridley nests have been documented twice in North Carolina, once on Oak Island in 1992 and once on Cape Lookout in 2003 ((Matthew Godfrey, pers. comm.). With a few exceptions, the entire Kemp's ridley population nests on the approximately 15 miles of beach in Mexico between the months of April and June (USFWS, 1991). The hawksbill sea turtle nests primarily in tropical waters in south Florida and the Caribbean. Considering the infrequency of Kemp's ridley nesting occurrence throughout North Carolina and the lack of historical nesting of Kemp's ridley and hawksbill sea turtles on Topsail Island, these species are not anticipated to nest within the project area. The loggerhead is considered to be a regular nester in the state, while green sea turtle nesting is infrequent and primarily limited to Florida's east coast (300 to 1,000 nests reported annually). According to Rabon *et al*. (2003), seven leatherback nests have been confirmed in North Carolina since 1998 constituting the northernmost nesting records for leatherbacks along the East Coast of the United States. Though almost all confirmed nesting activity in North Carolina has been between Cape Lookout and Cape Hatteras, the potential for leatherback nesting within the project area is likely.

Topsail Island is considered to be one of the more heavily nested areas along the North Carolina coast. Table 3, shows the total number of recorded loggerhead and green sea turtle nests on SCNTB beaches from 1990 to 2008. Though records were kept as early as 1984, consistent turtle nesting data has been recorded on Topsail Island only since 1990. Furthermore, Standardized nest patrols were not enacted statewide until the mid 1990s; therefore, values from the first part of the 1990's may not represent a full season of monitoring. Of the 1483 nests laid within the project areas since 1990, loggerhead sea turtles laid 1471 nests and 12 nests were laid by greens (Matthew Godfrey, pers. comm.). As shown in Table 3, sea turtle nesting numbers declined following hurricanes in the 1990's - Hurricane Emily, 1993, Hurricanes Bertha and Fran, 1996, and Hurricane Floyd, 1999. As part of the terms of local cooperation for this project, the project area will be monitored for sea turtle nesting and hatchling activity on an annual basis by the towns of Surf City and North Topsail Beach.

Table 3. Total sea turtle nest numbers for Surf City and North Topsail Beaches from 1990-2008. Loggerhead and green sea turtles are the only species with recorded nesting activity on Surf City and North Topsail beaches.

Year	Loggerhead (*Caretta caretta*)	Green (*Chelonia mydas*)
1990	68	0
1991	116	0
1992	91	0
1993	53	0
1994	80	0
1995	71	0
1996	102	1
1997	61	1
1998	89	3
1999	152	6
2000	87	0
2001	62	0
2002	77	0
2003	52	0
2004	49	0
2005	59	1
2006	77	0
2007	46	0
2008	79	0
TOTAL	1471	12

2.) Current Threats to Continued Use of the Area. In addition to affecting the coastal human population, coastal sediment loss also poses a threat to nesting sea turtles. A large percentage of sea turtles in the United States nest on nourished beaches (Nelson and Dickerson, 1988a), therefore, nourishment has become an important technique for nesting beach restoration (Crain *et al.*, 1995). Most of the project area has experienced severe erosion because of frequent hurricanes passing over or near the area since 1996. Since consistent turtle nesting surveys began on Topsail Island in 1990, there has been a gradual decline in the average numbers of nests laid per year (Table I-2). Coupled with this decline is the increase in nest relocations for those that are laid. One potential cause for decreased nest numbers and increased relocation numbers is loss of nesting habitat (Jean Beasley, pers. comm.). In areas were erosion is most severe, the tide is so high there is not acceptable beach to nest and without relocation efforts in these highly erosive areas, nests will be inundated and lost. Though concerns about beach nourishment, as it relates to relocation and nest success, are evident, with overall loss of habitat over time due to erosion, there will be complete loss of nesting on Topsail Island (Jean Beasley, pers. comm.).

Topsail Island is considered to be one of the major rookeries for the declining Northern loggerhead population; thus restoration of this important nesting habitat on Topsail Island is critical. Historically, the north and south ends of Topsail Island have experienced beach disposal operations from the maintenance of navigation channels. These small-scale disposal events have re-established lost nesting habitat and have allowed for some turtles to continue nesting in areas that would have otherwise been lost. In regards to suitability for nesting, turtles continue to nest on disposal beaches with hatch rate successes similar to non-disposal beaches (Jean Beasley, pers. comm.).

The primary threats facing these species worldwide are the same ones facing them in the project area. Of these threats, the most serious seem to be loss of breeding females through accidental drowning by shrimpers (Crouse, *et al.*, 1987) and human encroachment on traditional nesting beaches. Research has shown that the turtle populations have greatly declined in the last 20 years due to a loss of nesting habitat along the beachfront and by incidental drowning in shrimp trawl nets. It appears that the combination of poorly placed nests coupled with unrestrained human use of the beach by auto and foot traffic has impacted this species greatly. Other threats to these sea turtles include excessive natural predation in some areas and potential interactions with hopper dredges during the excavation of dredged material. With the exception of hopper dredges, none of the dredge plants (i.e., pipeline dredges) proposed for use in the construction of this project are known to take sea turtles.

d. Project Impacts.

In order to avoid periods of peak sea turtle abundance during warm water months and minimize impacts to sea turtles in the offshore environment, the proposed hopper dredging window for this project is 1 December through 31 March. By adhering to this dredging window to the maximum extent practicable, all subsequent beach placement of sediment will occur outside of the North Carolina sea turtle nesting season of 1 May through 15 November. The limits of the nesting season window are based on the known nesting sea turtle species within the state and the earliest and latest documented nesting events for those species.

In the unanticipated event that construction activities extend into the nesting season (i.e. weather, equipment breakdown, etc.), all available data associated with the nesting activities within the project area will be utilized to consider risks of working within the nesting season. Variables to consider will include the number of days construction will extend into the nesting season, existing conditions of the pre-project nesting habitat such as: erosion rates, existing protective measures (i.e. sandbags, beach bulldozing, etc.), development, recreational use, the historic nesting density within the project area, etc. In coordination with the USFWS and NCWRC, an evaluation of these variables will be used to potentially incorporate project modifications (i.e. modified pipeline routes, staging areas, etc.) during the nesting season that may avoid or minimize potential impacts.

Upon evaluation of site-specific conditions, if nourishment beach activities extend into a portion of the nesting season, monitoring for sea turtle nesting activity will be considered throughout the construction area including the disposal area and beachfront pipeline routes, in accordance with guidelines provided by the NCWRC and USFWS, so that nests laid in a potential construction zone can be bypassed and/or relocated outside of the construction zone prior to project commencement. However, relocation measures should be considered as a last alternative. The location and operation of heavy equipment on the beach within the project area will be limited to daylight hours to the maximum extent practicable in order to minimize impacts to nesting sea turtles.

Considering that the proposed 1 December to 31 March construction window for initial construction and each nourishment interval will avoid the nesting season, direct impacts associated with construction activities during the nesting season are not anticipated and will be avoided to the maximum extent practicable. However, if construction extends into the nesting season do to unforeseen circumstances, the following direct impacts may occur:

(1) Both stockpiled pipe on the beach and the pipeline route running parallel to the shoreline may impede nesting sea turtles from accessing more suitable nesting sites.
(2) The operation of heavy equipment on the beach may impact incubating nests.
(3) During nighttime operations, the nourishment construction process, including heavy equipment use and associated lighting, may deter nesting females from coming ashore and disorient emerging hatchlings down the beach.
(4) Burial of existing nests may occur if missed by monitoring efforts.
(5) Escarpment formations and resulting impediment to nesting females.
(6) Reduced nest success as a result of relocation efforts.

Indirect impacts associated with changes to the nesting and incubating environment, from the placement of sediment from alternate sources on the beach, are expected. The following section discusses both potential direct and indirect impacts to nesting sea turtles associated with the proposed project:

(1) Beach Placement of Sediment Impacts.

Post-nourishment monitoring efforts have documented potential impacts on nesting loggerhead sea turtles for many years (Fletemeyer, 1984; Raymond, 1984; Nelson and Dickerson, 1989; Ryder, 1993; Bagley *et al*., 1994; Crain *et al*., 1995; Milton *et al*., 1997; Steinitz *et al*., 1998; Trindell *et al*., 1998; Davis *et al*., 1999; Ecological Associates, Inc., 1999; Herren, 1999; Rumbold *et al*., 2001; Brock, 2005). Results from these studies indicate that, in most cases, nesting success decreases during the year following nourishment as a result of escarpments obstructing beach accessibility, altered beach profiles, and increased compaction. A comprehensive post-nourishment study conducted by Ernest and Martin (1999) documented an increase in abandoned nest attempts on nourished beaches compared to control or pre-nourished beaches as well as a change in nest placement with subsequent increase in wash-out of nests during the beach equilibration process. Contrary to previous studies, this study suggests that a post-nourishment decline in nest success is more likely a result from changes in beach profile than an increase in beach compaction and escarpment formation. According to Brock (2005), the sediment used for the nourishment of Brevard County beaches in Florida offered little or no impediment to sea turtles attempting to excavate an egg chamber. Furthermore, the physical attributes of the nourished sediment did not facilitate excessive scarp formation and; therefore, turtles were not limited in their ability to nest across the full width of beach. However, a decrease in nest success was still documented in the year following nourishment with an increase in loggerhead nesting success rates during the second season post-nourishment. This was attributed to increased habitat availability following the equilibration process of the seaward crest of the berm. This study suggests that, if compatible sediment and innovative design methods are utilized to minimize post-nourishment impacts documented in previous studies, than the post-nourishment decrease in nest success without the presence of scarp formations, compaction, etc. may indicate an absence of abiotic and or biotic factors that cue the female to initiate nesting.

As suggested by the historical literature, there are inherent changes in beach characteristics as a result of mechanically placing sediment on a beach from alternate sources. The change in beach characteristics often results in short-term decreases in nest success and/or alterations in nesting processes. Based on the available literature, it appears that these impacts are, in many cases, site specific. Careful consideration must be placed on pre- and post-project site conditions and resultant beach characteristics after beach-fill episode at a given site in order to thoroughly understand identified post-project changes in nesting processes. By better understanding potential project specific impacts, modifications to project templates and design can be implemented to improve habitat suitability. The following sections review, more specifically, documented direct or indirect impacts to nesting females and hatchlings.

a. Pipe Placement.

In the event unanticipated circumstances arise and construction operations extend into the sea turtle nesting season pipeline routes and pipe staging areas may act as an impediment to nesting females approaching available nesting habitat or to hatchlings orienting to the waters edge. If the pipeline route or staging areas extend along the beach face, including the frontal dune, beach berm, mean high water line, etc., some portion of the available nesting habitat will be blocked. Nesting females may either encounter the pipe and false crawl, or nest in front of the pipeline in a potentially vulnerable area to heavy equipment operation, erosion, and washover. If nests are laid prior to placement of pipe and are landward of the pipeline, hatchlings may be blocked or mis-oriented during their approach to the water.

Though pipeline alignments and staging areas may pose impacts to nesting females and hatchlings during the nesting season, several measures can be implemented to minimize these impacts. If construction activities extend into the nesting season, monitoring should be done in advance to document all nests within the beach placement template. Construction operations and pipeline placement could be modified to bypass existing nests. If bypassing is not a practical alternative for a given project, the relocation of nests outside of construction areas could be implemented as a last resort. Throughout the period of sea turtle nesting and hatching, construction pipe that is placed on the beach parallel to the shoreline could be placed as far landward as possible so that a significant portion of available nesting habitat can be utilized and nest placement is not subject to inundation or wash out. Furthermore, temporary storage of pipes and equipment can be located off the beach to the maximum extent practicable. If placement on the beach is necessary, it will be done in a manner so as to impact the least amount of nesting habitat by placing pipes perpendicular to shore and as far landward as possible without compromising the integrity of the existing or constructed dune system.

b. Slope and Escarpments.

Beach nourishment projects are designed and constructed to equilibrate to a more natural profile over time relative to the wave climate of a given area. Changes in beach slope as well as the development of steep escarpments may develop along the mean high water line as the constructed beach adjusts from a construction profile to a natural beach profile (Nelson *et al.*, 1987). For the purposes of this assessment, escarpments are defined as a continuous line of cliffs or steep slopes facing in one general direction, which is caused by erosion or faulting. Depending on shoreline response to the wave climate and subsequent equilibration process for a given project, the slope both above and below mean high water may vary outside of the natural beach profile; thus resulting in potential escarpment formation. Though escarpment formation is a natural response to shoreline erosion, the escarpment formation as a result of the equilibration process during a short period following a nourishment event may have a steeper and higher vertical face than natural escarpment formation and may slough off more rapidly landward.

Adult female turtles survey a nesting beach from the water before emerging to nest (Carr and Ogren, 1960; Hendrickson, 1982). Parameters considered important to beach selection include the geomorphology and dimensions of the beach (Mortimer, 1982; Johannes and Rimmer, 1984) and bathymetric features of the offshore approach (Hughes, 1974; Mortimer, 1982). Beach profile changes and subsequent escarpment formations may act as an impediment to a nesting female resulting in a false crawl or nesting females may choose marginal or unsuitable nesting areas either within the escarpment face or in front of the escarpment. Often times these nests are vulnerable to tidal inundation or collapse of the receding escarpment. If a female is capable of nesting landward of the escarpment prior to its formation, as the material continues to slough off and the beach profile approaches a more natural profile, there is a potential for an incubating nest to collapse or fallout during the equilibration process. Loggerheads preferentially nest on the part of the beach where the equilibration process takes place (Brock, 2005; Ecological Associates, Inc., 1999) and are more vulnerable to fallout during equilibration. However, according to Brock (2005), the majority of green turtle nests are placed on the foredune and; therefore, the equilibration process of the nourished substrate may not affect green turtles as severely.

A study conducted by Ernest and Martin (1999) documented increased abundance of nests located further from the toe of the dune on nourished vs. control beaches. Thus, post-nourishment nests may be laid in high-risk areas where vulnerability to sloughing and equilibration are greatest. Though nest relocation is not encouraged, considering that immediately following nourishment projects the likelihood of beach profile equilibration and subsequent sloughing of escarpments as profile adjustment occurs, nest relocation may be used as a last alternative to move nests that are laid in locations along the beach that are vulnerable to fallout (i.e. near the mean high water line). As a nourished beach is re-worked by natural processes and the construction profile approaches a more natural profile, the frequency of escarpment formation declines and the risk of nest loss due to sloughing of escarpments is reduced. According to Brock (2005), the return of loggerhead nesting success to equivalent rates similar to those on the adjacent non-nourished beach and historical rates two seasons post-nourishment were observed and are attributed to the equilibration process of the seaward crest of the berm.

Though the equilibration process and subsequent escarpment formation are features of most beach projects, management techniques can be implemented to reduce the impact of escarpment formations. For completed sections of beach during beach construction operations, and for subsequent years following as the construction profile approaches a more natural profile, visual surveys for escarpments could be performed. Escarpments that are identified prior to or during the nesting season that interfere with sea turtle nesting (exceed 18 inches in height for a distance of 100 ft.) can be leveled to the natural beach for a given area. If it is determined that escarpment leveling is required during the nesting or hatching season, leveling actions will be directed by the NCWRC and USFWS.

The Corps' Jacksonville, FL District Headquarters is currently working with the Florida DEP to identify aspects of beach nourishment construction templates that negatively impact sea turtles and develop alternative design criteria that may minimize these impacts. Project design modifications to develop a more "turtle friendly" beach profile could potentially increase post-nourishment nest density and success. A draft final report for phase one of this study, "Assessment of Alternative Construction Template for Beach Nourishment Projects," has been developed and reviewed. Based on the final results and feasibility of recommendations, the Corps may incorporate, to the maximum extent practicable, 'turtle friendly' beach profile criteria in future project designs in order to enhance sea turtle nesting habitat requirements; however, at this point in time no formal recommendations have been identified.

c. Incubation Environment.

Physical changes in sediment properties that result from the placement of sediment, from alternate sources, on the beach pose concerns for nesting sea turtles and subsequent nest success. Constructed beaches have had positive effects (Broadwell, 1991; Ehrhart and Holloway-Adkins, 2000; Ehrhart and Roberts, 2001), negative effects (Ehrhart, 1995; Ecological Associates, Inc., 1998), or no apparent effect (Raymond, 1984.; Nelson *et al*., 1987; Broadwell, 1991; Ryder, 1993; Steinitz *et. al.*, 1998; Herren, 1999) on the hatching success of marine turtle eggs. Differences in these findings are related to the differences in the physical attributes of each project, the extent of erosion on the pre-existing beach, and application technique (Brock, 2005).

If nesting occurs in new sediment following beach construction activities, embryonic development within the nest cavity can be affected by insufficient oxygen diffusion and variability in moisture content levels within the egg clutch (Ackerman, 1980; Mortimer, 1990; Ackerman *et al*., 1992); thus, potentially resulting in decreased hatchling success. Ambient nest temperature and incubation time are affected by changes in sediment color, sediment grain size, and sediment shape as a result of beach nourishment (Milton *et al*., 1997) and; thus, affect incubation duration (Nelson and Dickerson, 1988a). Sexual differentiation in chelonians depends on the temperature prevailing during the critical incubation period of the eggs (Pieau, 1971; Yntema, 1976; Yntema and Mrosovsky, 1979; Bull and Vogt, 1979), which occurs during the middle third of the incubation period (Yntema, 1979; Bull and Vogt, 1981; Pieau and Dorizzi, 1981; Yntema and Mrosovsky, 1982; Ferguson and Joanen, 1983; Bull, 1987; Webb *et al*. 1987; Deeming and Ferguson, 1989; Wibbels *et al*., 1991), and possibly during a relatively short period of time in the second half of the middle trimester (Webster and Gouviea, 1988). Eggs incubated at constant temperatures of 28°C or below develop into males. Those kept at 32°C or above develop into females. Therefore, the pivotal temperature, those giving approximately equal numbers of males and females, is approximately 30°C (Yntema and Mrosovsky, 1982). Estimated pivotal temperatures for loggerhead sea turtles nesting in North Carolina, Georgia, and southern Florida are close to 29.2°C (Mrosovsky and Provancha, 1989). Therefore, fluctuation in ambient nest temperature on constructed beaches could directly impact sex determination if nourished sediment differs significantly from that found on the natural beach. Since, the pivotal temperatures for the northern and southern geographic nesting ranges of loggerheads in the United States are similar, a higher percentage of males are produced on North Carolina beaches and a higher percentage of females on Florida beaches. Hatchling sex ratios are of conservational significance (Mrosovsky and Yntema, 1980; Morreale *et al*., 1982) since they may affect the population sex ratio and thus could alter reproductive success in a population (Hanson *et al*., 1998).

This assessment assumes sediment being placed on the beach meets the new state Sediment Criteria Rule Language (15A NCAC 07H .0312) (http://dcm2.enr.state.nc.us/Rules/rules.htm) for borrow material and subsequent beach placement adopted by North Carolina Coastal Resources Commission (CRC). Therefore, sediment characteristics will be compatible with native beaches.

d. Nest Relocation.

Relocation of sea turtle nests to less vulnerable sites was once common practice throughout the southeastern U.S. to mitigate the effects of natural or human induced factors. However, the movement of eggs creates opportunities for adverse impacts. Therefore, more recent USFWS guidelines are to be far less manipulative with nests and hatchlings to the maximum extent practicable. Though not encouraged, nest relocation is still used as a management technique of last resort where issues that prompt nest relocation cannot be resolved. Potential adverse impacts associated with nest relocation include: survey error (Shroeder, 1994), handling mortality (Limpus *et al.* 1979; Parmenter 1980), incubation environment impacts (Limpus *et al*., 1979; Ackerman, 1980; Parmenter, 1980; Spotila *et al*., 1983; McGehee, 1990), hatching and emergence success, and nest concentration.

Construction efforts associated with this project are scheduled, to the maximum extent practicable, to work outside of the sea turtle nesting season in order to avoid impacts to nesting females and the nest incubation environment. However, in some instances where an extension into the nesting season cannot be avoided, nest relocation may be used as a management tool to re-locate nests laid in the impact area to areas that are not susceptible to disturbance. For the identified project area, if the earliest documented nest attempt precludes the project completion date, nest relocation may be used as a last resort mitigation effort. If relocation is implemented, the proper protocol established by the NCWRC and USFWS will be adhered to in order to avoid the potential adverse impacts outlined above.

e. Beach Compaction and Hardness.

Sediment placed on the beach, as a component of coastal storm damage reduction projects, beach disposal, sand-bypassing, etc. is often obtained from three main sources: inlets, channels, or offshore borrow sites (Crain *et al*., 1995) with occasional use of upland sources. Significant alterations in beach substrate properties may occur with the input of sediment types from other sources. Sediment density (compaction), shear resistance (hardness), sediment moisture content, beach slope, sediment color, sediment grain size, sediment grain shape, and sediment grain mineral content can be changed by beach nourishment.

Current sea turtle literature has attributed post-nourishment beach hardness to sand compaction but it should be more appropriately attributed to sediment shear resistance. Increased shear resistance can be due to increased sand compaction (density), but it can also be due to other factors such as sand particle characteristics (size, shape) and interactions between the particles (Spangler and Handy, 1982; Nelson *et al.*, 1987; Nelson and Dickerson, 1989; Ackerman, 1996). Shear resistance describes the ability of the beach sand to resist sliding along internal surfaces. A measure of shear resistance can be described as a measure of beach hardening or strength. The sand particle surface characteristics contribute to the sliding friction ability of the sand particles. Various parameters (chemical composition, cohesion, moisture content, sediment layering and mixing) contribute to the interlocking ability of the sand particles. Sliding friction, interlocking, and compaction of the sand particles all contribute to a measure of shear resistance. Thus, a measurement of increased shear resistance does not necessarily mean that the beach is also compacted (Ackerman, 1996).

Factors which may contribute to increased beach hardness (shear resistance) on nourished beaches include a high silt component, angular fine-grained sand, higher moisture content, equipment and vehicular traffic, and hydraulic slurry deposition of sediments (Nelson, 1985; Nelson *et al.*, 1987; Nelson and Dickerson, 1988a; 1989; Ackerman, 1996). Beach fill can vary in amount of carbonate sand, quartz sand, shell, coral, silt, and clay content (National Research Council 1995). Sediments used for beach fill with clay or silt contents higher than 5-10% may cause high beach hardness once the sediment dries (Nelson, 1985; Dean, 1988). Harder nourished beaches typically result from angular, finer grain sand dredged from stable offshore borrow sites; whereas, less hard or "softer" beaches result from smoother, coarse sand dredged from high energy locations (e.g. inlets) (Spangler and Handy 1982; Nelson *et al.,* 1987; Nelson and Dickerson 1988a; 1989). Nourished beaches may result in sediment moisture content more than 4% higher than adjacent, natural beaches (Ackerman 1996, Ackerman *et al.,* 1992). Placement of fill material with heavy equipment imparts a component of "compactness" that should not occur on natural beaches. The natural process of beach formation, over an extended period of time, results in extensive sorting of the sand both by layers and within layers. Layer orientation is determined by the wave wash which is not the same for nourished beaches (National Research Council, 1995).

Hard sediment can prevent a female from digging a nest or result in a poorly constructed nest cavity. Females may respond to harder physical properties of the beach by spending more time on the beach nesting, which may result in physiological stress and increased exposure to disturbances and predation; thus, in some cases leading to a false dig (Nelson and Dickerson, 1989). Although increased shear resistance does not occur with every nourishment project, higher shear resistance measurement values have been more frequently reported over the past 30 years from nourished beaches than on natural beaches of the same area (e.g. Mann 1977; Fletemeyer 1983; Raymond 1984; Nelson *et al.,* 1987; Moulding and Nelson 1988; Nelson and Dickerson 1988a; Ryder 1995; Bagley *et al.*, 1994; Crain *et al.,* 1995; Ernest *et al.,* 1995; Foote and Truitt 1997; Milton *et al.,* 1997; Steinitz *et al.,* 1998; Trindell *et al.*, 1998; Davis *et al.,* 1999; Herren 1999; Allman *et al.*, 2001; Rumbold *et al.,* 2001; Piatkowski, 2002; Scianna *et al.,* 2001; Brock, 2005). Results have varied tremendously on the nesting success reported in these studies when comparing nourished and natural beaches of different shear resistance values. The natural variance in shear resistance values and the nesting success related to these values is still poorly understood. Due to the many variables involved from natural and non-natural causes, it is extremely difficult to identify impacts from nourishment projects by only evaluating nesting success data. Analyses of shear resistance values and nesting success have yet to determine a consistent relationship (Trindell *et al.*, 1998). It is difficult to define absolute or optimal shear resistance values until these relationships are better understood throughout the sea turtle nesting range in the

United States (Gulf and South Atlantic states). Crain *et al.* (1995) also recommended this as a research priority for beach nourishment impact studies.

Measuring shear resistance has become a common procedure of most beach nourishment projects and is usually done with a hand-held cone-penetrometer (Crain et al 1995). While holding the instrument in a vertical orientation, measurements are obtained by manually pushing it into the beach sediment. Based on data collected during the 1980's from nourished and non-nourished projects on the Atlantic coast of Florida, the U.S. Army Corps of Engineers provided initial guidelines on maximum cone-penetrometer values (600) below which might be more compatible with natural nesting beaches (Nelson *et al..,* 1987; Moulding and Nelson 1988; Nelson *et al.,* 1987; Nelson and Dickerson 1988a; 1989). The USFWS later adopted these guidelines into permitting regulations for all nourished projects along the U.S. Atlantic and Gulf of Mexico coasts with potential sea turtle nesting habitat. These requirements are still in effect to date and are outlined in state construction permit requirements and Biological Opinions issued by USFWS. According to the general USFWS compaction measurement guidelines for NC outlined below, compaction measurements of 500 PSI establishes the level of beach hardness when post-nourishment beach tilling should be done to reduce the shear resistance measurements.

General USFWS Compaction Guidelines

1. Compaction sampling stations will be located at 500-foot intervals along the project area. One station will be at the seaward edge of the dune line (when material is placed in this area); and one station must be midway between the dune line and the high water line (normal wrack line).

At each station, the cone penetrometer will be pushed to a depth of 6, 12, and 18 inches three times (three replicates). Material may be removed from the hole if necessary to ensure accurate readings of successive levels of sediment. Layers of highly compact material may lie over less compact layers. Replicates will be located as close to each other as possible, without interacting with the previous hole and/or disturbed sediments. The three replicate compaction values for each depth will be averaged to produce final values for each depth at each station. Reports will include 18 values for each transect line, and the final 6 averaged compaction values.

2. If the average value for any depth exceeds 500 pounds per square inch (psi) for any two or more adjacent stations, then that area must be tilled prior to May 1. If values exceeding 500 psi are distributed throughout the project area, but in no case do those values exist at two adjacent stations at the same depth, then consultation with the Fish and Wildlife Service will be required to determine if tilling is required. If a few values exceeding 500 psi are randomly present within the project area, tilling will not be required. For all circumstances where tilling is implemented, the designated area shall be tilled to a depth of 36 inches. Tilling will be performed (i.e. overlapping rows, parallel and perpendicular rows, etc.) so that all portions of the beach are tilled and no furrows are left behind All tilling activities must be completed prior to May 1 in accordance with the following protocol..

Readings of cone index values can be roughly equated to pounds per square inch (psi). However, this is a relative value and caution should be used when attempting to compare cone index values in pounds per square inch to other sources of data (Moulding and Nelson 1988). Ferrel *et al.* (2002) and Piatkowski (2002) used a Lang penetrometer, as opposed to the cone-penetrometer, because readings are not influenced by the mass of the user. This is an issue when multiple people of varying mass and strength are conducting the measurements. Much of the variation in the compaction data could be due to variability inherent in the use of the cone-penetrometer itself. Ferrell *et al.* (2002) investigated the strengths and weaknesses of several different types of instruments that measure sediment compaction and shear resistance suggesting that other instruments may be more suitable for measuring beach compaction relative to sea turtle nesting behavior. Because of instrument error and given that turtles do not dig vertically in the same fashion as a penetrometer moves through the sediment layers, some have concluded that penetrometers are not appropriate for assessing turtle nesting limitations (Davis *et al.*, 1999). However, even with this limitation, the hand-held cone-penetrometer remains the accepted method for assessing post-nourishment beach hardness.

According to Davis *et al.* (1999), on the Gulf Coast of Florida (1) there was no relationship between turtle nesting and sediment compactness, (2) the compactness ranges and varies widely in both space and time with little rationale, (3) tilling has a temporary influence on compactness and no apparent influence on nesting frequency, (4) and current compactness thresholds of 500 psi are artificial. According to Brock (2005), the physical attributes of the fill sand for Brevard County beaches did not result in severe compaction and therefore did not physically impede turtles in their attempts to nest. Therefore, additional studies should be considered to evaluate the validity of this threshold (500 PSI) and its general application across all beaches as a means to assess beach-tilling requirements. If sediment characteristics are similar to the native beach and sediment grain sizes are homogenous, the resultant compaction levels will likely be similar to the native beach and tilling should not be encouraged. A study by Nelson and Dickerson (1988b) documented that a tilled nourished beach will remain un-compacted for up to one year; however, this was a site-specific study and for some beaches it may not be necessary to till beaches in the subsequent years following nourishment.

Beach hardness impacts can be minimized by using compatible sand in accordance with the new NC state Sediment Criteria Rule Language (15A NCAC 07H .0312) (http://dcm2.enr.state.nc.us/Rules/rules.htm). In some cases, though sediment placed on the beach is compatible with the native sediment characteristics and the resultant compaction is similar to the native beach, tilling is still encouraged regardless of compaction levels. It has been suggested that, in some cases, the process of tilling a beach, with compaction levels similar to native beach, may have an effect on sea turtle nesting behavior and nest incubation environment. Research on evaluating tilling impacts to nesting turtles is limited. Therefore, the idea of not tilling beaches (immediately following and/or during consecutive years after construction operations) where compatible sediments are used and compaction levels are similar to the native beach should be taken into consideration on a case-by-case basis in order to account for potential impacts of tilling activities on nest success.

Recognizing the recent literature on beach compaction measurements and associated tilling, as well as and the current concerns with the existing compaction evaluation and subsequent tilling process outlined in the USFWS general compaction guidelines, the Corps, in coordination with

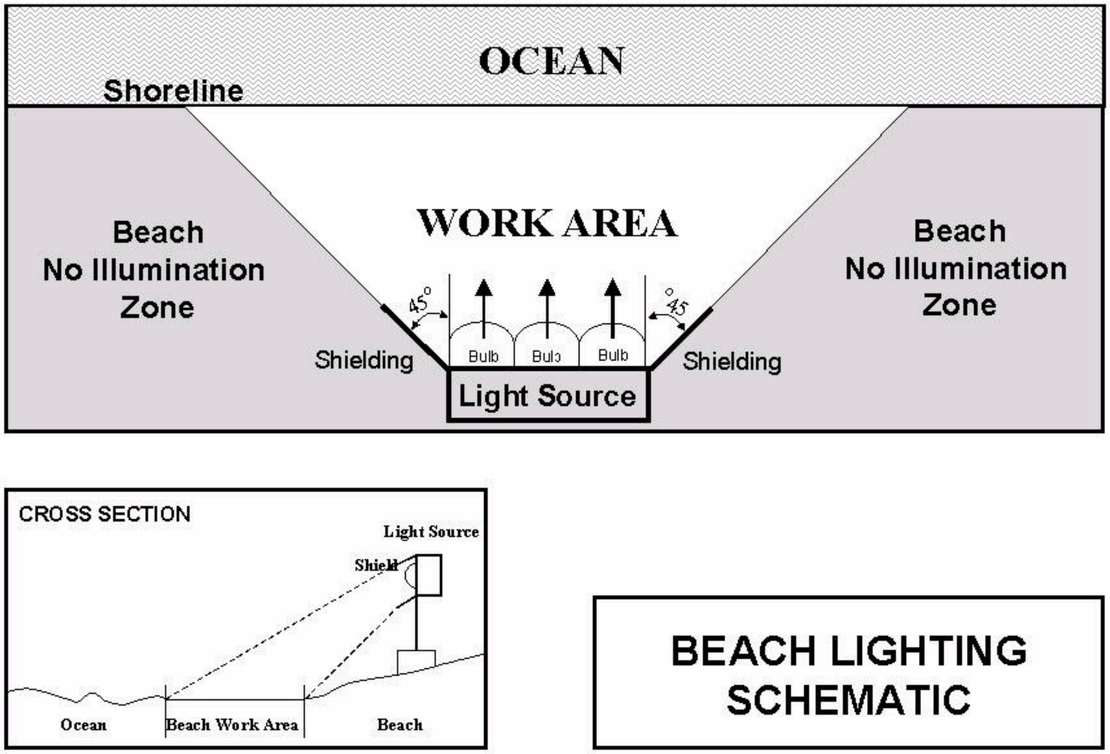
NCWRC and USFWS, has initiated a more qualitative approach for post construction compaction evaluations on North Carolina beaches where sediment meets the state compatibility standard. Results from this effort have recognized a reduction in the need for post construction tilling for many disposal and nourishment projects. Considering that only beach compatible sediment (i.e. in accordance with NC Sediment Criteria Rule Language) will be placed on the beach as a component of this project, the Corps will continue to work with NCWRC and USFWS in this qualitative post construction compaction and tilling evaluation in order to assure that impacts to nesting and incubating sea turtles are minimized.

f. Lighting.

The presence of artificial lighting on or within the vicinity of nesting beaches is detrimental to critical behavioral aspects of the nesting process including nesting female emergence, nest site selection, and the nocturnal sea-finding behavior of both hatchlings and nesting females. Artificial lighting on beaches tends to deter sea turtles from emerging from the sea to nest; thus, evidence of lighting impacts on nesting females is not likely to be revealed by nest to false crawl ratios considering that no emergence may occur (Mattison *et al*., 1993; Witherington, 1992; Raymond, 1984). Though nesting females prefer darker beaches (Salmon *et al*., 1995), considering the increased development and associated lighting on most beaches, many do nest on lighted shorelines. Although the effects of lighting may prevent female emergence, if emergence, nest site selection, and oviposition does occur, lighting does not affect nesting behavior (Witherington and Martin, 2003). However, sea turtles rely on vision to find the sea upon completion of the nesting process and use a balance of light intensity within their eyes to orient towards the brightest direction (Ehrenfeld, 1968); thus, misdirection by lighting may occur resulting in more time being spend to find the ocean. Furthermore, successful nesting episodes on lighted shorelines will directly effect the orientation and sea-finding process of hatchlings during the nest emergence and frenzy process to reach the ocean. Hatchlings rely almost exclusively on vision to orient to the ocean and brightness is a significant cue used during this immediate orientation process after hatch out (Mrosovsky and Kingsmill, 1985; Verheijen and Wilschut, 1973; Mrosovsky and Shettleworth, 1974; Mrosovsky *et al*., 1979). Hatchlings that are mis-oriented (oriented away from the most direct path to the ocean) or disoriented (lacking directed orientation or frequently changing direction or circling) from the sea by artificial lighting may die from exhaustion, dehydration, predation, and other causes. Though hatchlings use directional brightness of a natural light field (celestial sources) to orient to the sea, light from artificial sources interferes with the natural light cues resulting in misdirection (Witherington and Martin, 2003).

The impact of light on nesting females and hatchlings can be minimized by reducing the number and wattage of light sources or by modifying the direction of light sources through shielding, redirection, elevation modifications, etc. (Figure 1). If shielding of light sources is not effective, it is important that any light reaching the beach has spectral properties that are minimally disruptive to sea turtles like long wavelength light. The spectral properties of low-pressure sodium vapor lighting are the least disruptive to sea turtles among other commercially available light sources.

Figure 1. Schematic for recommended shielding of lighting associated with beach construction activities.



During beach placement construction operations associated with the proposed project, lighting is required during nighttime activities at both the pumpout site and the location on the beach where sediment is being placed. In compliance with the US Army Corps of Engineers Safety and Health Requirements Manual (2003), a minimum luminance of 30 lm/ft^2 is required for dredge operations and a minimum of 3 lm/ft^2 is required for construction activities on the beach. For dredging vessels, appropriate lighting is necessary to provide a safe working environment during nighttime activities on deck (i.e. general maintenance work deck, endangered species observers, etc.). During beach construction operations, lighting is generally associated with the active construction zone around outflow pipe and the use of heavy equipment in the construction zone (i.e. bulldozers) in order to maintain safe construction operations at night. Furthermore, on newly nourished beaches where the elevation of the beach berm is raised for coastal storm damage reduction purposes, it is possible that lighting impacts to nesting females and emerging hatchlings from adjacent lighting sources (streets, parking lots, hotels, etc) may become more problematic as shading from dunes, vegetation, etc. is not longer evident (Brock, 2005; Ehrhart and Roberts, 2001). In a study on Brevard county beaches, Brock (2005) found that loggerhead hatchling disorientations increased significantly post-nourishment. This was attributed to the increase in light sources not previously visible to be seen by hatchlings as a result of the increase in profile elevation combined with an easterly expansion of the beach. However, a dune feature will be constructed as a component of this project and is, therefore, expected to reduce lighting impacts to nesting and hatchling sea turtles that are associated with raising the beach elevation.

If beach construction activities extend into the sea turtle nesting and hatching season, all lighting associated with project construction will be minimized to the maximum extent practicable while maintaining compliance with all Corps, U.S. Coast Guard, and OSHA safety requirements. Direct lighting of the beach and near shore waters will be limited the immediate construction area(s). Lighting aboard dredges and associated vessels, barges, etc. operating near the sea turtle nesting beach shall be limited to the minimal lighting necessary to comply with the Corps, U.S. Coast Guard, and OSHA requirements. Lighting on offshore or onshore equipment will be minimized through reduced wattage, shielding, lowering, and/or use of low pressure sodium lights, in order to reduce illumination of adjacent beach and nearshore waters will be used to the extent practicable.

The use of sea turtle friendly lighting has been shown to significantly improve beaches for sea turtle nesting. Therefore, in conjunction with the proposed beach project, local lighting ordinances will be encouraged to the maximum extent practicable in order to reduce lighting impacts to nesting females and hatchlings.The local sponsors will be encouraged to work with the USFWS, local monitoring groups, and other concerned organizations to develop the best plan for the Towns of Surf City and North Topsail Beach.

(2) Dredging Impacts.

a. Food Supply.

After leaving the nesting beach, hatchling green and loggerhead turtles head towards the open ocean pelagic habitats (Carr, 1987) where their diet is mostly omnivorous with a strong carnivorous tendency in green turtles (Bjorndal, 1985). At about 20-25 cm carapace length Atlantic green turtles enter benthic foraging areas and shift to an herbivorous diet, feeding predominantly on sea grasses and algae but may also feed over coral reefs and rocky bottoms (Mortimer, 1982). At about 40 to 50 cm carapace length, loggerheads move into shallow water where they forage over benthic hard and soft bottom habitats (Carr, 1986). Loggerhead sea turtles feed on benthic invertebrates including mollusks, crustaceans, and sponges (Mortimer, 1982) but have also been found to eat fish, clams, oysters, sponges, jellyfish, shrimp, and crabs when near shore. Hawksbill and Kemp's ridley sea turtles are carnivorous (Mortimer, 1995) with a principal food source of crustaceans, mollusks, other invertebrates, and fish (Schwartz, 1977). Hawksbills feed on encrusting organisms such as sponges, tunicates, bryozoans, mollusks, and algae; whereas Kemp's ridleys feed predominantly on portunid crabs (Bjomdal, 1985). Leatherback sea turtles are carnivorous (Mortimer, 1995) and feed primarily on cnidarians and tunicates (salps, pyrosomas) throughout the water column but are commonly observed feeding at the surface (Bjorndal, 1985).

Dredging will be performed within offshore borrow areas located approximately 1 to 6 miles offshore and will not affect these resources in the inshore environment. Impacts on benthic habitat at the offshore borrow sites will be minor as dredging will only affect a limited portion of the offshore benthic habitat. Hardbottom surveys and subsequent mapping were performed within all proposed borrow sites and diver ground truth surveys were performed to characterize select sites. Dredging buffers of 400 ft for low relief and 500 m for moderate and high relief hard bottom systems will be adhered to in order to avoid impacts to hard bottom associated foraging habitat. Impacts to sandy bottom foraging habitat are expected to be isolated and short term in duration. Therefore, the project should not significantly affect the food supply of benthic foraging sea turtles in the offshore borrow sites. Considering that leatherbacks feed primarily within the water column on non-benthic organisms, the project should not significantly affect the food supply of this species

b. Relationship to Critical Periods in Life Cycle.

Sea turtles migrate within North Carolina waters throughout the year, mostly between April and December. The dredging of sediment from designated borrow sites during initial construction and each nourishment interval will be performed using a hopper dredge. Hopper dredges potentially pose the greatest risk to benthic oriented sea turtles through physical injury or death by entrainment as the hopper dredge dragheads remove sediment from sea bottom.

In order to minimize potential impacts, hopper dredges will be used from 1 December to 31 March of any year when water temperatures are cooler and sea turtle abundance is low, generally <14°C (57.2°F). However, because some sea turtle species may be found year-round in the offshore area, hopper-dredging activities may occur during low levels of sea turtle migration. Therefore, the proposed hopper dredging activities may adversely effect loggerhead, green, hawksbill, and Kemp's ridley sea turtles. Based on historic hopper dredging take data, leatherback sea turtles are not known to be impacted by hopper dredging operations. The Corps will abide by the provisions of the September 25, 1997 Regional Biological Opinion for The Continued Hopper Dredging Of Channels And Borrow Areas In The Southeastern United States or any superseding RBO provided by NMFS. To reduce impacts, the Corps anticipates taking certain precautions as prescribed by NMFS and USACE under standard hopper dredging protocol and will maintain observers on hopper dredges for the periods prescribed by NMFS to document any takes of turtle species and to ensure that turtle deflector dragheads are used properly.

(3) Summary Effect Determination.

All five species are known to occur within oceanic waters of the proposed project borrow areas; however, only the loggerhead, green, and leatherback sea turtles are known to nest within the limits of the project beach placement area. Therefore, species specific impacts may occur from both the beach placement and dredging operations. Considering the proposed dredging window to avoid the sea turtle nesting season to the maximum extent practicable, the proposed project may affect but is not likely to adversely affect nesting loggerhead, green, and leatherback sea turtles by altering nesting habitat. Though significant alterations in beach substrate properties may occur with the input of sediment types from other sources, re-establishment of a berm and dune system with a gradual slope can enhance nesting success of sea turtles by expanding the available nesting habitat beyond erosion and inundation prone areas. As previously stated, in regards to suitability for nesting, turtles continue to nest on disposal beaches of Topsail Island with hatch rate successes similar to non-disposal beaches (Jean Beasley, pers. comm.).

The proposed hopper dredging activities for initial construction, as well as each nourishment interval, may occur in areas used by migrating turtles. Hopper dredges pose risk to benthic oriented sea turtles through physical injury or death by entrainment. Though the 1 December to 31 March dredging window will avoid periods of peak turtle abundance during the warm water months, the risk of lethal impacts still exist as some sea turtle species may be found year-round in the offshore area. Therefore, the proposed hopper dredging activities may adversely affect loggerhead, green, hawksbill, and Kemp's ridley sea turtles. Based on historic hopper dredging take data, leatherback sea turtles are not known to be impacted by hopper dredging operations.

3.02.6 Shortnose Sturgeon

Detailed life history information associated with the the life cycle requirements for shortnose sturgeon and a subsequent analysis of impacts from the proposed dredging activities are provided within the following Section 7 consultation documents:

National Marine Fisheries Service. 1997. Regional Biological Opinion for the Continued Hopper Dredging of Channels and Borrow Areas in the Southeastern United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Silver Spring, Maryland

USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE, Wilmington District. Submitted to NMFS on 12 September 2008

A summary of project specific information and associated impacts is provided in the ensuing text.

a. Status. Endangered

b. Occurrence in Immediate Project Vicinity. Populations of shortnose sturgeon range along the Atlantic seaboard from the Saint John River in New Brunswick, Canada to the Saint Johns River, Florida (USFWS, 1999b). It is apparent from historical accounts that this species may have once been fairly abundant throughout North Carolina's waters; however, many of these early records are unreliable due to confusion between this species and the Atlantic sturgeon (*Acipenser oxyrhynchus*). There are historical records of the shortnose sturgeon both in Albemarle Sound and the nearshore ocean (Dadswell, *et al*., 1984). However, in the recent past, this species was thought to be extirpated from North Carolina (Schwartz, *et al*., 1977). During the winter of 1986-87, the shortnose sturgeon was taken from the Brunswick River, a component of the Cape Fear River basin. With this discovery, the species is once again considered to be a part of the state's fauna; however, there are still no recent records of the species within the New River inlet vicinity of the project area (F. Rhode 2008, pers. comm.). Because of the lack of suitable freshwater spawning areas in the project area and the requirement of low salinity waters by juveniles, any shortnose sturgeons present would most likely be non-spawning adults (NMFS, 1998).

c. Current Threats to Continued Use of the Area. Pollution, blockage of traditional spawning grounds, and over fishing are generally considered to be the principal causes of the decline of this species. The prohibition by North Carolina Division of Marine Fisheries (NCDMF) on taking any sturgeon in North Carolina should help to protect the species from commercial and recreational fishing pressure.

d. Project Impacts.

(1) Habitat.

The shortnose sturgeon is principally a riverine species and is known to use three distinct portions of river systems: (1) non-tidal freshwater areas for spawning and occasional over wintering; (2) tidal areas in the vicinity of the fresh/saltwater mixing zone, year-round as juveniles and during the summer months as adults; and (3) high salinity estuarine areas (15 parts per thousand (ppt.) salinity or greater) as adults during the winter. Habitat conditions suitable for juvenile and adult shortnose sturgeon could occur within the project area; however, spawning habitat should lie well outside of the project area and should not be affected by this project. The presence of juvenile shortnose sturgeon is not likely due to high salinity. Adults are found in shallow to deep water (6 to 30 feet) and, if present, would be expected to occupy the deeper channels during the day and the shallower areas adjacent to the channel during the night (Dadswell *et al*., 1984).

(2) Food Supply.

The shortnose sturgeon is a bottom feeder, consuming various invertebrates and stems and leaves of macrophytes. Adult foraging activities normally occur at night in shallow water areas adjacent to the deep-water areas occupied during the day. Juveniles are not known to leave deep-water areas and are expected to feed there.

Dredging for this project will occur at borrow sites located between 1-6 miles offshore; therefore, shallow water feeding areas will not be affected by the project.

(3) Effect Determination.

Although hopper dredges have been known to impact shortnose sturgeons, dredging for this project will occur in offshore environments, outside of its habitat range. Therefore, impacts from dredges are not anticipated to occur. Because of the unlikelihood of shortnose sturgeon being present in the project area (Fritz Rhode 2008, pers.comm.) and since dredging will occur in the offshore environment, it has been determined that the actions of the proposed project are not likely to adversely affect the shortnose sturgeon.

3.02.7 Seabeach Amaranth

a. Status. Threatened

b. Occurrence in Immediate Project Vicinity. Seabeach amaranth is an annual or sometimes perennial plant that usually grows between the seaward toe of the dune and the limit of the wave uprush zone occupying elevations ranging from 0.2 to 1.5 m above mean high tide (Weakly and Bucher, 1992). Greatest concentrations of seabeach amaranth occur near inlet areas of barrier islands, but in favorable years many plants may occur away from inlet areas. It is considered a pioneer species of accreting shorelines, stable foredune areas, and overwash fans (Weakly and Bucher, 1992; Hancock and Hosier, 2003). Seed dispersal of seabeach amaranth is achieved in a number of ways, including water and wind dispersal (USFWS, 1995).

Historically, seabeach amaranth was found from Massachusetts to South Carolina, but according to recent surveys (USACE 1992-2004), its distribution is now restricted to North and South Carolina with several populations on Long Island, New York. The decline of this species is caused mainly by development of its habitat, such as inlet areas and barrier islands, and increased ORV and human traffic, which tramples individual plants (Fussell, 1996).

Seabeach amaranth surveys have been performed on the northern 3.8 miles of North Topsail Beach since 1992; however, surveys were not conducted along the southern limits of North Topsail Beach (~8.0 miles) or Surf City (~5.5) miles) until 2006. Based on the available data, a total of 24,369 plants have been recorded throughout the towns of North Topsail Beach and Surf City for all years surveyed (Table 4). Hurricanes, long term shoreline erosion, and subsequent habitat loss, have likely played a role in the reduction in plant numbers on North Topsail Beach from 2001-2008.

Table 4. Annual seabeach amaranth survey results (1992-2008) at North Topsail Beach and Surf City, NC.

County	Beach Name	Sub-Part (Reach)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total All Yrs
			TOTAL AMARANTHUS PLANT COUNT BY YEAR																	
Onslow	North Topsail Beach	A	247	231	925	819	578	1	548	32	117	1,344	433	493	248	381	1	18	68	6,484
Onslow	" "	B	237	72	375	96	142	0	1,300	57	^ ^ ^	590	188	117	12	5	3	5	18	3,217
Onslow	" "	C	939	821	293	10,214	1,068	21	758	29	^ ^ ^	173	2	33	4	0	0	0	3	14,358
Onslow	" "	D	1	0	0	0	0	0	36	5	^ ^ ^	0	0	0	0	0	1	0	0	43
Onslow	" "	A1															0	63	66	129
Onslow	" "	A2															5	8	66	79
Onslow	" "	A3															3	37	11	51
Pender	Surf City	A															0	0	4	4
Pender		B															0	0	4	4
Pender		C															0	0	0	0
NOTES:			1,424	1,124	1,593	11,129	1,788	22	2,642	123	117	2,107	623	643	264	386	13	131	240	24,369

(blank box)	= Not surveyed
^ ^ ^	= Count combined in reach above
(green box)	= Year of hurricane impact
(blue box)	= Count exceeding 1,000 Amaranthus
(orange box)	= New Reach 2006

Since sea beach amaranth seeds are fairly resilient and germination is dependent on critical physical conditions, populations of seabeach amaranth are very dynamic with numbers of plants fluctuating dramatically from year to year. Germination begins in April as temperatures reach about 25ºC (77ºF) and continues at least through July with greatest germination occurring at 35ºC (95ºF) (USFWS, 1996b; Hancock and Hosier, 2003). Seed production begins in July or August, peaks in September, and continues until the plant dies (USFWS, 1996b). According to Hancock and Hosier (2003) sea beach amaranth is physically controlled (salt water inundation, temperature, emergence at depth, etc.) rather than biologically controlled (web worm). Furthermore, seedlings are unable to emerge from depths greater than 1cm; however, seabeach amaranth seeds are resilient, and century–old seeds of some species of amaranth are capable of successful germination and growth (USFWS, 1996b).

c. Current Threats to Continued Occurrence in the Project Area.

Seabeach amaranth has been eliminated from approximately two-thirds of its historic range. Habitat loss and degradation are the greatest threats to the continued existence of seabeach amaranth with localized herbivory by webworms also contributing to mortality in North Carolina. Though beach stabilization efforts are thought to be a leading contributor to the decrease in the population (USFWS, 1996b), new populations have been observed to follow sand placement on beaches where sand has been disposed by the Corps of Engineers (ex. Wrightsville Beach and Bogue Banks) (USFWS, 1996b; CSE, 2004). Seabeach amaranth is dependent on terrestrial, upper beach habitat that is not flooded during the growing season from May in to the fall. Therefore, beach erosion is probably the primary threat to the continued presence in the area. Furthermore, beach bulldozing is common practice on Topsail Beach and in many cases may add to the existing erosion problem and loss of seabeach amaranth habitat.

d. Project Impacts.

(1) Habitat.

The berm and dune project extends along a reach of 52,150 feet. On the north end, the project will adjoin an adjacent non-Federal beachfill project for North Topsail Beach. The proposed project limits avoids the northern portion of North Topsail Beach where historic survey data indicate amaranth most commonly occurs. The beachfront within the project limits is currently conducive to the growth of seabeach amaranth; however, due to high erosion rates and inundation from storm events its available habitat is deteriorating. Beach nourishment would have initial impacts through burial of existing plants and seeds; however, much of the habitat requirements for seabeach amaranth lost to erosion will be restored.

(2) Relationship to Critical Periods in Life Cycle.

Beach nourishment will be conducted outside of the germination and growing period. Initial construction and each nourishment event will be performed using a hopper dredge from 1 December through 31 March. If dredging takes place in the winter when only seabeach amaranth seeds are present, the direct impacts on individual plants will be avoided; however, burying seeds during any season could effect the population. While such construction is not an ideal management practice for the species, the restoration of the habitat is of prime importance. Beach nourishment rebuilds habitat for seabeach amaranth and can have long-term benefits (USFWS, 1996b). The project area would be included in the USACE seabeach amaranth monitoring program during the summertime growing season for the life of the beachfill.

(3) Effect Determination. Beach nourishment will restore much of the existing habitat lost to erosion and is expected to provide long-term benefits to seabeach amaranth; however, construction and deep burial of seeds on a portion of the beaches during project construction may slow germination and population recovery over the short-term. Therefore, the project may affect, but is not likely to adversely affect seabeach amaranth.

3.02.8 Piping Plover

a. Status. Threatened

b. Occurrence in Immediate Project Vicinity: The Atlantic Coast piping plover population breeds on coastal beaches from Newfoundland to North Carolina (and occasionally in South Carolina) and winters along the Atlantic Coast (from North Carolina south), the Gulf Coast, and in the Caribbean where they spend a majority of their time foraging. Since being listed as threatened in 1986, only 800 pairs were known to exist in the three major populations combined and by 1995 the number of detected breeding pairs increased to 1,350. This population increase can most likely be attributed to increased survey efforts and implementation of recovery plans (Mitchell *et. al*., 2000).

Piping plovers are known to nest in low numbers in widely scattered localities on North Carolina's beaches. The species typically nests in sand depressions on unvegetated portions of the beach above the high tide line on sand flats at the ends of sand spits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, sparsely vegetated dunes, and washover areas cut into or between dunes. Piping plovers head to their breeding grounds in late March or early April (http://pipingplover.fws.gov/overview.html) and nesting usually begins in late April; however, nests have been found as late as July (Potter, *et al*., 1980; Golder, 1985). During a statewide survey conducted in 1988, 40 breeding pairs of piping plovers were located in North Carolina. LeGrand (1984a) states that "all of the pipings in the state nest on natural beachfronts, both completely away from human habitation and [yet] in moderate proximity to man". The largest reported nesting concentration of the species in the State appears to be on Portsmouth Island where 19 nests were discovered in 1983 by John Fussell (LeGrand, 1983). The southernmost nesting record for the state was one nest located in Sunset Beach by Phillip Crutchfield in 1983 (LeGrand, 1984b). Feeding areas include intertidal portions of ocean beaches, washover areas, mud flats, sand flats, wrack lines, and shorelines of coastal ponds, lagoons, or salt marshes (USFWS, 1996a). Prey consist of worms, fly larvae, beetles, crustaceans, mollusks, and other invertebrates (Bent, 1928).

The piping plover is a fairly common winter resident along the beaches of North Carolina (Potter *et al*., 1980). On 10 July 2001, the USFWS designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for the wintering population of the piping plover where they spend up to 10 months of each year on the wintering grounds. Constituent elements for the piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The USFWS has defined textual unit descriptions to designate areas within the critical habitat boundary. These units describe the geography of the area using reference points, include the areas from the landward boundaries to the MLLW, and may describe other areas within the unit that are utilized by the piping plover and contain the primary constituent elements. Though no units are designated within the immediate project area, unit NC-11 is designated at the southern end of Topsail Beach on Topsail Island. Unit NC-11 encompasses approximately 1114 acres in Pender and New Hanover counties extending southwest from 1.0 km northeast of MLLW of New Topsail Inlet on Topsail Island to 0.53 km southwest of MLLW of Rich Inlet on Figure Eight Island. This unit includes Topsail Inlet and associated lands including emergent sandbars, from MLLW on Atlantic Ocean and sound side to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur. In Topsail Sound, the unit stops as the entrance to tidal creeks become narrow and channelized (Federal Register/Vol. 66, No 132, July 10, 2001).

Most piping plovers on Topsail Island have been observed as predominantly migratory and winter residents utilizing intertidal flats exposed at low tide for feeding and roosting; however, two breeding pairs have been observed on North Topsail Beach (Table 5). Based on survey data conducted since 1989 (annual nesting habitat surveys, coast-wide wintering surveys, and opportunistic surveys) a total of 11 piping plovers have been identified within the project vicinity.

Table 5. Piping plover observations based on nesting habitat annual surveys conducted since 1989, coast-wide wintering surveys conducted on select years (most recently in 1996, 2001, and 2006), and opportunistic surveys.

Location	Survey Date	Season	Number of Birds	Number of Breeding Pairs
North Topsail Beach - New River Inlet	7/1/1992	Breeding	2	1
North Topsail Beach	7/1/1993	Breeding	2	1
North Topsail Beach - New River Inlet	4/30/2000	Spring Migration	2	NA
North Topsail Beach	10/18/2000	Fall Migration	1	0
North Topsail Beach - New River Inlet	9/8/2001	Fall Migration	1	0
North Topsail Beach	9/2/2004	Fall Migration	2	NA
North Topsail Beach - New River Inlet	8/26/2008	Fall Migration	1	NA

c. Current Threats to Continued Use of the Area. Loss and degradation of habitat due to development and shoreline stabilization have been major contributors to the decline of piping plovers. The current commercial, residential, and recreational development has decreased the amount of coastal habitat available for piping plovers to nest, roost, and feed. Specifically on

North Topsail Beach, nesting habitat continues to be degraded. Washover habitat that was created after Hurricane Fran in 1996 has since been developed with residential homes resulting in a continued decrease in nesting habitat availability. Additionally, nesting habitat along the northern end of North Topsail beach, adjacent to New River Inlet, continues to be eroded away as result of the recent southwesterly shift of New River Inlet and the subsequent erosion towards the residential structures. Furthermore, long and short-term coastal erosion and the abundance of predators, including wild and domestic animals as well as feral cats, have further diminished the potential for successful nesting of this species. Since project beaches are wintering area for the piping plover, the major threat to its occupation of the area during the winter months would be continued degradation of beach foraging habitat. Similar degradation of beaches elsewhere could be a contributing element to declines in the state's nesting population.

d. Project Impacts.

(1) Habitat. The existing shorelines of Surf City and North Topsail Beaches are heavily developed and are experiencing significant shoreline erosion. Piping plover breeding territories on the Atlantic Coast typically include a feeding area along expansive sand or mudflats in close proximity to a sandy beach that is slightly elevated and sparsely vegetated for roosting and nesting (http://nc-es.fws.gov/birds/pipiplov.html). As erosion and development persist, piping plover breeding, nesting, roosting, and foraging habitat loss continues. Habitat loss from development and shoreline erosion and heavy public use has led to the degradation of piping plover habitat in the project area. The enhancement of beach habitat through the addition of beach fill may potentially restore lost roosting and nesting habitat; however, short-term impacts to foraging and roosting habitat may occur during project construction.

Initial construction and each periodic nourishment cycle will be performed using a hopper dredge and will adhere to a 1 December to 31 March dredging window. Since piping plovers head to their breeding grounds in late March and nesting occurs in late April, project initial construction and nourishment events will avoid impacts to breeding and nesting piping plovers to the maximum extent practicable. Additionally, the project construction limits do not extend into the high valued habitat located adjacent to New River Inlet at the North end of North Topsail Beach and will therefore avoid this documented nesting habitat. However, wintering habitat for roosting and foraging may be impacted. Direct short-term foraging habitat losses will occur during construction of the project fill. Since only a small portion of the foraging habitat is directly affected at any point in time during pumpout and adjacent habitat is still available, overall direct loss of foraging habitat will be minimal and short-term. Additionally, complete initial project construction template will be completed in four sections; therefore, un-impacted or recovered foraging habitat will be available throughout the duration of the initial construction period.

The selected plan consists of a sand dune constructed to an elevation of 15 feet above NGVD fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD. Piping plover nesting habitat includes blowout areas behind primary dunes as well as washover areas cut into or between dunes. The size and shape of the constructed dune may minimize the frequency of sand washover areas and subsequent nesting habitat availability. However, the project area is heavily developed already and based on the post-storm development response evidenced by Hurricane Fran, the washover fans created by large storm events are quickly re-developed by land owners. Due to the current development practices within the project area, the formation of these washover features will not be sustained in a similar fashion to undeveloped barrier islands; rather, it is anticipated that, without the proposed project, these washover features would be located on private (private residences) or state (NC Department of Transportation) owned property and would be cleared or built upon in order to re-establish the community to the pre-storm condition. Existing undeveloped habitat located adjacent to New River Inlet will not be impacted by the project.

(2) Food Supply. Piping plovers feed along beaches and intertidal mud and sand flats. Primary prey includes polychaete worms, crustaceans, insects, and bivalves. According to Section 8.01.6 of the EIS, the benthic invertebrate community will suffer short-term impacts from the placement of sediment on the beach; thus, a diminished prey base will subsequently impact piping plovers over the short term. However, only a portion of the beach is affected at any point in time (approximately 4-5,000 feet per month). Once construction passes that point, recruitment from adjacent beaches can begin. Therefore, un-impacted or recovering foraging habitat on Surf City and North Topsail beaches will be available throughout the duration of the project.

(3) Relationship to Critical Periods in Life Cycle. Beach placement of sand derived from identified borrow sites is expected to occur from 1 December to 31 March during initial construction and each periodic nourishment interval. Therefore, the breeding and nesting season will be avoided. However, foraging, sheltering, and roosting habitat may be temporarily impacted.

(4) Effect Determination. The long-term effects of the project may restore lost roosting and nesting habitat through the addition of beach fill; however, short-term impacts to foraging, sheltering, roosting habitat may occur during project construction. Therefore, it has been determined that the project may affect, but is not likely to adversely affect the piping plover.

3.02.9 Smalltooth Sawfish

Detailed life history information associated with the life cycle requirements for smalltooth sawfish and a subsequent analysis of impacts from the proposed dredging activities are provided within the following Section 7 consultation document:

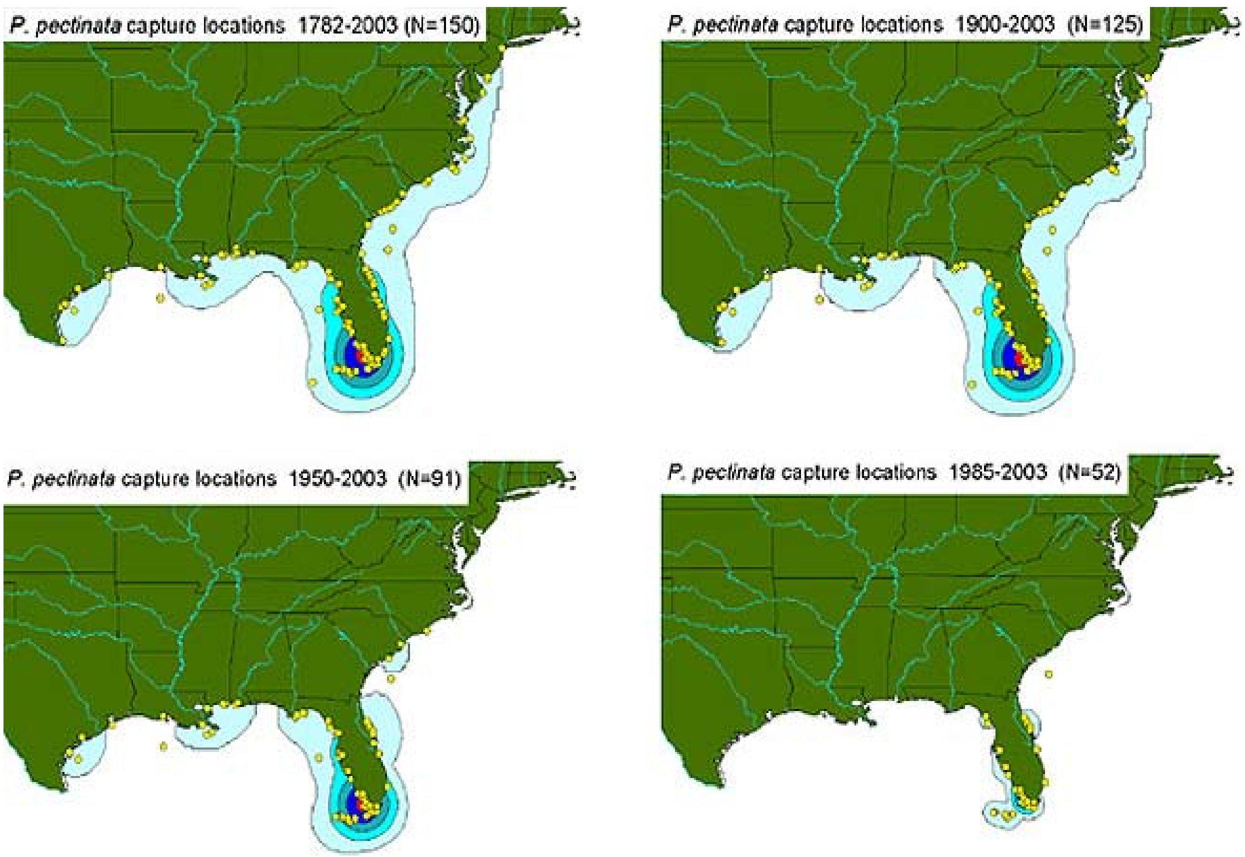
USACE. September 2008. Regional Biological Assessment for Dredging Activities in the Coastal Waters, Navigation Channels (including designated Ocean Dredged Material Disposal Sites (ODMDS)), and Sand Mining Areas in the South Atlantic Ocean. USACE,Wilmington District. Submitted to NMFS on 12 September 2008

A summary of project specific information and associated impacts is provided in the ensuing text.

a. Status. Endangered. The U.S. smalltooth sawfish distinct population segment (DPS) was listed as endangered under the ESA on April 1, 2003 (68 FR 15674) and is the first marine fish to be listed in the United States.

b. Occurrence in Immediate Project Vicinity. Historic records suggest that during the 19th century the smalltooth sawfish was a common resident of the Atlantic and Gulf coastal waters of the southeastern United States. Throughout the 20th century it was recorded with declining frequency and today it can be no longer considered a functional member of the nearshore coastal community of the northwest Atlantic. Historic records indicate that the smalltooth sawfish abundantly occurred in the mid-Atlantic region only during the summer months (Adams and Wilson, 1995). The smalltooth sawfish range has subsequently contracted to peninsular Florida and, within that area, can only be found with any regularity off the extreme southern portion of the state between the Caloosahatchee River and the Florida Keys (Figure 2). Smalltooth sawfish are most common within the boundaries of the National Everglades National Park and the Florida Keys, and become less common with increasing distance from this area (Simpfendorfer, 2002).

Figure 2. Historic and Current Distribution of Smalltooth Sawfish in the U.S. (Burgess *et al.,* 2003).



c. Current Threats to Continued Use of the Area. The principal habitats for smalltooth sawfish in the southeast U.S. are the shallow coastal areas and estuaries, with some specimens moving upriver in freshwater (Bigelow and Schroeder, 1953). The continued urbanization of the southeastern coastal states has resulted in substantial loss of coastal habitat through such activities as agricultural and urban development; commercial activities; dredge and fill operations; boating; erosion and diversions of freshwater run-off (SAFMC, 1998). Smalltooth sawfish may be especially vulnerable to coastal habitat degradation due to their affinity to shallow, estuarine systems. Smalltooth sawfish have historically been caught as by-catch in various fishing gears throughout their historic range, including gillnet, otter trawl, trammel net, seine, and to a lesser degree, hand line. Today, they are occasionally incidentally caught in commercial shrimp trawls, bottom longlines, and by recreational rod-and-reel gear. With the K-selected life history strategy of smalltooth sawfish, including slow growth, late maturation, and low fecundity, long-term commitments to habitat protection are necessary for the eventual recovery of the species. A complete review of the factors contributing to the decline of the smalltooth sawfish can be found in the "Status Review of Smalltooth Sawfish (*Pristis pectinata*)", (NMFS, 2000). The Draft Recovery plan for smalltooth sawfish (NMFS, 2006) also presents a detailed threats assessment with four major categories of threats: 1) Pollution; 2) Habitat degradation or loss; 3) Direct injury and 4) Fisheries Interactions. Neither of these discussions will be repeated in detail in this assessment, but are incorporated herein by reference.

d. Project Impacts. As identified in the August 2006 Draft Smalltooth Sawfish Recovery Plan, "habitat effects of dredging include the loss of submerged habitats by disposal of excavated materials, turbidity and siltation effects, contaminant release, alteration of hydrodynamic regimes, and fragmentation of physical habitats (SAFMC, 1998). Cumulatively, these effects have degraded habitat areas for smalltooth sawfish." The current range of sawfish has contracted to peninsular Florida and can only be found with any regularity off the extreme southern portion of the state. Smalltooth sawfish occur in shallow estuarine environments and juvenile sawfish are particularly dependent on mangrove habitat.

In the GRBO issued by NMFS on November 19, 2003 (as amended in 2005 and 2007), in the section entitled "Species Not Likely to Be Affected," NMFS concludes the following: "Smalltooth sawfish (*Pristis pectinata*) are tropical marine and estuarine fish that have the northwestern terminus of their Atlantic range in the waters of the eastern U.S. Currently, their distribution has contracted to peninsular Florida and, within that area, they can only be found with any regularity off the extreme southern portion of the state. The current distribution is centered in the Everglades National Park, including Florida Bay. They have been historically caught as by-catch in commercial and recreational fisheries throughout their historic range; however, such by-catch is now rare due to population declines and population extirpations. Between 1990 and 1999, only four documented takes of smalltooth sawfish occurred in shrimp trawls in Florida (Simpfendorfer, 2000). After consultation with individuals with many years in the business of providing qualified observers to the hopper dredge industry to monitor incoming dredged material for endangered species remains (C. Slay, Coastwise Consulting, pers. comm. August 18, 2003) and a review of the available scientific literature, NOAA Fisheries determined that there has never been a reported take of a smalltooth sawfish by a hopper dredge, and such take is unlikely to occur because of smalltooth sawfishes affinity for shallow, estuarine systems."

(e) Effect Determination. Based on the current South Atlantic distribution of smalltooth sawfish and only one sighting in North Carolina since 1999, hopper dredge impacts to smalltooth sawfish within the project area are unlikely. Additionally, the take of a smalltooth sawfish by a hopper dredge is unlikely considering the smalltooth sawfishes affinity for shallow, estuarine systems as well as the fact that there has never been a reported take of a smalltooth sawfish by a hopper dredge. Therefore, hopper dredge activities associated with this project are not likely to adversely affect smalltooth sawfish.

4.00 COMMITMENTS TO REDUCE IMPACTS TO LISTED SPECIES

The following is a summary of environmental commitments to protect listed species related to the construction and maintenance of the proposed project. These commitments address agreements with resource agencies, mitigation measures, and construction practices:

1. The Corps will strictly adhere to all conditions outlined in the most current National Marine Fisheries Service RBO for dredging of channels and borrow areas in the southeastern United States. Furthermore, as a component of this project, hopper dredging activities for both initial construction and each nourishment interval will adhere, to the maximum extent practicable, to a dredging window of 1 December to 31 March in order to avoid periods of peak sea turtle abundance. The use of turtle deflecting dragheads, inflow and/or overflow screening, and NMFS certified turtle and whale observers will also be implemented.

2. In order to determine the potential taking of whales, turtles and other species by hopper dredges, NMFS certified observers will be on board during all hopper dredging activities. Recording and reporting procedures will be in accordance with the conditions of the current NMFS RBO.

3. Endangered species observers (ESOs) will be on board all hopper dredges and will record all large whale sightings and note any potential behavioral impacts. The Corps and the Contractor will keep the date, time, and approximate location of all marine mammal sightings. Care will be taken not to closely approach (within 300 feet) any whales, manatees, or other marine mammals during dredging operations or transportation of dredged material. An observer will serve as a lookout to alert the dredge operator and/or vessel pilot of the occurrence of these animals. If any marine mammals are observed during other dredging operations, including vessel movements and transit to the dredged material disposal site, collisions shall be avoided either through reduced vessel speed, course alteration, or both.

4. The Corps will avoid the sea turtle nesting season during initial construction and each nourishment interval. If, due to unforeseen circumstances, construction extends into the nesting season, the Corps will implement a sea turtle nest monitoring and avoidance/relocation plan through coordination with USFWS and NCWRC.

5. Monitoring of sea turtle nesting activities in beach nourishment areas will be required to assess post nourishment nesting activity. This will include daily surveys beginning at sunrise from May 1 until September 15. Information on false crawl location, nest location, and hatching success of all nests will be recorded and provided to NCWRC.

6. The beach will be monitored for escarpment formation by the Contractor prior to completion of beach construction activities associated with initial construction and each nourishment interval. Additionally, the beach will be monitored by the local sponsor for escarpment formation prior to each turtle nesting season every year between nourishment events. Escarpments which exceed 18 inches in height for a distance of 100 ft. will be leveled by the Contractor or local sponsor accordingly. If it is determined that escarpment leveling is required during the nesting or hatching season, leveling actions should be directed by the USFWS

7. Only beach compatible sediment will be placed on the beach as a component of this project. Post nourishment beach compaction (hardness) will be evaluated by the Corps, in coordination with the NCWRC and USFWS, using qualitative assessment techniques to assure that impacts to nesting and incubating sea turtles are minimized and, if necessary, identify appropriate mitigation responses.

8. Local lighting ordinances will be encouraged to the maximum extent practicable in order to reduce lighting impacts to nesting females and hatchlings. The local sponsors will be encouraged to work with the USFWS, local monitoring groups, and other concerned organizations to develop the best plan for the Towns of Surf City and North Topsail Beach.

9. Throughout the duration of each nourishment event, both initial construction and periodic nourishment, the Contractor will be required to monitor for the presence of stranded sea turtles, live or dead. If a stranded sea turtle is identified, the Contractor will immediately notify the NCWRC of the stranding and implement the appropriate measures, as directed by the NCWRC. Construction activities will be modified appropriately as not to interfere with stranded animals, live or dead.

10. In order to better understand the threshold of sediment color change and resultant heat conduction from nourishment on temperature dependent sex determination of sea turtles, the Corps will monitor nest temperatures in the project area during the nesting season following initial construction. This data will be compared to non-nourished native sediment temperatures in order to support development of management criteria for sediment color guidelines.

11. In order to assess the abundance of sea turtles, and potential risk of hopper dredge take, within the proposed borrow areas for this project, the Corps will participate in the NCWRC's current satellite telemetry efforts to track the distribution and habitat usage of sea turtles in NC offshore waters.

12. Monitoring for seabeach amaranth on Surf City and North Topsail Beaches will be implemented in the growing season following initial construction to assess the post nourishment presence of plants. This survey will broken down into survey reaches for each town in accordance with the designated USACE sea beach amaranth survey reaches from 1991-2008 in order to maintain consistent data and survey techniques over time and results will be provided to USFWS

13. The Corps will implement precautionary measures for avoiding impacts to manatees during construction activities as detailed in the "Guidelines for Avoiding Impacts to the West Indian Manatee in North Carolina Waters" established by the USFWS.

14. The Corps will adhere to appropriate environmental windows for piping plovers and other shorebirds to the maximum extent practicable.

15. All staging areas, pipeline routes, and associated construction activities will avoid high value piping plover and shorebird habitat, located within the vicinity of New River Inlet, to the maximum extent practicable.

5.00 SUMMARY EFFECT DETERMINATION

Threatened and endangered species summary effect determination for beach placement and dredging activities associated with the proposed project area (No Effect (NE – green); May Affect Not Likely to Adversely Affect (MANLAA – orange); and May Affect Likely to Adversely Affect (MALAA – red).

Listed Species w/in the Project Area		Effect Determination	
		Beach Placement Activities (USFWS)	**In-Water Dredging Activities (NMFS)**
Sea Turtles	***Leatherback***	MANLAA	MANLAA
	Loggerhead	MANLAA	MALAA
	Green	MANLAA	MALAA
	Kemp's Ridley	NE	MALAA
	Hawksbill	NE	MALAA
Large Whales	***Blue, Finback, Sei, and Sperm***	NE	NE
	NARW	NE	MANLAA
	Humpback	NE	MANLAA
West Indian Manatee		NE	MANLAA
American Alligator		NE	NE
Piping Plover		MANLAA	NE
Red-cockaded Woodpecker		NE	NE
Shortnose Sturgeon		NE	NE
Smalltooth Sawfish		NE	NE
Seabeach Amaranth		MANLAA	NE
Golden Sedge		NE	NE
Chaffseed		NE	NE
Cooley's Meadowrue		NE	NE
Rough-leaved Loosestrife		NE	NE

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Feasibility Report
and
Environmental Impact Statement

on

Coastal Storm Damage Reduction

SURF CITY AND NORTH TOPSAIL BEACH
NORTH CAROLINA

Appendix J

Cumulative Impact Assessment

APPENDIX J
Cumulative Impact Assessment
Surf City and North Topsail Beach, NC
Coastal Storm Damage Reduction Project

The Council on Environmental Quality (CEQ) defines cumulative impact as:

The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7). This analysis follows the 11-step process outlined by the CEQ in their 1997 publication Considering Cumulative Effects Under the National Environmental Policy Ac (Table J-1).

Table J-1. Steps in the Cumulative Effects Analysis (as adapted from CEQ 1997)

Environmental Impact Assessment Components	CEA Steps
I. Scoping	a. Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals. b. Establish the geographic scope for the analysis. c. Establish the time frame for the analysis. d. Identify other actions affecting the resources, ecosystems, and human communities of concern.
II. Describing the Affected Environment	a. Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stresses. b. Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds. c. Define a baseline condition for the resources, ecosystems, and human communities.
III. Determining the Environmental Consequences	a. Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities. b. Determine the magnitude and significance of the cumulative effects. c. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects. d. Monitor the cumulative effects of the selected alternative and adapt management.

1. Significant Cumulative Effects Issues

This assessment of cumulative impacts will focus on impacts of dredging from the proposed ocean borrow sites and impacts of placement of sand material on the beach (whether for beach nourishment or disposal of dredge maintenance material) on significant coastal shoreline resources. In making this assessment, we have reviewed the following reports:

- U.S. Department of the Interior, Minerals Management Service (MMS) report entitled "Use of Federal Offshore Sand Resources for Beach and Coastal Restoration in New Jersey, Maryland, Delaware, and Virginia," dated November 1999 (DOI 1999)
- MMS report entitled "Collection of Environmental Data Within Sand Resource Areas Offshore North Carolina and the Environmental Implications of Sand Removal for Coastal and Beach Restoration, dated 2003 (Byrnes et al. 2003)
- U.S. Army Corps of Engineers Dare County Beaches (Bodie Island Portion) Final Feasibility Report and EIS on Hurricane Protection, dated September 2000
- U.S. Army Corps of Engineers Draft Evaluation Report and Environmental Assessment, Morehead City Harbor Section 933, dated May 2003.
- U.S. Army Corps of Engineers Final Integrated General Reevaluation Report and Environmental Impact Statement, Shore Protection, West Onslow Beach and New River Inlet (Topsail Beach), North Carolina, dated March 2009.

The last three reports listed above included comprehensive assessments of state-wide cumulative impacts. In discussing the potential cumulative impacts of offshore borrow area dredging and beach nourishment, we consider time crowded perturbations, and space crowded perturbations, as defined below, to be pertinent to this action.

> ***Time crowded perturbations** – repeated occurrence of one type of impact in the same area.*
> ***Space crowded perturbations** – a concentration of a number of different impacts in the same area.*

2. Geographic Scope

This analysis will focus on cumulative impacts within the project area since portions of affected beaches under the current proposal have received fill in the past and the proposed action represents an approximately 3.1% increase in the area of North Carolina beaches affected by sand placement as described in the Dare County Beaches EIS (USACE, 2000), Morehead City Harbor Section 933 (USACE, 2003) and Topsail Beach (USACE, 2009) documents referenced. Additionally, this analysis will study the cumulative impacts within the project area associated with increased offshore borrow area use. The proposed project represents a new impact to the offshore benthic resources in the Topsail Island area. However, cumulative impacts of beach nourishment/disposal and offshore borrow area use on a statewide scale will also be assessed herein.

3. Time Frame

This analysis considers known past, present and the reasonably foreseeable future sand placement and offshore borrow on a statewide scale and project vicinity scale over a 50-year period of analysis from 1965 to 2015. This time period was selected to include the first U.S. Army Corps of Engineers Wilmington District, beach nourishment projects in 1965 and includes the first Wilmington District placement of dredged material within the project area (in the vicinity of Topsail Beach) in about 1969. While historic accounts of local coastal storm damage reduction efforts including sand placement on Wrightsville Beach dating back to the mid-1930s were considered in this assessment, no attempt was made to quantify these actions since detailed data were not available. Projections were extended to 2015, as that date represents a reasonably foreseeable future and the majority of remaining ocean beach that could reasonably be expected to have federal and non-federal projects implemented or studies initiated.

At the project vicinity scale the cumulative assessment considers past periodic beach disposal of AIWW maintenance material either annually or on a six-year basis along portions of Topsail Island. This assessment assumes continued periodic beach disposal of maintenance material along Topsail Island and construction of the West Onslow Beach and New River Inlet (Topsail Beach) and proposed beach nourishment projects. The cumulative analysis also considers the potential that future federal (i.e. Brunswick County Beaches, Bogue Banks, etc.) and non-federal (i.e. Topsail Beach, Bald Head Island, Figure Eight Island, etc.) beach nourishment projects under study could be constructed.

4. Actions Affecting Resources of Concern

This analysis of cumulative effects of the proposed action will focus on the impacts of dredging from the proposed ocean borrow sites and placement of sand material on the beach. In making this assessment, we have reviewed an Environmental Report prepared for and published by the U.S. Department of Interior, Minerals Management Service, entitled "Use of Federal Offshore Sand Resources for Beach and Coastal Restoration in New Jersey, Maryland, Delaware, and Virginia," dated November 1999 (DOI 1999) and the report titled "Collection of Environmental Data Within Sand Resource Areas Offshore North Carolina and the Environmental Implications of Sand Removal for Coastal and Beach Restoration," dated 2003 (Byrnes et al. 2003). Additionally, a detailed review of the current pier reviewed scientific literature on the effects of dredging and beach placement of sediment was conducted and cited in sections 2.0 and 8.0 of the main report.

4a. Actions Affecting Benthic Resources

Dredging: Benthic organisms within the defined borrow areas dredged for construction and periodic nourishment will be impacted. However, re-colonization by opportunistic species is expected to begin soon after the dredging activity stops. Due to the opportunistic nature of the species that inhabit these soft bottom benthic habitats, recovery is expected to occur within 1-2 years. Rapid recovery is expected from re-colonization from the migration of benthic organisms from adjacent areas and by larval transport. Monitoring studies of post dredging effects and recovery rates of borrow areas indicates that most borrow areas usually show significant recovery by benthic organisms approximately 1 to 2 years after dredging (Naqvi and Pullen, 1982; Bowen and Marsh, 1988; Johnson and Nelson, 1985; Saloman *et al*., 1982; Van Dolah *et al*., 1984; and Van Dolah *et al*. 1992). According to Posey and Alphin (2000), benthic fauna associated with sediment removal from borrow areas off of Carolina Beach recovered quickly with greater inter-annual variability than differences from the effects of direct sediment removal. However, a potential change in species composition, population, and community structure may occur from the initial sediment removal impact as well as the change in surficial sediment characteristics, resulting in the potential for longer recovery times (2-3 years) (Johnson and Nelson, 1985; Van Dolah *et al*., 1984). Differences in community structure may occur that may last 2-3 years after initial density and diversity levels recover (Wilber and Stern, 1992). Specifically, large, deeper-burrowing infauna can require as much as 3 years to reach pre-disturbance abundance. According to Turbeville and Marsh (1982), long term effects of a borrow site at Hillsboro Beach, FL, indicated that species diversity was higher at the borrow site than at the control site. Jutte *et al*. (1999 and 2001) evaluated recovery rates of post-hopper dredged borrow areas and found that hopper dredging creates a series of ridges and furrows, with the ridges representing areas missed by the hopper dredge. Rapid recolonization rates were documented due to the dredge's inability to completely remove all of the sediment. Furthermore, Jutte *et al*. (2002) documented that dredging to shallower depths is less likely to modify wave energy and currents at a borrow site; thus, reducing the likelihood of infilling of fine grained sediment.

As a result of dredging borrow areas for beach nourishment sand, there is concern for potential cumulative impacts due to repeated dredging in a borrow area within short periods of time such that the benthic community may not have time to recover. Dredging in subsequent areas close to one another may result in impacts to potential adult organism recruitment to the dredged areas, further lengthening the time for recovery in an area (DOI 1999). However, as noted in Section 8.01.7 of the main report, considering the distance offshore and the shallow volumes of sediment within the borrow areas, it is anticipated that all dredging activities associated with initial construction and each re-nourishment interval will be conducted using a hopper dredge. Recognizing the thin volumes of sediment within each borrow area, it is anticipated that all available sediment within each dredged portion of a borrow site will be fully utilized. Therefore, re-occurring impacts to an individual portion of a borrow area are not anticipated and full recovery of each dredged site is expected prior to the next dredging event.

Other factors affecting Benthic Resources: Many factors unrelated to dredging of sand from borrow areas may affect benthic resources including, beach resources and ocean fish stocks. The factors can be a result of natural events such as natural population cycles or as a result of favorable or negative weather conditions including La Niña, El Niño, and major storms or hurricanes to name a few. These global events have far greater impacts on these resources at the population level than relatively local activities such as removal of sand from a given area of ocean bottom. Primary man-induced factors affecting fish stocks are over fishing and degradation of water quality due to pollution. When examining the cumulative effect of space crowded perturbations, these other factors may outweigh the potential incremental effects of borrow dredging of sand on benthic or fish populations.

4b. Actions Affecting Beach Resources

The major sources of beach impacts are local beach maintenance activities (which include local beach nourishment), disposal of dredged material from maintenance of navigation channels, and beach nourishment (berm and dune construction with long-term periodic maintenance). Of particular concern are macroinvertebrate (section 8.01.6 of the Feasibility Report/EIS), fisheries (section 8.01.3 of the Feasibility Report/EIS), shorebird (section 8.02.3 of the Feasibility Report/EIS), and sea turtle species (appendix I of the Feasibility Report/EIS) that utilize or occur on or adjacent to ocean beaches. These resources are also impacted by natural events and anthropogenic activities that are unrelated to disposal of sand on the beach as discussed below.

Local Maintenance Activity: Under the existing condition the project area is subjected to repeated and frequent maintenance disturbance by individual homeowners and local communities following major storm events. These efforts are primarily made to protect adjacent shoreline property. Such repairs consist of dune rebuilding using sand from beach scraping and/or upland fill. Limited fill and sandbags are generally used to the extent allowable by CAMA permit. Such frequent maintenance efforts could keep the natural resources of the barrier island ecosystems from re-establishing a natural equilibrium with the dynamic coastal forces of the area.

Non-Federal Beach Nourishment: Local efforts can also include beach nourishment such as that conducted along Pine Knoll Shores, Salter Path, Indian Beach, and Emerald Isle by local interests in 2001-2004. The number of locally funded beach nourishment activities has increased significantly since 2004 along other developed North Carolina beaches. Though non-federal beach nourishment efforts continue to increase, many of these projects are being pursued as one-time interim efforts until the federal beach nourishment projects can be implemented. Therefore, this increase permitted non-federal projects does not necessarily reflect a subsequent increase in resource acreage impacts. Many of the non-federal projects occur within the limits of federal projects which are already authorized but un-funded (i.e. Dare County Beaches) or projects which are under study (i.e. Bogue Banks). Beaches that have been nourished under permit, or may be permitted to be nourished, include, but are not limited to: Nags Head, Bogue Banks, North Topsail Beach, Topsail Beach, Figure Eight Island, Bald Head Island, and Holden Beach (Table J-2). Individually, these projects total approximately 75 miles of beach or 23% of North Carolina beaches. These frequent maintenance efforts could keep the natural resources of the barrier island ecosystems from reestablishing a natural equilibrium with the dynamic coastal forces of the area.

Federal (USACE) Beach Nourishment: Federal beach nourishment activities typically include the construction and long-term (50-year) maintenance of a berm and dune. The degree of cumulative impact would increase proportionally with the total length of beach nourishment project constructed. The first federal North Carolina beach nourishment projects were constructed at Carolina and Wrightsville Beaches in 1965, and totaled approximately 6.4 miles. An additional 3.8 miles of federal beach nourishment project was constructed in 1975 at Kure Beach. In 2004, coastal storm damage reduction along 14 miles of Dare County Beaches was authorized, but has not yet been constructed. Most of the remaining developed North Carolina beaches (including the proposed project area) are currently under study by the Wilmington District for potential future beach nourishment projects (Table J-2). Individually, these existing or proposed federal projects total approximately 122 miles of beach or 38% of North Carolina beaches. Considering all existing and proposed federal and non-federal nourishment projects, and recognizing that some of the projects are overlapping or represent the same project area, approximately 112 miles or 35 % of the North Carolina coast could have private or federal beach nourishment projects by 2015.

Table J-2. Summary of federal and non-federal beach nourishment projects in North Carolina that have recently occurred, are currently underway, or will occur in the reasonably foreseeable future. (This list is not entirely comprehensive and does not include all small scale beach fill activities (i.e. dune restoration, beach scraping, etc.). (* - federal or non-federal projects which may utilize the same borrow sources and/or overlap beach placement locations).

Federal / Non-Federal	Project	Source of Sand for Nourishment	Beachfront Nourished	Approximate Length of Shoreline (miles)	Approximate Distance From the SCNTB Project Area (miles)
Federal	*Dare County Beaches, NC Bodie Island (Coastal Storm Damage Reduction)	Offshore Borrow Areas	Kitty Hawk and Nags Head Beaches	14	150
	Dare County Beaches, NC Hatteras to Ocracoke Portion	NA	Hatteras and Ocracoke Island (Hot Spots)	10	130
	Cape Lookout National Seashore -East Side of Cape Lookout Lighthouse	Channel	East Side of Cape Lookout Lighthouse	1	50
	*Beaufort Inlet Dredging - Section 933 Project (Outer Harbor)	Beaufort Inlet Outer Harbor	Indian Beach, Salter Path, and Portions of Pine Knoll Shores	7	35
	*Beaufort Inlet and Brandt Island Pumpout - Section 933 (Dredge Disposal to Eastern Bogue Banks)	Beaufort Inlet Inner Harbor and Brandt Island Pumpout	Fort Macon and Atlantic Beach	4	40
	*Bogue Banks, NC (Coastal Storm Damage Reduction)	Offshore Borrow Areas	Communities of Bogue Banks	24	35
	Surf City and North Topsail Beach - (Coastal Storm Damage Reduction)	Offshore Borrow Areas	Surf City and North Topsail Beach	10	0
	*West Onslow Beach New River Inlet (Topsail Beach) (Coastal Storm Damage Reduction)	Offshore Borrow Areas	Topsail Beach	6	10
	Wrightsville Beach (Coastal Storm Damage Reduction)	Masonboro Inlet and Banks Channel	Wrightsville Beach	3	30
	Carolina Beach and Vicinity, NC Carolina Beach Portion (Coastal Storm Damage Reduction)	Carolina Beach Inlet	Carolina Beach	2	40
	Carolina Beach and Vicinity, NC Kure Beach Portion (Coastal Storm Damage Reduction)	Wilmington Harbor Confined Disposal Area 4 and an Offshore Borrow Area	Kure Beach	2	45
	*Brunswick County Beaches, NC - Oak Island, Caswell, and Holden Beaches (Coastal Storm Damage Reduction)	Offshore Borrow Areas - Jay Bird Shoals and Frying Pan Shoals	Caswell Beach, Yaupon Beach, Long Beach, Holden Beach	30	65
	*Wilmington Harbor Deepening (Section 933 Project) - Sand Management Plan	Wilmington Harbor Ocean Entrance Channels	Bald Head Island, Caswell Beach, Oak Island	4	65
	*Holden Beach (Section 933 Project)	Wilmington Harbor Ocean Entrance Channels	Holden Beach	2	65
	*Oak Island Section 1135 - Sea Turtle Habitat Restoration	Upland Borrow Area - Yellow Banks	Oak Island	2	65
	Ocean Isle Beach, NC (Coastal Storm Damage Reduction)	Shallotte Inlet	Ocean Isle Beach	2	70

Non-Federal	*Town of Nags Head - Beach Nourishment Project	Offshore Borrow Areas	Nags Head	10	150
	*Emerald Isle FEMA Project	Offshore Borrow Areas - Morehead City Port Shipping Channel (ODMDS)	Emerald Isle	4	30
	*Bogue Banks FEMA Project	Offshore Borrow Areas – Morehead City Port Shipping Channel (ODMDS)	Emerald Isle (2 segments), Indian Beach, Salter Path, Pine Knoll Shores	13	35
	*Bogue Banks Restoration Project – Phase I – Pine Knoll Shores and Indian Beach Joint Restoration	Offshore Borrow Areas	Pine Knoll Shores and Indian Beach	7	35
	*Bogue Banks Restoration Project – Phase II – Eastern Emerald Isle	Offshore Borrow Areas	Indian Beach and Emerald Isle	6	30
	*Bogue Banks Restoration Project – Phase III– Bogue Inlet Channel Realignment Project	Bogue Inlet Channel	Western Emerald Isle	5	30
	*North Topsail Dune Restoration (Town of North Topsail Beach)	Upland borrow source near Town of Wallace, NC	North Topsail Beach	NA	0
	*North Topsail Beach Shoreline Protection Project	New River Inlet Realignment and Offshore Borrow Area	North Topsail Beach	11	0
	*Topsail Beach - Beach Nourishment Project	New Topsail Inlet Ebb Shoal and Offshore Borrow areas	Topsail Beach	6	10
	Figure Eight Island	Banks Channel and Nixon Channel	North & South Sections of Figure Eight Island	3	30
	Rich Inlet Management Project	Relocation of Rich Inlet	Figure Eight Island	NA	30
	Mason Inlet Relocation Project	Mason Inlet (new channel) and Mason Creek	North end of Wrightsville Beach and south end of Figure Eight Island	2	30
	Bald Head Island Creek Project	Bald Head Creek	South Beach	0.34	55
	Bald Head Island - Beach Nourishment	Offshore Borrow Area - Jay Bird Shoals	West and South Beach of Bald Head Island	4	55
	*Holden Beach East & West	Upland Borrow Source (Truck Haul)	Extension of 933 Project	3	65
	*Holden Beach East & West	Upland Borrow Source (Truck Haul)	Extension of 933 Project	3	65

Federal (USACE) Navigation Beach Disposal: Maintenance material from dredging in the vicinity of Topsail Island has historically been disposed within authorized disposal limits along 1.5 miles of beach at North Topsail Beach and 1.6 miles of beach at Topsail Beach (Table J-3). Throughout North Carolina, a total of approximately 41 miles of beach (~13% of North Carolina beaches) are authorized for disposal of beach quality dredged material from maintenance dredging of navigation channels. However, not all of these projects are routinely dredged and a majority of the authorized disposal limits are not actually disposed on to the full extent. Additionally, many of the authorized disposal limits overlap with existing federal or non-federal beach projects. Therefore, without double counting for overlapping beach projects, navigation dredged material is placed along approximately 19 miles, or 6% of North Carolina beaches. The Wilmington District currently uses about 50 percent of the length of beach in North Carolina that is approved for this purpose and does not anticipate significant increases in beach disposal in the foreseeable future.

Beach quality sand is a valuable resource that is highly sought by beach communities to provide wide beaches for recreation and tourism, as well as to provide hurricane and wave protection for public and private property in these communities. When beach quality sand is dredged from navigation projects, it has become common practice of the Corps to make this resource available to beach communities, to the maximum extent practicable. Placement of this sand on beaches represents return of material, which eroded from these beaches, and is, therefore, replenishment with native material. The design of beach placement sites generally extends the elevation of the natural berm seaward.

Table J-3 Summary of dredged material disposal activities on North Carolina ocean front beaches associated with navigation dredging. Projects listed and associated disposal locations and quantities may not be all encompassing and represent an estimate of navigation disposal activities for the purposes of this cumulative impacts assessment. (***** - Navigation disposal sites which may overlap with existing Federal or Non-Federal beach nourishment projects).

PROJECT		DISPOSAL LOCATION	APPROVED DISPOSAL LIMITS	ESTIMATED ACTUAL DISPOSAL LIMITS	ESTIMATED QUANTITY (CY)	COMMENTS
Outer Banks	**Avon**	Begins at a point 1.15 miles south of Avon Harbor and extends north 3.1 miles	3.1 miles (16,368 lf)	0.4 miles or 2,000 linear feet	<50,000 every 6 yrs	Special Use Permit Required From NPS/CHNS
	Rodanthe	Extends from rd to Rodanthe Harbor south 700' to south end of beach disposal area (straight out from existing dirt road). North end at Wildlife Refuge Boundary (PINWR)	.91 miles (4,800 lf)	0.4 miles or 2,000 linear feet	<100,000 every 6 yrs	Special Use Permit Required From NPS/CHNS
	Ocracoke Island	Begins at a point 5,000 linear feet south of Hatteras Inlet and extends southward about 3,000 linear feet.	0.6 mile (3,000 lf)	0.4 mile or 2,000 linear feet	<100,000 every 2 to 3 years	Special Use Permit Required From NPS/CHNS
	Rollinson (Hatteras)	Begins at a point 0.85 miles south of Hatteras Harbor and extends north 5.85 miles to a point north of Frisco, NC	5.85 miles (30,888 lf)	0.4 miles or 2,000 linear feet	<60,000 every 2 years	Special Use Permit Required From NPS/CHNS
	Silver Lake (Teaches Hole/Ocracoke)	From a point 2,000' NE of inlet and extending approximately 2,000 linear feet (0.4 miles) to the NE (Ocracoke Island)	0.4 miles (2,000 lf)	0.4 miles or 2,000 linear feet	<50,000 every 2 yrs	Special Use Permit Required From NPS/CHNS
	Oregon Inlet		3 miles(15,840 lf)	1.5 miles or 7,920 linear feet	300,000 Annually	Special Use Permit Required From USFWS/PINWR
	Drum Inlet	Core Banks. From a point 2,000 feet on either side of inlet extending for 1 mile in either direction	2 miles (10,560 lf)	1 mile or 5,280 linear feet	298,000 initial, 100,000 maint. (Assume 8 year cycle)	SUP from NPS/CLNS (Included in analysis; however, no determination of site being reused can be made at this time)
Beaufort	***Morehead City (Brandt Island)**	2,000 ft west of inlet, Fort Macon and Atlantic Beach to Coral Bay Club, Pine Knoll Shores	7.3 miles (38,300 lf)	5.2 miles or 27,800 linear feet	3.5 million every 8 yrs	Material from Ocean Bar routinely placed in nearshore berm or ODMDS on annual basis

	***AIWW Section I, Tangent B**	Pine Knoll Shores, vicinity of Coral Bay	2 miles (10,500 lf)	0.4 miles or 2,000 linear feet	<50,000 every 5 yrs	This area is included every 8 years as part of the pumpout fo Brandt Island. Also included in the area under investigation for beach nourishment at Bogue Banks.
Swansboro	***AIWW Bogue Inlet Crossing Section I, Tangent-H through F**	Approx. 2,000 feet from inlet going east to Emerald Point Villas, Emerald Isle (Bogue Banks)	1mile (5,280 lf)	0.4 miles or 2,000 linear feet	<100,000 annually	
Browns Inlet	**AIWW Section II, Tangents-F,G,H**	Camp Lejeune, 3,000 feet west of Browns Inlet extending westward	1.58 miles (6,000 lf)	1 mile or 5,280 linear feet	<200,000 every 2 yrs	
New River Inlet	***AIWW, New River Inlet Crossing Section II, Tangents I & J, Channel to Jax. Section III, tangents 1&2**	N. Topsail Beach, 3,000 feet west of inlet extending westward to Maritime Way (Galleon Bay area)	1.5 miles (8,000 lf)	0.8 miles or 4,000 linear feet	<200,000 annually	Two areas 2,000 linear feet on either side of disposal area are routinely used.
Hampstead	***AIWW, Sect. III**	Topsail Island, Queens Grant	0.6 miles (2,500 lf)	0.6 miles or 2,500 lf	<50,000 every 6 yrs	
	***AIWW, Topsail Inlet Crossing & Topsail Creek**	Topsail Beach, from a point 2,000 feet north of Topsail Inlet	1 mile (5,280 lf)	0.4 mi or 2,000 ft	<75,000 annually	
Wrightsville Beach	**AIWW Sect. III,Tang 11&12 Mason Inlet Crossing**	Shell Island (north end of Wrightsville Beach from a point 2,000 feet from Mason Inlet	0.4 miles (2,000 lf)	0.4 mi. or 2,000 lf	<100,000	Not recently required since the inlet crossing closed up. If reopened will be rescheduled if needed
	***Masonboro Sand Bypassing**	At a point 9,000 feet from jetty extending southward midway of island	1.2 miles (6,000 lf)	1 mile 5,280 lf	500,000 every 4 years	Same time as Wrightsville Beach Nourishment
Carolina Beach	**AIWW, Section IV, Tangent 1**	Southern end of Masonboro Island at a point 2,000 linear feet from Carolina Beach Inlet extending northward to Johns Bay area	1.3 miles (7,000 lf)	0.4 miles (2,000 linear feet)	<50,000 annually	This site is used alternately with Carolina Beach Disposal Site on North end of Island
Caswell Beach	***Caswell Beach**	Beachfront on eastern end of island	4.7 miles (25,000 lf)	4.7 miles or (25,000 linear feet)	1.1 million every 6 years	Disposal Material from Wilmington Harbor Ocean Bar Project
Bald Head	***Bald Head**	Beach front on eastern and western shoreline	3.0 miles (16,000 lf)	3.0 miles or 16,000 lf	1.1 million every 2 years (except every 6th when it goes to Caswell)	Least Costly Disposal Option From Wilmington Harbor Ocean Bar Project.

Table J-3 (Continued)

Other factors affecting Beach Resources: Many factors unrelated to placement of sand on the beach may affect beach resources including: benthic invertebrate resources, shorebird populations, and ocean fish stocks. The factors can be a result of natural events such as natural population cycles or as a result of favorable or negative weather conditions including droughts, floods, La Niña, El Niño, and major storms or hurricanes to name a few. A primary anthropogenic factor affecting shorebird populations is beach development resulting in a loss or disturbance of nesting habitat and invasion of domestic predators. Primary man-induced factors affecting fish stocks are over fishing and degradation of water quality due to pollution.

5. Significant Resources

Based on scoping comments from resource agencies and others, the primary concerns with the proposed dredging and beach disposal are direct and indirect impacts to hard bottom communities, macro-invertebrates, fish, shorebirds, and sea turtles. Federally listed threatened or endangered species which could be present along the North Carolina coast are the blue whale, finback whale, humpback whale, North Atlantic right whale, sei whale, sperm whale, West Indian manatee, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, shortnose sturgeon, seabeach amaranth, and piping plover. Impacts to all listed species are provided in Appendix I and summarized below and include, but are not limited to, mortality, reduction in prey species, habitat change, and disturbance during construction activities. Also discussed are the benefits of periodic renourishments, which are expected to enhance nesting habitat of sea turtles and to provide additional habitat for sea beach amaranth. In relation to dredging of offshore sites for material, the primary concerns are the potential impacts to benthic organisms, fish species, and hard bottom habitat areas. Detailed discussions of all significant resources and associated impacts considered in this assessment are included in Sections 2.0 and 8.0 of the Feasibility Report/EIS.

Beach and Dune. Terrestrial habitat types within these areas include sandy or sparsely vegetated beaches and vegetated dune communities. Mammals occurring within this environment are opossums, cottontails, gray foxes, raccoons, feral house cats, shrews, moles, voles, and house mice. Common vegetation of the upper beach includes beach spurge, sea rocket and pennywort. The dunes are more heavily vegetated, and common species include American beach grass, panic grass, sea oats, broom straw, seashore elder, and salt meadow hay. Seabeach amaranth, a Federally listed threatened species, is present throughout most of North Carolina. Ghost crabs are important invertebrates of the beach/dune community. The beach and dune also provide important nesting habitat for loggerhead and green sea turtles as well as habitat for a number of shorebirds and many other birds, including resident and migratory songbirds. Placement of material along the ocean beach enhances and improves important habitat for a variety of plants and animals, and restores lost habitat in the areas of most severe erosion. This is especially important for nesting loggerhead sea turtles and seabeach amaranth. Historic nesting data from Topsail Island indicate that sea turtles continue to nest on disposal beaches with hatch rate successes similar to non-disposal beaches (Jean Beasley, pers. comm.). Furthermore, new populations of seabeach amaranth have been observed to follow sand placement on beaches where sand has been disposed by the Corps of Engineers (ex. Wrightsville Beach and Bogue Banks) (USFWS, 1996b; CSE, 2004). Individually and cumulatively, in addition to providing important habitat, beach nourishment projects protect public infrastructure, public and private property, and human lives.

Marine Waters. Along the coast of North Carolina, marine waters provide habitat for a variety of ocean fish and are important commercial and recreational fishing grounds. Kingfish, spot, bluefish, weakfish, spotted seatrout, flounder, red drum, king mackerel, and Spanish mackerel are actively fished from boats, the beach, and local piers. Offshore marine waters serve as habitat for the spawning of many estuarine dependent species. Oceanic large nekton located offshore of North Carolina are composed of a wide variety of bony fishes, sharks, and rays, as well as fewer numbers of marine mammals and reptiles. Marine mammals and sea turtles that may be present in the offshore borrow sites are addressed in Appendix I. Dredging and placement of beach fill may create impacts in the marine water column in the immediate vicinity of the activity, potentially affecting the surf zone and nearshore ocean. These impacts may include minor and short-term suspended sediment plumes and related turbidity, as well as the release of soluble trace constituents from the sediment. Overall water quality impacts for any given project are expected to be short-term and minor. Cumulative effects of multiple simultaneous beach nourishment operations could potentially impact fishes of the surf zone. However, the high quality of the sediment selected for beach fill and the small amount of beach affected at any point in time would not suggest that this activity poses a significant threat.

Intertidal and Nearshore Zones. The intertidal zone within the proposed beach nourishment areas serves as habitat for invertebrates including mole crabs, coquina clams, amphipods, isopods, and polychaetes, which are adapted to the high energy, sandy beach environment. These species are not commercially important; however, they provide an important food source for surf-feeding fish and shore birds. The surf zone is suggested to be an important migratory area for larval/juvenile fish moving in and out of inlets and estuarine nurseries (Hackney *et al*., 1996). Disposal operations along the beach can result in increased turbidity and mortality of intertidal macrofauna, which serves as food sources for various fish and bird species. Therefore, feeding activities of these species may be interrupted in the immediate area of beach sand placement. These mobile species are expected to temporarily relocate to other areas as the project proceeds along the beach. Though a short-term reduction in prey availability may occur in the immediate disposal area, only a small area is impacted at any given time, and once complete, organisms can recruit into the nourished area. The anticipated construction timeframes for beach projects are typically from 15 November to 30 April and would avoid a majority of the peak recruitment and abundance time period of surf zone fishes and their benthic invertebrate prey source. To summarize, the impacts of beach renourishment projects on the intertidal and nearshore zones are considered temporary, minor and reversible. Cumulative effects of multiple simultaneous beach nourishment operations could be potentially harmful to benthic invertebrates in the surf zone; however, the high quality of the sediment selected for beach fill and the small amount of beach affected at any point in time would suggest that this activity would not pose a significant threat.

Hardbottoms. Hardbottoms are also called "live-bottoms" because they support a rich diversity of invertebrates such as corals, anemones, and sponges, which are refuges and food sources for fish and other marine life. They provide valuable habitat for reef fish such as black sea bass, red porgy, and groupers. Hardbottoms are also attractive to pelagic species such as king mackerel, amberjack, and cobia. While hardbottoms are most abundant in southern portions of North Carolina, they are located along the entire coast (USFWS, 1990). As identified in Figure J-1, there are dispersed hardbottom areas present in offshore environment and borrow areas off of Surf City and North Topsail Beach. Hardbottoms in the Surf City North Topsail Beach area and potential project related impacts are discussed in detail in Sections 2.01.10 and 8.01.8.2 of the Feasibility Report/EIS. In order to assess the potential impact of the proposed project on: (1) nearshore hard bottom habitat as a result of burial or sedimentation from the beach fill equilibration process and (2) offshore habitat from hopper dredging activities, the Corps contracted side scan sonar, multi-beam, and diver ground truth data collection. Diver ground truth verification was used to confirm the presence or absence of hard bottom within high backscatter areas identified as “potential hard bottom” from the remote sensing efforts. Diver ground truth confirmation of 8 selected areas previously identified as “potential” hard bottom, in conjunction with the sidescan interpretation, supported the conclusion that no hard bottom was identified landward of the calculated -7 m (-23 ft.) depth of closure. Additional refined analyses of the remote sensing data coupled with the (1) diver ground truth transects, (2) collected sediment samples, and (3) digital video, identified the previously defined “high backscatter anomalies” to be regions of coarse gravel and shell hash. These features identified in the nearshore environment off Surf City and North Topsail Beach are consistent with previously identified “rippled scour depressions (RSD)” (Cacchione *et al*., 1984; Thieler *et al*., 1999; Thieler *et al*., 2001), “ripple channel depressions (RCD)” (McQuarrie, 1998), or “sorted bedform”(Murray and Thieler, 2004) features identified throughout the coast of NC (Wrightsville Beach, Figure Eight Island, Topsail Island, etc.). Hard bottom of varying low (<0.5 m (1.6 ft.)) to moderate (0.5 m (1.6 ft.) to 2.0 m (6.6 ft.)) relief (i.e. large contiguous hard bottom, patchy outcroppings, and/or distinct ledges) and total area were confirmed and characterized within multiple borrow areas in the offshore (>-23 ft NGVD) environment. Sections 2.01.10 and 8.01.8.2 of the main report and Appendix R discuss the identified hard bottom resources and potential impacts in more detail. Additionally, specific project measures in order to avoid impacts to hard bottoms are provided. Recognizing the detailed hard bottom resource inventory completed for this project and the avoidance measures identified impacts to hard bottom communities are not anticipated from this project. Though hard bottom communities are located throughout North Carolina, recognizing the current resource inventories in place to identify and avoid hard bottom communities for dredging and beach nourishment projects, the cumulative effects are not significant.

Figure J-1. Hard bottom resources identified within 16 borrow areas (A-T) located offshore of Topsail Island.

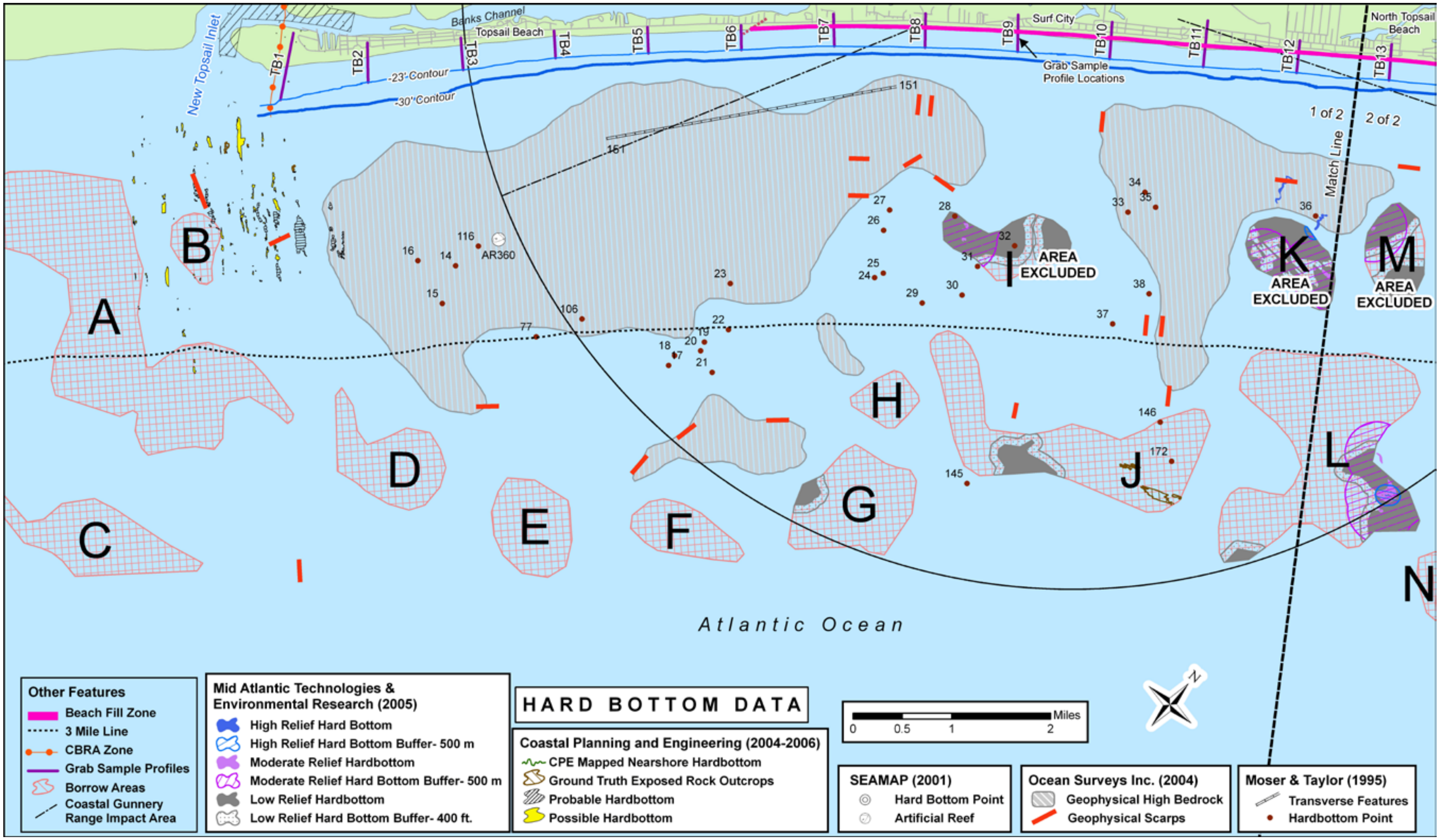
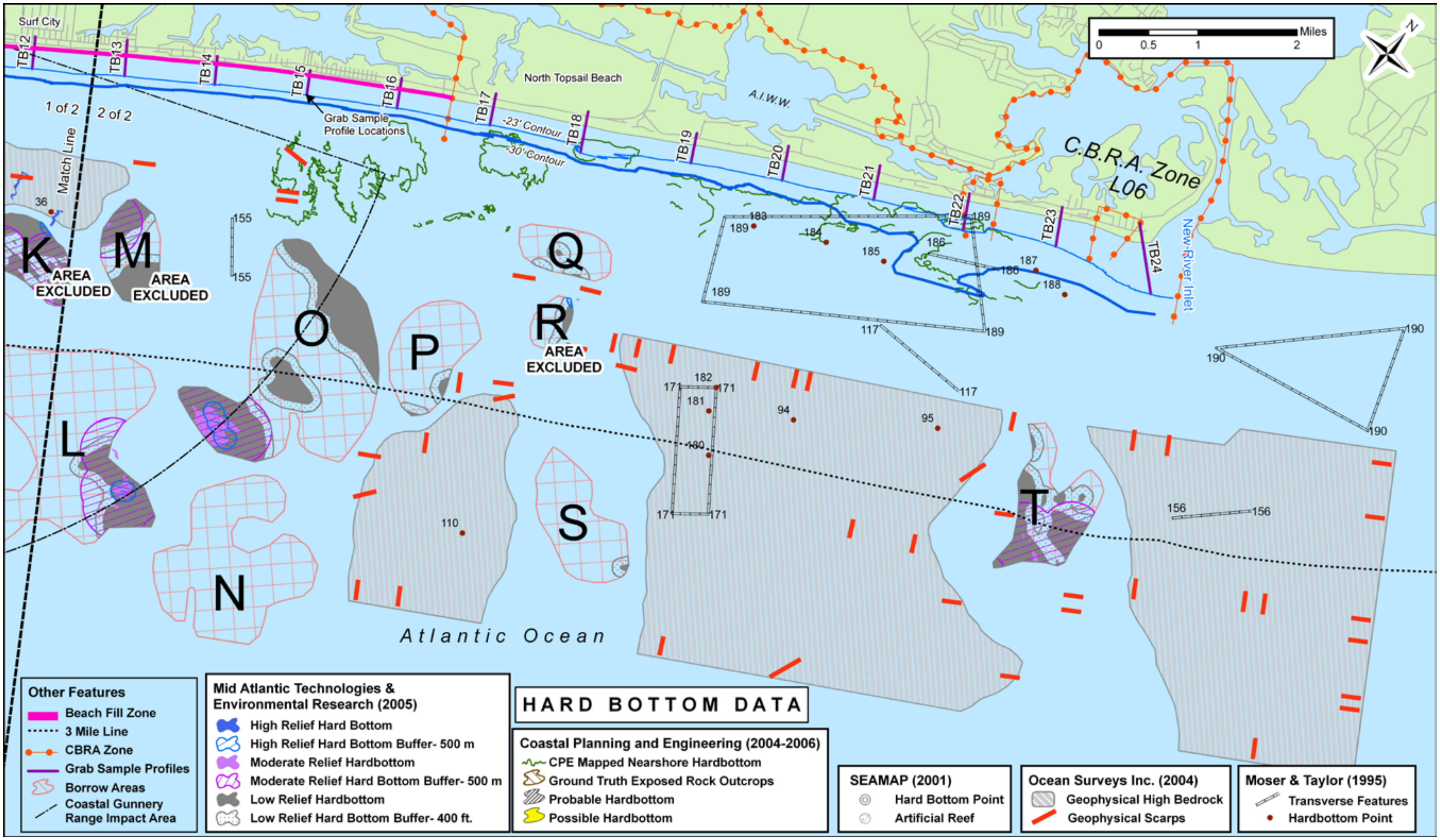


Figure J-1. (continued)



Nearshore Zone. Beach nourishment projects introduce fill into nearshore waters out to a specified depth of closure, usually from about –20 to –25 feet NGVD Benthic organisms, phytoplankton, and seaweeds are the major primary producers in this community with species of *Ulva* (sea lettuce), *Fucus*, and *Cladocera* (water fleas) being fairly common where suitable habitat occurs. Many species of fish-eating birds are typically found in this area including gulls, terns, cormorants, loons, and grebes (Sections 2.02.3 and 8.02.3). Marine mammals and sea turtles also are frequently seen in this area and are discussed in detail in Sections 2.01.7, 2.02.4, and Appendix I. Fishes and benthic resources of this area are discussed in Sections 2.01.4, 2.01.5, 2.01.8, and 2.01.9 respectively.

5a. Other Resources

Air Quality. The ambient air quality for all of coastal North Carolina has been determined to be in compliance with the National Ambient Air Quality Standards. All coastal counties in North Carolina are designated as attainment areas and do not require conformity determinations.

Additionally, although ozone is not a significant problem in the coastal counties, ozone is North Carolina's most widespread air quality problem, particularly during the warmer months. High ozone levels generally occur on hot sunny days with little wind, when pollutants such as nitrogen oxides and hydrocarbons react in the air. The ozone season is April through October. Dredging with beach disposal or renourishment typically takes place during the cooler months of the year, during times of low biological activity and outside of the ozone season. Section 8.08.1 provides detailed emissions analysis of the proposed project. Based on this analysis, this project is not anticipated to create any adverse effect on the air quality of this attainment area or cumulative effect on the ambient air quality for all of coastal North Carolina.

Social and Economic. The coastal areas of North Carolina will continue to grow and expand both with and without beach nourishment projects. Therefore, the economic benefit analysis for the proposed project claims no increase in benefits or hurricane and storm damage due to induced development. Development of vacant lots is limited to lots buildable under the regulations set forth by CAMA, flood plain regulations, State and local ordinances, and applicable requirements of the Federal Flood Insurance Program.

IWR Report 96-PS-1, FINAL REPORT: An Analysis of the U.S. Army Corps of Engineers Shore Protection Program, June 1996 states: "Corps projects have been found to have no measurable effect on development, and it appears that Corps activity has little effect on the relocation and/or construction decisions of developers, homeowners, or housing investors."

Wave Conditions. Localized deepening of offshore borrow areas is the only potential source of impacts on wave conditions, however, these changes are not expected to be significant considering the shallow nature of the proposed borrow sites. For the proposed Surf City North Topsail Beach project, the borrow area use plan identifies sixteen detached, relatively small borrow areas scattered offshore of Topsail Island.

These borrow areas include 10 identified for the Surf City/North Topsail Beach project and the excess amount from 6 borrow areas identified for the Topsail Beach Federal project (USACE, 2009). These areas are typically between 1 and 6 miles offshore and have pre-dredge bottom depths between 35 and 50 feet. This identified borrow area use plan should have less impact on wave conditions than dredging of a large, contiguous area.

Shoreline and Sand Transport. Existing water depths in offshore borrow areas are substantially deeper than the estimated active profile depths. Therefore no impacts to the active profile are expected due to borrow area dredging for this project or any other projects in the State.

Net movement of material placed on Surf City North Topsail Beach will be predominantly to the north based on transport analysis, with northerly sediment transport being roughly twice that of southerly transport on average. On a regional basis, renourishment projects add material to the longshore transport system, thus providing positive impacts. Although a regional sediment budget analysis has not been completed, it is expected that the proposed action and the combined effects of all other existing and proposed beach projects will have a minimal effect on shoreline and sand transport.

6. Resource Capacity to Withstand Stress and Regulatory Thresholds

There are no known thresholds relating to the extent of ocean bottom that can be disturbed without significant population level impacts to fisheries and benthic species. Therefore, a comparison of cumulative impacts to established thresholds is not made. However, the potential impact area of the proposed project is small relative to the area of available similar habitat on a local, vicinity, and statewide basis and the quick recovery rate of opportunistic species. It is expected that there is a low risk that the direct and cumulative impacts of the proposed action and other known similar activities would reach a threshold with potential for population level impacts on important commercial fish stocks. In regard to physical habitat alterations it is expected that alterations in depths and bottom sediment may occur and be persistent. However, site modifications would be within the range of tolerance by these species and, although man-altered, consistent with natural variations in depth and sediment within the geographic range of EFH for local commercial fish species. The Final Report, Collection of Environmental Data Within Sand Resource Areas Offshore North Carolina and The Environmental Implications of Sand Removal for Coastal and Beach Restoration (Byrnes et al. 2003) provided the following assessment of potential impacts to benthic organisms from dredging:

Because the sedimentary regime of North Carolina sand source areas is vertically uniform, recolonization of surficial sediments by later successional stages likely will proceed even if dredged shoals are not completely reestablished. Furthermore, dredging of only a small portion of the area within each of the resource areas will ensure that a supply of non-transitional, motile taxa will be available for rapid migration into dredged sites. While community composition may differ for a period of time after the last *dredging, the infaunal assemblage type that exists in mined areas will be similar to naturally occurring assemblages in the study area, particularly those assemblages inhabiting inter-ridge troughs. Based on previous observations of infaunal reestablishment in dredged sites, the infaunal community in dredged sites most likely will become reestablished within 2 years, and will exhibit levels of infaunal abundance, diversity, and composition comparable to nearby non-dredged sites.*

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

Because benthic organisms living in beach habitats are adapted to living in high energy environments, they are able to quickly recover to original levels following beach nourishment events; sometimes in as little as three months (Van Dolah et al. 1994; Levison and Van Dolah 1996). This is again attributed to the fact that intertidal organisms are living in high energy habitats where disturbances are common. Because of a lower diversity of species compared to other intertidal and shallow subtidal habitats (Hackney et al. 1996), the vast majority of beach habitats are recolonized by the same species that existed before nourishment (Van Dolah et al. 1992; Nelson 1985; Levison and Van Dolah 1996; Hackney et al. 1996).

While the proposed beach disposal may adversely impact benthic macrofauna, these organisms are highly resilient and any effects will be localized, short-term, and reversible.

7. Baseline Conditions

The following Feasibility Report/EIS section describes the status of significant resources that may be affected by this and other similar projects that are pertinent to this analysis.

Section 2.0, Affected Environment.

8. Cause and Effect Relationships

The following Feasibility Report/EIS section describes impacts of the proposed action on significant resources. Cause and effect relationships described in the report are consistent with those that would be expected for other similar projects that are pertinent to this analysis.

Section 8.0, Environmental Effects.

9. Magnitude and Significance of Resource Impacts

9a. Offshore Borrow Areas

Site Specific Impacts: Sixteen borrow areas have been identified for the Surf City/North Topsail Beach Coastal Storm Damage Reduction Project. These borrow areas include 10 identified for the Surf City/North Topsail Beach project and the excess amount from 6 borrow areas identified for the Topsail Beach Federal project (Figure J-1 and Table J-4).

Table J-4. Topsail Island Borrow Area Characteristics.

Borrow Area	Total Acreage (**excluding hard bottom and buffers)	Estimated Volume (Million yd^3)	Distance Offshore (miles)	Surface Elevation (ft. MLLW)
A	2,272	*	1 to 3	-38.5 to –49.0
B	158	*	1.5 to 2.5	-42.2 to –43.2
C	598	*	4 to 5.5	-45.5 to -47.7
D	471	*	3.5 to 4.5	-43.5 to –46.9
E	406	*	4.5 to 5.5	-49 to –50
F	282	*	4.5 to 5.5	-47.2 to -48
G	574	2.41	4 to 5.5	-46.5 to -49
H	158	0.72	3.5 to 4.5	-44.4 to -45.2
J	912	3.67	3 to 4.5	-42 to -47.4
L	1298	6.13	3 to 5.5	-42.3 to -47
N	1001	5.64	4 to 6	-43.6 to -46.7
O	807	3.85	1.5 to 4	-40.6 to -43.9
P	409	2.73	2 to 3.5	-39.5 to -40.5
Q	144	0.73	1 to 1.5	-35.2 to -35.4
S	472	1.46	3.5 to 4.5	-43.8 to -44.8
T	86	0.25	2 to 4	-37.2 to -42

* - These borrow areas are planned to be used for the Topsail Beach Federal and non-Federal projects (USACE, 2009). The excess material not used for these projects is expected to be available for the Surf City/North Topsail Beach project. This amount is approximately 9.68 million cubic yards.

* * - Acreage calculations represent available area to be dredged for sediment taking into account the avoidance of hard bottom habitat and associated buffers.

There are many possible sequences and methods for dredging and placing available material on the beach for the project and a site specific borrow area use plan has yet to be defined. The economic optimization of the use of the borrow areas for the life of the project will be further evaluated when the final borrow area data has been collected and fully analyzed during the Plans and Specifications (P&S) phase. However, for a majority of the identified borrow sites to be utilized for this project, the depths of available sediment are relatively shallow with an average range of 2.6 to 6.4 ft for borrow areas G-T located offshore of Surf City and North Topsail Beach. Under the proposed plan, initial construction would require about 11.8 mcy and each nourishment interval would require about 2.6 mcy. Both initial construction and each nourishment interval will likely utilize multiple borrow areas with a sequence of temporary impacts to benthic resources over the life of the project. Considering the shallow average thickness of the borrow areas and the associated dredging operations and production capabilities to effectively dredge the sediment, it is anticipated that individual dredged areas within each borrow area will be fully utilized and will not be dredged again at consecutive dredging events. Therefore, once the dredged site recovers from the initial dredging impact, it will likely not be impacted again as all of the available sediment would be exhausted from the dredged area. Considering that the identified borrow areas are all consistently shallow, the size of the impact area can be correlated to the volume of sediment needed. For example, initial construction will require about 11.8 mcy and will therefore have the largest acreage impact among multiple borrow areas during that one time event. Each subsequent nourishment interval will require about 2.6 mcy and will impact a reduced amount of acres at six year intervals for the duration of the project. Once all of the sand is dredged from the identified borrow areas to meet the demand for the 50 year duration of the project, a total of about 10,047 acres (SCNTB (G-T) – 5,861 acres; Topsail Beach (A-F) – 4,186 acres) could be impacted among all 16 identified borrow sites offshore of Topsail Island (Table J-4).

Subsequent intervals of dredging within an individual borrow area will likely occur in portions of the borrow area that have not previously been dredged. Upon each dredging interval, recovery in adjacent areas will have already occurred; therefore, re-occurring impacts to any sub-component of a borrow area are not anticipated. Therefore, the total acreage of impact that could occur during any given dredging event is the one time impact of the surface area required to dredge the volume of sediment for initial construction or nourishment. This cyclic use of borrow areas would result in cumulative effects from space crowded perturbations on a local scale. Assuming that the borrow areas are not impacted by repeatedly dredging recently used areas, unusually high sedimentation rates, or some other disturbance, a natural succession of species should occur, potentially restoring the area to its original levels of abundance and biomass within 1-5 years (Naqvi and Pullen, 1982; Bowen and Marsh, 1988; Johnson and Nelson, 1985; Saloman *et al*., 1982; Van Dolah *et al*., 1984; Van Dolah *et al*. 1992; Johnson and Nelson, 1985; Van Dolah *et al*., 1984; and Wilber and Stern, 1992). Considering that un-impacted or recovered portions of the borrow area will likely be available during any particular dredging event, more rapid recruitment from adjacent areas is expected to expedite recovery. The impacts of this activity on benthic invertebrates are discussed in more detail in Section 8.01 Feasibility/EIS titled "Marine Environment."

Cumulative impacts from space crowded perturbations could occur at the local scale resulting from the use of borrow sites A-F for initial project construction and periodic maintenance of the Topsail Beach federal and non-federal projects as well as borrow areas G-T for the Surf City and North Topsail Beach federal and non-federal projects.

Statewide Impacts:

Existing and Potential Sites: Beach compatible sediment identified for all federal and non-federal nourishment projects throughout North Carolina is most often identified from: upland sites, maintenance or deepening of navigation channels, and/or offshore borrow areas (Table J-2). For the purposes of this impact assessment, only offshore borrow areas are evaluated for cumulative marine resource impacts considering that upland sources are outside of the marine environment and navigation channels are repeatedly dredged already in order to maintain navigation servitude. Of all the projects listed with offshore borrow areas in Table J-2, there is currently only one federal (Carolina Beach and Vicinity, NC Kure Beach portion) and three non-federal (Bogue banks FEMA, Bogue Banks Restoration Project – Phases 1&2, and Bald Head Island Beach Nourishment) offshore borrow sites that have received permits and/or authorizations and funding, and are currently in use. Other offshore borrow areas identified for projects are either under study and have not been permitted and/or authorized yet or have received permits and/or authorizations but have not been funded or constructed yet. Considering only the projects that are currently in use, significant cumulative impacts associated with time and space crowded perturbations are not expected considering that these borrow areas are spread out throughout the state and the acreage of impact for these borrow areas relative to the available un-impacted sites throughout the state is not significant. However, recognizing the potential for all of the federal and non-federal projects identified in North Carolina to occur within the reasonably foreseeable future (Table J-2), there is a potential for cumulative impacts for time and space crowded perturbations associated with the cyclic use of the offshore borrow areas throughout the state.

9b. Beach Areas

The impacts of beach disposal on North Carolina beaches are evaluated in Section 8.0 of the Feasibility Report/EIS. The degree of cumulative impact would increase proportionally with the total length of beach impacted. The most likely projects to increase the length of North Carolina beach disposal are beach nourishment projects.

As shown in Table J-5 below, the North Carolina ocean beaches (320 miles) can be divided up based on the potential that a beach nourishment project will be proposed for them. The Coastal Area Management Act (CAMA) applies to all 20 North Carolina Coastal Counties. Proper beach nourishment , navigation disposal, and/or local maintenance within these counties is generally regulated under CAMA or USACE permitting authorities alone, and for this analysis, are labeled CAMA regulated. Approximately 37 percent of North Carolina beaches are in this category. Other North

Carolina ocean beach areas which are less likely to be considered for beach disposal include those identified under the Coastal Barrier Resources Act (CBRA) of 1982 (PL 9-348), the Coastal Barrier Improvement Act of 1990 (PL 101-591), and National and State park lands. CBRA restricts federal expenditures in those areas comprising the Coastal Barrier Resources System (CBRS); thus, long term federal beach nourishment projects will not occur in defined CBRA zones. However, though long term federal beach nourishment projects are restricted from CBRA zones, non-federal permitted projects may still occur (i.e. North Topsail Beach) on a short term basis. National or state park lands are the least likely to have beach nourishment projects considering that their mission is often to manage lands in their natural state and protection of infrastructure is less common. National and state parks allow highly restricted disposal under special use permits and conduct disposal only as required to protect resources, such as at Pea Island. Only about 10 percent (on National/Federal and State Parks) of all existing or projected disposal/nourishment in North Carolina are on beaches within this category.

Table J-5. North Carolina beach classifications and associated potential for beach disposal/nourishment activities.

Beach Classification	Percentage of NC Beaches	Potential for Beach Disposal/Nourishment Activities
Coastal Barrier Resource System	19	Medium
Developed and/or CAMA Regulated	37	High
National Park Lands	40	Low
State Park Lands	4	Low

Statewide Impacts

The following quantitative analyses of statewide impacts were determined based on data provided in Tables J-2 and J-3. These data represent an estimate of the percent of North Carolina beach affected by sand disposal for maintenance of federal navigation channels, and existing, proposed, or potential federal and non-federal beach nourishment projects. Table J-6 represents the total project miles for all existing and proposed federal and non-federal beach nourishment projects and the full authorized limits for beach disposal of navigation dredged material. However, assuming all of these activities were constructed to the full extent (which is very unlikely considering funding constraints, dredging needs from navigation channels, etc.) these estimates would not represent the actual extent of North Carolina ocean beach impacted because of overlapping project areas.

Table J-6. Summary of total project miles for existing and/or proposed federal and non-federal nourishment activities and federal navigation disposal.

Project Type	Total Project Miles	% NC Beach
Federal Beach Nourishment	122	38
Non-Federal Beach Nourishment	75	23
Federal Authorized Beach Disposal	41	13
TOTAL	**238**	**75**

Recognizing that many of the existing or proposed federal and non-federal beach nourishment project limits overlap and that some portions of the federal authorized beach disposal limits are within these project areas as well, Table J-7 provides an estimate of total mileage of North Carolina Ocean beach that could cumulatively be impacted by beach nourishment or navigation disposal activities without double counting the overlapping projects.

Table J-7. Summary of cumulative mileage of North Carolina Ocean beach that could be impacted by beach nourishment and/or navigation disposal activities.

Project Type	Total Miles Impacted (*w/o double counting for overlapping projects)	% NC Beach
Federal and Non-Federal Beach Nourishment	112	35
Federal Authorized Beach Disposal	19	6
TOTAL	**131**	**41**

a. Existing Beach Nourishment:

- Of the total 197 potential federal and non-federal beach nourishment project miles proposed for NC ocean beaches (Table J-6), a total of 74 (23%) have actually been constructed. However, this estimate represents actual project miles nourished and does not reflect circumstances where the projects overlap. Therefore, the total number of actual miles of beach nourished is less.

b. Proposed Beach Renourishment:

- 123 miles or 38 percent of the North Carolina ocean beaches are proposed for beach nourishment (federal and non-federal).

c. Cumulative Impacts:

- Considering all proposed and existing disposal and nourishment impacts throughout the ocean beaches of North Carolina, a significant portion of the shoreline will have beach placement activities in the foreseeable future, likely resulting in time and space crowded perturbations. However, recognizing the funding constraints to complete all authorized and/or permitted activities, the availability of dredging equipment, etc.; it is very unlikely that all of these proposed projects would ever be constructed all at once. Therefore, though time and space crowded perturbations are expected in the reasonably foreseeable future, assuming each project adheres to project related impact avoidance measures, it is likely that adjacent un-impacted and/or recovered portions of beach will be available to support dependent species (i.e. surf zone fish, shore birds, etc.) and facilitate recovery of individual project sites to pre-project conditions.

Project Level Impacts
(10-mile study area)

The Surf City and North Topsail Beach study area is a berm and dune project extending along approximately 10 miles of the oceanfront. The southern limit of the project is the boundary between Topsail Beach and Surf City. The northern limit is within North Topsail Beach at the southern edge of the Coastal Barrier Resources System (Topsail Unit, L06).

a. Existing Local Maintenance:

- Under existing conditions, the entire study area (10 miles) is expected to experience frequent local maintenance, including beach scraping, bulldozing, dune restoration, beach restoration, etc.

b. Existing Disposal Activities:

- Annual disposal activities (<200,000 cy) occur within a 1.5 mile area on the north end of N. Topsail Beach, approximately 3,000 feet west of inlet extending westward to Maritime Way (Galleon Bay area).
- The placement of nourishment material along the 10-mile study area is not expected to affect the current disposal schedule.

c. Existing Beach Nourishment:

- None.

d. Proposed Beach Nourishment:

- The entire 10-mile federal study area is proposed for beach nourishment. Additionally, a non-federal study is proposed to nourish the remaining portions of North Topsail beach, including the CBRA units.

e. Cumulative Impacts:

- The currently approved navigation disposal limits are located outside of the proposed project area study area; therefore, none of the area proposed for sand deposition within the 10-mile study area has had previous beach disposal, other then small scale emergency fill events.

- For areas that have had local disturbances (i.e. beach bulldozing), it is possible that the proposed action will impact beach invertebrates in areas that have not fully recovered from past sand deposition, extending recovery time.

Conclusion

Historically, the extent of beach nourishment activities on North Carolina beaches was limited to a few authorized federal projects including: Wrightsville Beach, Carolina and Kure Beaches, and Ocean Isle Beach. However, in the past 10 years, a significant number of federal and non-federal beach nourishment efforts were pursued to provide coastal storm damage reduction along the increasingly developed North Carolina shoreline. Additionally, the number of non-federal permitted beach nourishment projects has increased in recent years in efforts to initiate coastal storm damage reduction measures in the interim of federal projects being authorized and/or funded (i.e. Nags Head, North Topsail Beach, and Topsail Beach). Considering the extent of coastal development and subsequent vulnerability to long and short term erosion throughout the North Carolina shoreline it is likely that the proposed beach nourishment projects within the reasonably foreseeable future will be constructed. Furthermore, the frequency of beach disposal activities for protection of infrastructure will continue throughout the state resulting in cumulative time and space crowded perturbations. However, assuming projects continue to adhere to environmental commitments for the reduction of environmental impacts, and un-developed beaches throughout the state continue to remain undisturbed, it is likely that adjacent un-impacted and/or recovered portions of beach will be available to support dependent species (i.e. surf zone fish, shore birds, etc.) and facilitate recovery of individual project sites to pre-project conditions. Assuming recovery of impacted beaches and the sustainability of un-developed protected beaches (i.e. National/Federal and State Parks and Estuarine Reserves) the potential impact area from the proposed and existing actions is small relative to the area of available similar habitat on a vicinity and statewide basis.

10. Actions to Reduce Cumulative Impacts

Sections 7.03.6 and 10.06.1 of the Feasibility Report/EIS include environmental commitments and monitoring proposed to minimize project impacts. These actions will also reduce any cumulative impacts related to beach nourishment and offshore borrow activities. Several of the incrementally larger beach projects considered in this assessment including Wilmington Harbor, Bogue Banks (local nourishment project), and Dare County Beaches have conducted significant monitoring components that address beach impacts on northern, central and southern North Carolina beaches. The Dare County Beaches project also has a significant offshore borrow area monitoring component for both pre- and post-borrow activities.

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Feasibility Report
and
Environmental Impact Statement

on

Coastal Storm Damage Reduction

SURF CITY AND NORTH TOPSAIL BEACH
NORTH CAROLINA

Appendix K

Scoping Letters and List of Respondents

Below is a list of agencies/individuals that responded to the NEPA Scoping letter, dated February 14, 2001. Their responses and the NEPA Scoping letter are attached in the same order.

1. U. S. Fish and Wildlife Service, Raleigh Field Office, letter dated 16 March 2001

2. N. C. Department of Cultural Resources, State Historic Preservation Office, letter dated 2 April 2001.

3. N. C. State Clearinghouse, Department of Administration, response dated 19 March 2001

4. PenderWatch & Conservancy, Hampstead, NC, letter dated 13 March 2001

5. N. C. Wildlife Resources Commission, Habitat Conservation Program, letter dated 13 March 2001.

6. N. C. Division of Water Resources, Water Project Section, letter dated 12 March, 2001

7. N. C. Division of Environmental Health, Shellfish Sanitation Section, letter dated 27 February 2001

8. N. C. Division of Environmental Health, Public Health and Pest Management Section, response dated 26 February 2001.

9. N. C. Division of Coastal Management, memorandum dated 23 February 2001

10. N. C. Division of Water Quality, Wilmington Regional Office, response dated 9 March 2001

11. Natural Resources Conservation Service, letter dated 11 February 2002

12. NEPA Scoping letter, letter dated, February 14, 2001

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

March 16, 2001

Mr. W. Eugene Tickner
Deputy District Engineer
Programs and Project Management
U. S. Army Corps of Engineers
P. O. Box 1890
Wilmington, North Carolina 28402-1890

Dear Mr. Tickner:

This letter is a response to your February 14, 2001, request for scoping comments on a review undertaken by the Wilmington District, U. S. Army Corps of Engineers (Corps) for the communities of North Topsail Beach and Surf City, Onslow and Pender Counties, North Carolina, in the interest of shore protection and related purposes. The Corps is also reinitiating studies necessary to prepare a General Reevaluation Report (GRR) for the community of Topsail Beach in Pender County. An earlier Draft Feasibility Report and Environmental Impact Statement (EIS) (U. S. Army Corps of Engineers [hereafter USACOE] 1988) for Topsail Beach presented a selected plan consisting of a dune constructed to 13 feet above mean sea level and a constructed berm 160 feet wide along a main fill length of approximately 1.9 miles. These three communities are located on Topsail Island, a barrier island (Figure 1). These comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667d) and Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543). This letter does not constitute the report of the Department of the Interior as required by Section 2(b) of the Fish and Wildlife Coordination Act.

A major concern of the Service is that efforts to reduce storm damage to man-made structures may seriously degrade the habitat values provided by beaches and nearshore marine areas. This concern is most acute in regard to the long-term impacts of engineered structures, e.g., seawalls and artificial beach-dune systems, constructed to allow structures and infrastructure to remain in a fixed location. It is now well known that barrier islands move landward in the face of a rising sea level. Storms and a rising sea may move beaches, but these factors do not eliminate beaches in undeveloped areas (see Figure 2). If a commitment is made to hold man-made structures at a fixed location on islands surrounded by a rising sea, it is likely that temporary measures such as an artificial beach-dune system will inevitably be replaced by larger and larger constructed beaches or harder, permanent structures such as a seawall (see Figure 3). While a seawall would protect structures, the habitat values of the natural beach would inevitably disappear.

The Service also has several concerns regarding the periodic construction of an artificial beach-dune system. The recurring removal of large quantities of sand from offshore and nearshore areas is harmful to the organisms that use such areas. The placement of sand on beaches is harmful to the beach invertebrates living on the beaches and the vertebrates that feed on the beach infauna. The turbidity caused by sand placement and the resulting sedimentation are harmful to nearshore organisms and may adversely impact important hardbottom communities.

The Service believes the single most important planning goal for a storm damage reduction project on Topsail Island should be a rigorous adherence to the procedures contained in the National Environmental Policy Act (NEPA). The current planning effort for all of Topsail Island should not accept the plan selected 13 years ago (USACOE 1988) for construction of an artificial berm and dune system at the southern end of the Island, but take a fresh look at the alternatives available today in light of new information on the impacts to the important biological resources in the project area.

The development of feasible alternatives should be based on a thorough consideration of the rise in sea level. Project planning should use the best available information on present rates of global sea level rise and possible increases in the rate of sea level rise. Titus (1990) notes that estimates of global sea level rise in the 1990-2100 period range from two to seven feet, and considers the effects on barrier islands. Hudgens (1999) notes that predictions of relative sea level rise at Hampton Roads, Virginia, between 1990 and 2100 range from 18 to 45 inches and considers possible adaptions to the National Flood Insurance Program. Titus and Narayanan (1995) write that sea level is most likely to rise six to 13 inches in the 1995-2100 period, but there is a ten percent chance that the rise in this period could be 12 inches by 2050 and 26 inches by 2100. While future projections vary, it is clear that the rate of sea level rise is increasing and that projections based on past evidence are not justified. In developing feasible alternatives for storm damage reduction on North Carolina's barrier islands, the issue of future sea level rise should be addressed with an indication of how the efficacy of each alternative would be affected by various elevations of sea level, e.g., 1, 2, and 3 feet by 2050.

The movement and creation of sediment in Onslow Bay, offshore of Topsail Island ,, should also be considered. Cleary (2001) states that much of the shoreline in southeastern North Carolina is "sediment starved ... [with] little storm protection in place and ... marginal or no potential for locating beachfill quality sand on the shoreface for nourishment programs. As a consequence, major sections of some of the high hazard shoreline reaches will have to be abandoned, as relocation to a nearby site is not an option." Most of the sediments in Onslow Bay are created through bioerosion of offshore hardbottoms of limestone and siltstone (e.g., Riggs et al. 1998). Topsail Island and Onslow Beach are well-known for the extensive rock outcrops offshore, including rock ledges and rubble mounds that can be found in 30 feet of water with up to 15 feet in relief (e.g., Riggs 1994, Riggs et al. 1995). "Morphologically prominent hardbottoms are actively being degraded and retreating in response to intense bioerosion by endolithic bivalves, crustaceans, and worms" (Riggs et al. 1996, p. 844). This bioerosion may develop seafloor relief of millimeters to meters to tens of meters depending on the lithology and bioerosional processes involved (Riggs et al. 1998). The paucity of sand offshore and underneath the island controls the erosion and accretion patterns and storm response of these communities by making them less flexible to movement and absorption of wave energy (e.g., Riggs 1994, Riggs et al. 1995, Cleary 2001).

Your letter indicates that shore protection alternatives include no action, beach nourishment, and non-structural measures (relocation). The Service recommends two additional approaches that could be used either singularly or in combination. First, modification of existing development and infrastructure. This approach includes retrofitting existing structures to withstand storms, elevating houses, and improved placement of roads and utility lines. Second, improved zoning and land use planning. This second approach would include greater avoidance of hazard areas by development, expanded use of setbacks for structures, and overall lower development density. Both alternatives would significantly reduce storm damage.

Of all the barrier islands in North Carolina, Topsail Island is the most in need of innovative storm damage reduction methods. At least three hurricanes in the last four years have severely affected this island, cutting storm breaches through the island and effortlessly rearranging homes and mobile home parks. Pilkey et al. (1998, p. 171) characterize the island following Hurricane Fran in 1996 as resembling a war zone that had been bombed. The south end of the island was redesigned by natural storm processes (e.g., dunes and vegetation removed). Vacant lots currently exist throughout the island, suggesting that relocation of oceanfront structures as needed over time is feasible. Figure 4 shows that new lots are being sold on the sound-side of the island as overwash nourishes the marshes and creates new upland habitat.

The Service requests that special attention be given to one potential type of relocation. This option would consist of a systematic program to use the uplands created by natural island overwash as relocation sites for threatened, oceanfront structures. The Corps has informed the Service that "many acres of marsh" at Topsail Beach have been buried in sand to the extent that these areas have become uplands suitable for buildings (Figure 4). The Service requests that the alternatives analysis quantify the area of buildable uplands created by the hurricanes in the 1996-1999 period and compare that area to the areal extent of oceanfront land lost to shoreline recession. The alternative analysis could then include a detailed description and analysis of a systematic, long-term program for relocating threatened oceanfront structures to uplands created by natural island overwash.

The Service recommends that the Corps ask the Federal Emergence Management Agency (FEMA) to serve as a cooperating agency for this storm damage reduction project. The FEMA deals with the aftermath of storms and the recovery process. This agency has knowledge of storm damage reduction through its Hazard Mitigation Program and the evaluation of land-use and control measures used to rate communities for the National Flood Insurance Program. The cooperation and input from the FEMA, especially in regard to removing structures in high hazard zones, would be a major step in dispelling the idea that the preferred alternative is biased toward the construction of an artificial beach-dune system.

A significant indirect impact that should be addressed in the EIS is the most likely socioeconomic condition of the project area at the end of the 50-year life of the initial storm damage reduction project. We would hope the EIS should specifically discuss: (1) whether storm damage efforts can be allowed to end after 50 years; (2) if storm damage efforts are forced to end after 50 years, what are the mostly likely consequences for structures on Topsail Island; and (3) if storm damages efforts are continued beyond 50-years which alternative, e.g., beach nourishment, relocating structures, etc., has the best chance of success for an additional 50 years. All the environmental factors should be carefully weighed to determine the alternative with the least overall environmental impacts.

The Service has outlined the direct impacts of a major sand mining-beach construction operation (U. S. Fish and Wildlife Service [hereafter USFWS] 2000, Appendix B) in six tables. The EIS needs to consider the environmental consequences of each direct impact listed in these tables. The Service believes that most, if not all, of these physical changes will adversely impact fish and wildlife resources.

Sand mining is likely to alter the bathymetry and substrate characteristics of offshore borrow areas (USFWS 2000, Appendix B, Table 6), sites of significant microalgal biomass where production is concentrated in the surface layer of bottom sediment. Cahoon and Cooke (1992) state that primary production data from Onslow Bay indicate that the sediment-water interface must be viewed as a dynamic part of continental shelf habitat. Benthic microalgae provide a dependable food source for both benthic deposit feeders and suspension feeders. The physical alterations given by the Service produce both direct and indirect impacts on primary productivity and benthic fauna. The direct environmental consequences of removing benthic microalgae as part of any offshore sand mining should be evaluated. The Service is also concerned that greater depths at offshore borrow areas produced by sand mining will result in reduced primary productivity. Cahoon et al (1990) concluded that the presence of benthic chlorophyll *a* indicated a productive benthic microflora in Onslow Bay. While some benthic primary productive exists across the bay, this work indicates that concentrations of chlorophyll *a* decrease as water depth increases, and thus sand mining that produces permanent pits in offshore areas is likely to lower primary productivity. There is also a reduction in the number of algae species with depth and creating pits by mining sand has the potential to lower species diversity (Schneider 1976 as cited in Cahoon et al. 1990).

According to our information, sediment for a long-term nourishment project anywhere along Topsail Island is limited to non-existent. Cahoon et al. (1990) cite Mearns et al. (1988) as finding that the sediment in Onslow Bay is generally a thin veneer overlaying hard substrates. Backstrom et al. (2001), for example, characterize the shoreface offshore of Surf City as not containing "a significant volume of sand ... [for] a viable borrow site" of nourishment sand within the nearest 75 square kilometers. The offshore seafloor consists of extensive hardbottoms covered with a "patchy, thin veneer of interbedded muddy sands and shell units." Backstrom et al. (2001) estimate that over 3.5 million cubic meters of sand would be needed for an initial beach fill project, a volume not available in the area, and they note that Surf City's "central location along Topsail Beach and the use of the relatively small bordering ebb deltas further minimizes future nourishment." These authors suggest that additional development be discouraged.

Sediment placement during the sea turtle nesting season is likely to adversely affect the reproductive success of these federally-listed species. Sand disposal operations conducted during the nesting and hatching season may result in the burial or crushing of nests or hatchlings or loss of sea turtles through disruption of nesting activity. While a nest monitoring and relocation program would likely reduce these impacts, nests may be inadvertently missed or misidentified as false crawls during daily patrols. Nests may be destroyed by operations at night prior to beach patrols being performed. Under the best of conditions, approximately 7 percent of nests are misidentified as false crawls by experienced sea turtle nest surveyors (Schroeder, 1994).

The EIS should discuss the direct impacts of alternatives other than a beach nourishment program. The EIS would be enhanced by a table that compares the direct impacts of all the alternatives developed.

Indirect impacts, also known as secondary impacts, are those that occur in a different location and at a different time from a given action. The Service has listed the indirect, physical impacts associated with a long-term program of beach nourishment (USFWS 2000, Appendix B). As with direct impacts, the alteration or modification of physical characteristics or processes are very likely to adversely impact fish and wildlife resources. The Service recommends that the environmental staff of the Corps consider the environmental pathways between the physical impacts presented and the habitat values of the project area.

One indirect impact of an artificial berm and dune project is sediment starvation of the sound-side shoreline by preventing cross island overwash of sand during storms. Croft and Leonard (2001) state "coastal development, inlet stabilization, and post-storm bulldozing, disrupt the natural processes of marsh accretion by limiting sediment inputs." All three of these processes already occur on Topsail Island, where both New River and New Topsail Inlets are maintained with navigational dredging and beach bulldozing occurs regularly. Figure 4 illustrates an instance when the natural processes succeeded in nourishing the marsh despite coastal development; the replacement of the bulldozed dune or levee ridge, however, will prevent further nourishment of the marsh until the next large storm. Large-scale nourishment projects that construct and maintain berm and levee systems inhibit this natural process on a grand scale, and such adverse impacts should be addressed.

A major indirect impact of maintaining the island at its present location as sea level rises is the gradual reduction in freshwater supplies to plants and animals (Figure 3). In coastal areas fresh groundwater is found as a lens overlying salt water. The depth to which freshwater extends below sea level in unconfined aquifers is usually estimated to be 40 times the elevation of the water table above mean sea level (Fletcher 1992). As sea level rises the capacity of the freshwater lens is reduced. If the North Carolina barrier islands are held in place and not allowed to naturally migrate to higher ground as sea level rises, the islands will become similar to ocean coral atolls that cannot migrate. Roy and Connell (1991) have considered the impact of sea level rise on coral atolls. Fletcher (1992) summarizes these concerns by stating:

> "As erosion reduces island size, groundwater lens shrink beneath larger islands and nearly disappear beneath smaller ones. Vegetation and island ecosystems become stressed by the decrease in usable water and the ability to support human habitation is reduced. . . . Storm overwashes would increase in frequency, damaging vegetation and coastal development, and increase the salinization of the fresh ground water lens. Conceivably (Roy and Connell 1991), in the next several decades accelerated coastal erosion on the order of 1-2 m/yr, resulting from accelerated sea-level rise, could reduce the dimensions of some presently inhabited islands to the point where their ground water supplies are no longer able to support a viable ecology or permanent human habitation."

While human habitation of North Carolina barrier islands may not face the same threats as ocean atolls, the communities of plants and animals may be at risk. Human inhabitants are able to bring in freshwater from the mainland and construct artificial barriers to protect structures. However, artificial barriers will not stop the subsurface rise of salt water under the island. In time the shallow freshwater resources on which plants and animals depend may be lost. The 1992 land use plan of Surf City notes that town water is derived from wells supplied by the Castle Haynes limestone aquifer (Surf City 1993). The wells are located about a mile inland because of poor water quality (e.g., iron, chlorides, etc.) in the immediate beach area. The presence of chlorides in water supplies suggests that salt water intrusion is occurring. Development based on the sense of security provided by an artificial beach-dune system would create additional demands on freshwater supplies and wastewater treatment facilities. The future availability of freshwater resources for plant and animal communities under various sea level rise scenarios should be addressed. This would be especially important if efforts to reduce storm damage are based on a plan to hold the island in its present location and prevent natural island migration (Figure 3).

The indirect impacts of removing millions of cubic yards of sand from the seafloor around Topsail Island should also be addressed. Sand removal would create a deeper nearshore environment and allow waves with greater energy to strike the beach. The project EIS should consider the storm damage implications of higher energy waves striking the beach as the offshore area becomes deeper.

The potential for turbidity and sedimentation resulting from sand mining (USFWS 2000, Appendix B, Tables 5 and 6) and beach placement (USFWS 2000, Appendix B, Table 4) may directly harm hardbottoms by covering exposed rock substrate. These types of hardbottoms can support vast macroalgal meadows or no visible biota at all, and are the most abundant type of hardbottom in Onslow Bay (Riggs et al. 1996).

High relief scarped hardbottoms support flourishing reef-fish communities (Riggs et al. 1996). Species diversity and density of infauna and epibenthos increases with the relief of these types of livebottoms.

The availability of specific hardbottoms for development of a benthic community, as well as the
structure of that community, are greatly influenced by specific habitat controls including
composition, geometry, and morphology (Riggs et al. 1996, p. 844). Surficial sediment patterns
control the composition and spatial distribution of benthic communities (Riggs et al. 1998).
Thus any project that could remove or add to the surface sediments via dredging and filling will
influence the availability of the hardbottom habitats, their benthic communities and the structure
of those communities. The Corps has stated that "[B]orrow sites designated solely for
nourishment can experience the greatest impact if the borrow activity affects hard bottom 7
communities, or there is a change in sediment composition" (Yelverton 2001). Thus long-term
beach construction along this island would affect sensitive hardbottoms and introduce a different
sediment composition (quartz sand as opposed to carbonate, silty or rock fragmented material) to
the nearshore system.

The addition of millions of cubic yards of sediment from beach fill projects poses a significant threat to the sensitive nearshore habitats. Thieler et al. (1995) documented that sediment moves from Wrightsville Beach offshore to at least 17 meters (56 feet) water depth. Approximately 2 million cubic meters (2.6 million cubic yards), or one-fourth, of the nourishment sediment for Wrightsville Beach has accumulated on the lower shoreface and inner shelf in water depths exceeding 9 meters (29 feet) (Thieler et al. 2001). Riggs (1994) states that nourishment sediment has buried hardbottoms off Wrightsville Beach, Carolina Beach and Kure Beach, taking these reefs "out of production" for aquatic resources. A water depth of 9 to 28 meters (29-92 ft) is traditionally not considered to have significant sediment movement in a coastal engineering sense, but this research shows that it does have a significant impact in an ecological sense. Riggs (1994) expresses concern that a beach construction project on Topsail Island could harm offshore hardbottoms. The Corps GRR, feasibility report and EIS should fully consider the adverse impacts that sedimentation due to either dredging or sand placement could have on the highly productive hardbottom communities of Onslow Bay and the fisheries resources that they support.

The long-term adverse impacts on populations of beach macroinvertebrates should be considered in the evaluation of all project alternatives. An earlier planning document (USACOE 1988, p. eis-1-5) states that no long term impacts on beach infauna would occur. This assessment considered a main beachfill of approximately 1.9 miles, and not the approximately 17-18 miles currently under consideration. Smaller linear distances of beach construction allow for greater recruitment from undisturbed adjacent beaches. If beaches receive new sediment every three years, there is a question as whether some areas of the artificial beach will be repopulated at all or ultimately have a greatly reduce invertebrate population. Any determination that a 50-year program of sand disposal for beach construction can be completed without harm to beach invertebrates should be supported with references to the life cycles of these organisms, the timing of future sand placements, and the direction of the longshore current in relation to adjacent undisturbed beaches.

Project planning should evaluate the ways in which each alternative would influence future development in the project area. For example, a beach nourishment project aimed at providing storm surge protection for hurricanes in categories 1-3 may provide a sense of security that leads to additional development of more and larger structures. All the additional development would be vulnerable to the storm surge of a hurricane in categories 4-5. If the project is designed to protect against hurricanes in categories 1-3, the EIS should clearly describe the socioeconomic impacts associated with the landfall of a major storm, such as a category 5 hurricane, for which protection is not intended.

The species protected by the ESA that are most likely to affected on Topsail Island include the loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), piping plover (*Charadrius melodus*), and seabeach amaranth (*Amaranthus pumilis*). The two sea turtles and the piping plover were the subject of a December 29, 1989, Biological Opinion for the West Onslow Beach and New River Inlet Project.

All five Atlantic sea turtles are protected by the ESA and may occur in the coastal waters of North Carolina. In addition to the threatened loggerhead and green sea turtles, offshore water may be used by federally endangered Kemp's ridley (*Lepidochelys kempi*), hawksbill (*Eretmochelys imbricata*), and leatherback (*Dermochelys coriacea*) sea turtles. Any consideration of sand placement during the sea turtle nesting and incubation period, May 1 through November 15, should include measures to minimize adverse impacts on sea turtle reproduction. Measures to relocate sea turtle nests should discuss the area to which nest would be relocated and the physical differences, e.g., sand grain size, sand color, moisture availability, between the natural nest site and the relocation nest site.

Piping plovers use the project area for nesting, migration, and overwintering (U. S. Fish and Wildlife Service [hereafter USFWS] 1989, p. 23). Nesting piping plovers within the project area are part of the Atlantic Coast population, and are federally listed as threatened. Piping plovers nest above the high tide line on coastal beaches; on sandflats at the ends of sandspits and barrier islands; on gently sloping foredunes; in blowout areas behind primary dunes (overwashes); in sparsely vegetated dunes; and in overwash areas cut into or between dunes. The species requires broad, open, sand flats for feeding, and undisturbed flats with low dunes and sparse dune grasses for nesting. Piping plovers from the Federally endangered Great Lakes population as well birds from the threatened populations of the Atlantic Coast and Northern Great Plains overwinter on North Carolina beaches. Project planning must consider the manner and extent to which each alternative would impact the primary constituent elements of plover overwintering habitat.

Seabeach amaranth, an annual plant, exists adjacent to inlets, along beaches between dunes and the high tide line, and in areas of extreme overwash. The plant helps to trap sand and build dunes. The species is listed as threatened by both the federal government and the State of North

Carolina. Suitable habitat for this plant occurs in the project area. The Service reported that 50 plants were found during a survey of the south end of Topsail Island during the late 1980s (USFWS 1989, p. 26). Service records contain a letter from the Corps dated February 22, 1993, that reports survey data for seabeach amaranth on Topsail Beach during 1992. This survey reported 22,410 plants on Topsail Beach. Therefore, project planning should consider potential impacts of the various alternatives on this species.

The lack of offshore sand may lead to a consideration of sand mining at inlets and estuarine areas. In the mid-1980s planning for berm construction along the southern part of Topsail Beach included excavation of material from estuarine areas in Banks Channel. Sand mining at inlet and estuarine bottoms, especially areas with submerged aquatic vegetation, during the warmer months of the year would pose a risk to the federally endangered West Indian manatee (*Trichechus manatus*), also known as the Florida manatee. Numbers of manatee sightings are very low, but they do occur along the southern coast of North Carolina (Schwartz 1995). Such mining poses a risk to other protected marine mammals. If such areas are considered as possible mining sites, the Corps should assess potential impacts to the marine mammals and fisheries resources that pass through the inlet and/or use estuarine habitats in the project area.

If the Corps determines that the preferred alternative may affect federally-listed species, consultation with the Service must be initiated. Marine mammals, such as whales, seals, porpoises, and dolphins, are under the jurisdiction of the National Marine Fisheries Service and that agency should be contacted regarding these animals.

In addition to federally species, Corps planning should also consider impacts to state protected species. The North Carolina Natural Heritage Program (NCNHP) has a web page (http://www.ncsparks.net/nhp) that provides information on state-listed species by topographic quad. Most of the project area falls within three quads: New River Inlet, Holly Ridge, and Spicer Bay. The table below gives four species of birds and two species of reptiles that occupy habitats occurring in the project area. These species have special status in North Carolina. The Service will address potential impacts to the these species in our Fish and Wildlife Coordination Act Report. However, the Corps may also consider potential impacts during early project planning.

Common Name	Scientific Name	North Carolina Status	General Habitat
Birds			
Bachman's sparrow	*Aimophila aestivalis*	Special Concern	open pine woods with undergrowth of bushes and grass
Black skimmer	*Rynchops niger*	Special Concern	beaches
Gull-billed tern	*Sterna nilotica*	Threatened	marshes, fields, coastal bays
Eastern painted bunting	*Passerina ciris ciris*	Significantly Rare	maritime shrub thicket
Reptiles			
American alligator	*Alligator mississippiensis*	Threatened	brackish waters and marshes
Carolina Diamondback Terrapin	*Malaclemys terrapin centrata*	Special Concern	coastal marsh, tidal flats, brackish waters

The Service has outlined the cumulative physical impacts of the beach nourishment option that may degrade habitat for fish and wildlife resources (USFWS 2000, Appendix B, Tables 1-6). We encourage the Corps to address these impacts in the context of both ongoing and future beach nourishment programs within North Carolina. The Service also recommends that the project EIS consider any cumulative impacts associated with statewide removal of threatened structures, improved construction standards, and zoning restrictions that would reduce the vulnerability of structures to coastal storms. In regard to storm damage reduction projects, the Service recommends that North Carolina be considered the geographic area and the time frame be 50 years, the customary official planning life of federal beach nourishment projects.

Topsail Island already has active beach disposal of navigational dredge spoil (Fig. 1) at both Topsail Beach and North Topsail Beach. Beach scraping or bulldozing occurs on an annual basis and artificial levees are reconstructed after every storm event. Some structures are protected by sandbags. Over 1300 permits have been issued by the Corps for beach scraping and sandbag revetments in North Carolina since 1980 (J. Richter, pers. comm., February 2001). Federal, local and private beach nourishment projects are proposed or ongoing for over half of the North

Carolina shoreline, more than double the proportion of any other state in the southeast (USFWS, unpub. data). The hardbottoms of Onslow Bay have already been adversely impacted by nourishment projects at Wrightsville, Carolina and Kure Beaches. Projects proposed or ongoing at Figure Eight Island, Onslow Beach, and Bogue Banks will further increase the proportion of Onslow Bay coastline artificially manipulated and maintained. Thus the impacts of these proposed projects on Topsail Island pose a cumulative threat to the Onslow Bay coastal and marine ecosystems.

One approach to cumulative impacts analysis is the preparation of an area-wide or programmatic EIS. Such a comprehensive document is particularly useful when similar actions, viewed with other reasonably foreseeable or proposed agency actions, share common timing or geography. The many projects in North Carolina that involve the dredging of sand from offshore, nearshore, and inlets for placement on developed beaches share many important geological and biological characteristics. For these projects that gradually affect a greater proportion of beaches and offshore areas in North Carolina, an overview or area-wide EIS would serve as a valuable analysis of the affected environment and the potential cumulative impacts of reasonably foreseeable actions for storm damage reduction within the state.

The Service requests that the Corps prepare a programmatic EIS for its civil works and regulatory activities along the North Carolina coast prior to proceeding with the development of specific project plans at Topsail Island, Bogue Banks, Dare County Beaches South (Hatteras and Ocracoke Islands Portion), and Brunswick County Beaches (Caswell Beach, Oak Island and Holden Beach Portion). Such a comprehensive effort would yield a coastal management strategy that identifies areas where socioeconomic resources support shoreline stabilization and those where ecological resources support no such activities. The Service would be willing to partner with the Corps in this endeavor.

Overall, the Service requests that planning for storm damage reduction on Topsail Island have a clear, logical path from the project need to the selection of the preferred alternative. The Service also requests that the Corps hold an interagency scoping meeting and interagency planning meetings and for this project. These meetings would allow a full and open dialogue between all of the planning partners and sponsors and allow issues to be addressed early in the planning process rather than creating obstacles at a later date. These meeting should be initiated while alternatives are being developed. At these meetings all affected agencies could discuss information on the value of property to be protected, offshore sand resources, potential areas for sand mining, and details of a phased program of structural relocation. In addition to state and federal resource agencies, the FEMA and North Carolina Department of Emergency Management should attend and present their perspectives on the extent to which the various alternatives would reduce storm damage.

The Service appreciates the opportunity to provide these comments and we look forward to continued involvement with the Corps on this project. Please keep this office informed on progress in the planning process. General questions or comments should be directed to Howard

Hall at 919-856-4520, ext 27, or by e-mail at < howard_hall@fws.gov >. Specific questions regarding the physical environment and impacts of various alternatives may be directed to Ms. Tracy Rice at ext. 12 or at < tracy_rice@fws.gov >.

Sincerely,

Garland B. Pardue
Ecological Services Supervisor

FWS/R4/HHall/March 16, 2001/919-856-4520, ext. 27/C:TB_Scop301fin.wpd

cc:

Bruce Bell, USFWS, Atlanta, GA
Gerald Miller, US EPA, Atlanta, GA
Larry Hardy, NMFS, Beaufort, NC
William Straw, FEMA, Atlanta, GA
Steve Benton, NC Division of Coastal Management, Raleigh, NC
Charles Jones, NC Division of Coastal Management, Raleigh, NC
Preston Pate, NC Division of Marine Fisheries, Morehead City, NC
Frank McBride, NC Wildlife Resources Commission, Raleigh, NC
David Allen, NC Wildlife Resources Commission, Trenton, NC
Joanne Steenhuis, NC Division of Water Quality, Wilmington, NC
Gavin Smith, NC Division of Emergency Management, Raleigh, NC

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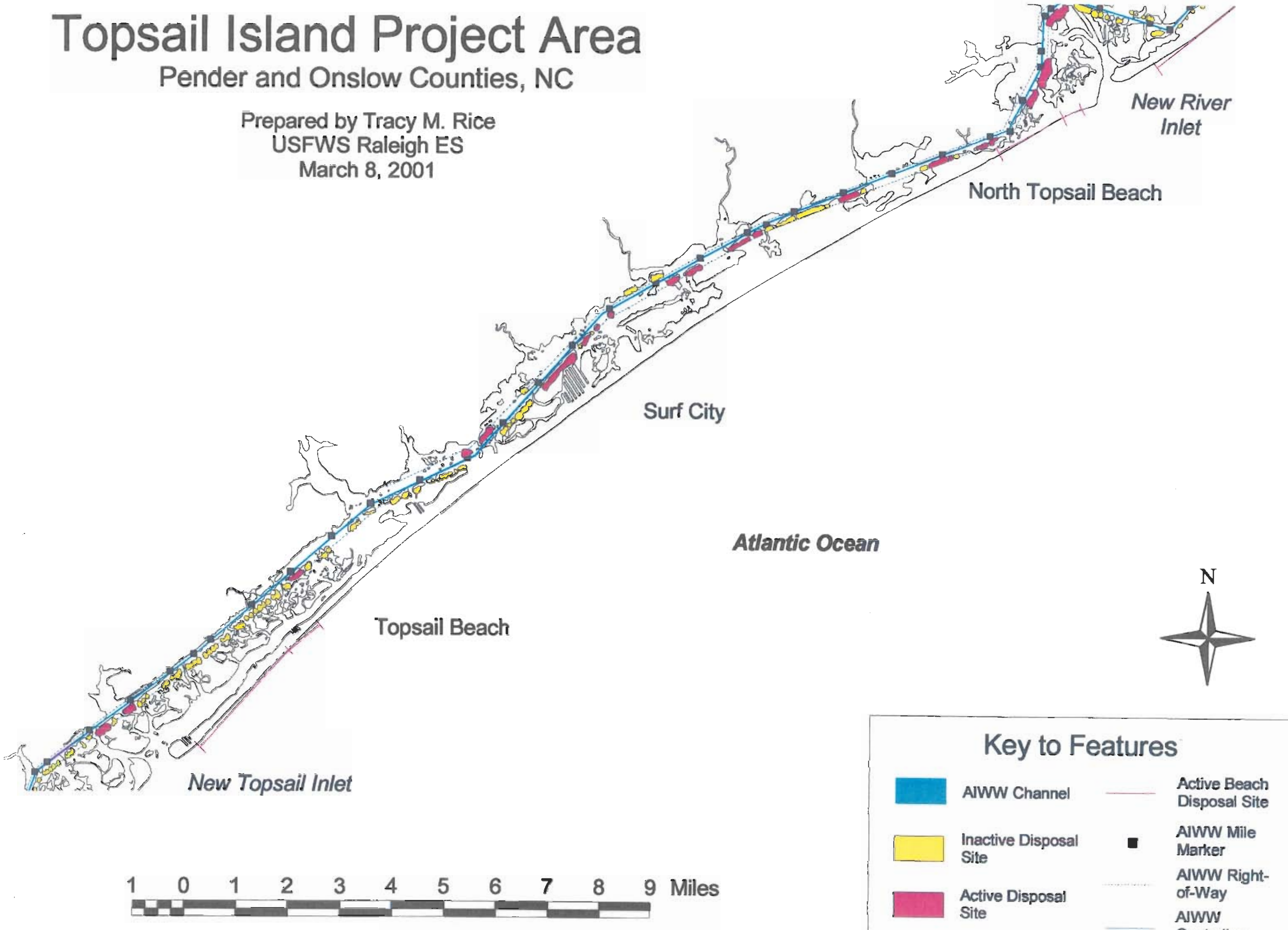
Figure 1

Topsail Island Project Area

Pender and Onslow Counties, NC

Prepared by Tracy M. Rice
USFWS Raleigh ES
March 8, 2001



Data Source: COE Wilmington District AIWW Project for ArcView 3.2

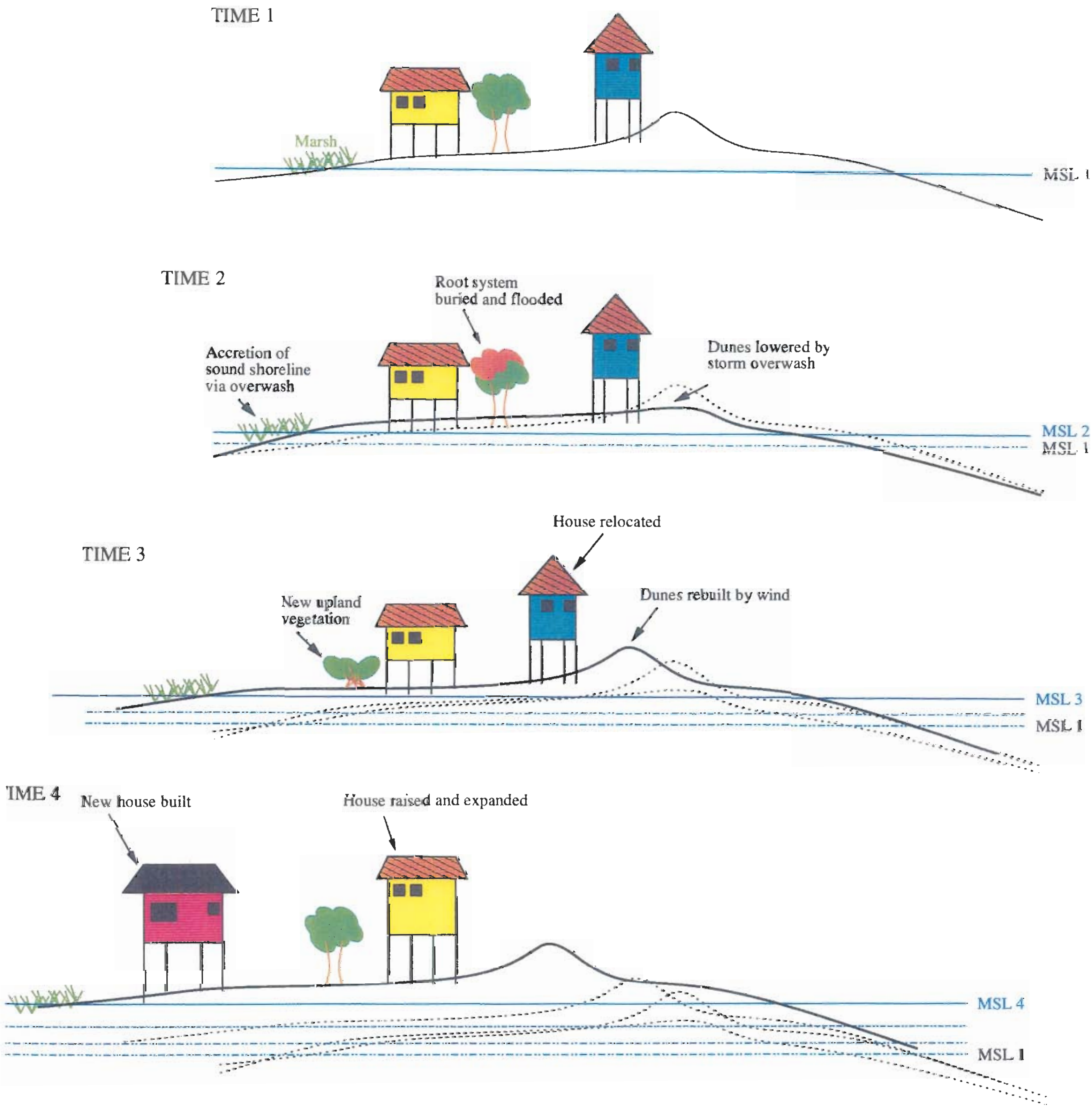


Figure 2. Barrier island migration during a period when sea level is rising at an accelerating rate. Habitat types shift landward (to the left) with the island, but are not permanently lost. Development can be relocated from the ocean-front to the soundside over time.

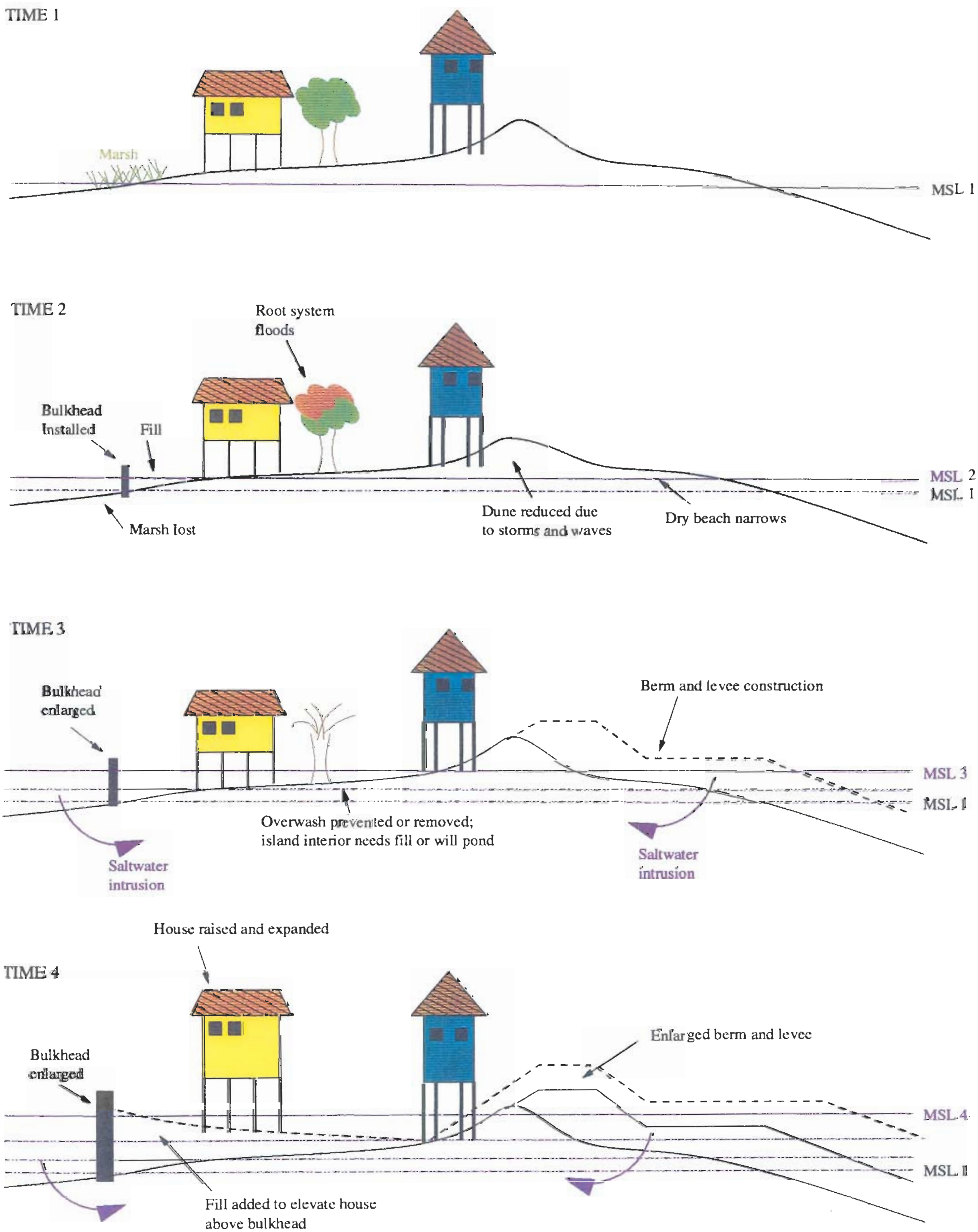
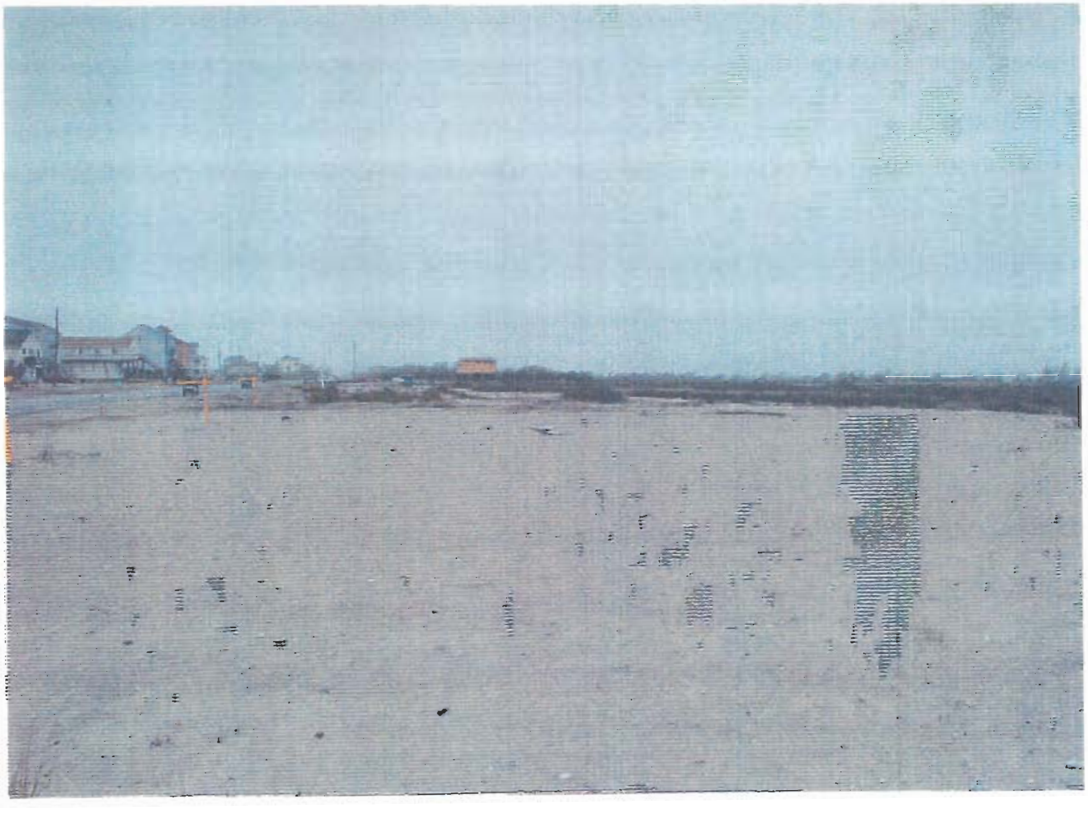


Figure 3. Evolution of a barrier island during a period when sea level is rising at an accelerating rate and the shorelines are stabilized. Habitats are modified and lost, saltwater intrudes on the freshwater table, and a circle of "dikes" replaces island migration processes.

Figure 4. Storm overwash of sand has naturally nourished the sound-side marshes of North Topsail Beach (top), creating new upland habitat that is now listed for sale and development (bottom). Photographs taken February 14, 2001 by U.S. Fish and Wildlife Service.



North Carolina Department of Cultural Resources
State Historic Preservation Office
David L. S. Brook, Administrator

Michael F. Easley, Governor
Lisbeth C. Evans, Secretary

Division of Archives and History
Jeffrey J. Crow, Director

April 2, 2001

Glenn McIntosh
U.S. Army Corps of Engineers
Wilmington District
PO Box 1890
Wilmington, NC 28402-1890

Re: Shore protection activities, Surf City and North Topsail, between New Topsail Inlet and New River Inlet, Pender & Onslow Counties, CH 01-E-0000-0497

Dear Mr. McIntosh:

We have received notification form the State Clearinghouse concerning the above mentioned study area. We would like to take this opportunity to comment.

The shore protection activities, especially beach bulldozing operations involved with re-nourishment, may encounter the remains of vessels lost along the on the beach between New Topsail Inlet and New River Inlet and buried over the last 450 years.

There is one known beach wreck (0001NTB) located within the study area that should be avoided. Our underwater research files also indicate at least five known ship losses between the two inlets.

While the archaeological and historical record does not support a recommendation for a comprehensive archaeological survey, all involved parties should be aware that the possibility that this work may unearth a beached shipwreck. If such an event occurs, work should move to another area and the Underwater Archaeology Branch contacted immediately (910/458-9042). A staff member will be sent to make an assessment of the wreckage and determine the proper course of action. Any questions regarding the wreck 0001NTB can be directed to the Underwater Archaeology Branch (910/458-9042).

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

	Location	Mailing Address	Telephone/Fax
Administration	507 N. Blount St, Raleigh, NC	4617 Mail Service Center, Raleigh 27699-4617	(919) 733-4763 •733-8653
Restoration	515 N. Blount St, Raleigh , NC	4613 Mail Service Center, Raleigh 27699-4613	(919) 733-6547 •715-4801
Survey & Planning	515 N. Blount St, Raleigh, NC	4618 Mail Service Center, Raleigh 27699-4618	(919) 733-4763 •715-4801

Thank you for your cooperation and consideration. If you have questions concerning the above comment, contact Renee Gledhill-Earley, Environmental Review Coordinator, at 919/733-4763.

Sincerely,

Renee Gledhill-Earley

for David Brook
Deputy State Historic Preservation Officer

DB:kgc

cc: State Clearinghouse

NORTH CAROLINA STATE CLEARINGHOUSE
DEPARTMENT OF ADMINISTRATION
INTERGOVERNMENTAL REVIEW

STATE NUMBER: 01-E-0000-0497 H05
DATE RECEIVED: 02/14/2001
AGENCY RESPONSE: 03/09/2001
REVIEW CLOSED: 03/14/2001

MS RENEE GLEDHILL-EARLEY
CLEARINGHOUSE COORD
DEPT OF CUL RESOURCES
ARCHIVES-HISTORY BLDG - MSC 4617
RALEIGH NC

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HISTORIC PRESERVATION OFFICE

REVIEW DISTRIBUTION
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DEHNR - COASTAL MGT
DENR LEGISLATIVE AFFAIRS
DEPT OF CUL RESOURCES
EASTERN CAROLINA COUNCIL

8m 3/5
CS 2/27/01
Agm
see letter

PROJECT INFORMATION
APPLICANT: Dept. of the Army Corps of Engineers
TYPE: National Environmental Policy Act
ERD: Scoping
DESC: Proposal to Determine Necessary Actions Relative to Shore Protection Activities for Surf City and North Topsail Beach in Pender and Onslow Counties

The attached project has been submitted to the N. C. State Clearinghouse for intergovernmental review. Please review and submit your response by the above indicated date. If additional review time is needed, please contact this office at (919)807-2425.

AS A RESULT OF THIS REVIEW THE FOLLOWING IS SUBMITTED:

- [ ] NO COMMENT
- [x] COMMENTS ATTACHED

SIGNED BY: Renee Gledhill-Earley

DATE: 3/26/01

PenderWatch & Conservancy
P.O. Box 662 Hampstead, NC 28443

March 13, 2001

Mr. Glenn McIntosh
U.S. Army Corps of Engineers
Wilmington District
Post Office Box 1890
Wilmington, North Carolina 28402-1890

Dear Mr. McIntosh,

PenderWatch & Conservancy (PW&C) thanks you for providing a copy of the scoping letter (Feb 14. 2001) regarding shore protection for Surf City and North Topsail Beach in Pender and Onslow Counties. PW&C is a Pender County group concerned with the environment and quality of life in Pender County.

Beach renourishment is, and will continue to be, a difficult public policy issue in this community. In the latest issue of our newsletter a guest columnist suggested an approach to the renourishment dilemma. I enclose the article (Todd Miller's essay on p. 4 of the enclosed newsletter). PW&C endorses these guidelines. This letter and Mr. Miller's article will serve as our comment on your scoping notice.

Please place this statement in your record. Also please send us copies of all official actions regarding this proposed project.

Sincerely,

Burt Millette,
President PenderWatch and Conservancy

Cc: North Carolina Coastal Federation

PENDERWATCH

If you are not recycling you are throwing it all away

February, 2001

From the President

Burt Millette

It is an honor to be selected to serve as PW&C President for the year 2001, which incidentally is the fifteenth anniversary of the organization. During this time PW&C has grown to its present level of about 300 dedicated members. One of the goals during the upcoming year will be to both increase the membership and to obtain greater participation from existing members in PW&C affairs. A little help from members will ease the burden on our hard-working Board pf Directors. Your ideas and suggestions are always welcome. Come to a Board meeting (every 2nd Wednesday, 9:00 A.M., at the Hampstead library) or call a Board member with your thoughts. Following Dave Richie in the President's role will be difficult. As President, Dave was dedicated, knowledgeable in environmental affairs and unselfish with his time. He inspired others to get the job done. Fortunately, Dave will stay on the Board and, as evidenced by his message, will continue to be active in PW&C.

From the Past President

Dave Richie

Over sixty PenderWatch and Conservancy members and friends enjoyed a fascinating presentation at our annual meeting, January 17, by Andy Wood, now the Education Coordinator for North Carolina Audubon Society. Andy was supported by some wonderful slides taken by Walker Golder, our originally scheduled speaker, and shared his abundant knowledge about the birds and "critters" that inhabit Lea Island.

Audubon North Carolina will be managing Lea Island primarily to protect nesting birds, while allowing existing recreational activities to continue. They hope to have a resident warden by this summer and expect to have a role for volunteers. Let me know if you are interested. 270-4751.

Andy's talk inspired me to revisit the Holly Shelter sites he interpreted so memorably on our Earth Day trip last April. I was surprised to find Lodge Road in excellent condition, providing access to a wealth of places to walk and explore. The gate in north Hampstead, just beyond the Topsail Baptist Church, will remain open through April. Hunting days are Monday, Wednesday, and Saturday. It is a peaceful, lovely place to be the other four days of the week.

My walk in Holly Shelter reawakened an earlier ambition. If there is enough interest, I would be willing to help organize an informal Friends of Holly Shelter. The main idea would be to share nature-oriented experiences—bird and flower walks, for example. The project could grow into a cooperative, supportive relationship with the Wildlife Resources Commission staff that manages Holly Shelter. There is an evident need for litter pick-up along the roads (not bad, actually, just distracting) and there may be an opportunity to locate a few trails to make it easier to access off-road areas of interest. If you are a potential member of such a group, please call me.

There is one more possible activity I would be willing to help organize. Some of you, I know, are interested in local history, including tangible remnants of earlier human activity. My interest was sparked by an earthen dam near our home that pre-dates the Civil War, and has grown to include traces of old roads in our neighborhood, an old cemetery near Country Club Road and what's left of the railroad right-of-way. It could be fun to assemble bits and pieces of local history and meet from time to time to share what we learn. Please let me know if you would like to be included.

As many of you know, I have been appointed to the Pender County Planning Board and will now be an advocate for good planning and environmental protection from a different vantage point. It has been a privilege to serve you as President for the last two years.

Long Range Planning Proposal

The Long Range Planning Committee submitted their Growth Management Plan to the Pender County Board of Commissioners. This plan was completed after a year of research and meetings. The committee was formed in order to manage the rapid growth that has occurred in Pender County over the past decade. A panel of fifteen volunteers from around the county was formed to develop a cross section of ideas. Harbeck Associates was also brought to the board as a consultant.

The plan developed by the committee is a document called "Pender 2020, Pender County Growth Management Plan".

The people of Pender County drive this plan. The plan consists of twenty different policies which are broken into three different sections as follows:

Section 1 outlines the history of the project and listed policies, which are the principals, set down for growth management.

These policies include sections and categories for policy recommendation. These are protection for primary nursery areas, controlling stormwater runoff, supporting vegetation buffers, controlling development, flood prevention, planning road projects, developing a master drainage plan and limiting septic tanks in flood plains. These policies are designed to last for 10 years but should be looked at every 5 years.

Section 2 of the plan is the narrative. It explains why each one of the policies is put in place.

Section 3 is a list of twenty goals the committee felt the county should address first.

These can be checked off once they are done. Some of these include preserving agricultural areas, establishing stricter estuarine standards, limiting the use of personal watercraft, preserving state game lands and Moores Creek National Battlefield, monitoring the Cape Fear Basin and ground water quality, looking at options for water and sewer, the use of hydric soil definitions to limit development, promoting buffers, tightening mobile home storage, and enforcing sign regulations.

This plan serves as a guidance policy for the most appropriate use of property. It will make development easier and more predictable. The Committee feels it has developed a good plan that will work.

Commissioners are currently reviewing the plan and will hold public hearings on it.

Copies of the plan are on display at both the Hampstead and Burgaw libraries and at the County Planning office in Burgaw.

PenderWatch Hosts Coastal Caucus

On Tuesday, January 9, PW&C hosted the bimonthly meeting of the Coastal Caucus at the Manor in Olde Point.

The Coastal Caucus is made up of organizations similar in many respects to PenderWatch and shares many of our goals for planned growth and environmental protection.

The Coastal Caucus grew from several meetings organized by the North Carolina Coastal Federation (NCCF) for environmental groups in southeastern North Carolina to stop the loss of thousands of acres of wetlands in our area due to illegal ditching and draining.

PenderWatch was involved in those earlier meetings along with the Coastal Federation, Carteret County Crossroads, Brunswick Environmental Action Team, Cape Fear River Watch, The Southern Environmental Law Center, and interested individuals. This group involved the Environmental Protection Agency, initiated legal action to successfully stop the illegal ditching, and caused much of the ditching to be restored.

From that early beginning, the groups involved believed we could accomplish much more if we worked together on problems we shared in common. Those involved asked the NCCF to take on the task of organizing the initial meetings of groups the Coastal Federation thought would add to the organization. They agreed, and the Caucus was formed.

Representatives from eight groups including NCCF, Carteret County Crossroads, Brunswick Environmental Action Team, ConNet, SBTA, New River Foundation, Concerned Citizens of Southeastern NC and PenderWatch, and invited individuals attended the meeting at Olde Point. The items discussed included the proposed CAMA land use planning rules, stormwater rules, beach renourishment, and suspected pollution from forestry activities in the Green Swamp area. Priorities were set for a planned meeting in 2001.

The participants were so impressed by the central location of Hampstead as a meeting place and the amenities provide by the Manor at Olde Point that PenderWatch was drafted to host the next meeting planned for March. We look forward to the opportunity.

Adopt-A-Highway

PW&C continues its efforts to make our environs a better place.

Since the last newsletter we conducted two pick-ups. Eleven volunteers picked up Highway 17 on Thursday, October 19. Many thanks to **Bob Julius**, **Bob Wilfong**, **Lou Garrard**, **Clem** and **Marjorie Bribitzer**, **Terry and Fred Bender**, **Margaret** and **Raymond Rose**, **Phyllis Powder** and **Elsa O'Connor**. We picked up 20 bags of trash and 1 bag of aluminum cans. The total was lower than we often collect because a crew of prison inmates had picked up the road early in September. The State gave us a head start, and we were able to get it very clean!

PenderWatch volunteers were out in full force Saturday, February 3, in spite of the cold weather. We picked up 37 bags of trash and one bag of aluminum along Highway 17. We had 11 volunteers donating 25 hours in order to keep Hampstead clean and beautiful. Many thanks to **John** and **Mary Oleshiewicz**, **Johanna Timberlake**, **Phyllis Powder**, **Clem** and **Marjorie Bribitzer**, **Betty Wolak Howard Sterne**, **Jim** and **Marilyn Fisher** and **Elsa O'Connor**.

Occasionally we pick up unusual items. Why we almost always find gloves is inexplicable. One volunteer got lucky on the last pick up and found a crisp $10 bill. While we will not guarantee that this will always happen, join us and try your luck.

Please call Elsa O'Connor to volunteer for the next pick up which is Tuesday April 17, 2001.

We make many calls to recruit volunteers for the Adopt-A-Highway program. Often the response is one of sympathy but that physical limitations preclude helping. You can still help the program by making calls. We could use a volunteer to recruit volunteers. Any volunteers? Please call Elsa (270-4946) if you could assist us.

It is not too early to mark your calendars for Beach Sweep, September 15, 2001. We will organize a small flotilla and travel to Lea and Hutaff Island(s) to clean up the beach. We especially need volunteers who have boats. Call Elsa to volunteer.

From the Editors Desk

Clem Bribitzer

A new year. New board members. The same commitment – to protect the environment and our quality of life.

Congratulations to the new Board members, who are introduced in this newsletter! Congratulations to new officers Burt Millette, President, Al Amatruda, 1st Vice President, Clem Bribitzer, 2nd Vice President, Charles Askey, Secretary, and Marion Kurdyla, Treasurer.

In the last year, PW&C has been growing and increasing our influence. One encouraging development is that PW&C is strengthening its relations with other environmental groups. An article contributed by the North Carolina Coastal Federation will be a regular feature in the newsletter.

The annual meeting was well attended. Andy Woods gave an inspiring presentation that was covered by three local newspapers. Andy is now Education Director with Audubon North Carolina, the local arm of the National Audubon Society. He described the Society's plans for protecting wildlife on Lea and Hutaff Islands giving us graphic illustrations of the natural beauty and ecological importance of our own closest barrier islands. Members who would like to support Audubon North Carolina's "Friends of the Coastal Islands Sanctuary" program can send a check made out to "Audubon North Carolina" to National Audubon Society, 3806B Park Avenue, Wilmington, NC 28403. Audubon North Carolina will apply the funds specifically to their activities at Lea and Hutaff islands if you make that designation on your check or accompanying note. Membership categories begin at $25. Larger amounts are welcome.

PW&C is working with the Audubon Society to arrange an educational trip to Lea Island sometime this spring. This could be fun and interesting. We will send out more information as we make firm plans.

To change the subject drastically, as I emptied a plastic bottle of olive oil today, I was reminded that we need guidance as to what can be recycled. The County went to the trouble of seeking a vendor for slick paper, but the arrangement fell through. We should encourage seeking another vendor. It is not clear which plastics are actually recycled and which are eventually trashed. The citizens of Pender county need to know what can or cannot be brought to the disposal facilities for recycling! The County Commissioners promised a new brochure on the subject. Where is it?

Beach Plan Already Exists: Now Let's Carry It Out

Todd Miller

Executive Director

NC Coastal Federation

Tucked away in this year's budget passed by the NC General Assembly is an unfunded mandate for the Department of Environment and Natural Resources to prepare a plan by May 1, 2001 to determine how to fund beach restoration projects in North Carolina.

Pressure to get the State more vested in these projects is coming from oceanfront towns and counties from the Outer Banks to Ocean Isle. Local governments are worried that along more than 160 miles of beach, the ocean may soon undermine homes, rental properties, hotels and condos, as well as the streets, highways and other utilities that service these seaside resorts. Mounting damages include eroding property values, incomes from rental properties, and the tourism economy.

North Carolina knew decades ago that this "day of reckoning" for oceanfront properties was on the way. That's why it adopted formal regulatory policies for how best to respond to continuing and predictable shoreline migration. Land use planning, construction setbacks, building relocation, subdivision rules, management of vegetation, and pumping sand on beaches are preferred responses to erosion – so assert these state policies.

Based upon these regulatory principles, projects designed to respond to erosion should avoid losses to natural heritage and not adversely affect the productivity of our coastal and ocean waters. The public trust right of the public to use the ocean beaches, including traditional recreational uses such as walking, swimming, surf-fishing and commercial fishing, are to be preserved.

It's predictable that oceanfront communities are lobbying for help in paying to put more sand on their beaches. For awhile such projects can reduce property losses and they hold out some hope for maintaining the "status quo" or even allowing more intense oceanfront development. But sea level is now rising at a projected rate of 1.7 feet per century, hurricanes and northeasters are predicted to occur more frequently and at greater intensity, and there are chronic shortages of economical sources of sand along significant portions of our coast. All this means that the ongoing costs of drawing a line in the sand and attempting to hold the beaches where they are today will escalate until it is not technologically or economically feasible to do so.

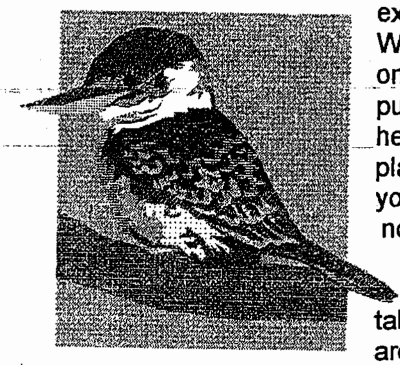
The State should base its new beach restoration strategy on its existing oceanfront policies that require a multi-faceted response to beach migration. In communities where beach renourishment is under consideration, it should only be carried out if the following tests can be met:

- There must be acceptable and adequate sources of sand available;
- The project must be properly planned, timed and executed;
- Adequate habitat and water quality monitoring must occur to evaluate effects on fisheries and water quality;
- Project planners must be completely forthcoming about the long-term costs of renourishment;
- The project must provide adequate public parking;
- The project must include an "exit strategy" to deal with beachfront property when renourishment is no longer feasible due to insufficient funds, sand supplies, and/or future storm activity; and,
- The project must be financed so that it places the burden on the people that benefit from renourishment.

Environmental Corner

Howard Sterne

A week or so ago when I sat down to write this article on cleaning up petroleum-polluted soils, I knew of no local examples. Then the Wilmington *Morning Star*, on January 31, 2001, published a report headlined, "Polluted soil plagues Pender pipeline." If you read the article, you will note that the contamination is difficult to trace because our high water table tends to move it around.



My report uses as sources two articles from Environmental Science and Technology. These are, "The Complicated Challenge of MTBE Cleanups," and "Will Ethanol-Blended Gasoline Affect Groundwater Quality?"

MTBE (methyl *tert*-butyl ether) was initially added to gasoline to increase octane ratings following the U. S. ban on alkyl lead additives in 1979. MTBE's potential for groundwater and surface water contamination was not a significant consideration when the decision was made. It is now known that the chemical is a very mobile and persistent contaminant in aqueous systems because of its high solubility and low biodegradation rates. The pungent turpentine-like odor and taste limit acceptable levels in drinking water to 5-40 p.p.b. There is, however, significant debate regarding what level is safe.

The movement of MTBE through the ground is very dependent on soil types, soil layering, movement of groundwater, and pumping rates of water wells in an area. In fact, investigators found that when wells stopped pumping, the plume of contamination could change direction. This material can move very quickly; some has been measured moving at 26-43 feet/day. Thus it is important to stop any gasoline leaks quickly and monitor them at various levels and directions from the original site. Seven states have implemented policies to phase out MTBE, and three states are limiting the concentration in gasoline. The federal government is also proposing a reduction or ban through the Toxic Substance Control Act.

The use of ethanol (ethyl alcohol) as a fuel source is often advocated because, as it is obtained from grain, it is a renewable fuel. It is highly biodegradable under both aerobic and anaerobic conditions, and likely will essentially disappear under natural conditions. There is a $0.54/gallon federal excise tax exemption to promote the sale of ethanol, and it is becoming more widely used in concentrations up to 10%.

So we think we have solved the problem? Hold on! There are two issues of great concern. Ethanol in water can create a co-solvent effect, and its biodegradation can deplete the groundwater of nutrients. Both processes can result in increased concentrations of hydrophobic compounds (water haters) such as benzene, increasing the distances these substances could travel from a spill site.

So we are left with a great many underground tanks that either are leaking or have leaked in the past, and that pose a threat to the environment and to our health.

At the beginning of this article, I mentioned contaminated soil in Southwestern Pender County. At the recent County Commissioners' meeting, we heard of waste spillover at the Hampstead and other trash disposal sites. Finally, today, February 3, 2001, while filling my gas tank at the Scotchman at the corner of Rte. 17 and Country Club Drive, I noticed that they are drilling a monitoring well on site. This was ordered by the State Department of Energy and Natural Resources to monitor groundwater because of leaking tanks on the site a few years ago.

We have to be vigilant! Let's keep our eyes open and make sure we report and stay on top of any spills, odors, or other potential groundwater contamination indicators. If we in PenderWatch can help, let us know!

Welcome New Board Members

PenderWatch is very happy to announce the election of six new members to the Board. With their varied backgrounds and fresh talent, 2001 should be a great year! Our new members are:

John Bonitz - John is a native North Carolinian whose career in theatre-related fields has included acting, directing, designing, and eventually becoming a film talent agent. John and his wife Suzanne now live in Hampstead where he lists his hobbies as gardening and traveling.

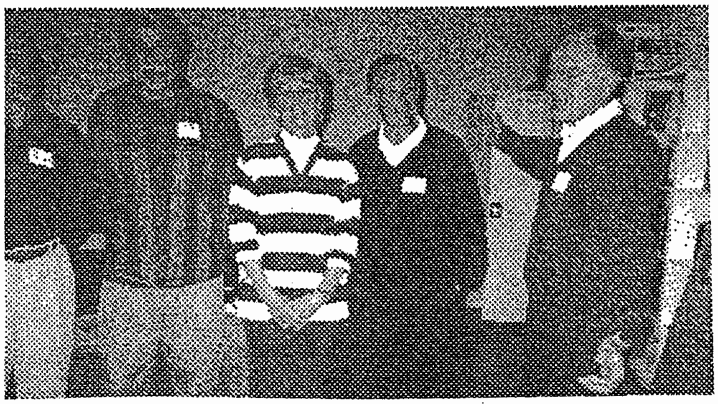
Jim Fisher - Jim is a Licensed Professional Engineer in North Carolina as well as Vermont and his former home, New York. After working for Honeywell, Inc., he joined a small consulting engineering firm in Albany where he rose to become President of the partnership.

Ken Just - Ken is originally from St. Louis but has lived in a number of places in the U. S. and around the world. He is a retired salesman who moved to the Wilmington area in 1993. He is interested in helping PW&C maintain the quality of life that brought him and his wife Mary Ann to Hampstead in 1994.

Marion Kurdyla - Marion is a New Jersey native who retired here with husband Rich in 1995. She lists her accomplishments as raising her family and reaching the post of Administrative Assistant to the Director of the Summit Free Public Library.

Bob Muller - Bob and his wife Joanne moved to Hampstead from Raleigh in 1990. His career with IBM began in upstate New York and brought him to North Carolina by way of Fujisawa, Japan. Among his professional activities, he has conducted management workshops for North Carolina State.

Jim Timberlake – Jim chose teaching as a profession after spending three years as a stationary engineer. While pursuing his career on Long Island, he did volunteer work for The Nature Conservancy in New York maintaining trails and protecting piping plover nesting sites. He and his wife Johanna moved to Hampstead in 1990.



Dave Richie introduces new Board members (from left to right) Jim Timberlake, Ken Just, Marion Kurdyla and Jim Fisher

PenderWatch Attends Fisheries Workshop

Jim Timberlake and Dave Richie attended "A Workshop for Citizens on Fish Conservation" at the Pine Knoll Shores Aquarium on February 3. Speakers were excellent and good information was provided, including a substantial packet to take home.

The intention was to stimulate more citizen activism on behalf of ocean resources, including habitat protection for fish nurseries and spawning areas in tidal creeks and estuaries, which we have in abundance in Pender County.

Jim Timberlake will be coordinating comments on important habitat protection draft reports by the N.C. Division of Marine Resources, which are due out in the next few months. Members who have a special interest or qualifications in this area are encouraged to contact Jim. 270-3155.

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North Carolina
Department of Administration

Michael F. Easley, Governor | Gwynn T. Swinson, Secretary

March 19, 2001

Mr. Glenn McIntosh
Dept. of the Army Corps of Engineers
Wilmington District
P.O. Box 1890
Wilmington, NC 28402-1890

Dear Mr. McIntosh:

Re: SCH File # 01-E-0000-0497; Scoping Proposal to Determine Necessary Actions Relative to Shore Protection Activities for Surf City and North Topsail Beach in Pender and Onslow Counties

The above referenced project has been reviewed through the State Clearinghouse Intergovernmental Review Process. Attached to this letter are comments made by agencies reviewing this document.

Should you have any questions, please do not hesitate to call me at (919) 807-2425.

Sincerely,

Chrys Baggett

Ms. Chrys Baggett
Environmental Policy Act Coordinator

Attachments

cc: Region O
Region P

North Carolina
Department of Environment and Natural Resources

Michael F. Easley, Governor
William G. Ross Jr., Secretary

NCDENR

MEMORANDUM

TO: Chrys Baggett
State Clearinghouse

FROM: Melba McGee
Environmental Review Coordinator

RE: 01E-0497 Scoping Shore Protection Alternative on Topsail Beach and Surf City, Pender and Onslow Counties

DATE: March 14, 2001

The Department of Environment and Natural Resources has reviewed the proposed information. The attached comments are for the applicant's information and consideration.

Thank you for the opportunity to review.

Attachments

RECEIVED

MAR 15 2001

N.C. STATE CLEARINGHOUSE

North Carolina Wildlife Resources Commission

Charles R. Fullwood, Executive Director

MEMORANDUM

TO: Melba McGee
Office of Legislative & Intergovernmental Affairs

FROM: Bennett Wynne
Habitat Conservation Program

DATE: March 13, 2001

SUBJECT: Request for scoping comments regarding resources potentially impacted by various shore protection alternatives on Topsail Island, Onslow and Pender Counties, North Carolina. Project Number: 01E-0497.

It is our understanding the Army Corps of Engineers has been directed to determine the need for shoreline protection measures on Topsail Island. Shoreline protection alternatives examined in Environmental Impact Statements would include beach nourishment, non-structural measures (relocation), and no action. We are pleased to see the inclusion of relocation among the alternatives and recommend that it be given serious consideration during preparation of the environmental documents.

State and federally listed (Threatened) sea turtles nest along the entire ocean beach of Topsail Island and the south end of the island is proposed as critical habitat for wintering piping plovers, another listed species (also Threatened). Piping plovers also nested at the south end two years ago, but this past year there was only one piping plover present on the site. The north end of the island also has some use by piping plovers, and even the North Topsail overwash (near Chadwick Bay) has had one sighting of a piping plover.

Both the north and south ends of the island get heavy use by migrating shorebirds and other waterbirds. The south end always has several pairs of nesting Wilson's plovers and American Oystercatchers (both high priority species, and oystercatchers are also State listed as Special Concern). Least terns (State listed as Special Concern) also usually try to nest there, but predation by house cats is high. There has been a fairly large and successful nesting colony of least terns at the North Topsail overwash in recent years. Several pairs of Wilson's plovers also nest there. The north end of the island gets less use for nesting purposes, but still generally has a couple pairs of Wilson's plovers nesting on the site, and sometimes American oystercatchers. Large numbers of waterbirds use the north end for resting and roosting.

Potential adverse impacts to fish and wildlife resources that should be thoroughly addressed in environmental documents include:

- interference with sea turtle nesting and hatching
- disturbance of colonial nesting birds
- loss of overwash fan habitat
- reduced habitat quality and quantity of sand borrow areas, particularly sand flats associated with the flood tide delta of inlets.
- decimation of beach invertebrate populations and effects thereof on dependent shorebirds and fishes
- increased turbidity or other water quality decline
- filling or disturbance of wetlands during sand transport to the beaches
- cumulative impacts related to any of the above associated with this project, subsequent maintenance of this project, and other similar projects

We expect the Corps to include an April 1 to November 15 colonial nesting bird/sea turtle nesting moratorium for the beach nourishment alternative. In addition, all alternatives should take measures to avoid depletion of naturally migrating inlet and overwash habitats. Finally, due to the expanse of the project(s), potential for adverse impacts, and the need for an open exchange of concerns and ideas, we recommend that an interagency scoping meeting be held

Thank you for the opportunity to comment on the project at this early stage. If you have questions, please call me at (252) 514-4738.

Cc: Howard Hall, USFWS
Tracy Rice, USFWS
Ron Sechler, NMFS
Fritz Rohde, NCDMF
Anne Deaton, NCDMF
David Allen, NCWRC

North Carolina
Department of Environment and Natural Resources
Division of Water Resources

Michael F. Easley, Governor
William G. Ross, Jr., Secretary
John Morris, Director

NCDENR

March 12, 2001

MEMORANDUM

TO: Melba McGee, Environmental Coordinator
Office of Legislative and Intergovernmental Affairs

FROM: John Sutherland, Chief
Water Projects Section

SUBJECT: Comments on Scoping Letter for Possible Shore Protection Measures for Surf City, North Topsail Beach, and Topsail Beach, Pender and Onslow Counties by the U.S. Corps of Engineers, Project No. 01E-0497

The Division of Water Resources has worked closely with the Wilmington District, U.S. Army Corps of Engineers, on several shore protection studies for communities susceptible to damage from hurricanes and other major storms. We support the District's effort to determine which, if any, storm protection measures are economically and environmentally feasible in these three communities in Pender and Onslow Counties. We are also committed to providing up to 50 percent of the non-federal cost of the studies to be done, provided that North Carolina General Assembly appropriates the funding for them.

cc: John Morris

1611 Mail Service Center, Raleigh, North Carolina, 27699-1611
Phone: 919 – 733-4064 \ FAX: 919 – 733-3558 \ Internet: www.ncwater.org

State of North Carolina
Department of Environment
and Natural Resources
Division of Environmental Health

James B. Hunt, Jr., Governor
Bill Holman, Secretary
Linda C. Sewall, Director

NCDENR
NORTH CAROLINA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES

MEMORANDUM

TO: Melba McGee

FROM: Gina Brooks

SUBJECT: National Environmental Policy Act, Department of the Army, Corps of Engineers

DATE: February 27, 2001

The Shellfish Sanitation and Recreational Water Quality Section would have no objection to the above mentioned project provided that the following conditions are met: 1) beach disposal occurs only between November 1st and April 30th when recreational usage is low and 2) clean sand is used and not dredged sand from closed shellfishing areas. If beach disposal was to occur at times other than stated above or if sand from a closed shellfishing area is to be used, a swimming advisory may be posted and a press release may be made. Please notify this office when such disposal occurs.

If you have any questions regarding this matter, please contact me at (252)726-6827 or you may email me at gina.brooks@ncmail.net.

NORTH CAROLINA STATE CLEARINGHOUSE
DEPARTMENT OF ADMINISTRATION
INTERGOVERNMENTAL REVIEW

STATE NUMBER: 01-E-0000-0497 H05
DATE RECEIVED: 02/14/2001
AGENCY RESPONSE: 03/09/2001
REVIEW CLOSED: 03/14/2001

MS MELBA MCGEE
CLEARINGHOUSE COORD
DEHNR - COASTAL MGT
C/O ARCHDALE BLDG
RALEIGH NC

REVIEW DISTRIBUTION
CAPE FEAR COG
DEHNR - COASTAL MGT
DENR LEGISLATIVE AFFAIRS
DEPT OF CUL RESOURCES
EASTERN CAROLINA COUNCIL

PROJECT INFORMATION
APPLICANT: Dept. of the Army Corps of Engineers
TYPE: National Environmental Policy Act
ERD: Scoping
DESC: Proposal to Determine Necessary Actions Relative to Shore Protection Activities for Surf City and North Topsail Beach in Pender and Onslow Counties

The attached project has been submitted to the N. C. State Clearinghouse for intergovernmental review. Please review and submit your response by the above indicated date. If additional review time is needed, please contact this office at (919)807-2425.

AS A RESULT OF THIS REVIEW THE FOLLOWING IS SUBMITTED:

☐ NO COMMENT
☑ COMMENTS ATTACHED - Some areas of salt marsh are heavy mosquito production habitat. Please consult with Onslow Co mosquito control 910 455-0181

SIGNED BY: Alice L. Anderson

DATE: 26/02/01

North Carolina
Department of Environment and Natural Resources
Division of Coastal Management

Michael F. Easley, Governor
William G. Ross Jr., Secretary
Donna D. Moffitt, Director

NCDENR

MEMORANDUM

TO: Melba McGee, NC Division of Policy and Development
FROM: Caroline Bellis, NC Division of Coastal Management
SUBJECT: Review of SCH#01-0497 DATE: 2/23/01

✓ A COPY OF ALL ACENCY COMMENTS RECEIVED IS REQUESTED
___ REVIEWER COMMENTS ARE ATTACHED

Review Comments:

___ This document is being reviewed for consistency with the NC Coastal Management Program pursuant to federal law and or NC Executive Order 15. Agency comments received by SCH are needed to develop the State's consistency position. Project Review Number (if different from above) ______________.
A consistency position will be developed based upon our review on or before ____________.

✓ A Consistency Determination document ✓ is, or ___ may be required for this project pursuant to federal law and or NC Executive Order 15. Applicant should contact Caroline Bellis in Raleigh, phone (919) 733-2293, for information on proper document format and applicable state guidelines and land use plan policies.

✓ Proposal is in draft form, a consistency response is inappropriate at this time. A Consistency Determination should be included in the final document.

___ A Consistency Determination Document (pursuant to federal law and/or NC Executive Order 15) is not required.
___ A consistency response has already been issued.
Project Number __________ Date Issued __________
___ Proposal involves < 20 Acres and or a structure < 60,000 Square Feet and no AECs or Land Use Plan problems.
___ Proposal is not in the Coastal Area and will have no significant impacts on any land or water use or natural resources of the Coastal Area.

___ A CAMA Permit ___ is, or ___ may be required for all or part of this project. Applicant should contact ____________________ in ______________________, phone # ____________________, for information.

___ A CAMA Permit ___ has already been issued, or ___ is currently being reviewed under separate circulation.
Permit Number ____________ Date Issued ____________

___ Other (see attached).

State of North Carolina Consistency Position:

___ The proposal is consistent with the NC Coastal Management Program provided that all conditions are adhered to and that all state authorization and/or permit requirements are met prior to implementation of the project.

___ The proposal is inconsistent with the NC Coastal Management Program.

___ Other (see attached).

State of North Carolina
Department of Environment and Natural Resources

Reviewing Office: Wilmington

INTERGOVERNMENTAL REVIEW – PROJECT COMMENTS

Project Number: 01E-0497 Due Date: 3/9/01

After review of this project it has been determined that the ENR permit(s) and/or approvals indicated may need to be obtained in order for this project to comply with North Carolina Law. Questions regarding these permits should be addressed to the Regional Office indicated on the reverse of the form. All applications, information and guidelines relative to these plans and permits are available from the same Regional Office.

	PERMITS	SPECIAL APPLICATION PROCEDURES or REQUIREMENTS	Normal Process Time (statutory time limit)
☐	Permit to construct & operate wastewater treatment facilities, sewer system extensions & sewer systems not discharging into state surface waters.	Application 90 days before begin construction or award of construction contracts. On-site inspection. Post-application technical conference usual.	30 days (90 days)
☐	NPDES - permit to discharge into surface water and/or permit to operate and construct wastewater facilities discharging into state surface waters.	Application 180 days before begin activity. On-site inspection. Pre-application conference usual. Additionally, obtain permit to construct wastewater treatment facility-granted after NPDES. Reply time, 30 days after receipt of plans or issue of NPDES permit–whichever is later.	90-120 days (N/A)
☐	Water Use Permit	Pre-application technical conference usually necessary	30 days (N/A)
☐	Well Construction Permit	Complete application must be received and permit issued prior to the installation of a well.	7 days (15 days)
☐	Dredge and Fill Permit	Application copy must be served on each adjacent riparian property owner. On-site inspection. Pre-application conference usual. Filling may require Easement to Fill from N.C. Department of Administration and Federal Dredge and Fill Permit.	55 days (90 days)
☐	Permit to construct & operate Air Pollution Abatement facilities and/or Emission Sources as per 15 A NCAC (2Q.0100, 2Q.0300, 2H.0600)	N/A	60 days
☐	Any open burning associated with subject proposal must be in compliance with 15 A NCAC 2D.1900	N/A	60 days (90 days)
☐	Demolition or renovations of structures containing asbestos material must be in compliance with 15 A NCAC 2D.1110 (a) (1) which requires notification and removal prior to demolition. Contact Asbestos Control Group 919-733-0820.		
☐	Complex Source Permit required under 15 A NCAC 2D.0800		
☐	The Sedimentation Pollution Control Act of 1973 must be properly addressed for any land disturbing activity. An erosion & sedimentation control plan will be required if one or more acres to be disturbed. Plan filed with proper Regional Office (land Quality Sect.) At least 30 days before beginning activity. A fee of $30 for the first acre and $2000 for each additional acre or part must accompany the plan.		20 days (30 days)
☐	The Sedimentation Pollution control Act of 1973 must be addressed with respect to the referenced Local Ordinance.		(30 days)
☐	Mining Permit	On-site inspection usual. Surety bond filed with ENR. Bond amount varies with type mine and number of acres of affected land. Any are mined greater than one acre must be permitted. The appropriate bond must be received before the permit can be issued.	30 days (60 days)
☐	North Carolina Burning permit	On-site inspection by N.C. Division Forest Resources if permit exceeds 4 days	1 day (N/A)
☐	Special Ground Clearance Burning Permit - 22 counties in coastal N.C. with organic soils	On-site inspection by N.C. Division Forest Resources required "if more than five acres of ground clearing activities are involved. Inspections should be requested at least ten days before actual burn is planned."	1 day (N/A)
☐	Oil Refining Facilities	N/A	90-120 days (N/A)
☐	Dam Safety Permit	If permit required, application 60 days before begin construction. Applicant must hire N.C. qualified engineer to: prepare plans, inspect construction, certify construction is according to ENR approved plans. May also require permit under mosquito control program. And a 404 permit from Corps of Engineers. An inspection of site is necessary to verify Hazard Classification. A minimum fee of $200.00 must accompany the application. An additional processing fee based on a percentage or the total project cost will be required upon completion.	30 days (60 days)

	PERMITS	SPECIAL APPLICATION PROCEDURES or REQUIREMENTS	Normal Process Time (statutory time limit)
☐	Permit to drill exploratory oil or gas well	File surety bond of $5,000 with ENR running to State of NC conditional that any well opened by drill operator shall, upon abandonment, be plugged according to ENR rules and regulations.	10 days N/A
☐	Geophysical Exploration Permit	Application filed with ENR at least 10 days prior to issue of permit. Application by letter. No standard application form.	10 days N/A
☐	State Lakes Construction Permit	Application fees based on structure size is charged. Must include descriptions & drawings of structure & proof of ownership of riparian property.	15-20 days N/A
☑	401 Water Quality Certification	N/A	60 days (130 days)
☐	CAMA Permit for MAJOR development	$250.00 fee must accompany application	55 days (150 days)
☐	CAMA Permit for MINOR development	$50.00 fee must accompany application	22 days (25 days)
☐	Several geodetic monuments are located in or near the project area. If any monument need to be moved or destroyed, please notify: N.C. Geodetic Survey, Box 27687 Raleigh, NC 27611		
☐	Abandonment of any wells, if required must be in accordance with Title 15A. Subchapter 2C.0100.		
☐	Notification of the proper regional office is requested if "orphan" underground storage tanks (USTS) are discovered during any excavation operation.		
☐	Compliance with 15A NCAC 2H 1000 (Coastal Stormwater Rules) is required.		45 days (N/A)
*	Other comments (attach additional pages as necessary, being certain to cite comment authority)		

REGIONAL OFFICES

Questions regarding these permits should be addressed to the Regional Office marked below.

☐ **Asheville Regional Office**
59 Woodfin Place
Asheville, NC 28801
(828) 251-6208

☐ **Fayetteville Regional Office**
225 Green Street, Suite 714
Fayetteville, NC 28301
(910) 486-1541

☐ **Mooresville Regional Office**
919 North Main Street
Mooresville, NC 28115
(704) 663-1699

☐ **Raleigh Regional Office**
3800 Barrett Drive, P.O. Box 27687
Raleigh, NC 27611
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Wilmington, NC 28405
(910) 395-3900

☐ **Winston-Salem Regional Office**
585 Waughtown Street
Winston-Salem, NC 27107
(336) 771-4600

Committee on Transportation and Infrastructure

Congress of the United States
House of Representatives
Washington, DC 20515

Bud Shuster
Chairman

Jack Schenendorf, Chief of Staff
Michael Strachn, Deputy Chief of Staff

James L. Oberstar
Ranking Democratic Member

David Heymsfeld, Democratic Chief of Staff

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, D.C.

RESOLUTION

Docket 2629

North Topsail Beach, North Carolina

Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers on West Onslow Beach and New River Inlet, North Carolina, published as House Document 393, 102nd Congress, 2nd Session, dated September 23, 1992, and other pertinent reports, to determine whether any modifications of the recommendations contained therein are advisable at the present time in the interest of shore protection and related purposes for North Topsail Beach, North Carolina.

Adopted: April 11, 2000

ATTEST: Bud Shuster
BUD SHUSTER
CHAIRMAN

United States Department of Agriculture

NRCS Natural Resources Conservation Service

USDA

4405 Bland Road, Suite 205, Raleigh, NC 27609
Telephone No.: (919) 873-2134
Fax No.: (919) 873-2154

February 11, 2002

Mr. Glenn McIntosh
U. S. Army corps of Engineers
Wilmington District
P O Box 1890
Wilmington NC 28402-1890

Dear Mr. McIntosh:

Thank you for the opportunity to provide comments on Topsail Beach, Surf City, and North Topsail Beach in Pender and Onslow Counties, North Carolina.

The Natural Resources Conservation Service does not have any comments at this time.

Sincerely,

Mary K. Combs

Mary K. Combs
State Conservationist

February 14, 2001

Project Management Branch

Dear Sir or Madam:

The U.S. House of Representatives Committee on Transportation and Infrastructure has directed the Secretary of the Army to review the report of the Chief of Engineers on West Onslow Beach and New River Inlet, North Carolina, published as House Document Number 393, 102nd Congress, 2nd Session, dated September 23, 1992, to determine whether any actions are advisable at the present time in the interest of shore protection and related purposes for Surf City and North Topsail Beach, in Pender and Onslow Counties, respectively, in North Carolina. On this same beach strand, we are also reinitiating studies necessary to prepare a General Reevaluation Report (GRR) for Topsail Beach, in Pender County, North Carolina. The limits of each of these study areas are shown on the attached map.

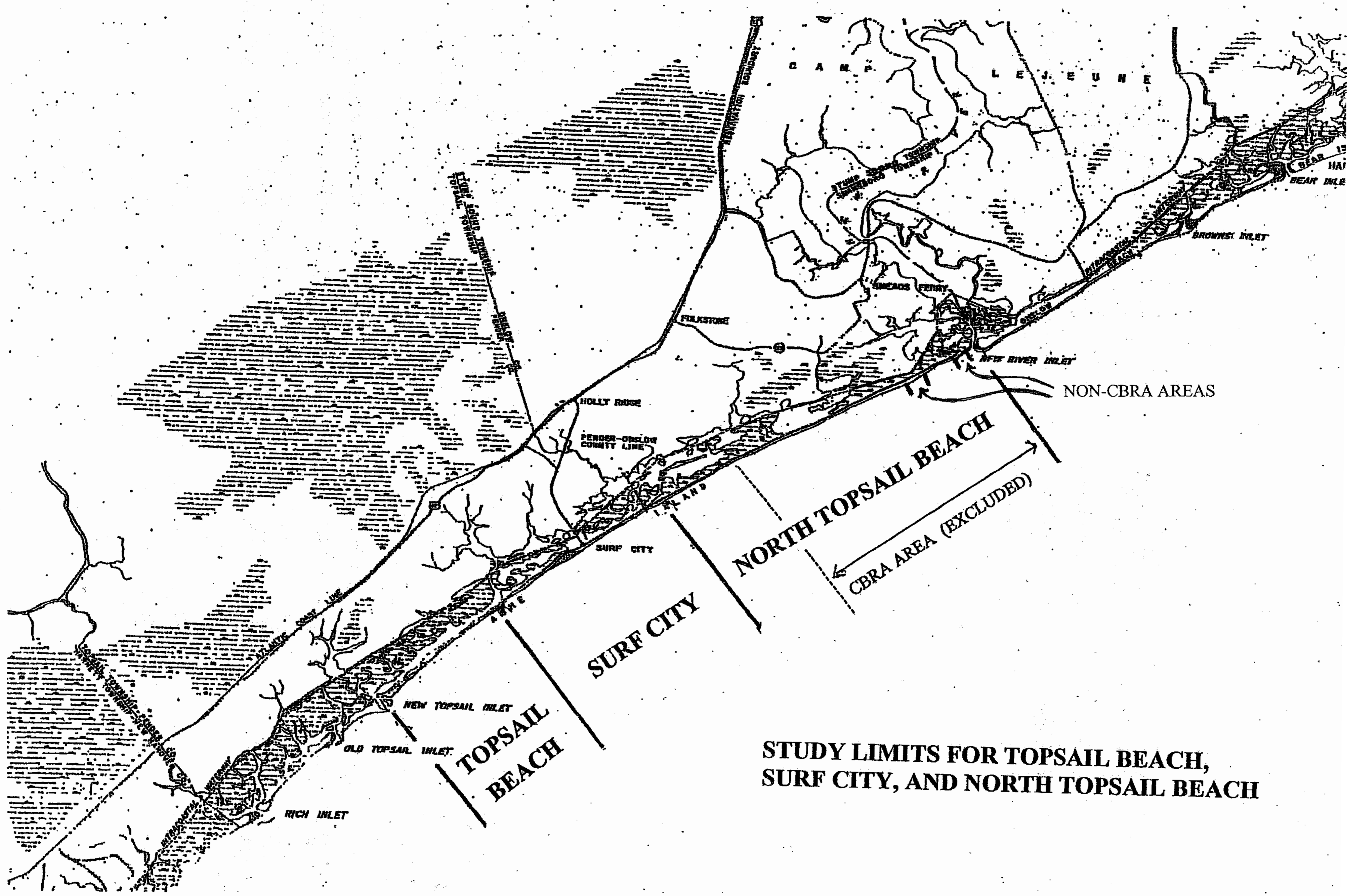
For each study area, various shore protection alternatives will be examined, including beach nourishment, non-structural measures (relocation), and No Action. Areas of North Topsail Beach that are included in the Coastal Barrier Resources Act (CBRA) will be excluded from study. We are requesting comments from agencies, interest groups, and the public to identify significant resources that may occur in these study areas or other issues of concern. Comments received as a result of this scoping letter will be used to help identify potential impacts on the environment, determine appropriate studies to be conducted, and determine the range of alternatives to be examined. These items will be addressed, as needed, in Environmental Impact Statements. No formal scoping meetings are planned; however, based on the responses received, scoping meetings may be held with specific agencies or individuals as required.

We request that you provide written comments on any of these matters within 30 days from the date of this letter. Comments should be addressed to Mr. Glenn McIntosh, U.S. Army Corps of Engineers, Wilmington District, Post Office Box 1890, Wilmington, North Carolina 28402-1890. If you have any questions, please contact Mr. McIntosh at (910) 251-4671 or e-mail address glenn.mcintosh@usace.army.mil.

Sincerely,

W. Eugene Tickner, P.E.
Deputy District Engineer
Programs and Project Management

Enclosure



STUDY LIMITS FOR TOPSAIL BEACH, SURF CITY, AND NORTH TOPSAIL BEACH

INTEGRATED

FEASIBILITY REPORT

AND

ENVIRONMENTAL IMPACT STATEMENT

COASTAL STORM DAMAGE REDUCTION PROJECT

SURF CITY AND NORTH TOPSAIL BEACH

NORTH CAROLINA

Appendix L

Final Fish and Wildlife Coordination Act Report

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

August 19, 2010

Philip M. Payonk
Chief, Environmental Resources Section
Wilmington District, US Army Corps of Engineers
69 Darlington Ave.
Wilmington, NC 28403-1343

Subject: Section 7 consultation on the Coastal Storm Damage Reduction – Surf City and North Topsail Beach Project, Pender and Onslow Counties, North Carolina.

Dear Mr. Payonk:

Based on coordination over the past month with Mr. Doug Piatkowski of your staff, the U. S. Fish and Wildlife Service (Service) has been informed that formal consultation must be re-initiated on the subject project. The project consists of initial construction of a berm and dune system along approximately 9.9 miles of Atlantic shoreline in the central section of Topsail Island with periodic reconstruction of the system at approximately three-year intervals over a period of 50 years. Beachfill material would be dredged from offshore, marine sand deposits. These comments are provided regarding project impacts pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543).

The Service has worked with the U. S. Army Corps of Engineers (Corps) in planning this project for more than a decade. During this period we have recommended design features, construction techniques, and monitoring procedures to avoid and assess impacts on federally listed species. Appendix I of the Corps' Draft Environmental Impact Statement (DEIS), dated August 2009, represented a Biological Assessment (BA) for the project. Appendix I listed 12 commitments to reduce impacts to listed species. Based on these commitments the Corps determined (p. I-37) that the proposed work would have either "no effect" or may affect, but was "not likely to adversely affect" the species under the jurisdiction of the Service.

The Service provided the Corps with a Final Fish and Wildlife Coordination Act Report in May 2010. The reported stated that based on the information provided in the DEIS and BA, the Service concurred with the Corps determinations that the proposed action is not likely to adversely affect federally listed species or their critical habitat as defined by the ESA. At that time, the requirements of section 7 (a)(2) of the ESA had been satisfied for this project. However, we stated that the Corps' obligations under the ESA must be reconsidered if: (1) new information identifies impacts of this action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is modified in a manner that was not considered in this review; or, (3) a new species is listed or critical habitat determined that may be affected by the identified action.

On July 22, 2010, Mr. Piatkowski informed the Service by email that the Wilmington Corps had been directed by Corps Headquarters Policy reviewers to remove two monitoring commitments that were identified during the informal consultation process and subsequently included within the DEIS to reduce the potential effects of the subject project on nesting sea turtles and seabeach amaranth germination. One commitment removed, listed as number 9 in the DEIS, involved Corps contribution of funds for the North Carolina Wildlife Resources Commission to continue its temperature studies in order to gather nest temperatures on nourished beaches throughout the state, including Topsail Island, in comparison to non-nourished native sediment temperatures. The Wilmington Corps was interested in understanding the threshold of sediment color change and resultant heat conduction on impacting temperature-dependent sex determination of sea turtles. These data were to be used to help develop management criteria for sediment color guidelines. This would enable managers to modify this and other projects in future years to reduce effects to sea turtles, as appropriate. The second commitment removed, designated as number 11 in the DEIS, involved monitoring for seabeach amaranth on Surf City and North Topsail Beaches to assess the post-nourishment presence of plants. This survey was to be broken down into survey reaches for each town in accordance with the designated Corps seabeach amaranth survey reaches from 1991-2008 in order to maintain consistent data and survey techniques over time. The results were to be provided to the Service as part of our ongoing recovery efforts for this threatened plant. The other nine conservation measures given in the BA were not affected by the Corps Headquarters Policy review.

Subsequent discussions within the Corps led to a decision to retain the two conservation measures on a one-time basis. Essentially, the measures would be employed after initial construction and then discontinued for the remainder of the 50-year project. By email on August 4, 2010, the Wilmington Corps requested the Service's opinion on the status of ESA compliance with the incorporation of the proposed changes into the project.

The Service determined that changes in the project constitute new information that was not considered in the Service's concurrence on the absence of adverse impacts to both sea turtles and seabeach amaranth. After reviewing the overall project, the Service informed the Wilmington Corps on August 10, 2010, that our initial concurrence would remain in effect only during the period when all the original conservation measures continued to be implemented. That is, the Service would concur with the Corps' determination only through the one-time implementation of all 12 conservation measures. This concurrence would apply to the initial beach construction effort, but not to any of the subsequent reconstruction events over the 50-year project period described in the DEIS.

By this letter the Service is informing the Corps that our concurrence with your effects determination applies only to initial construction and post-construction monitoring phase of this project. We recommend that the Corps provide a new determination and seek consultation prior to initiation of subsequent phases. These determinations must be based on a thorough analysis of data gathered after initial construction. None of the proposed reconstruction events should occur prior to a consultation with the Service.

At this time, the Corps has complied with ESA requirements for only the initial construction effort and the required monitoring after that construction. In accordance with the ESA and based on the information provided and other available information, it appears that the one-time, initial beach construction for the subject project is not likely to adversely affect federally listed species or their critical habitat as defined by the ESA. We believe that the requirements of section 7 (a)(2) of the ESA for this limited part of the overall project have been satisfied. However, obligations under the ESA must be reconsidered for the initial construction effort if: (1) new information identifies impacts of this action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is modified in a manner that was not considered in this review; or, (3) a new species is listed or critical habitat determined that may be affected by the identified action.

Additionally, please note that it is not our practice to conclude consultation on something less than a complete project. We are only doing so in this case in the interest of moving the project forward in light of the fact that no take of listed species is anticipated in association with the first phase; and on the assumption that consultation will be re-initiated prior to subsequent phases. We do not intend to do this again for this or other Corps projects, and recommend that future Corps requests for consultation include only those conservation actions to which the Corps is confident they can commit.

The Service appreciates the Corps' commitment to protecting federally listed species that may be impacted by this beach construction project. All conservation measures, even if they may seem minor, contribute to the Federal effort to recover each species. If you have questions regarding this consultation between now and the end of 2010, please contact Howard Hall at (919) 856-4520, extension 27. For consultation in 2011 and beyond, please contact me for the appropriate member of my staff.

Sincerely,

Pete Benjamin
Field Supervisor

cc:

Ron Sechler, NOAA Fisheries, Beaufort, NC
Molly Ellwood, NC Wildlife Resources Commission, Wilmington, NC
Matthew Godfrey, NC Wildlife Resources Commission, Wilmington, NC
Stephen Rynas, Federal and State Consistency Coordinator, NC Division of Coastal Management, Morehead City NC
Anne Deaton, NC Division of Marine Fisheries, Morehead City, NC

FINAL
FISH AND WILDLIFE COORDINATION ACT REPORT
for
SURF CITY – NORTH TOPSAIL BEACH, NORTH CAROLINA, SHORE PROTECTION PROJECT

May 2010

This constitutes the Final Fish and Wildlife Coordination Act (FWCA) Report of the U. S. Fish and Wildlife Service (Service) for the Surf City-North Topsail Beach (SC-NTB), Shore Protection Project, Pender and Onslow Counties, North Carolina. The project consists of initial construction of a berm and dune system along approximately 9.9 miles of Atlantic shoreline in the central section of Topsail Island with periodic reconstruction of the system at approximately three-year interval over a period of 50 years. Beachfill material would be dredged from offshore, marine sand deposits. This report identifies fish and wildlife resources located in the project area and the potential impacts of the Corps' recommended project on these resources. This report constitutes the Service's report in accordance with Section 2(b) of the FWCA (48 Stat. 401, as amended; 16 U.S.C. 661 - 667d) and is provided in accordance with our FY 2010 Transfer Funding Agreement and Scope of Work.

Introduction

The Service has coordinated with the Corps on various beach construction efforts on Topsail Island since the 1990s. On March 16, 2001, The Service provided scoping comments on the SC-NTB project. These comments expressed concerns that efforts to reduce storm damage to man-made structures may seriously degrade the habitat values provided by beaches and nearshore marine areas. This concern is most acute in regard to the long-term impacts of engineered structures (e.g., seawalls and artificial beach-dune systems) constructed to allow structures and infrastructure to remain in a fixed location as global sea level rises. On September 9, 2003, the Service provided a Planning Aid Letter that discussed five adverse, environmental impacts of a beach construction effort. The Service provided a Draft FWCA Report in June 2008 with 15 recommendations to avoid or minimize the adverse impacts of the 50-year program of beach construction using offshore sediment (U. S. Fish and Wildlife Service [hereafter USFWS] 2008). Most recently, the DOI provided comments on March 3, 2010, on the Draft Integrated Feasibility Report and Environmental Impact Statement (U. S. Army Corps of Engineers [hereafter USACE] 2009b).

Project Area and Need

This area represents the central portion of the Topsail Island, a 26-mile long barrier island. The need facing development in the project area is clearly evident from published descriptions of Topsail Island. Pilkey et al. (1998, p. 171) note that Topsail Island has a troublesome geologic setting along its entire length. The island is very narrow and flat with no significant area higher than the 500-year flood elevation. Most of the island lies on the 100-year floodplain. The U. S. Navy abandoned a missile range on the island because storms and hurricanes repeatedly destroyed buildings and equipment during the mid-1940s and early 1950s (Frankenberg 1997 p. 171). Hurricane Hazel which struck the southern North Carolina coast in 1954 generated a storm surge of 9.5 feet on the island which has an average elevation of nine feet (Pilkey et al. 1998, p. 171). A 1987 evaluation by the North Carolina Department of Emergency Management indicated that the island would be largely underwater in a category 1 or 2 hurricane and would be completely submerged in a category 3 hurricane (Pilkey et al. 1998, p. 173).

The island was severely impacted by two hurricanes within an eight-week period during 1996. Prior to Hurricanes Bertha and Fran, a prominent artificial dune, 12 feet high and 50 feet wide, existed along much of southern Topsail Island (Pilkey et al. 1998, p. 180). Barnes notes (1998, p. 177-178) that large portions of the dunes between Figure Eight Island and Emerald Isle, an area including the current project area, were washed away by the first storm, Bertha, which set the stage for extensive beach erosion and ocean overwash during the second storm, Fran. Hurricane Fran leveled the dune on southern Topsail Island and the entire area was overwashed by the storm surge which deposited up to three feet of overwash sand in some parts of Surf City, (Pilkey et al 1998, p. 180). The storm surge associated with Hurricane Fran, a minimal category 3 storm at landfall, created a storm surge of 8-12 feet along North Carolina's southeastern coast (Barnes, 1998, p. 177).

Since private interests have chosen to develop Topsail Island as an ocean resort community in spite of its history of recurring storm damage, the Service agrees that there is a need to reduce damage to man-made structures in the project area. However, the discussion of the project area and project need is deficient in the lack of any appropriate consideration of global sea level rise. As sea level rises, there are natural geological processes that shift barrier islands landward. These processes allow these areas to persist and maintain natural sandy beaches. When efforts to preserve coastal development seek to prevent the adjustment of coastal areas to sea level rise, the results appear as the chronic erosion, a well recognized problem in the project area. The DEIS correctly notes (USACE 2009b, p. 75) that "substantial portions of the berm and dune system have been lost as the shoreline is being 'squeezed' between the ocean and adjacent development." A basic understanding of the receding shoreline is critical to developing effective, long-term solutions to protecting man-made structures near the ocean.

The Tentatively Selected Alternative

After eliminating a non-structural approach from a thorough evaluation, the Corps indentified a course of action identified as the tentatively selected plan (USACE 2009b pp 100-138). This plan consists of a sand dune constructed to an elevation of 15 feet above the National Geodetic Vertical Datum (NGVD, roughly equivalent to mean sea level, fronted by a 50-foot wide beach berm constructed to an elevation of 7 feet above NGVD. The berm and dune project would extend along a reach of 52,150 feet (9.9 miles) from the southern boundary of Surf City northward to the boundary of a Coastal Barrier Resource System Unit in North Topsail Beach. Depending on endpoint conditions found at the time of construction, up to 2,000 feet of the berm and dune on each end of the project may be replaced with a tapered transition section.

The proposed borrow sites are located between 1 and 6 miles offshore at depths of 35 to 50 feet below mean lower low water (MLLW). Initial construction would require 11.5 million cubic yards of borrow material. Reconstruction would require 1.6 million cubic yards of borrow material at 4 year intervals. In total, about 31.1 million cubic yards of dredge material would be required for the 50-year project.

Several important conservation measures incorporated in the plan are provided (USACE 2009b, pp. 192-194) in Section 10.06.1. These commitments to reduce impacts to listed species include limiting hopper dredging to the period from December 1 through March 31, but only to the "maximum extent practicable." There would also be a commitment to use sediment compatible with the existing beach along with measures to assess and rectify any sediment compaction or escarpment formation.

Fish and Wildlife Resources in the Project Area

The general fish and wildlife resources in the area of the SC-NTB project have been discussed in prior reports by the Service (USFWS 2007, pp. 23-26; USFWS 2008, pp. 11-13). These prior reports provide a sufficient basis for the concerns and recommendations discussed in this report.

Evaluation of Environmental Impacts of the Tentatively Selected Plan

The Corps has provided a detailed discussion of the anticipated environmental effects of implementing the tentatively selected plan (USACE 2009b, pp. 139 - 185). In general, all the major resources are considered and the likely impacts of initial construction and the early reconstruction events are considered. However, the discussion seems based on the assumption that present environmental conditions will continue throughout the 50 years of the authorized project.

Current planning documents appear to lack a consideration of adverse environmental impacts that could occur in the final decades of the project if sea level rise is greater than currently predicted. For example, the plan assumes a consistent four-year reconstruction cycle throughout the project (USACE 2009b, p. 103). Plans for initial construction (USACE 2009b, pp. 100-101) indicate that a portion of the beachfill would be below mean low water, approximately -1.9 feet NGVD. Placing beachfill below the low tide line is essentially putting sand in the ocean. As sea level rises over the decades of the project, efforts to save the existing ocean front structures would result in a greater portion of imported sediment for each reconstruction event being placed in an area that would be open ocean under natural conditions.

Sediment placed below the natural low tide line is likely to be less stable than that placed on an intertidal or dry beach. Any accelerated loss of imported material is very likely to result in a reduction of the reconstruction interval. Such a reduction could pose a risk to beach macroinvertebrates that form an important base on the coastal food chain. Literature dating back to the early 1970s along the southeast coast indicates that opportunistic infauna species (ex. *Emerita* and *Donax*) found in the beachfill areas are subject to direct mortality from burial; but recovery often occurs within one year (USACE 2009b, p. 143 and references therein). More frequent reconstruction operations along with post-storm, emergency sand placements would provide less time for these organisms to recover and maintain healthy population levels.

Over time, beach reconstruction at intervals less than four years would pose a risk to sea turtle reproductive success. The Biological Assessments states that, in most cases, sea turtle nesting success decreases during the year following beachfill operations as a result of escarpments obstructing beach accessibility, altered beach profiles, and increased compaction (USACE 2009b, Appendix I, p. 14). In Florida a decrease in nesting success was documented in the year following construction with an increase in loggerhead sea turtle (*Caretta caretta*) nesting success rates during the second season post-construction (Brock 2005 as cited in USACE 2009b, p. I-16). This was attributed to increased habitat availability following the equilibration process of the seaward crest of the berm. This study suggested that, if compatible sediment and innovative design methods are utilized to minimize post-construction impacts documented in previous studies, then the decrease in nesting success without the presence of escarpment formations, compaction, etc. may indicate an absence of abiotic and or biotic factors that cue the female to initiate nesting. That is to say, even constructed beach that appear to offer easy access for nesting sea turtles may lack some unknown factor necessary for nesting.

Overall, the literature indicates that there are inherent changes in beach characteristics as a result of importing beachfill to construct artificial dunes and berms. These changes can result in short-term decreases in sea turtle nesting success and/or alterations in nesting processes. The abundance of important beach invertebrates may be reduced (Peterson et al. 2000). Any decrease in the reconstruction interval on Topsail Island could result in less time for the imported material to assume the natural characteristics of beaches necessary for successful sea turtle reproduction and healthy populations of beach macrofauna.

Service Recommendations

The Service offered 15 specific recommendations in the Draft FWCA Report of June 2008 (USFWS 2008, pp. 42-47). The Corps has provided an official response to each recommendation (USACE 2009b, pp. 211-222). These 15 recommendations still form the basis for avoiding and minimizing adverse environmental impacts. This report offers the following additional information on the aspects of the project related to the Service's recommendations

The second recommendation of the Service requested a greater consideration of future sea level rise in assessing the environmental impacts of the proposed 50-year program of beach construction. Sea level in the final decades of the project may have a profound influence on the severity of environmental impacts. In order to provide full consideration of the direct and indirect physical effects of a range of possible sea level change scenarios, the Corps released Circular No. 1165-2-211 (circular), entitled "Water Resources Policies and Authorities Incorporating Sea-Level Change Considerations Into Civil Works Programs" (USACE 2009a). The circular refers to the work of the U. S. Climate Change Science Program (CCSP 2009) and states that sea-level change can cause a number of impacts in coastal and estuarine zones, including changes in shoreline erosion, inundation or exposure of low-lying coastal areas, changes in storm and flood damages, shifts in extent and distribution of wetlands and other coastal habitats, changes to groundwater levels, and alterations to salinity intrusion into estuaries and groundwater systems (USACE 2009a, p. B-1). It is clear that the natural resources of barriers islands, such as Topsail Island, would benefit from being allow to naturally adapt to sea level rise by gradually move landward and upward on the coastal plain. A 50-year program of beach construction may provide some protection during smaller storms, but the longer-term net benefits are uncertain.

The circular states that sea level change must be considered in every Corps coastal activity as far inland as the extent of estimated tidal influence (USACE 2009a, p. 1). Furthermore, planning studies and engineering designs should consider alternatives that are developed and assessed for the entire range of possible future rates of sea level change (USACE 2009a, p. 2). The circular requires an evaluation of alternatives using "low," "intermediate," and "high" rates of future sea-level change for both "with" and "without" project conditions. The historic rate of sea level change will be considered as the "low" rate. The circular provides guidance in determining the intermediate and high rates of sea level rise.

Planning for the SC-NTB Project is based on a projected rate of sea level rise of 9.6 inches (0.8 of a foot) over the next 100 years (USACE 2009b, p. 212) and notes that this figure is within the likely range of sea level rise reported for all but the most pessimistic scenarios of the Intergovernmental Panel on Climate Change (IPCC). However, the Corps' circular requires a consideration of both the most recent IPCC projections and modified National Research Council (NRC) projections (National Research Council 1987). These projections should be added to the local rate of vertical land movement.

The Corps' circular notes (USACE 2009a, p. B-9) that the NRC report includes a range of possible future sea-level rise scenarios that is much greater than those presented by the IPCC (Intergovernmental Panel on Climate Change [hereafter IPCC] 2007). The 2007 IPCC report has received some criticism for not fully considering the possibility of rapid ice loss in Antarctica due to massive failures of the West Antarctic Ice Sheet. Including the upper scenarios from the NRC report allows planners and engineers to consider the possibility of much greater rates of sea-level rise than those presented in the 2007 IPCC report and to thus accommodate some of the criticism directed at the 2007 IPCC report. Overall, the "high" rate of sea level rise mandated by the recent Corps circular for use in project planning exceeds the upper bounds of IPCC estimates from both 2001 and 2007 to accommodate for the potential rapid loss of ice from Antarctica and Greenland (USACE 2009a, p. 2).

For the current project, the Corps should consider that since 1990, observed sea level has followed the uppermost uncertainty limit of the IPCC Third Assessment Report of 2002 (Rahmstorf 2007). Sea level is expected to rise as the ocean takes up heat and ice starts to melt, until a new equilibrium sea level is reached. Rahmstorf (2007) presents a semi-empirical approach for predicting future sea level rise. Based on temperature increases projected by the IPCC, Rahmstorf (2007) projects that sea level in 2100 may be one-half meter (1.64 feet) to 1.4 meters (4.59 feet) above the 1990 level.

The third recommendation of the Service requested a more comprehensive discussion of any Corps conclusion that the proposed project complied with Executive Order 11988. This EO was enacted to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative (USACE 2009b, p. 194). Most of Topsail Island is in the 100-year floodplain (Pilkey et al. 1998, p. 171) and most of the island would be largely underwater in a category one or two hurricane and nearly completely submerged in a category three hurricane (Pilkey et al. 1998, p. 173). Except for some dune areas, the entire SC-NTB project area is subject to hurricane storm surge flooding (USACE 2006b, p. 9).

In considering compliance with EO 11988, the Corps should realize that the most significant environmental impacts of the proposed 50-year program of periodic beach construction are likely to come in the final decades of the project. These adverse impacts would emerge as efforts are made to save existing development as sea level rises. The DEIS states (USACE 2009b, p. 212) that it is likely that the without-project condition (with its diminished dune and berm) would be more sensitive to sea level rise than the with-project condition, and thus the net benefits for the beachfill project would be increased. This statement is based on the premise that resources will be available to effectively protect existing development for decades to come. Since the offshore area, Onslow Bay, is a sediment starved system consisting mostly of a thin patchy veneer of three to six feet of modern sediments covering the low relief Oligocene limestone and siltstone (USACE 2009b, p. 24), fill material may become limited in the final decades of the project.

The Corps responded (USACE, 2009b, p. 195) that beach nourishment has been accepted as a valuable tool in moderating flooding and protecting floodplains. Placement of beachfill will occur in the floodplain of area beaches. This placement will be conducted specifically for its beneficial effect in offsetting erosion and restoring damaged beaches, and is, therefore judged acceptable. The action is expected to have an insignificant effect on the floodplain. The Corps concludes, therefore, that the proposed action is in compliance with the requirements of EO 11988 and with State/local flood plain protection standards.

The Service believes that the 50-year program of sediment disposal will have adverse impacts on the Topsail Island floodplain, especially if the time interval between reconstruction events is reduced in the final decades of the project. Important beach infauna would have less time to recover between reconstruction events. Important nearshore fishes and shorebirds may lose part of important food resource if infaunal populations are not given sufficient time to recover.

If the Corps has a broad mandate to reduce storm damage and protect human lives in the project area (as opposed to preserving current development and facilitating additional development), then there should be a consideration of whether development on the low lying and flood-prone barrier island represents wise use of this floodplain. As noted by Frankenberg (1997, p. 171) the military abandoned its missile testing operations on Topsail Island because storms and hurricanes repeatedly destroyed buildings and equipment. It is only a matter of time before a storm similar to Hurricane Hazel (1954) strikes. That storm destroyed 210 of the 230 houses in what was then the community of New Topsail Beach (Barnes 1998, p. 100). Past history and the likelihood of more intense storms should be considered in the Corps' compliance with EO 11988.

In determining whether a given course of federal action would comply with EO 11988 there should be a consideration of conditions at the northern end of the island which is within the Coastal Barrier Resource System (CBRS). The CBRS was established by the Coastal Barrier Resources Act (CBRA) of 1982. In the legislation Congress declared (16 U.S.C. § 3501(a)(3)) that "coastal barriers serve as natural storm protective barriers and are generally unsuitable for development because they are vulnerable to hurricanes and other storm damage and because natural shoreline recession and the movement of unstable sediments undermine manmade structures." Furthermore, "certain actions and programs of the Federal government have subsidized and permitted development on coastal barriers and the result has been the loss of barrier resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year" (16 U.S.C. § 3501(a)(4)).

The CBRA seeks to minimize the loss of human life, wasteful federal expenditures, and damage to fish, wildlife, and other natural resources associated with coastal barriers. The areas placed within the CBRS included "undeveloped coastal barriers." More than seven miles at the northern end of Topsail Island are included within the CBRS. Therefore, Congress has determined that development within certain areas at the northern end of the island pose a risk to human life and such development has the potential for requiring wasteful federal expenditures. The project area for this federal action was excluded from the CBRS due to the level of existing development at the time the CBRS was enacted. It was correctly determined that it would be unfair to retroactively deny federal assistance, including federal flood insurance, to existing property owners in the more developed central and southern parts of the island. The exclusion of all but the northern part of the island from the CBRS was based on the level of existing development, not on any determination that there was less risk to human life or the potential for wasteful federal expenditures. Considering the spatial extent of major hurricanes at landfall, the variation in storm damage between the northern, central, and southern portion of this 26-mile-long barrier island are likely to be slight to none.

Compliance with EO 11988 requires a consideration of whether the SC-NTB project area shares the same characteristics as the CBRS area directly north of project area. If the project area does have the same level of risk as the adjacent area, does the proposed 50 years of beach construction, which seeks to preserve development, comply with the intent of EO 11988? The Service is not suggesting in any way that the restrictions on federal funding applicable to areas within the CBRS be applied to areas outside the system. We are suggesting that the conditions which led to the inclusion of northern Topsail Island in the CBRS be considered for the current proposal for beach construction in the context of EO 11988. The CBRA and EO 11988 are entirely different factors to be considered by the Corps. That is to say, Congress has declared that federal expenditures for development on the northern part of the island (within the designated CBRA Unit) could contribute to the loss of human life, wasteful federal expenditures, damage to fish, wildlife, and other natural resources. Therefore, when viewed from the perspective of EO 11988, federal expenditures for constructing and maintaining an artificial beach may contribute to additional development directly south of the CBRS Unit and thereby support the "unwise use" of a floodplain.

Unless a storm damage reduction strategy is implemented to provide protection against storms such as Hazel and Fran, the area will continue to have repeated cycles of destruction and rebuilding. The question to be answered in regard to EO 11988 is whether such repeated destruction and rebuilding represents unwise floodplain development which should not be supported by actions of the executive branch. Whether state and local funds would be periodically provided to construct the beach is not the issue, the issue is whether actions by the Corps, as part of the executive branch of the federal government, maintain existing development and support additional development in an inherently dangerous location.

The DEIS states that an Independent External Peer Review (IEPR) will be conducted following the Agency Team Review (USACE 2009b, p. iv). The IEPR will be conducted by a non-USACE national team of experts in the field, and coordinated by the National Planning Center of Expertise in Coastal Storm Damage Reduction, North Atlantic Division, U. S. Army Corps of Engineers. Comments and responses will accompany the report to the Assistant Secretary of the Army for Civil Works (ASA(CW)) and the Office of Management and Budget (OMB). Documentation of IEPR certification will accompany the final report. The Corps should ensure that the IEPR fully considers a low, medium, and high rate of sea level rise over the course of the project life. The long-term viability of existing and future development on the floodplain of Topsail Island under each sea level rise scenario should be fully evaluated in light of the mandate of EO 11988. That is, a determination should be made on whether existing and future development represent the wise use of the floodplain under each sea level rise scenario.

Both the Corps and the IEPR should conduct a broad reevaluation of the merits of structural versus non-structural alternatives for reducing storm damage in the project area. The Corps stated that in analyzing potential measures, the study team considered both structural and non-structural measures in all cases where technically sound and environmentally feasible (USACE 2009b, p. iv). Nonstructural measures, such as removal and relocation, were found to be of greater cost than benefits, and therefore, were not recommended for the purposes of storm damage reduction.

However, the study team's recommendations that accompany all structural recommendations for dune and berm construction include continued and vigilant attention to the need for pro-active hurricane and coastal storm threat education, coastal storm and hurricane warning and evacuation planning procedures, floodplain management, and other non-structural activities directed at both damage reduction and preservation of life and safety. These actions are recommended, although many do not fall within current Corps implementation authorities.

A new evaluation in light of the potential for a high rate of sea level rise may reveal that a program of periodic beach construction will not adequately protect development on the Topsail Island floodplain. The carefully planned implementation of non-structural actions, including phased removal and relocation of buildings, may provide greater long-term economic and social benefits.

Federally Protected Species

Recommendations 12 through 15 of the Service's Draft FWCA Report addressed conservation measures for federally protected species. The Corps responded to each recommendation (USACE 2009b, pp. 211-222). Additional consideration of federally protected species is given in the DEIS (USACE 2009b, Appendix I). This appendix represents the Biological Assessment (BA) of the Corps. The species considered in the BA (Table 2, p. I-4) includes all the federally protected species likely to be directly or indirectly impacted by the tentatively selected plan. The BA separates these species into those which could be impacted by in-water dredging activities and those which could be impacted by onshore sediment placement and beach construction. The former group, primarily those found exclusively in a marine environment, is under the jurisdiction of the National Marine Fisheries Service. The latter group, those likely to be impacted by beach construction, is under the jurisdiction of the Service. Protection of sea turtles is divided between these agencies with the Service being responsible for sea turtles when they come ashore to nest. The species considered by the Service include the West Indian manatee (*Trichechus manatus)*, piping plover (*Charadrius melodus*), seabeach amaranth (*Amaranthus pumilus*), and three species of sea turtles, the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and leatherback (*Dermochelys coriacea*).

The BA accurately states that dredging operations, beach placement of material, and associated construction operations (i.e. operation of heavy equipment, pipeline route, etc.) may adversely affect some species and their habitat (USACE 2009b, p. I-5). Potential impacts vary according to the type of equipment used, the nature and location of sediment discharged, the time period in relation to life cycles of organisms that could be affected, and the nature of the interaction of a particular species with the dredging activities.

The two most critical factors of any beach construction effort that influence the degree of impacts are the physical compatibility of the material used for beach construction (i.e., the degree of sediment compatibility) and the time of year that the work is conducted. The BA addresses these and other conservation measures in Section 4 of the BA, Commitments to Reduce Impacts to Listed Species. These commitments are also provided in the DEIS (USACE 2009b, pp. 192-194).

Current plans state that initial construction and each nourishment interval will avoid the sea turtle nesting season (USACE 2009b, p. 193). The proposed dredging and beach construction schedule extends from December 1 through March 31 for both initial construction and each reconstruction event (USACE 2009b, p. 220). If, due to unforeseen circumstances, construction extends into the nesting season, the Corps will implement a sea turtle nest monitoring and avoidance/relocation plan through coordination with Service and the North Carolina Wildlife Resources Commission

Current plans state that beachfill material will comply with grain size and percent weight requirements specified in 15A NCAC 07H .0312, Technical Standards for Beach Fill Projects (USACE 2009b, p. 214). The Technical Standards require compatibility of the native beach with borrow sources in regards to the percentage of silt, granular sediment, gravel, and calcium carbonate (or shell content for projects initiated before implementation of the rules). Furthermore, the Corps intends to perform rigorous boring analyses of proposed borrow areas in order to minimize the risk of placing incompatible material on the beach (USACE 2009b, p. 214). Throughout the duration of construction operations, the Corps will employ full-time construction inspection personnel to perform on-sight inspections of the project operations to assure quality control and compliance with contract specifications. The Corps will receive daily production reports from the contractor that provide detailed information pertaining to the Contractor's daily operations. Corps construction inspection personnel will inspect the beach for any significant amount of incompatible material within the project limits throughout the contract duration, and if any incompatible material is identified within the placement area, the Corps will coordinate with the appropriate agencies to identify the quantity of material and discuss the methods of removal and disposal prior to the sea turtle nesting season.

The Corps summarizes the effects of in-water dredging activities and beach placement activities in a table in Appendix I (USACE 2009b, p. I-37). While in-water dredging is likely to adversely affect the five species of sea turtles, such impacts are considered by the National Marine Fisheries Service. Among the species under the jurisdiction of the Service, including all sea turtles that come ashore to nest, the proposed work is expected to have either no effect or is not likely to adversely affect on these species. The table correctly notes that there is no formally designated critical habitat in the project area.

Overall, based on the information provided in the DEIS and BA, the Service concurs with the Corps determinations that the proposed action is not likely to adversely affect federally listed species or their critical habitat as defined by the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543). Therefore, the requirements of section 7 (a)(2) of the ESA have been satisfied for this project. However, the Corps' obligations under the ESA must be reconsidered if: (1) new information identifies impacts of this action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is modified in a manner that was not considered in this review; or, (3) a new species is listed or critical habitat determined that may be affected by the identified action.

With regard to project modification, the Corps should contact the Service if beachfill must be extended outside the proposed schedule of December 1 through March 31 or the material to be used for the beachfill deviates significantly from the standards proposed in the DEIS. Furthermore, significant placements of beachfill between the scheduled reconstruction operations given in Table 7.11 (USACE 2009b, p. 126) would represent modification of the proposed effort. The Corps should contact the Service if more than 1.6 million cubic yards of material, the standard reconstruction volume, are placed on project area beaches between established reconstruction events.

Summary of Findings and Position of the Service

Overall, the DEIS presents an excellent review of the resources in the project area and the potential adverse impacts of offshore dredging and beach construction under present day conditions. However, the DEIS states (USACE 2009b, p. 83) that the planning process is subject to limitations imposed by certain restraints. These restraints include current limits of knowledge, information, and predictive ability. These limitations are critically important in regard to the future rise of sea level and the real possibility of more frequent storms of greater magnitude. Therefore, the Service recommends that the policies outlined in the Corps' July 2009 circular be applied to the current project. Specifically, over the 50 years of proposed beach construction efforts (from approximately 2014 to the early 2060s) the effectiveness of the artificial beach and environmental impacts of maintaining such a beach should be evaluated for a low, intermediate, and high projection of sea level rise. The low projection would be essentially the rate of rise observed in the recent past. For the high projection, and to a lesser extent the intermediate projection, the reconstruction intervals should be carefully evaluated in the final decades of the project. It is very likely that significant sea level rise would result in much shorter reconstruction intervals that would create adverse environmental impacts not considered in the current DEIS.

Barrier islands and spits are inherently dangerous places for any man-made structures such as roads, houses, or utility infrastructure. The islands are subject to the full force of both tropical hurricanes and winter storms (nor'easters). Early residents recognized this fact of coastal living and built their homes as far from the ocean as possible. On the Outer Banks, development was limited to the sound side of the islands until the mid-1880s (Frankenberg 1995, p. 118). Current beach front development occupies an extremely hazardous location as shown by the devastation seen in North Carolina by Hurricane Hazel in 1954 and the Gulf Coast by Hurricane Katrina in August 2005.

The threat to all development on barrier islands is increased by the rise in global sea level. While the causes of sea level rise may be debated, the increase has been well documented (see Appendix B, USACE 2009a) and is likely to continue for many decades, perhaps at an increasing rate of rise. The intensity of hurricanes may also increase as ocean waters become warmer. Therefore, both the threat of damage during storms and the gradual inundation of the coastline can be expected to continue throughout the proposed 50 years of the beach construction effort and beyond.

While it may appear that even calm ocean waters are destroying the beaches through erosion, this is not correct. Barrier islands are not fixed, stationary landforms. These islands are unconsolidated masses of gravel, sand, and mud surrounded by ocean and estuarine waters. They are characterized by low elevation, narrow width, and fragile vegetation cover (Bush et al. 1996, p. 11).

When global sea level is rising, natural processes push the islands landward and allow them to survive. One of these natural processes is the movement of sand from the beaches across the island to the sound side. From the perspective of a beachfront structure, this process of island overwash appears to represent the destruction of the beach. If artificial dunes block the island overwash process, the sand may be lost to deeper offshore waters rather than contributing to the survival of the island. Pilkey et al. (1998, p. 4) state that "when sea level is rising, as it is today, barrier islands do not stay in one place; they migrate in order to survive."

Therefore, it should be understood that while hurricanes cause tremendous damage to fixed, man-made structures, they do not create long-term damage to barrier islands. In fact, the forces that occur during major storms and are so destructive to man-made structures are necessary for barrier islands to respond to sea level rise and ultimately continue to exist. The wide natural beaches that are so important to the tourist economy are not destroyed as the islands move landward. They merely change location. The current loss of the beach in the project area results from the area being squeezed between a rise ocean and a fixed line of structures.

All man-made structures near the rising ocean are unquestionably in danger. If governments at all levels take no action to hold back the rising ocean, individual property owners will probably undertake short-term efforts (e.g., beach bulldozing, sandbag walls) to save structures near the ocean. These efforts are likely to be ineffective in the long term and the width of the beaches would continue to diminish (USACE 2006a, p. B-32).

Therefore, while government action is not needed to save the beach, action is needed to save beach front development. Government action can be categorized as either non-structural or structural. A non-structural approach involves a number of actions to remove or relocate structures threatened by storms and coastal inundation. This type of response is based on the premise that storm damage is reduced when there is nothing to be damaged. These measures would require consideration of suitable relocation sites and compensation for property owners. The approach would also restore valuable barrier island habitats, such as overwash areas, that have been lost by effort to stop the landward movement of barrier islands.

On the other hand, structural responses consist primarily of construction to either hold existing sand in place (seawalls, groins, jetties, sandbags, etc) or the periodic placement of imported beachfill to replace the sand that has washed away. These approaches generally produce numerous short-term adverse impacts on fish and wildlife resources. There are design features and construction techniques to minimize the some of the adverse impact of actual beach construction at the present sea level. The use of highly compatible beach fill, a restricted work schedule, and a reconstruction interval of four years would retain most of the habitat functions of the beach and dune communities.

The most significant question with regard to the long-term conservation of fish and wildlife resources is whether beach construction efforts which provide limited security in the short run can be maintained over 50 years and beyond as sea level continues to rise. Over many decades, a greater portion of the beach fill used to reconstruct the beach at its present location will actually be below what would be the natural low tide level. The artificial beach, partially built in the ocean, will wash away in ever shorter time intervals over the life of the project. There is a concern that over many decades the escalating costs of more frequent beach replacement along with diminishing supplies of available beachfill will lead to demands for rock seawalls to protect the ever increasing value of shoreline property. Where seawalls are built, the beach is eventually lost (Pilkey et al. 1980, p. 10).

In light of the findings discussed above, the Service believes that action must be taken to reduce the periodic destruction of man-made structures in the project area. However, implementation of a long-term program of beach construction is not likely to remain effective as sea level continues to rise. The environmental issues surrounding a long-term program of beach and dune construction involve much more than just offshore sediment extraction and beach construction. The most significant issues are the consequences of attempting to hold the island in place as the ocean rises around it. When beachfill no longer provides cost effective protection, rock seawalls would be required to hold back the rising water. Eventually the beaches and salt marshes of the sound would be lost. Pilkey et al. (1998, p. 102) have summarized the issue by stating that "in the long run, North Carolinians must make a decision. They can have beaches or they can have beachfront buildings; they can't have both. If we opt in favor of buildings, the beaches will be lost – and so, ultimately will the buildings."

Our review of the available information regarding this project leads us to believe that the long-term success of the proposed approach is questionable and it is likely that other structural or non-structural measures will need to be implemented during the life of the project. Furthermore, we note that non-structural measures would be more successful at conserving the natural resources of the project area.

The Service again recommends that planning for the current project should give greater consideration to EO 11988 which seeks to avoid federal support for unwise development within floodplains which can result in both high costs for reconstruction and danger to human life and safety. The SC-NTB project is immediately south of a CBRS unit and shares the same storm damage risks as the CBRS unit. Current plans acknowledge (USACE 2009b, p. 129) that structures will continue to be subject to damage from hurricane winds and windblown debris. Damages from flooding and winds are expected to decrease as older structures are replaced with those meeting floodplain ordinances and wind hazard building construction standards. But even new construction is not immune from storm damage, especially from major hurricanes. Therefore, the Corps should carefully consider whether this federal effort, currently proposed as a 50-years program of beach construction, is in compliance with EO 11988 which seeks to reduce the loss of human life, wasteful federal expenditures, and damage to fish, wildlife, and other natural resources by avoiding unwise development of floodplains.

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