

6. PLAN SELECTION

6.01 National Economic Development Plan

The National Economic Development (NED) Plan is the alternative among plans with the greatest net economic benefits. The dune and berm plan, named 1550, having the greatest net economic benefits, is the NED plan. Plan 1550 consists of a 26,200-foot long dune and berm system to be constructed to an elevation of 15 feet NGVD fronted by a 7-foot NGVD (50-foot wide) beach berm with a main fill length of 22,800 feet, from Godwin Avenue to the Topsail Beach town limit, and having 2,000-foot transition length on the north end and a 1,400-foot transition on the south end.

6.02 Locally Preferred Plan (LPP)

The Town of Topsail Beach has selected Plan 1250X as the Locally Preferred Plan. Plan 1250X consists of a 26,200-foot long dune and berm system to be constructed to an elevation of 12 feet NGVD fronted by a 7-foot NGVD (50-foot wide) beach berm with a main fill length of 23,200 feet, from a point 400 feet southwest of Godwin Avenue to the Topsail Beach town limit, and having 2,000-foot transition length on the north end and a 1,000-foot transition on the south end.

6.03 Other Plans

No other plan has been proposed as being the selected plan.

6.04 Selected Plan

In some instances there are reasons for selection of a plan other than the NED plan. Plans which are smaller than the NED plan will normally be considered favorable for an exception to the NED requirements. Affordability is a valid reason for selecting a plan smaller and less costly than the NED plan.

The Locally Preferred Plan, Plan 1250X, is the selected plan to be recommended for Federal action. The LPP has a dune 3 feet lower and 400 feet longer than the NED Plan. The initial construction cost of the LPP is lower than the NED plan, and the renourishment costs are about the same.

The lower elevation dune of the LPP does not provide as much storm damage reduction as the NED plan. Average annual storm damage reduction benefits as shown in Table 5.2 are \$7,168,000 for the NED plan and for the LPP are \$6,588,000, a reduction of \$580,000, or 8% from the NED plan. Recreation benefits are the same for both plans.

Average annual costs of shown in Table 5.2 are \$3,440,000 for the NED plan and for the LPP are \$3,027,000. The renourishment volumes and cost for both plans are the same, with the cost differences originating from initial construction of the project.

The comparative costs and benefits described in this section and in Table 5.2 were developed during Fiscal Year 2005 and use October 2004 costs and prices and the Federal Water Resources FY 2005 interest rate of 5.375%. This concludes comparative evaluations of the alternatives. Detailed evaluations of costs and benefits in Section 7 of the Final GRR of the NED plan and the Locally Preferred Plan are conducted at October 2008 costs and prices and the FY2009 interest rate of 4.625%.

7. THE SELECTED PLAN

The purpose of this report section is to centralize information concerning the Selected Plan. The Selected Plan is discussed in terms of features, construction, maintenance, real estate requirements, accomplishments, and economic feasibility.

7.01 Plan Description and Components

The Selected Plan is Plan 1250X, which is the Locally Preferred Plan. Plan 1250X consists of a 26,200-foot long dune and berm system. Sand for the beachfill would be delivered from offshore borrow areas by dredge. A cross section is shown in Figure 7.1. A plan view is shown in Figure 7.2, and in more detail in Appendix A, Project Maps.

7.01.1 Main fill

The plan has a main fill length of 23,200 feet, from approximately 400 feet southwest of Godwin Avenue, in reach 3, to the Topsail Beach town limit in reach 26. The two essential features of the selected plan are the dune and the berm.

The plan has a dune at an elevation of 12 feet NGVD and with a crest width of 25 feet. The side slopes of the dune are 5H:1V on the landward side and 10H:1V on the seaward side to the berm.

The plan includes a berm seaward of the dune. The berm has a flat, level section with an elevation of 7-feet NGVD and an optimum width of 50 feet. The seaward slope of the berm extends the beach fill approximately another 100 feet at a slope of approximately 15H:1V down to Mean Low Water (MLW) elevation (-1.9 feet-NGVD), below which the with-project profile parallels the existing profile out to a closure depth of 23 feet.

The landward construction line for the project is placed to minimize impacts on existing structures, to parallel the existing shoreline, to allow the Perpetual Beach Storm Damage Reduction Easement to extend about 20 feet landward of the dune toe, and to tie the fill into a minimum elevation of 7 feet NGVD.

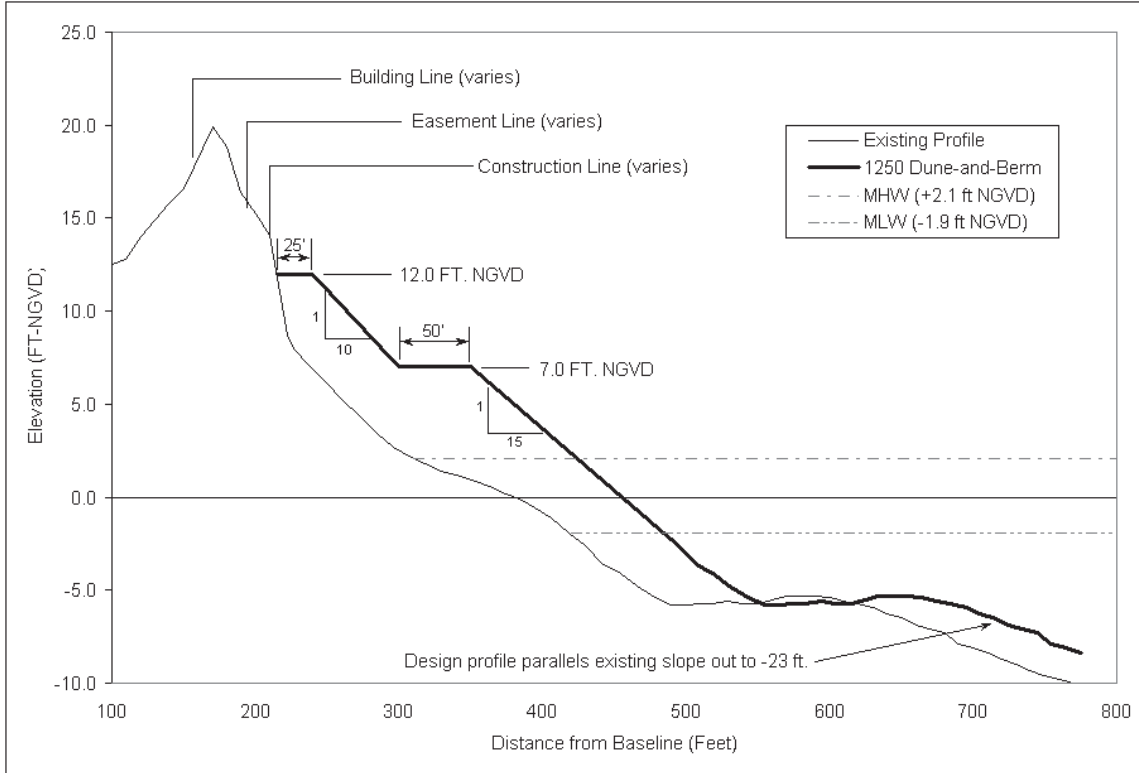


Figure 7.1 Plan 1250X, Locally Preferred Plan, Cross Section

7.01.2 Transition Sections

The transition sections at both ends of the main fill are necessary to improve project stability and reduce end losses. The 2,000-foot northern transition consists of a tapered berm only, with the dune not extending beyond the limits of the main fill section, resulting in a starting transition berm width of 155 feet that uniformly tapers to zero. The southern transition section is similar to the northern transition, except for the length of 1,000 feet.

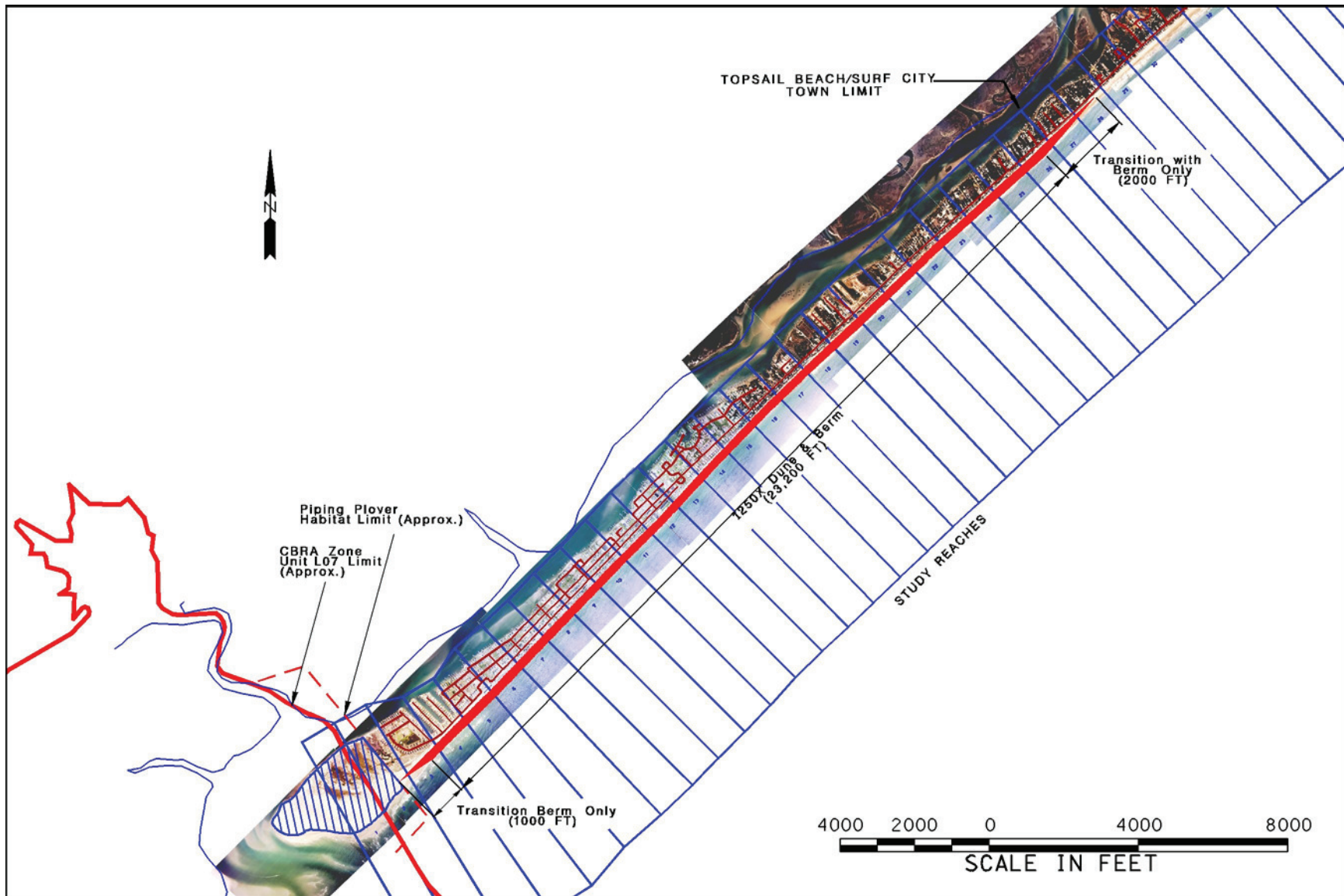


Figure 7.2 Plan 1250X, Locally Preferred Plan, Plan View

7.02 Rationale for Support of the Locally Preferred Plan

The Town of Topsail Beach notified Wilmington District of the town's support for Plan 1250X as the Locally Preferred Plan. The letter from Topsail Beach, dated January 13, 2006, is contained in Appendix H. The Town's letter indicated that some of the reasons for preferring Plan 1250X over NED Plan 1550 are;

1. both plans move the shoreline significantly seaward,
2. Plan 1250X costs 24% less, but reduces net benefits 2%,
3. Plan 1250X has the greatest HSDR benefit to cost ratio, and the second highest total benefit to cost ratio,
4. Plan 1250X has a lower cost to the Town,
5. Plan 1250X will have lower Congressional appropriation requirements, and
6. Plan 1250X provides better protection to the Godwin Avenue area.

7.03 Design and Construction Considerations

7.03.1 Initial Construction and Renourishment

Initial construction will require approximately 3,223,000 cubic yards (CY) of sand from the borrow area with an overfill ratio of 1.35. The material will be pumped to the beach by pipeline dredge and shaped on the beach by earth moving equipment. The initial construction profile will extend seaward of the final design berm profile a variable distance to cover anticipated sand movement during and immediately following construction. This variable distance will generally range from 100 to 200 feet along the project depending upon foreshore slopes established by the fill material. Once sand redistribution along the foreshore occurs, the adjusted profile should resemble the design berm profile. Initial beachfill construction will take 5 months to complete. The project will be constructed in FY2012 (November 2011 – April 2012), subject to availability of funds. Periodic renourishment will require approximately 866,000 CY of sand from the borrow areas with an overfill ratio of 1.25 at intervals of 4 years. The renourishment material will be removed from the borrow areas by hopper dredge. Delivery of sand could occur by hauling filled scows to a pumping station buoy or by hopper dredge hauling sand to the pipeline buoy. In both initial construction and during renourishment the delivery pipeline will be placed to avoid the piping plover habitat areas along the south end of the beach and material between the toe of dune and mean high water line would be tilled to prevent compaction. Over the 50 year life of the project 13,615,000 CY of sand will be placed on Topsail Beach. The volumes required are reported as borrow volumes including overfill ratios, not actual volume in place, which is less.

7.03.2 Dune vegetation

The dune portion of the project will be stabilized against wind losses by planting appropriate native beach grasses. Dune stabilization would be accomplished by the vegetative planting of the dune during the optimum planting seasons and following the berm and dune construction. Planting stocks will consist of a variety of native dune plants including sea oats (*Uniola paniculata*), American beachgrass (*Ammophila*

breviligulata), panic grass (*Panicum amarum*), and seaside little bluestem (*Littoralis variety*). The vegetative cover shall extend from the landward toe of the dune to the seaward intersection with the storm berm for the length of the dune. Plant spacing guidelines will follow the recommendations provided by the North Carolina Sea Grant publication, "The Dune Book." Sea oats will be the predominant plant with American beach grass and panic grass as a supplemental plant. Seaside little bluestem will be planted on the backside of the dune away from the most extreme environment. The total area for dune plantings is estimated to be 48 acres.

7.03.3 Access

The Town now has 22 public access sites, most with wooden dune walkovers. Two of these access sites are designated as a drive-over for vehicles. The drive-over sites will provide access during construction of the beachfill for delivery and removal of the dredge pipeline and for other construction equipment. The widest, most suitable site for access is at Drum Avenue. Most of the existing dune walkovers will be totally or partially removed prior to beachfill construction. After the beachfill is completed, new walkovers will be built and remaining walkovers will be extended over the dune. Including 3 proposed public access sites, the total number of walkovers required is estimated to be 23. Of these, approximately 5 will be constructed to allow wheelchairs to cross the dune. The walkovers are to be constructed as a shared project construction cost. The cost of providing the access locations is not part of the project cost and is not creditable.

7.03.4 Renourishment Interval

An analysis of various renourishment intervals from 2 to 8 years determined that a 7-year periodic nourishment interval results in slightly higher net benefits. Net benefits increase as a function of renourishment interval from 2 to 4 years, beyond which net benefits change about 1 percent as the interval increases. Longer renourishment intervals increase the risks between renourishment events of allowing accumulated erosion to create escarpments, narrow the non-dune portion of the beachfill, erode the toe of the dune, and damage dune vegetation. The potential reduction in the project's ability to sustain recreational uses and to provide a suitable habitat for sea turtles and other species on the beach outweigh the slight gain in net storm damage reduction benefits. Therefore the recommended renourishment interval is 4 years which captures over 97% of the maximum economic benefits and better sustains other benefits.

7.03.5 Beachfill Monitoring

A comprehensive monitoring program in accordance with USACE guidance (Coastal Engineering Manual, Part V, Chapter 4 and Coastal and Hydraulics Engineering Technical Note II-35) is planned for the Topsail Beach shore protection project to assess and ensure project functionality throughout its design lifetime. Estimated October 2008 annual costs for beachfill monitoring are \$251,000. The annual monitoring plan will consist of (1) semi-annual beach profile surveys, \$137,000, (2) annual hydrographic survey of New Topsail Inlet, \$6,000, (3) annual aerial photography of the inlet and beach

(cost included in inlet hydrographic survey), (4) an annual monitoring report, \$93,000, and (5) monitoring program coordination, \$15,000. Beach profile surveys will allow assessment of anticipated beachfill performance and determination of renourishment volume requirements. In addition, whenever sporadic maintenance dredging of navigation channels results in dredged material being placed in the southern project area, surveys can account for this additional material and determine if upcoming renourishment quantities can possibly be reduced accordingly. Hydrographic surveys of New Topsail Inlet will be useful for identifying any unanticipated project impacts on the adjacent inlet and evaluating sediment transport in the project area vicinity. An aerial photographic record of the inlet and beach will further facilitate assessment of the beachfill performance and inlet response. An annual monitoring report will be prepared that presents the data collected and the corresponding analysis of project performance, including recommendations on renourishment requirements.

7.03.6 Environmental Monitoring and Commitments.

The environmental goal of this project is to avoid and minimize adverse impacts to the maximum extent practicable. The following list is a summary of environmental commitments to protect species and habitat types related to the construction and maintenance of the proposed project. This summary includes commitments to federally listed threatened and endangered species as identified in Appendix I. Post construction costs for Environmental Monitoring are shared 50% Federal and 50% non-federal. Sea turtle nesting surveys, item (12) are estimated to have an effective average cost of about \$17,000 per year. Seabeach amaranth surveys, item (17) are estimated to have an effective average cost of about \$1,000 per year. Benthic Invertebrate Monitoring, part of item (19), occurs only once after initial construction and is estimated to cost \$120,000.

Species / Habitat	Commitments to Reduce Environmental Impacts
<i>Sediment Compatibility</i>	<p>(1) Total project volume results in a 70% utilization of available material from the borrow areas allowing for contingency due to unforeseen pockets of incompatible sediment.</p> <p>(2) During the P&S phase of this project additional borings and/or geophysical surveys will be performed to better delineate the borrow area boundaries and material types.</p> <p>(3) If necessary, the Wilmington District will make the decision on a suitable contingency measure which may include moving the dredge to another site within the borrow area or to another borrow area and will notify the agencies of this contingency measure.</p>
<i>Piping Plover &</i>	<p>(4) The Corps will adhere to appropriate windows to the</p>

Other Shorebirds

maximum extent practicable.

(5) During initial nourishment, when project construction will extend into the nesting timeframe (1-30 April), the Corps will coordinate with the NCWRC to plan construction activities around potential nesting areas as well as monitor the pipeline route for any potential nests prior to de-mobilization. If a nest is encountered, pipe segments within the vicinity of the nest will be left in place until approval has been obtained from NCWRC for their removal.

(6) During initial construction, as well as each re-nourishment event, the order of work for beach template construction will be from south to north so that construction activities will be north of the breeding and nesting habitat, located at the inlet spit, during the March and April time-frame; thus, further minimizing project impacts. Furthermore, all pipeline and associated construction activities will avoid the piping plover critical habitat.

Manatee

(7) 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.

Sea turtles

(8) The National Marine Fisheries Service Regional Biological Opinion for the continued hopper dredging of channels and borrow areas in the southeastern United States dated 25 September, 1997 will be strictly adhered to. Furthermore, Hopper dredging activities will comply with the South Atlantic Division Corps of Engineers hopper dredging protocol which requires a hopper dredging window of 1 December to 31 March, the use of turtle deflecting dragheads, inflow and/or overflow screening, and NMFS certified turtle and whale observers.

(9) In order to determine the potential taking of whales, turtles and other species by hopper dredges, NMFS certified observers will be on board the hopper dredges during construction. To the maximum extent feasible, the observers will record all species taken along with length and weight and any unusual circumstances that might have

led to the species capture. Observers will also record all whale observations within the project vicinity

(10) The Corps will avoid the sea turtle nesting season to the maximum extent practicable during initial construction.

(11) If the nesting window cannot be adhered to, the Corps will implement a sea turtle nest monitoring and relocation plan through coordination with USFWS and NCWRC.

(12) 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.

(13) The beach will be monitored for escarpment formation prior to each nesting season. Escarpments that are identified prior to and/or during the nesting season that interfere with sea turtle nesting (exceed 18 inches in height for a distance of 100 ft.) will be leveled. If it is determined that escarpment leveling is required during the nesting or hatching season, leveling actions should be directed by the USFWS

(14) USFWS compaction assessment guidelines will be followed and tilling will be performed as deemed necessary by the USFWS and NCWRC.

(15) Throughout the duration of each nourishment contract, during initial construction and each periodic nourishment event, 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.

(16) The Corps is interested in understanding the threshold of sediment color change and resultant heat conduction on impacting temperature dependent sex determination of sea turtles. The Corps will contribute funds for the NCWRC to continue its temperature studies in order to gather nest temperatures on nourished beaches throughout the state,

including Topsail Beach, in comparison to non-nourished native sediment temperatures. This data could be used to help develop management criteria for sediment color guidelines

Seabeach amaranth

(17) Monitoring for seabeach amaranthus on Topsail Beach will be required to assess the post nourishment presence of plants. This survey will be broken down into 5 survey reaches (A1, A2, A3, A4, B) in accordance with the designated USACE sea beach amaranth survey reaches from 1991-2004 in order to maintain consistent data and survey techniques over time.

Benthic Invertebrates

(18) The anticipated construction timeframe for initial and periodic nourishment events (November 16-April 30), will avoid peak recruitment and abundance time period for surf zone fishes and benthic invertebrates.

(19) The Corps will convene a work group to identify study objectives that answer questions regarding critical life cycle requirements of benthic invertebrates and will contribute funds to carry out subsequent scientific investigations.

Shellfishing

(20) The Corps will contact the North Carolina Shellfish Sanitation and Recreational Water Quality Section prior to start of work, so the project area may be posted as required.

Erosion/Sediment Control

(21) If required, an erosion and sediment control plan will be developed and approved.

Water Quality

(22) Prior to construction, the Corps will obtain Section 401 Water Quality Certification from the North Carolina Division of Water Quality.

Terrestrial Impacts

(23) Land-based equipment necessary, for beach nourishment work shall be brought to the site through existing accesses. Should the work result in any damage to existing accesses, the accesses will be restored to pre-project conditions immediately upon project completion.

Other Commitments

(24) Prior to construction the existing Mean High Water (MHW) line will be surveyed, and a copy provided to the NC Division of Coastal Management. If construction is not initiated within sixty days (60) and/or there is a major shoreline change prior to the commencement of beach

nourishment, a new survey will be conducted.

(25) Prior to construction the first line of stable natural vegetation will be surveyed. This survey must be conducted no more than 60 days prior to project initiation and be coordinated with the NC Division of Coastal Management.

(26) Upon completion of the post construction beach profile surveys, the Corps will coordinate with the NC Floodplain Mapping Program to support revisions to the Digital Flood Insurance Rate Maps (DFIRMs). As part of this coordination the Corps will provide a Letter of Map Revision.

(27) The contract specifications for the proposed project would direct the contractor to immediately stop work and inform the contracting officer if unexploded ordnance is encountered during dredging or beachfill placement. At that time, additional measures will be implemented, as necessary, including inspection of dredged material on the beach and installation of outflow screens on the dredge pipeline. Any unexploded ordnance found on the beach would be promptly removed.

7.04 Borrow Area

Six borrow areas are located in the ocean between 1 mile and 5.5 miles from the shoreline, as shown in Appendix A, Figure A-6. These areas are between the 30-foot and 60-foot NGVD depth contour. The largest and closest site, borrow area A, has a sufficient sand layer thickness and volume to be designated as the borrow source for initial construction. The total volume of suitable material available from all six sites is approximately 21,100,000 CY. This volume is sufficient to meet the project requirements. Detailed information on borrow areas is contained in Appendix C.

7.04.1 Borrow Area Use Plan

There are many possible sequences and methods for placing available material on the beach for the project. The purpose of this plan is to discuss the following subjects: borrow area characteristics; dredging specifics; project construction plan; project sand requirements, and borrow area utilization. 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. Additional vibracore boring data will be collected and made a part of the final borrow area use plan, but for now, the currently defined borrow areas will be utilized. In addition to borrow area parameters (material quantities and location), the

dredging production rates and dredging window are critical to selection of the optimum borrow use plan.

7.04.1.1 Borrow Area Parameters

The offshore borrow areas as shown in Figure A-6, Appendix A are located beyond the 30-foot NGVD depth contour to approximately 5.5 miles offshore. The offshore borrow areas beyond 3 nautical miles offshore will be subject to federal mining requirements of the Minerals Management Service (MMS). The borrow areas have been configured based on a geotechnical evaluation (Appendix C, Geotechnical Analysis) and results of the compatibility analysis (Appendix E, Sand Compatibility Analysis).

Table 7.1 Topsail Beach Project Borrow Area Characteristics

Borrow Area	Composite Grain Size	Material Passing #200 Sieve	Final Overfill Ratio	Estimated Volume (CY) and size (AC)	Distance Offshore (miles)	Surface Elevation (FT. MLLW)
A	2.35 phi (0.20 mm)	7.6%	1.35	13,200,000 2,297	1 to 3	-38.5 to -48.2
B	2.17 phi (0.22 mm)	5.0%	1.23	820,000 158	1.5 to 2.5	-42.2 to -43.2
C	2.32 phi (0.20 mm)	4.4%	1.45	2,570,000 600	4 to 5.5	-45.5 to -47.7
D	2.13 phi (0.23 mm)	6.0%	1.22	1,860,000 467	3.5 to 4.5	-43.5 to -46.9
E	2.15 phi (0.23 mm)	3.4%	1.04	1,390,000 406	4.5 to 5.5	-49 to -50
F	0.80 phi (0.57 mm)	4.9%	1.20	1,290,000 282	4.5 to 5.5	-47 to -48
Total	-	-	-	21,200,000 3,870	-	-

Of the six (6) identified offshore borrow areas (A, B, C, D, E, and F), approximately 62% of the sand is located in borrow area A. The characteristics of each borrow area is shown in Table 7.1. Borrow area A is located approximately 1.5 miles south of New Topsail Inlet and will be the sole source of sand for initial construction of the proposed project and the major source of sand for the project. Pipeline/hopper dredging distances from area A are approximately 3.5 miles to the project area. The material in borrow areas B, D, E, and F is limited and will only be used for periodic nourishment cycles. Borrow area C will only be used for contingency purposes, due to the relative long distance to the project area (over 5 miles). Based on preliminary evaluations, borrow area F may be incompatible with native material at Topsail Beach. However, additional characterization of the borrow areas will be conducted prior to use to confirm compatibility.

7.04.1.2 Dredging Production

Dredging production refers to the average volume transported per day and relates to factors such as plant, material, distance, and weather. This information is used to estimate project cost and construction time. Production rates are estimated to average 31,000 CY/day for a 30-inch pipeline dredge for the initial construction and 14,000 CY/day for hopper dredges for periodic nourishment.

7.04.1.3 Dredging Window

In determining the optimum borrow use plan, pipeline dredging window restrictions for initial construction were evaluated, with respect to nesting sea turtles, using a November 16 to April 30 dredging window. This plan considers that the initial construction will be performed in one season for the project. In order to complete initial construction in one season, the project will extend into the first 30 days of the bird nesting window of 1 April - 31 August.

A 4-year periodic nourishment cycle using hopper dredges is considered for the 50-year life of the project. Hopper dredging operations for this project will work in accordance with the “1997 National Marine Fisheries Service (NMFS) South Atlantic Regional Biological Opinion (SARBO) for the continued hopper dredging of channels and borrow areas in the Southeastern United States”. Though the NMFS SARBO does not window hopper dredging operations from Pawley’s Island, SC through North Carolina, both the USACE South Atlantic Division (SAD) office and South Atlantic Wilmington (SAW) District office recommend implementation of a December 1 to March 31 dredging window, to the extent practicable, in order to minimize impacts to sea turtles in the offshore environment. A summary for the recommended construction plan follows with a brief discussion of start-stop times, number of contracts required, type and number of dredges required, and dredging presence in the project area during the life of the project.

7.04.1.4 Recommended Construction Plan

Initial construction would begin November 16 of year 0 for the project. The initial construction would consist of pipeline dredging from Borrow Area A and proceed until completion before April 30 of the following year. Periodic nourishment would begin in year 4 and consist of hopper dredging due to limited thickness of available material in the borrow areas and long haul distances. Periodic nourishment for the project would use a combination of offshore borrow areas. Because the potential for sea turtle interactions using hopper dredges is higher during the warmer months, periodic nourishment cycles would adhere to the hopper-dredging window and begin December 1 for each cycle and proceed until completion before March 31 of the following year. In summary, every 4 years one hopper dredge would be expected to complete the renourishment within the designated hopper-dredging window. The plan would require separate contracts for initial construction and for each periodic nourishment cycle.

7.04.1.5 Borrow Sand Requirements

The initial construction volume for the project is 3,223,000 CY. The periodic renourishment will require 866,000 CY at 4-year intervals. Over 50 years the total of the 12 renourishment events is 10,392,000 CY. With the initial construction volume, the total project requirement over the 50 year life is 13,615,000 CY. These volumes are borrow quantities that have been adjusted for overfill factors. For example to achieve the required 690,000 CY in place on the beach, 866,000 CY of material from the borrow area is needed.

7.04.1.6 Borrow Area Utilization

The recommended borrow area use plan for initial construction calls for the project to take material by pipeline dredge from borrow area A. During periodic nourishment, the plan calls for the project to take material by hopper dredge from a combination of borrow areas B, D, E, and F and the remainder of A for 12 periodic nourishment cycles. Table 7.1 identified approximately 21.1 million CY available in the borrow areas. The total project volume required is approximately 15 million CY. Therefore, the total project volume results in a 70% utilization of available material from the borrow areas. By not fully utilizing all of the borrow areas, there will be flexibility to refine the borrow use plan in future investigations as a contingency due to unforeseen pockets of non-compatible sand. Areas to be used for borrow will be further defined during the Plans and Specifications phase of this project. Additional borings and/or geophysical surveys will be performed to better delineate the borrow area boundaries and material types. Vibracore borings will be performed in a grid pattern, on a 500 foot to 1000 foot spacing, in any area prior to its use as a borrow source.

7.04.1.7 Borrow Area Contingency Plan

Borrow area compatibility is determined based on grain size analyses from borings taken prior to construction, during both the feasibility study and plans and specifications phase. The borings conducted during the plans and specifications phase will provide any additional data necessary to help further refine borrow area compatibility limits. The final spacing of both sets of borings will range from 500 ft. to 1000 ft. apart. This additional characterization of the borrow material will increase the level of confidence for borrow material compatibility and decrease the degree of interpolation between boring locations. Qualitative visual characterizations of the in-place material will be made by representatives of the U.S. Army Corps of Engineers (USACE) construction and environmental offices throughout the project construction.

Furthermore, dredging production rates are specific to each dredge and its operation and can be quantified. The recommended construction plan identified in Section 7.04.1.4 discusses the use of a hydraulic cutterhead pipeline dredge during initial construction and the use of hopper dredges during each periodic nourishment event. For hydraulic cutterhead pipeline dredges, once production rates are known for a given contract, a prediction can be made of the dredging time and volume of material between the

instantaneous dredge location and the next known boring location of suitable material. Thus, a qualitative and quantitative assessment can be made of whether this volume of potentially incompatible material is significant relative to the overall project. Results from these calculations will be used by appropriate USACE personnel to determine whether the cutterhead dredge should continue in the dredge's present location or relocate. During periodic nourishment events, hopper dredges will utilize pumpout facilities for each dredged hopper load. Considering hopper dredges have a maximum capacity per load and are self propelled, potential incompatible material can feasibly be managed by the Corps.

Federal and state environmental agencies will be notified if, and how much, potentially incompatible material is encountered during dredging operations. If necessary, the Wilmington District will make the decision on a suitable contingency measure which may include moving the dredge to another site within the borrow area or to one of the other designated borrow areas, depending on availability of sediment, and will notify the agencies of this contingency measure.

7.05 Real Estate Considerations

Real estate requirements for the Selected Plan include lands, easements, rights-of-way and relocations, and disposal/borrow areas, which are referred to as LERRD. Real estate requirements in each of these categories are discussed and followed by a summary of estimated real estate costs. There is no major improvement that will be impacted by the proposed project. There is one pier located within the study area, Jolly Roger Pier, which will not be acquired. Impacts to the pier are not anticipated. There will be no utility relocation. There is no existing Federal project within the acquisition area.

7.05.1 Borrow Areas

Proposed borrow areas are located offshore. Coordination and concurrence for the sand removal from the offshore borrow areas will be required from appropriate state and/or federal agencies.

7.05.2 Pipeline

Material for initial project construction and beach nourishment will be dredged by pipeline dredge and hopper dredge from the offshore borrow areas, then moved by pipeline to the beach. The pipeline will be routed along the ocean shoreline, where it will be placed either below Mean High Water or within the acquired Perpetual Beach Storm Damage Reduction Easements.

7.05.3 Construction Area

The project limits, including both main fill and transition sections, extend from the north end of reach 2 to the north end of reach 28, a total length of 26,200 feet. The northern 2,000 feet is a transition section and is located within the town limits of Surf City. The

southern transition is 1,000 feet long and extends into reach 2. The estate to be acquired for the project will be a Perpetual Beach Storm Damage Reduction Easement for approximately 397 parcels, approximately 50 acres. Based on project maps and ground examination, no structures appear to be impacted. There will be no relocation of landowners. Improvements (other than the pier) within the project include walkover structures that allow beach access from private and public property. The easement specifies that construction of walkover structures shall not violate the integrity of the constructed dune. Approval of plans and specifications for construction of new walkover structures must be obtained from the Project Sponsor.

7.05.4 Real Estate Costs

Estimated real estate costs for the Selected Plan of Improvement are shown in Table 7.2. The land value for the Perpetual Beach Storm Damage Reduction Easements is \$0. As “off setting benefits” applies, a determination is made that the project will not reduce the value of the land. Rather it will remain the same or increase after construction of the project. A value of \$35,200 is used for planning purposes for a temporary work area easement for a staging area. It is possible that valuation under Federal rules may conclude that the benefits do not fully offset the value of the temporary work area easement. The estimated real estate costs include federal and non-Federal administrative fees for acquiring the required easements. Administrative costs are those costs incurred for verifying ownership of lands, certification of those lands required for project purposes, legal opinions, analysis or other requirements that may be necessary during acquisition.

7.06 Operation and Maintenance Considerations

Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) requirements will consist of project inspections and dune vegetation maintenance. Project inspections and surveillance include assessment of dune vegetation, access facilities, dune crest erosion, trash and debris, and unusual conditions such as escarpment formation or excessive erosion. Periodic renourishment and beachfill monitoring (including the semi-annual beach profile surveys) are classified as continuing construction, not as OMRR&R. Dune vegetation maintenance includes watering, fertilizing, and replacing dune plantings as needed. Other maintenance is reshaping of any minor dune damage, repairs to walkover structures and vehicle accesses, and grading of any large escarpments. Estimated OMRR&R annual costs are \$22,000.

Table 7.2 Real Estate Costs – Selected Plan, Code of Accounts, October 2008 levels.

CODE	CATEGORY	FEDERAL	NON-FEDERAL	TOTALS
01A	PROJECT PLANNING			
	Project Cooperation Agreement	\$	\$	\$
01AX	Contingencies (25%)	\$	\$	\$
	Subtotal	\$	\$	\$
01B	LANDS AND DAMAGES			
01B40	Acq./Review of PS	\$ 167,600	\$	\$ 167,600
01B20	Acquisition by PS	\$	\$ 1,256,900	\$ 1,256,900
01BX	Contingencies (15%)	\$ 25,100	\$ 188,500	\$ 213,700
	Subtotal	\$ 192,700	\$ 1,445,400	\$ 1,638,100
01H	AUDIT			
01H10	Real Estate Audit	\$	\$	\$
01HX	Contingencies (15%)	\$	\$	\$
	Subtotal	\$	\$	\$
01R	REAL ESTATE LAND PAYMENTS			
01R1B	Land Payments by PS	\$	\$ 30,600	\$ 30,600
01R2B	PL91-646 Relocation Pymt by PS	\$	\$ -	\$ -
01R2D	Review of PS	\$	\$	\$
01RX	Contingencies (15%)	\$	\$ 4,600	\$ 4,600
	Subtotal	\$	\$ 35,200	\$ 35,200
TOTALS, Rounded		\$ 193,000	\$ 1,481,000	\$ 1,673,000

7.07 Plan Accomplishments

The Selected Plan will significantly reduce expected annual damages to structures and roads from storm and hurricane damages along the project reaches 3 through 26. It also will significantly reduce damages due to long-term progressive erosion.

The Selected Plan will reduce, but not entirely eliminate, damages due to short term erosion, inundation, and wave overwash during storms. Although the Selected Plan will substantially reduce damages due to hurricane-wave overwash, it should be noted that the plan provides for storm protection only in terms of protecting development from the action of ocean storm surge and wave action. There are no provisions in the project to protect the area against storm-tide flooding occurring from increased water levels in the channel landward of Topsail Island.

The Selected Plan will reduce emergency costs and other damages and will increase the width of beach available for recreation and for beach habitat, providing incidental benefits. Topsail Beach was included in a study of recreation demand and benefits to four barrier islands on the North Carolina coast. A contingent valuation on-site and telephone survey was used to gather information about willingness to pay for recreation

or improvement of Topsail Beach along with information about socio-economic and other characteristics of the respondents. These data were used to predict annual and peak visitation by day visitors at Topsail Beach. In addition, the survey data was used to determine NED recreation benefits for the with-project conditions. It is predicted from analysis of the survey data that an increase in beach width will increase both demand for and the willingness to pay for beach recreation at Topsail Beach. The Selected Plan will increase the useable recreation beach width by 45 feet for Topsail Beach (see Appendix O). The expected average annual benefit (AAB) for Topsail beach for the with-project condition tentative selected alternative of the Selected Plan is estimated at \$5,500,000.

A summary of economic benefits for the Selected Plan is presented in section 7.08.1, "Selected Plan - Benefits."

7.08 Economics of the Selected Plan

Many suitable plans were identified that have benefits that exceed costs. The Selected Plan is the Locally Preferred Plan (LPP). The NED plan has the greatest net benefits. Benefits and costs of the Selected Plan are developed and evaluated in this section at October 2008 price levels. The Water Resources Interest Rate for Fiscal Year 2009 of 4.625% is used to develop present values and annual values for benefits, costs, and net benefits. For comparisons purposes similar data for the NED plan is also presented.

7.08.1 Selected Plan - Benefits

The total expected annual benefits for the Selected Plan are estimated at \$13,328,000 and at \$13,989,000 for the NED Plan. An itemized listing of expected annual benefits is presented in Table 7.3.

Table 7.3, Expected Annual Benefits, October 2008 levels, 4.625% interest rate.

Benefit Category	Expected Annual Benefit	
	Selected Plan, LPP	NED
Hurricane and Storm Damage Reduction		
Storm Erosion	\$6,216,000	\$6786,000
Flood*	\$(65,000)	\$(87,000)
Wave	\$72,000	\$184,000
Land and Long Term Erosion	<u>\$1,518,000</u>	<u>\$1,519,000</u>
Subtotal	\$7,741,000	\$8,402,000
Emergency Costs and Other Damage Reduction	\$ 87,000	\$ 87,000
Recreation	\$ 5,500,000	\$ 5,500,000
Sub Total Annualized Benefits	\$13,328,000	\$13,989,000
Benefits During Construction, negligible	<u>\$ 0</u>	<u>\$ 0</u>
TOTAL EXPECTED ANNUAL BENEFITS, SELECTED PLAN OF IMPROVEMENT	\$13,328,000	\$13,989,000

*See Section 5.06.4 regarding flood benefits.

7.08.2 Selected Plan - Costs

Determination of the economic costs of the Selected Plan consists of four basic steps. First, project First Costs are computed. First Costs include expenditures for project design and initial construction and related costs of supervision and administration. First Costs also include the lands, easements, and rights of way for initial project construction and periodic nourishment. Total First Costs are estimated to be \$37,712,000 at October 2008 price levels as presented in Table 7.4. The baseline cost estimate for construction in FY2012 is \$40,060,000. For comparison, the NED plan Total First Costs are estimated to be \$50,332,000 at October 2008 price levels.

Table 7.4 Project First Costs – Selected Plan, LPP (October 2008 price levels)

ACCT. CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTIN- GENCY	TOTAL COST
01	LANDS AND DAMAGES						
	Acquisition				\$1,409,000	\$211,000	\$1,620,000
	Land Payments				\$30,000	\$4,000	\$34,000
	Subtotal						\$1,654,000
17	BEACH REPLENTISHMENT						
	Mobilization and Demobilization	1	JOB	LS	\$3,599,000	\$726,000	\$4,325,000
	Dredging and Beach Fill	3,223,000	CY	\$7.38	\$23,785,000	\$4,757,000	\$28,542,000
	Dune Vegetation	48	AC	\$9,000	\$432,000	\$65,000	\$497,000
	Beach Tilling	68	AC	\$700	\$48,000	\$7,000	\$55,000
	Public Walkovers	23	EA	\$38,000	\$874,000	\$131,000	\$1,005,000
	Subtotal						\$34,424,000
30	PLANNING, ENGINEERING, AND DESIGN				\$971,000	\$194,000	\$1,165,000
31	CONSTRUCTION MANAGEMENT				\$391,000	\$78,000	\$469,000
	TOTAL FIRST COST						\$37,712,000

Second, Interest During Construction is added to the project First Cost. Interest During Construction is computed from the start of PED through the 1 year initial construction period. Interest During Construction for the Selected Plan is estimated to be \$302,000. The project First Cost plus Interest During Construction represents the Total Investment Cost required to place the project into operation. Total Investment Cost for the Selected Plan is estimated to be \$38,014,000 as shown in Table 7.5.

Table 7.5 Total Investment Cost – Selected Plan, Oct. 2008 levels, 4.625% interest rate.

ITEM	AMOUNT
Total First Cost	\$37,712,000
Interest During Construction	\$302,000
Total Investment Cost	\$38,014,000

Third, Scheduled Renourishment Costs are computed. These costs are incurred in the future for each renourishment. At this point neither discounting to present value, nor

escalation for anticipated inflation is included. Renourishment Costs are estimated to be \$9,492,000 as shown in Table 7.6.

Table 7.6 Project Renourishment Costs – Selected Plan, LPP October 2008 levels.

ACCT. CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTIN- GENCY	TOTAL COST
17	BEACH RENOURISHMENT						
	Mobilization and Demobilization	1	JOB	LS	\$1,100,000	\$220,000	\$1,320,000
	Dredging and Beach Fill	866,000	CY	\$6.78	\$6,070,000	\$1214,000	\$7,284,000
	Beach Tilling	30	AC	\$700	\$21,000	\$3,000	\$24,000
	Subtotal						\$8,065,000
30	PLANNING, ENGINEERING, AND DESIGN				\$543,000	\$81,000	\$624,000
31	CONSTRUCTION MANAGEMENT				\$209,000	\$31,000	\$240,000
	TOTAL RENOURISHMENT COST						\$9,492,000

Fourth, Expected Annual Costs are computed. These costs consist of interest and amortization of the Total Investment Cost, and the equivalent annual cost of project operation, maintenance, and renourishment. The Expected Annual Costs provide a basis for comparing project costs to expected annual benefits. Expected Annual Costs for the Selected Plan are estimated to be \$4,450,000. A summary of the computations involved in each of these three steps is presented in Table 7.7. By comparison the Expected Annual Costs for the NED plan are \$5,107,000.

Table 7.7 Project Annual Costs – Selected Plan, LPP, Plan 1250X October 2008 price levels, 4.625% interest rate.

ITEM	YEAR	AMOUNT	PRESENT VALUE, 2011
Total Investment Cost	2011	\$38,014,000	\$38,014,000
Renourishment	2015	\$9,492,000	\$7,922,000
Renourishment	2019	\$9,492,000	\$6,611,000
Renourishment	2023	\$9,492,000	\$5,517,000
Renourishment	2027	\$9,492,000	\$4,605,000
Renourishment	2031	\$9,492,000	\$3,843,000
Renourishment	2035	\$9,492,000	\$3,207,000
Renourishment	2039	\$9,492,000	\$2,676,000
Renourishment	2043	\$9,492,000	\$2,234,000
Renourishment	2047	\$9,492,000	\$1,864,000
Renourishment	2051	\$9,492,000	\$1,556,000
Renourishment	2055	\$9,492,000	\$1,298,000
Renourishment	2059	\$9,492,000	\$1,084,000
Total Investment Cost, Present Value			\$80,431,000
Annual Costs			
Interest & Amortization, 50 years at 4.625 %			\$4,153,000
Monitoring			\$275,000
OMRR&R			\$22,000
Total Annual Cost			\$4,450,000

7.08.3 Benefit to Cost Ratio

With expected annual benefits of \$13,328,000 and average annual costs of \$4,450,000 the benefit to cost ratio for the Selected Plan, Plan 1250X, is 3.0 to 1. The annual net benefits are \$8,878,000. By comparison, the NED Plan has expected annual benefits of \$13,989,000, average annual costs of \$5,107,000, annual net benefits of \$8,882,000, and a benefit to cost ratio of 2.7 to 1.

7.08.4 Section 902 Analysis

The Section 902 analysis of the Selected Plan covers changes in scope, changes in cost, and an incremental analysis of the change.

7.08.4.1 Change in Scope

HD 393/102/2 contains descriptions of the Old 1990 NED Plan and the Authorized Plan. The terminal groin was not part of the Authorized Plan. Changes in the scope of the project from the Authorized Plan to the GRR Selected Plan, Plan 1250X, and to the GRR NED Plan, Plan 1550 are shown in Table 7.8. For comparison purposes volumes shown in Table 7.8 for both plans are estimated in-place volumes of fill on the beach. Volumes shown elsewhere in the GRR volumes are estimated borrow volumes including losses. Estimated project construction volumes were revised in the Design Memorandum, dated August 1992.

Table 7.8 Plan Comparison Table

Dimensions	Plan		
	Authorized # HD 393/102/2	GRR, LPP, Plan 1250X	GRR, NED, Plan 1550
Dune, topwidth	25 feet	25 feet	25 feet
Dune, elevation, NGVD	13.6 feet	12 feet	15 feet
Dune, landward slope	5H:1V	5H:1V	5H:1V
Dune, seaward slope	5H:1V	10H:1V	10H:1V
Dune and storm berm, width	35 feet	None	None
Dune and storm berm, elevation, NGVD	9.6 feet	None	None
Dune and storm berm, seaward slope	5H:1V	None	None
Beach berm, width	40 feet	50 feet	50 feet
Beach berm, elevation, NGVD	7.6 feet	7 feet	7 feet
Beach berm, seaward slope	12H:1V	15H:1V	15H:1V
Dune and berm fill, length	10,250 feet	23,200 feet	22,800 feet
North transition section, length	7,150 feet	2,000 feet	2,000 feet
South transition section, length	1,800 feet	1,000 feet	1,400 feet
Total Length	19,200 feet	26,200 feet	26,200 feet
Volume, initial, in-place	*2,659,000 CY	2,387,000 CY	3,420,000 CY
Volume, renourishment, in place	372,000 CY	690,000 CY	690,000 CY
Renourishment interval	2 years	4 years	4 years
Borrow source	Banks Channel	Off shore	Off shore

*including 372,000 CY advance nourishment # revised volumes from DM.

The two most significant changes in scope are the increased lengths, first the length of the dune and berm fill, and second the total project length. The Authorized Plan and the GRR LPP, Plan 1250X are compared schematically in Figure 7.3.

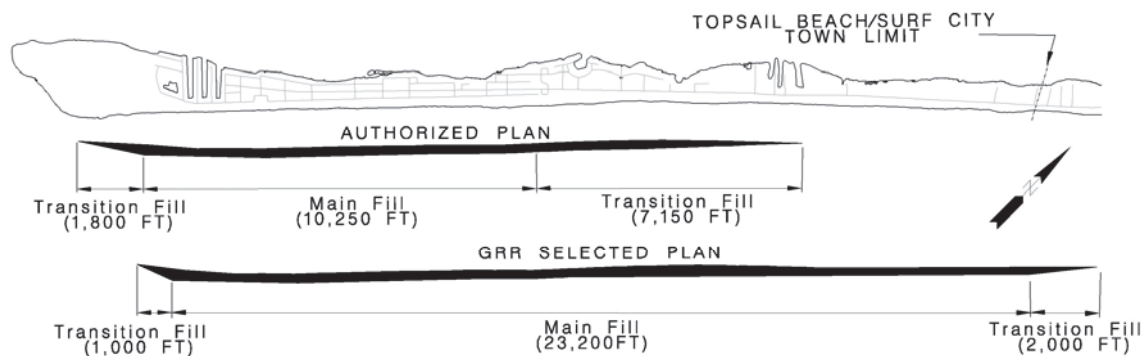


Figure 7.3 Authorized Plan (HD 393/102/2) and GRR Selected Plan, Plan view

The other changes in the scope are in widths and heights of the components, shown in Figure 7.4. These changes in cross section are not as significant as the length increases. The overall cross section of the Selected Plan, Plan 1250X is lower and slightly smaller than the cross section of the Authorized Plan. The locally natural berm elevation for this

coast is 7 feet NGVD. To prevent unacceptable beach scarping, the higher storm berm found in the Authorized Plan is not included in any of the plans evaluated in the GRR

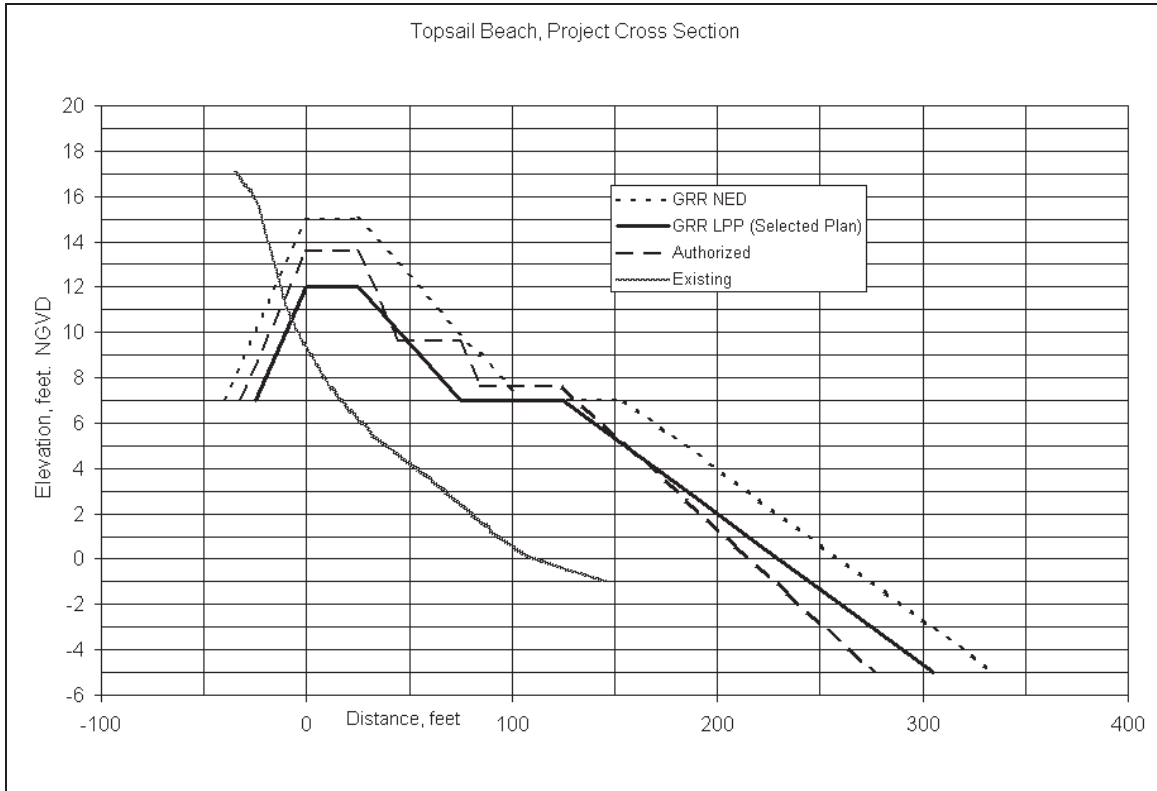


Figure 7.4 Authorized Plan (HD 393/102/2) and GRR LPP Plan 1250X, Cross section view

7.08.4.2 Change in Costs

The GRR Selected Plan (Plan 1250X) has a Total First Cost of \$37,712,000 at October 2008 levels and a baseline cost in FY2012 of \$40,060,000. As reported in Section 1.10, the maximum cost of initial construction limited by Section 902 is \$27,293,000. The Total First Costs and the Baseline Costs of both the NED Plan and the GRR Selected Plan all exceed the Section 902 limit for this project. These amounts are presented in Table 7.9. For some shore protection projects Section 902 applies to both initial construction and to continued renourishment. No administrative limit on renourishment was established for this project. As shown in Table 7.8 the renourishment volumes are very similar per event. However because the Authorized Plan would be renourished every 2 years, the overall total renourishment costs of the GRR Selected Plan with a renourishment cycle of 4 years, as explained in Section 7.03.4, would be less than the total renourishment costs of the Authorized Plan.

Table 7.9 Cost Comparison Table, Updated to October 2008 levels.

Description	Amount
Section 902 limit, October 2008	\$27,293,000
GRR Selected Plan, Plan 1250X, Total First Cost, October 2008	\$37,712,000
GRR Selected Plan, Plan 1250X, Baseline Cost, October 2011	\$40,060,000
GRR NED Plan, Plan 1550, Total First Cost, October 2008	\$50,332,000
GRR NED Plan, Plan 1550, Baseline Cost, October 2011	\$53,465,000

7.08.4.3 Incremental Analysis

The incremental analysis of project scope is an evaluation of the incremental costs and benefits of the one-step increase in project length. The GRR Selected Plan can be separated into two segments; the original authorized length and the incremental increase in length. Most cost estimate line items can be prorated based on length, volume, or time. Mobilization and demobilization costs are incurred entirely in the cost of the first segment, no mobilization and demobilization cost is incurred in the second segment. Benefits were also separated into the two segments. Most reaches were entirely within or entirely outside of the Authorized Plan reaches and the benefits were assigned to the appropriate reach. Through the Authorized Plan transition zone, benefits were prorated between the two segments. Table 7.10 presents the results of the incremental analysis of the two segments. Both with and without consideration of recreation benefits, the incremental benefits exceed the incremental costs. The incremental benefit to cost ratio is 3.0 to 1 for HSDR benefits only and 5.5 to 1 for all benefits, including incidental recreation benefits.

Table 7.10 Incremental Analysis, in thousands, October 2008 levels and interest rates.

Item	Segments		
	GRR Selected	Authorized	Incremental
Total First Cost	\$37,712	\$29,152	\$8,560
Interest During Construction	\$302	\$233	\$69
Total Investment Cost, Initial Construction	\$38,014	\$29,385	\$8,629
Renourishment, every 4 years	\$9,492	\$7,446	\$2,046
Present Value, TIC & Renourish.	\$80,431	\$62,658	\$17,773
Annual Costs			
Interest and Amortization	\$4,153	\$3,235	\$918
Monitoring	\$275	\$233	\$42
OMRR&R	\$22	\$16	\$6
Total	\$4,450	\$3,484	\$966
HSDR Benefits	\$7,741	\$4,837	\$2,904
Net Benefits (HSDR only)	\$3,291	\$1,353	\$1,938
BCR (HSDR only)	1.7	1.4	3.0
HSDR Benefits	\$7,741	\$4,837	\$2,904
Recreation and Other Benefits	\$5,587	\$3,143	\$2,444
Total Benefits (all)	\$13,328	\$7,980	\$5,348
Net Benefits (all)	\$8,879	\$4,496	\$4,382
BCR (all)	3.0	2.3	5.5

7.09 Evaluation of Risk and Uncertainty

GRANDUC's lifecycle approach to plan formulation explicitly incorporates risk and uncertainty into the formulation process. Three significant variables in GRANDUC are currently programmed to incorporate uncertainty, namely:

- 1) erosion distance – plus or minus 5.0 feet
- 2) structure distance – plus or minus 2.0 feet
- 3) structure elevation – plus or minus 0.1 feet

Given the probabilistic nature of the analysis, the dune-and-berm alternatives were evaluated to determine the percent chance that the given alternative would have positive net benefits, or conversely, the risk of having negative net benefits. Based on analysis of 1,000 lifecycles, the selected plan (12-ft dune elevation with 50-ft berm and modified southern transition) has a 99.3 percent chance of having positive net benefits (i.e., less than a 1 percent risk of negative net benefits in any given year).

7.10 Residual Risks

The proposed beachfill plan would greatly reduce average annual storm damages. The selected plan, 1250X will reduce damages by 84%. Some damages will still occur, estimated to average \$1,543,000 per year over the 50-year period of analysis. The project is designed to protect mainly against storm waves and storm-induced erosion, two major categories of storm damage. The project will not prevent any damage from sound side flooding, therefore any ground level floors of structures, ground level floor contents, vehicles, landscaping, and property stored outdoors on the ground will still be subject to saltwater flooding that will flow in through New Topsail Inlet and Banks Channel. Structures will continue to be subject to damage from hurricane winds and windblown debris. Damages from flooding and winds will decrease as older structures are replaced with those meeting floodplain ordinances and wind hazard building construction standards. But even new construction is not immune damage, especially from severe storm events. Also, the condition of the HSDR project at the time of storm occurrence can affect the performance of the project for that event.

The proposed beachfill reduces damages, but does not have a specific design level. In other words, the project is not designed to fully withstand a certain category of hurricane or a certain frequency storm event. The project purpose is storm damage reduction, and the berm-and-dune is not designed to prevent loss of life. Loss of life is prevented by the existing procedures of evacuating the barrier island completely well before expected hurricane landfall and removing the residents from harms way. The erratic nature and unpredictability of hurricane path and intensity require early and safe evacuation. This policy should be continued both with or without the storm damage reduction project.

Table 7.11 Residual Risks - Average Annual Values, 50 year duration, 4.625% interest rate, October 2008 costs levels.

Plan	Residual Damages	HSDR Benefits
No Action	\$9,284,000	\$0
Plan 1550, NED	\$883,000	\$8,401,000
Plan 1250X, LPP	\$1,543,000	\$7,741,000