Wilmington Harbor, North Carolina
Navigation Improvement Project

Integrated
Section 203 Study
&
Environmental Report

APPENDIX R

DREDGED MATERIAL MANAGEMENT

June 2019

Table of Contents

List of Tables

List of Figures

1 INTRODUCTION

The USACE Planning Guidance Notebook, ER1105-2-100, states that "All Federally maintained navigation projects must demonstrate that there is sufficient dredged material disposal capacity for a minimum of 20 years." Sufficient capacity is demonstrated in a Preliminary Assessment, which documents the:

- continued viability of the project; and
- the availability of dredged material disposal capacity sufficient to accommodate 20 years of maintenance dredging.

If the preliminary assessment determines that there is not sufficient capacity to accommodate maintenance dredging for the next 20 years, then a dredged material management study must be performed (USACE 2000a).

Dredged Material Management Plans (DMMPs) are required to be prepared, on a priority basis, for all Federal navigation projects, or groups of inter-related harbor projects, or systems of inland waterway projects (or segments). Priority will be given to projects for which existing dredged material disposal sites, including existing confined disposal facilities, are expected to reach capacity or to no longer be available sometime in the next 10 years, or existing and projected navigation usage of the project indicates that continued maintenance of the project, or of any substantial increment thereof, may not be warranted (USACE 2000b).

A DMMP for the Wilmington Harbor Navigation Channel Project was developed and evaluated by the USACE Wilmington District (SAW) (USACE 2007). The DMMP accommodates all new work construction material and 50 years of federal and non-federal maintenance material through a combination of disposal at the Eagle Island Confined Disposal Facility, the New Wilmington Harbor ODMDS, and beneficial use placement as beach replenishment and bird nesting island restoration. New work construction material and the incremental addition of maintenance material due to the project will be managed in the same least-cost disposal method as existing material is managed by the DMMP.

This Preliminary Assessment verifies dredged material disposal capacity for the Wilmington Harbor Navigation Channel Project and recommends continued implementation of the existing DMMP. The continued economic viability and environmental acceptability of the project has been demonstrated in Section 9: Economic Evaluation of Final Alternatives and Section 8: Environmental Consequences, of the Integrated Feasibility Study/Environmental Report.

2 EXISTING DMMP

The DMMP developed in 2007 provides for the placement of both new work and maintenance material, including non-federal maintenance material. The existing DMMP consists of three dredged material placement categories:

- upland confined disposal;
    - Eagle Island Confined Disposal Facility (CDF);
- offshore ocean disposal;
    - New Wilmington Harbor ODMDS;

- beneficial use;
    - Bald Head Island and Oak Island as beach replenishment; and
    - South Pelican Island and Ferry Slip Island as bird nesting island restoration.

2.1 Eagle Island Confined Disposal Facility

The Eagle Island Confined Disposal Facility is situated on a 1,473-acre tract of land that forms a peninsula between the Cape Fear and Brunswick Rivers. Eagle Island CDF is operated in a three-cell configuration. Cell 1 consists of 230 acres, Cells 2 is approximately 260 acres, and Cell 3 is approximately 265 acres, for a total of 755 acres of diked uplands. Maximum dike height is currently 40 feet above mean sea level for Cell 1 and 42 feet for Cells 2 and 3 (USACE 2017).

Eagle Island CDF historically receives silty material from the upper reaches of the channel (from the Lower Brunswick channel reach to the upstream limits of the federal navigation project). Dredged material from the upper channel reaches is placed into the Eagle Island CDF with varying frequency (USACE 2007). Upstream of Lower Big Island Channel to the upstream limits of the project, dredging is performed by pipeline dredge and material is pumped to the Eagle Island Disposal Area. Maintenance dredging in Upper Big Island Channel upstream through Upper Brunswick Channel is performed every 2 years. Between Channel and the Anchorage Basin are dredged annually. The project area upstream of the Anchorage Basin to the upstream limits of the project is dredged about once every 5 years. The dikes for all three cells are proposed to be raised to 50 feet above mean sea level, which will extend the useful life of Eagle Island CDF to 2032 (USACE 2017).

2.2 New Wilmington Harbor ODMDS

The Site Management and Monitoring Plan for the New Wilmington ODMDS was originally finalized in July 2002 and an SMMP update was approved in January 2013. The 2013 updated SMMP remains in effect. Dredged material from the ocean bar channel of the Wilmington Harbor Federal navigation project and from the access channel and berths at the Military Ocean terminal at Sunny Point (MOTSU) are placed at the New Wilmington ODMDS. The updated SMMP indicates that 2 to 3 million cubic yards of dredged material is anticipated to be placed at the ODMDS annually (USACE and EPA, 2013).

Material from Bald Head-Caswell Channel, Southport Channel and Battery Island Channel is dredged about once every four years by hopper dredge and deposited in the ODMDS. Material from Snows Marsh Channel to Lower Big Island Channel is dredged once every two years by bucket and barge or by hopper dredge and deposited in the ODMDS.

The New Wilmington ODMDS has an area of approximately 9.4 square nautical miles. Existing depths range from -35 feet MLLW to -52 feet MLLW. The disposal depth limitation is -30 feet MLLW (USACE and EPA, 2013). Based on bathymetry taken in 2017, the existing static dredged material disposal capacity at the New Wilmington ODMDS is 386 million cubic yards.

2.3 Beach Placement at Bald Head Island and Oak Island

Bald Head Island and Oak Island form the mouth of the Cape Fear River on the east and west boundaries, respectively. Beach management at Bald Head Island and Oak Island has been an

ongoing process. The Wilmington Harbor Sand Management Plan (USACE 2000) stipulated that these islands would share material from maintenance dredging on a regular basis for the purpose of shore protection. Based on the terms of that management plan, Bald Head Island receives material in years two, four, and eight; while Oak Island receives material in year-six of an overall eight-year interval (USACE 2007). In 2013, the results of a comprehensive annual beach monitoring program of Bald Head Island, which started in 2000, came to the conclusion that beach placement alone could not successfully offset navigation channel impacts from erosion. Construction of a terminal groin was completed in 2015 to mitigate for these increased erosion rates and the results of recent surveys in 2017 and 2018 showed that the groin is performing as expected by reducing sediment losses and beach erosion. However, sand placement is still an essential factor to maintain the existing beaches given their proximity to the high energy environment of the Cape Fear River (Olsen Associates Inc. 2018).

2.4 South Pelican Island and Ferry Slip Island Restoration and Expansion

South Pelican Island and Ferry Slip Islands are artificial, dredged-sand islands located in the lower Cape Fear River south of Wilmington, which were created in the early 1970s (Personal communication, L. Addison, Audubon NC March 2019). The islands have been a haven for nesting pelicans, gulls, and terns for more than two decades. The pair of these islands are the most important nesting areas for royal and sandwich terns and support the largest colony of brown pelicans in the southeast region of North Carolina (National Audubon Society 2010b and 2010c).

Each island is permitted to a size of seven acres above mean high water (MHW). Both islands currently occupy less than five acres each above MHW. They are periodically nourished and need sand replenishment approximately every four to seven years in order to maintain avian habitats. Material from Snows Marsh Channel and Horseshoe Shoal Channel may be pumped to these islands by pipeline dredge. However, recent trends have resulted in the majority of clean, beach-quality sand being diverted to local beaches instead, so these islands have been receding due to lack of nourishment. This lack of available material poses a threat to the avian species that use these islands for nesting; as these islands have been subject to erosion, vegetative encroachment, and human disturbance.

3 DREDGED MATERIAL MANAGEMENT FOR THE TSP

Construction dredging material will be placed within the New Wilmington ODMDS. Dredged sediment is expected to primarily include fine- to medium-grained sand with fines from the upper channel reaches and the anchorage basin. Dredged rock is expected to be siltstone and sandstone (sedimentary rock). Beneficial use of dredged material is being evaluated for:

- Beach placement on Bald Head Island and Oak Island;
- Battery Island shore placement;
- South Pelican and Ferry Slip Island restoration;
- Island creation adjacent to South Pelican and Ferry Slip Islands; and
- Wetland restoration on Battery, Shellbed, and Striking Islands using thin-layer placement.

3.1 Dredged Material Characteristics

Characterization of materials likely to be encountered during dredging was developed using grain size curves and data plots showing fines content and unconfined compressive strength (UCS) versus elevation for channel reaches which contained historical data. Transverse cross sections were also performed approximately every 1,500 feet beginning at Anchorage Basin to the end of Baldhead Shoal Reach 3 to aid with the interpretation and characterization. Seismic survey data acquired for this project provided additional interpretation for the location of potential shallow rock outcrops, especially on the channel flanks, to further aid in both the inner and outer channel subsurface conditions. Seismic data was correlated with the historical geotechnical and previous mapping to show which formation is likely to be encountered (if any) if deepening were to occur. A previously unmapped area 8.7 miles long, southwest of the end of Baldhead Reach 3, was surveyed and geologic formations were interpreted.

3.2 Physical Characteristics

Table 3-1 provides a summary of the interpreted subsurface conditions for each channel reach, with the material being categorized based on its potential beneficial use:

- Category A = Potentially Suitable for Engineering Structural Fill or Beach Nourishment; Fines content typically less than 10% and low calcium carbonate content;
- Category B = Potentially Suitable for Non-Engineered Fill; Fines content typically between 10 and 20%; may include thin lenses of fine-grained deposits;
- Category C = Potentially Suitable for Low-Quality Fills (e.g. habitat restoration and development, offshore berms, parks and recreation, etc.); Fines content 20 to 25%; and
- Category D = Disposal Area (Upland or Offshore).

The geotechnical analysis evaluated potential opportunities for beneficial use of dredged materials. Several areas were identified as containing material that potentially be used for fill or beach nourishment projects. Interpretation of geotechnical and geophysical data suggest that channel flanks in Keg Island through Lower Lilliput and Horseshoe Shoal reaches likely contain material with low fines content, which may be desirable for use as fills. Lower Midnight, Reaves Point, Lower Swash reaches and north of the Anchorage Basin reach appear to have materials with a low fines content and may be desirable for repurposing as Category A and B materials. The other channel reaches appear to contain material with high fines content or substantial interbeds of fines (clay and silt) and do not appear to desirable for fills and beach nourishment projects, which are considered Category C and/or D materials.

Table 3-1
Summary of Subsurface Conditions

Channel Reach	Beneficial Use Widening	Beneficial Use Deepening	Deepening Interval (ft)	Rock Encountered	Average Rock Strength (psi)
Anchorage Basin	D	D	0 to 5	Likely (Peedee)	534
		D	5 to 10	Likely (Peedee)	
Between Channel	D	D	0 to 5	Likely (Peedee)	776
		D	5 to 10	Likely (Peedee)	
Fourth East Jetty	D	D	0 to 5	Likely (Peedee)	4,880
		D	5 to 10	Likely (Peedee)	
Upper Brunswick	C, D	C, D	0 to 5	Likely (Peedee)	No data
		C, D	5 to 10	Likely (Peedee)	
Lower Brunswick	C, D	C, D	0 to 5	Likely (Peedee)	4,346
		C, D	5 to 10	Likely (Peedee)	
Upper Big Island	C, D	C, D	0 to 5	Likely (Castle Hayne B/A)	3,997
		C, D	5 to 10	Likely (Castle Hayne B/A)	
Lower Big Island	C, D	C, D	0 to 5	Likely (Castle Hayne B/A)	3,806
		C, D	5 to 10	Likely (Castle Hayne B/A)	
Keg Island	A, B, C, D	B, C, D	0 to 5	Likely (Peedee)	7,230
		C, D	5 to 10	Likely (Peedee)	
Upper Lilliput	A, B, C, D	B, C, D	0 to 5	Likely (Peedee)	1,958
		B, C, D	5 to 10	Likely (Peedee)	
Lower Lilliput	A, B, C, D	A, B, C, D	0 to 5	Not Likely	2,177
		A, B, C, D	5 to 10	Not Likely	
Upper Midnight	C, D	C, D	0 to 5	Not Likely	3,410
		C, D	5 to 10	Not Likely	
Lower Midnight	B, C, D	B, C, D	0 to 5	Not Likely	No Data
		B, C, D	5 to 10	Not Likely	
Reaves Point	B, C, D	B, C, D	0 to 5	Not Likely	No Data
		B, C, D	5 to 10	Not Likely	
Horseshoe Shoal	A, B, C, D	A, B, C, D	0 to 5	Not Likely	No Data
		A, B, C, D	5 to 10	Not Likely	
Snows Marsh	C, D	C, D	0 to 5	Likely (Peedee)	No Data
			5 to 10	Likely (Peedee)	
Lower Swash	B, C, D	B, C, D	0 to 5	Likely (Castle Hayne B)	No Data
		C, D	5 to 10	Likely (Castle Hayne B)	
Battery Island	A, B, C, D	C, D	0 to 5	Likely (Castle Hayne B)	No Data
		C, D	5 to 10	Likely (Castle Hayne B)	
Southport	No Geotechnical Data Available		0 to 5	Likely (Castle Hayne B)	No Data
			5 to 10	Likely (Castle Hayne B)	
Baldhead-Casewell			0 to 5	Not Likely	No Data
			5 to 10	Not Likely	
Smith Island			0 to 5	Not Likely	No Data
			5 to 10	Not Likely	
Baldhead Shoal Rch 1	C, D	C, D	0 to 5	Not Likely	2,513
		C, D	5 to 10	Not Likely	
Baldhead Shoal Rch 2	No Geotechnical Data Available		0 to 5	Not Likely	No Data
			5 to 10	Not Likely	
Baldhead Shoal Rch 3			0 to 5	Likely (Castle Hayne)	No Data
			5 to 10	Likely (Castle Hayne)	

3.3 Underlying Channel Rock

Geotechnical analyses were performed to map the top of rock and confirm mapping of top of rock performed previously by others. "Rock" implies that the materials have undergone lithification (deposits have been subjected to pressure, heat, and/or cementation and lithified as a rock) and exhibit physical properties (e.g. strength) of rock. "Formation" refers to materials that have been assigned to a geologic formation and been given a formation name (e.g. Castle Hayne and Turrilettid formations). Formation materials may exhibit properties similar to rock or soil (e.g. dense to very dense sand or hard clay). The geotechnical analysis interpreted seismic horizons (or reflectors) and interpreted their association with formations. In the inner harbor, the interpreted seismic horizons generally correlate well with rock intervals described on exploration logs and top of rock mapping presented by others. However, in the offshore channel reaches there appear to be differences between top of rock mapping by others and the seismic horizons presented in this study.

In general, from the 25 Foot Project channel reach through the Upper Lilliput any type of deepening from the current channel bottom is likely to encounter rock. In addition, based on the average UCS data, deepening in the Fourth East Jetty, Lower Brunswick, and Keg Island reaches may require blasting (UCS > 4,300 psi) to remove the encountered rock. From Lower Lilliput through Horseshoe Shoal, deepening of the channel is not likely to encounter rock. From Snows Marsh to approximately the end of Smith Island Channel, it is likely to encounter rock (interpreted to be Castle Hayne Unit B) if any deepening were to occur, although due to a lack of strength data it is uncertain if blasting will be required to excavate the material. Baldhead Reach 2 appears to be overlying a relatively large paleochannel and any deepening is not likely to encounter rock. Deepening between Baldhead Reach 2 and Baldhead Reach 3 is interpreted to likely encounter Castle Hayne Unit B materials.

3.4 Chemical Characteristics

Materials dredged from the Federal navigation channel historically have been suitable for ocean placement at the New Wilmington ODMDS (USACE and EPA, 2013) and beneficial use in accordance with the Sand Management Plan (USACE 2000):

- as beach replenishment material at Bald Head Island and Oak Island; and
- as bird nesting island restoration at South Pelican Island and Ferry Slip Island.

Prior to placement at the New Wilmington ODMDS, material must be determined suitable for ocean placement by the Wilmington District USACE in a MPRSA Section 103 evaluation and independently concurred by EPA Region 4 prior to disposal. Modeling (LTFATE and MTFATE) to evaluate potential mounding and dispersion may be required prior to material disposal.

3.5 Dredged Material Quantities

Dredging quantities (Table 3-2) were calculated based on the channel configurations detailed in Section 6.1.1 Dredging the Federal Channel. Dredging in-situ volumes are based on the required dredge depth, which consists of the proposed channel dimensions and a one-foot rock buffer in areas where rock is encountered. Two feet of allowable overdepth has been included in the project volume estimates.

Table 3-2
Dredge Material Construction Volumes (cy)

Material	In-Situ Volumes -47-foot Plan
Rock	4,168,000
Sand and Silt	22,685,000
Total	**26,853,000**

New work and incremental maintenance dredging volumes resulting from the proposed improvements to the Federal Navigation channel fit within the limitations of the Wilmington District's existing Dredge Material Management Plan (DMMP) and there are no substantial modifications to existing placement sites required. The existing DMMP includes the least cost method of dredge material disposal from the existing Wilmington Harbor project, which is the same method recommended in this report for material dredged for the -47-foot project.

All construction material will be either disposed at the New Wilmington ODMDS or placed at one or multiple beneficial use sites being evaluated for this project. All post-construction maintenance material will be placed at the existing sites currently in use. Beneficial use of dredged material is being evaluated for:

- Beach placement on Bald Head Island and Oak Island;
- Battery Island shore placement;
- South Pelican and Ferry Slip Island restoration;
- Island creation adjacent to South Pelican and Ferry Slip Islands; and
- Wetland restoration on Battery, Shellbed, and Striking Islands using thin-layer placement.

3.6 Sufficiency Analysis

Investigations into the effects of the TSP on the existing DMMP include effects on:

- New Wilmington ODMDS; and
- Eagle Island Confined Disposal Facility.

3.6.1 New Wilmington ODMDS

The Site Management and Monitoring Plan for the New Wilmington ODMDS originally finalized in July 2002 and the SMMP update was approved in January 2013. The 2013 updated SMMP remains in effect. Dredged material from the ocean bar channel of the Wilmington Harbor Federal navigation project and from the access channel and berths at the Military Ocean terminal at Sunny Point (MOTSU) are placed at the New Wilmington ODMDS on a mostly annual basis. The updated SMMP indicates that 2 to 3 million cubic yards of dredged material is anticipated to be placed at the ODMDS annually (USACE and EPA, 2013).

The New Wilmington ODMDS has an area of approximately 9.4 square nautical miles. Existing depths range from -35 feet MLLW to -52 feet MLLW. The disposal depth limitation is -30 feet MLLW (USACE and EPA, 2013). Based on bathymetry taken in 2017, the existing static dredged material disposal capacity at the New Wilmington ODMDS is 386 million cubic yards.

Table 3-3 shows the total amount of construction material to be dredged is 26.8 million cubic yards, which would be placed during three years of construction. Placement of construction material into the New Wilmington ODMDS will not reduce the disposal area's capacity during the 50-year life of the project. Placement of additional maintenance material at the ODMDS is projected to increase by less than 57,000 cubic yards per year due to increased shoaling in the entrance channel reaches; however, this material it is very likely that this material would be suitable for beach placement as a beneficial use alternative. With project construction material and all future maintenance material (estimated at the largest historical annual volume) placed at the ODMDS for 50 years, the New Wilmington ODMDS will have 40% of its capacity (156 million cubic yards) available at the end of 50 years.

Table 3-3
New Wilmington ODMDS Capacity (cy)

Dredging	Volume	50-Year Total
Construction	26,800,000	26,800,000
Anchorage Annual Increase (HRSLR)[1]	121,500	6,080,000
Entrance Annual Increase[2]	57,000	2,840,000
Total Project		35,720,000
Maximum Annual Historical Placement	3,887,000	194,350,000
Maximum 50-year Placement		230,070,000
ODMDS Capacity		386,000,000
Remaining Capacity after 50 Years		155,930,000

[1]This material alternatively may be placed at Eagle Island
[2]This material alternatively may be used beneficially as beach placement material

3.6.2 Eagle Island Confined Disposal Facility

The Eagle Island Confined Disposal Facility is situated on a 1,473-acre tract of land that forms a peninsula between the Cape Fear and Brunswick Rivers. Eagle Island CDF is operated in a three-cell configuration. Cell 1 consists of 230 acres, Cells 2 is approximately 260 acres, and Cell 3 is approximately 265 acres, for a total of 755 acres of diked uplands. Maximum dike height is currently 40 feet above mean sea level for Cell 1 and 42 feet for Cells 2 and 3 (USACE 2017).

Eagle Island CDF historically receives silty material from the upper reaches of the channel (from the Lower Brunswick channel reach to the upstream limits of the federal navigation project). Dredged material from the upper channel reaches is placed into the Eagle Island CDF with varying frequency (USACE 2007). The dikes for all three cells are proposed to be raised to 50

feet above mean sea level, which will extend the useful life of Eagle Island CDF to 2032 (USACE 2017).

Placement of additional maintenance material from the channel improvement project would increase the 5-year placement cycle volume by 9.4% (Table 3-4). Note that the maintenance material dredged at a frequency of every five years and every two years is dredged from outside of the -47-foot plan boundaries (upriver). Annual maintenance material is projected to be placed at the Eagle Island CDF until it achieves capacity in 2032. The annual addition of 64,000 to 122,000 cubic yards of maintenance material during the last few years[1] of the CDF's useful life would have limited, if any, impact on use of the facility.

Creating additional capacity at the Eagle Island CDF by raising the dikes to 62 feet above mean sea level was evaluated by USACE (USACE 2017) but was determined to economically infeasible. If the Eagle Island CDF is not available for placement of maintenance material after 2032, the material would likely be placed at the New Wilmington ODMDS, which has more than sufficient capacity for inner harbor maintenance material.

Table 3-4
Eagle Island CDF 5-Year Placement Cycle Volumes (cy)

Frequency	Without-Project	With-Project
One time each year	6,261,500	6,869,020
One time every 2 years	95,900	95,900
One time every 5 years	97,300	97,300
Total	6,454,700	7,062,220
5-Year Volume Difference		607,520
5-Year Percentage Difference		9.4%

4 CONCLUSION

The Planning Guidance Notebook indicates that if a Preliminary Assessment identifies a disposal capacity shortage over the next 10 years, then a DMMP needs to be developed. A DMMP is required to identify 20 years of dredged material disposal capacity. The existing DMMP identified 50 more than years of dredged material disposal capacity. This Preliminary Assessment verifies the 50-year dredged material disposal capacity, including new construction and maintenance material generated by the TSP. A new or updated DMMP is not required at this time.

[1] The projected first year of post-channel improvement maintenance is 2028.

5 REFERENCES

USEPA and USACE 2012. Site Management and Monitoring Plan New Wilmington Ocean Dredged Material Disposal Site. December 2012

USACE 2000a. Planning Guidance Notebook, USACE 22 April 2000, ER 1105-2-100.

USACE 2000b. Planning Guidance Notebook, USACE 22 April 2000, ER 1105-2-100, Appendix E: Civil Works Missions and Evaluation Procedures, Section E-15.

USACE 20007. Wilmington Harbor Cape Fear River, NC Dredged Material Management Plan, Alternative Formulation Briefing Preconference Materials. October 2007.

USACE 2017a. Final Environmental Assessment and Finding of No Significant Impact Eagle Island Improvements Dike Raising to Elevation 50 Feet. April 2017

USACE 2017b. MPRSA Section 103 Evaluation of Dredged Material Proposed for Ocean Disposal Wilmington Harbor Navigation Project. June 2017

Attachment A: Beneficial Use of Dredged Material

1 Introduction

The Federal Government has placed considerable emphasis on using dredged material in a beneficial manner. Statutes such as the Water Resources Development Acts of 1992, 1996, 2000, and 2007 demonstrate that beneficial use has been a Congressional priority. The USACE has emphasized the use of dredged material for beneficial use through such regulations as 33 CFR Part 335, ER 1105-2-100, and ER 1130-2-520 and by Policy Guidance Letter No. 56. (ER 1105-2-100 at E-69) states that "all dredged material management studies include an assessment of potential beneficial uses for environmental purposes including fish and wildlife habitat creation, ecosystem restoration and enhancement and/or hurricane and storm damage reduction."

Opportunities exist for beneficial use of dredged material associated with the dredging of new work material during the construction of the Wilmington Harbor Improvement Project (WHIP). In accordance with ER 1105-2-100, the USACE is considering beneficial use of dredged material as a part of the project. The USACE regulations (ER 1105-2-100) state that, "where environmentally beneficial use of dredged material is the least cost, environmentally acceptable method of disposal, it is cost shared as a navigation cost." The incremental costs of a beneficial use that is above the least cost disposal option would need to be funded by a non-federal sponsor or cost-shared according to the applicable authority. The beneficial use concepts and alternatives discussed below may or may not be constructed, particularly if the costs are greater than the least cost disposal option and a non-federal sponsor is not identified to pay for the incremental increase in cost.

During the feasibility phase, the local sponsor hosted an interagency technical working group meeting on 19 February 2019 to discuss the various opportunities for beneficial uses of dredged material and provide preliminary information about the types of analyses that would be needed: monitoring requirements, ecological and shore protection benefits, construction methods, construction windows, physical characteristics of material, etc. Based on a review of the information gained from this meeting, the following options were identified.

- Beach placement on Bald Head Island and Oak Island
- Battery Island shore placement
- South Pelican and Ferry Slip Island restoration
- Island creation adjacent to South Pelican and Ferry Slip Islands
- Wetland restoration on Battery, Shellbed, and Striking Islands using thin-layer placement

A map of the beneficial use project area can be seen in Figure A-1. During the PED phase, options for beneficial uses that are cost-effective and meet regulatory and environmental protection requirements would be pursued. The additional cost (above the least cost option described above) of most potential beneficial use options would need to be paid by a willing partner.

Figure A-1
Proposed Beneficial Use Project Area

1.1 Dredged Material

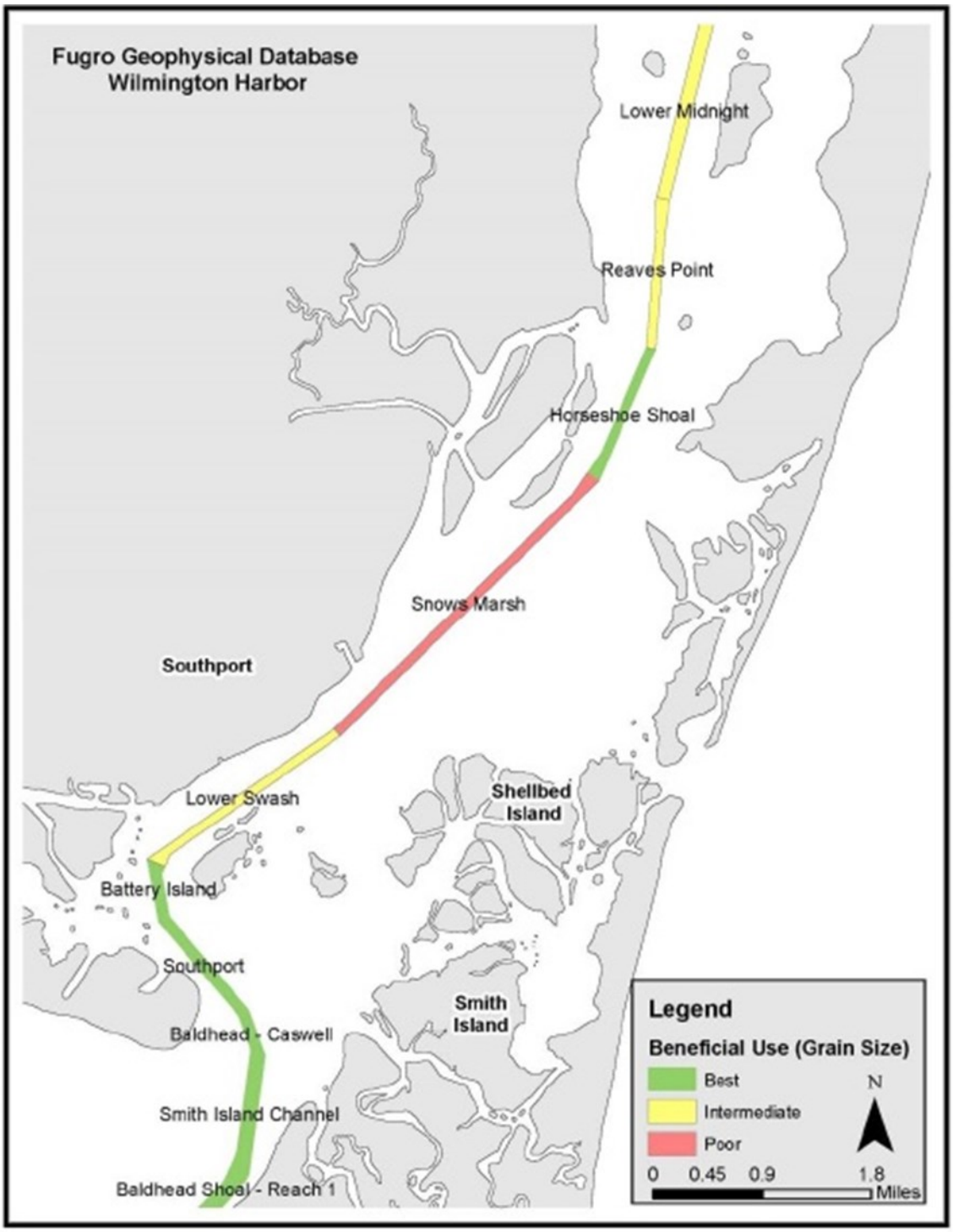
The amount of dredged material that will be available for beneficial uses varies in quality and location within the project area. Quality of sediment for beneficial use is characterized primarily by grain size and suitability (Fugro 2019).

- Category A (Best) – Potentially suitable for engineering structural fill or beach nourishment. Fines content typically <10%, d50 of at least 0.25-mm and low calcium carbonate content.
- Category B (Intermediate) – Potentially suitable for non-engineered fill. Fines content approximately 10-20% and may include thin lenses of fine-grained deposits.
- Category C (Poor) – Potentially suitable for low-quality fills (e.g. habitat restoration and development, offshore berms, parks and recreation, etc.). Fines content approximately 20-25%
- Category D (Poor) – Disposal Area (upland or offshore)

Categories C and D are considered to be poor or unsuitable for fills and beach nourishment due to their high percent fines content. Although a significant amount of historical data has been collected on the type of dredged material that is available, further analysis will be required to thoroughly evaluate the amount, quality, and location of sediments in the project area. The approximate distribution of the various types of sediment can be seen in Figures A-2 through A-5 (Fugro 2019). Overall, there is a large quantity of Category A and B material spanning from the start of the entrance channel offshore and extending up through the mouth of the Cape Fear River. The proximity of this good and intermediate quality material to the proposed beneficial use sites in the southern area of the project area will be an advantage in reducing the costs of transport and disposal. Further analysis will be required to assess the cost-effectiveness of the remaining material north of the proposed beneficial use sites.

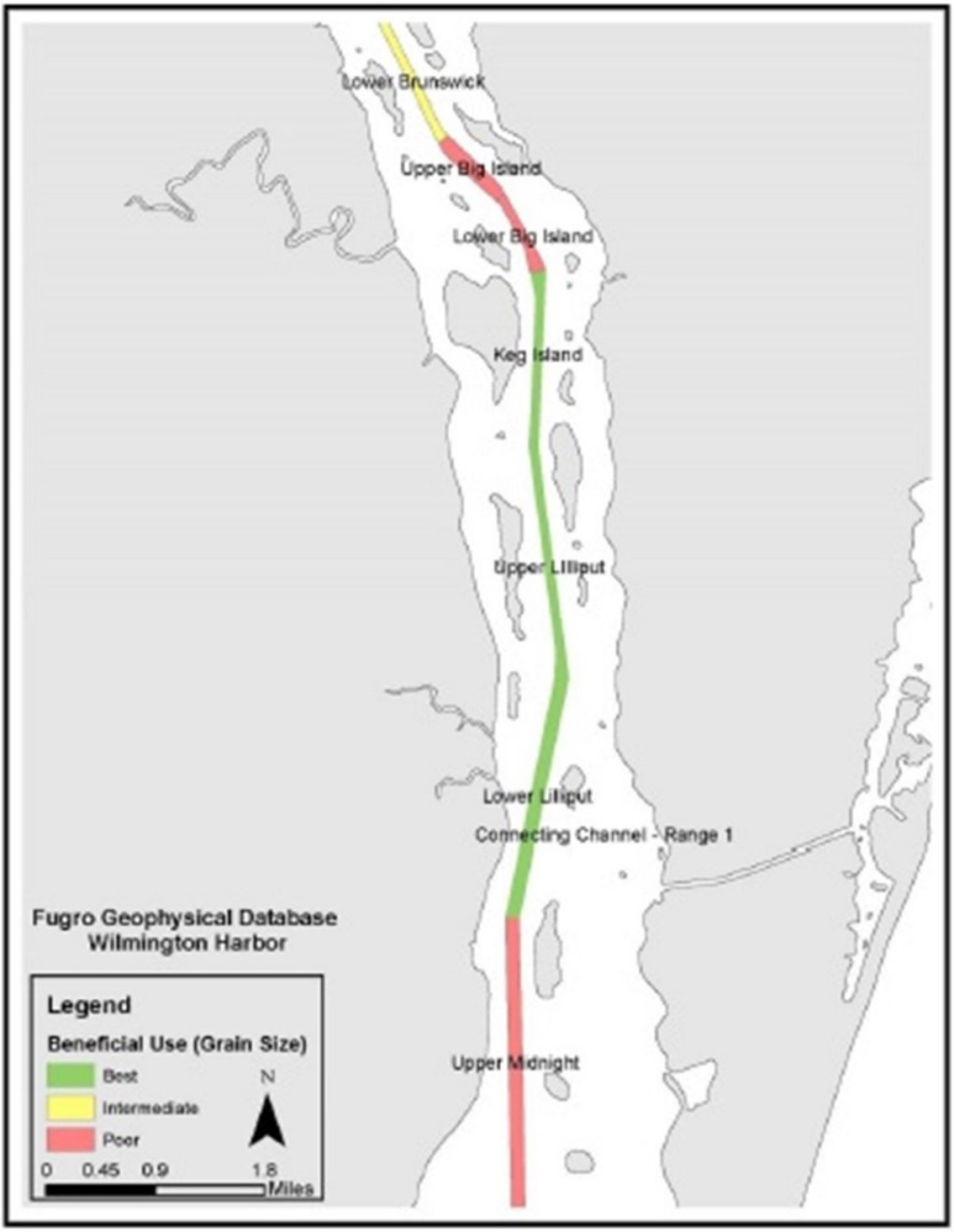
Note: Best (Category A material), Intermediate (Category B material), Poor (Categories C and D material)

Figure A-2
Approximate Distribution and Type of Dredged Material within the Project Area Extending from Baldhead Shoal –Reach 3 to Southport



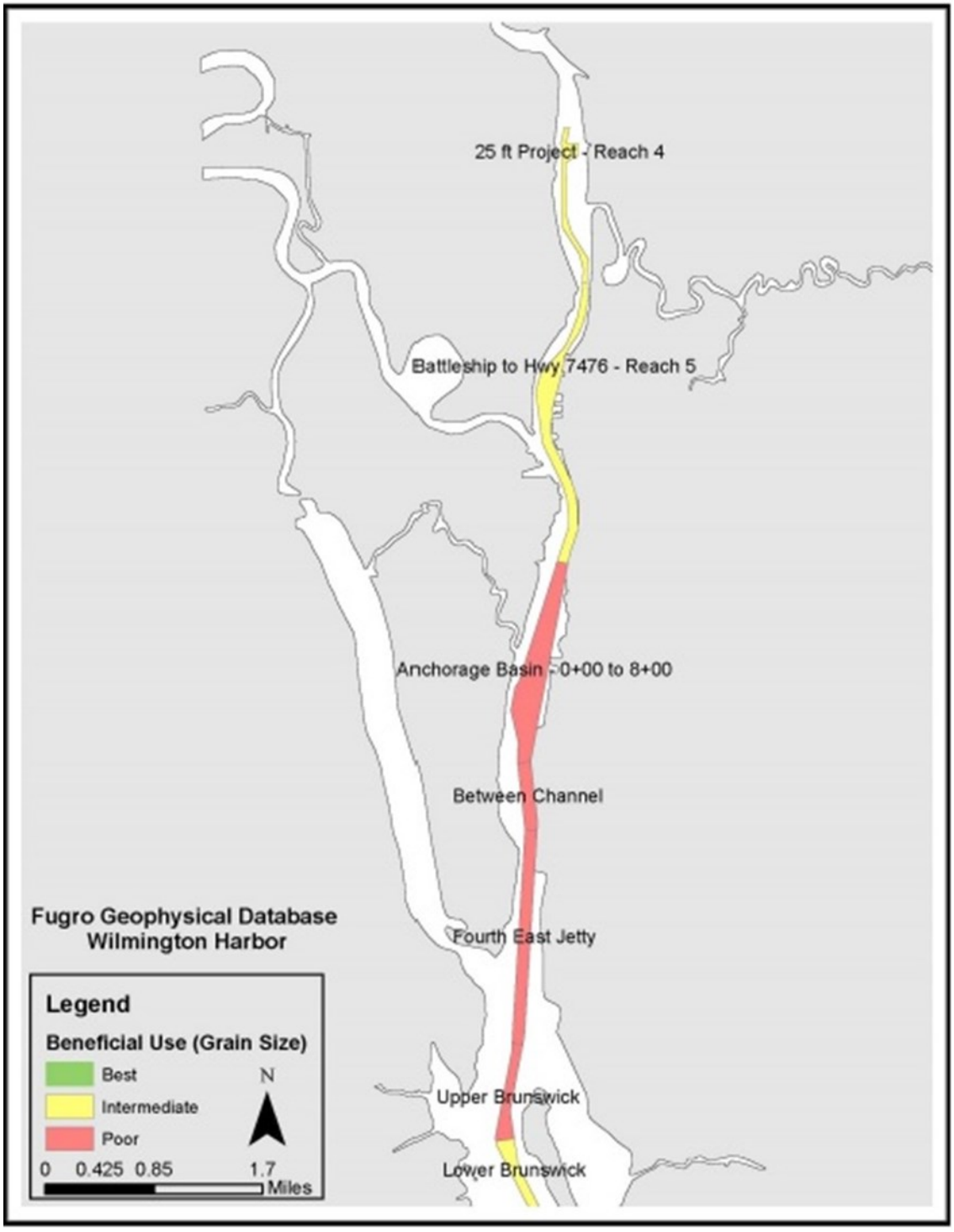
Note: Best (Category A material), Intermediate (Category B material), Poor (Categories C and D material)

Figure A-3
Approximate Distribution and Type of Dredged Material within the Project Area Extending from Baldhead Shoal - Reach 1 to Lower Midnight



Note: Best (Category A material), Intermediate (Category B material), Poor (Categories C and D material)

Figure A-4
Approximate Distribution and Type of Dredged Material within the Project Area Extending from Upper Midnight to Lower Brunswick



Note: Best (Category A material), Intermediate (Category B material), Poor (Categories C and D material)

Figure A-2
Approximate Distribution and Type of Dredged Material within the Project Area Extending from Lower Brunswick to 25-ft Project – Reach 4

1.2 Beach Placement on Bald Head Island and Oak Island

Bald Head Island and Oak Island form the mouth of the Cape Fear River on the east and west boundaries, respectively. Beach management at Bald Head Island and Oak Island has been an ongoing process. The Wilmington Harbor Sand Management Plan (USACE 2000) stipulated that these islands would share material from maintenance dredging on a regular basis for the purpose of shore protection. Based on the terms of that management plan, Bald Head Island receives material on two, four, and eight-year intervals; while Oak Island receives material on a six-year interval (USACE 2000). In 2013, the results of a comprehensive annual beach monitoring program of Bald Head Island, which started in 2000, came to the conclusion that beach placement alone could not successfully offset navigation channel impacts from erosion. Construction of a terminal groin was completed in 2015 to mitigate for these increased erosion rates and the results of recent surveys in 2017 and 2018 showed that the groin is performing as expected by reducing sediment losses and beach erosion. However, sand placement is still an essential factor to maintain the existing beaches given their proximity to the high energy environment of the Cape Fear River (Olsen Associates Inc. 2018).

Dredged material could be used to re-nourish the beaches on Bald Head Island and Oak Island by placing material on the existing beach areas adjacent to the mouth of the Cape Fear River (Figure A-6). Nourishment of these beaches would help to minimize damage from future storm events and maintain the existing beach profiles on both islands. The precise size, distribution of material between the two beaches, and scope of the project would be determined during the PED phase and would be dependent on the availability and proximity to suitable material. Further geotechnical analysis during the PED phase will also be needed to fully characterize the quantity and quality of material for potential use.

Figure A-6
Potential Beach Placement Areas on Oak Island and Bald Head Island

1.3 Battery Island Shore Placement

Battery Island is a natural island located within the mouth of the Cape Fear River. Dredged material has been deposited here in the past, which was used to form the southern upland area of the island and consists of red cedars (*Juniperus virginiana)*, yaupon (*Ilex vomitoria)*, and other shrubs. Battery Island provides ideal nesting, foraging, and roosting habitat for a variety seabirds due to its isolated nature, relatively small size, and lack of mammalian predators. It supports North Carolina's largest colony of wading birds, which includes nine distinct species and upwards of 15,000 nesting pairs of birds. Species include white ibis (*Eudocimus albus*), American oystercatchers (*Haematopus palliates)*, willets (*Tringa semipalmata)*, clapper rails (*Rallus crepitans)*, seaside sparrows (*Ammodramus maritimus)*, and marsh wrens (*Cistothorus palustris*) (National Audubon Society 2010a).

The island has been decreasing in size due to its location adjacent to the main channel in the lower Cape Fear River, which subjects it to high tidal currents. Dredged material could be used to enlarge Battery Island by placing material on the existing beach sandy areas on the north, west, and south sides (Figure A-7). This would assist in the support of the diverse array of avian species that utilize the island. Due to its exposure to the strong tidal currents, this material would be sacrificial in the long-term but would extend the lifespan of the island and its avian community. The precise size and scope of the project would be determined during the PED phase and would be dependent on the availability and proximity to suitable material.

Figure A-7
Proposed Shoreline Fill Location for Battery Island

1.4 South Pelican Island and Ferry Slip Island Restoration and Expansion

South Pelican Island and Ferry Slip Islands are artificial, dredged-sand islands located in the lower Cape Fear River south of Wilmington, which were created in the early 1970s (Personal communication, L. Addison, Audubon NC March 2019). The islands have been a haven for nesting pelicans, gulls, and terns for more than two decades. The pair of these islands are the most important nesting areas for royal and sandwich terns and support the largest colony of brown pelicans in the southeast region of North Carolina (National Audubon Society 2010b and 2010c).

Each island is permitted to a size of seven acres above mean high water (MHW). Both islands currently occupy less than five acres each above MHW. They are periodically nourished and need sand replenishment approximately every four to seven years in order to maintain avian habitats. However, recent trends have resulted in the majority of clean, beach-quality sand being diverted to local beaches instead, so these islands have been receding due to lack of nourishment. This lack of available material poses a threat to the avian species that use these islands for nesting; as these islands have been subject to erosion, vegetative encroachment, and human disturbance. Dredged material could be used to enlarge South Pelican Island and Ferry Slip Island by placing material along the perimeter of each island (Figures A-8 and A-9). Options include restoring each island to the permitted size or increasing the permitted size. The maximum recommended upland area would be approximately 37 ac, which is the optimal size for supporting avian species but not sustainable habitat for mammalian predators (Personal communication, W. Golder, Audubon NC February 2019).

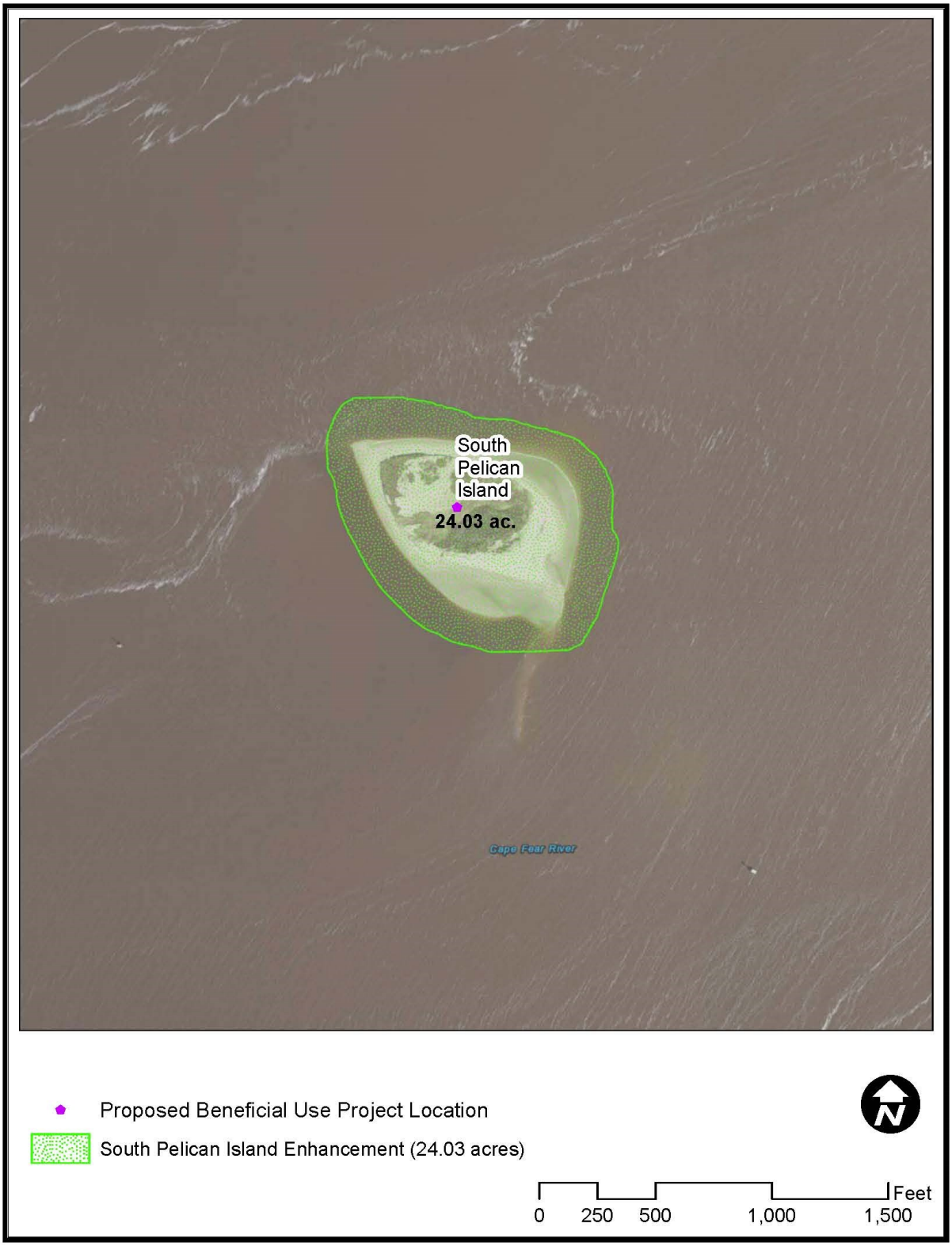


Figure A-8
Proposed Restoration for South Pelican Island

Figure A-9
Proposed Restoration for Ferry Slip Island

1.5 Construction of New Bird Islands

Dredged material could be used to create additional islands in the area between Battery Island and South Pelican Island. Dredged-sand islands like Ferry Slip and South Pelican have proven to be highly beneficial to local and migratory bird populations by providing ideal habitat for nesting and roosting. However, both the natural and artificial islands in the lower Cape Fear River have been eroding over time due to a variety of impacts including storm activity, ship wakes, and sea-level rise (Adam 2002, Wolters et. al. 2005). The creation of new islands would significantly increase the amount of avian habitat available. This option would also serve to retain this sediment within the estuarine system where it serves an ecological purpose as opposed to transporting it to the ocean dredged material disposal site (ODMDS).

The area between Battery Island and South Pelican Island is ideal due to its distance from larger land masses, which would prohibit or limit access to mammalian predators. These islands would ideally be located away from the channel in relatively shallow areas (Figure A-10). New islands should be situated in close proximity to areas with good and intermediate quality material to facilitate low-cost replenishment during future maintenance dredging events. If possible, placement of new islands should be in a relatively low-energy area to minimize the effects of erosion. New islands would be no larger than 37 ac in upland area to prevent colonization by mammalian predators. Elevation would be no higher than 5-meters to prevent destabilized sediment, which is not preferred by seabird species. These islands should be crescent or U-shaped due to the hydrodynamic benefits of these island shapes, which promote long-term retention of material. Ideally, dredged material should be 80-90% beach quality sand but sand-shell and gravel material would also be acceptable. If the preferred amount of high quality material is unavailable, poor or intermediate quality sediment could be used as a foundational layer and capped with higher quality sediment. Proximity to oyster beds would also be preferred as this would provide additional foraging habitat. Alternatively, artificial oyster reefs could be created adjacent to these islands, assuming suitable material from the project area is available. The precise size and scope of the project would be determined during the PED phase and would be dependent on the availability and proximity to suitable material and further engineering analysis.

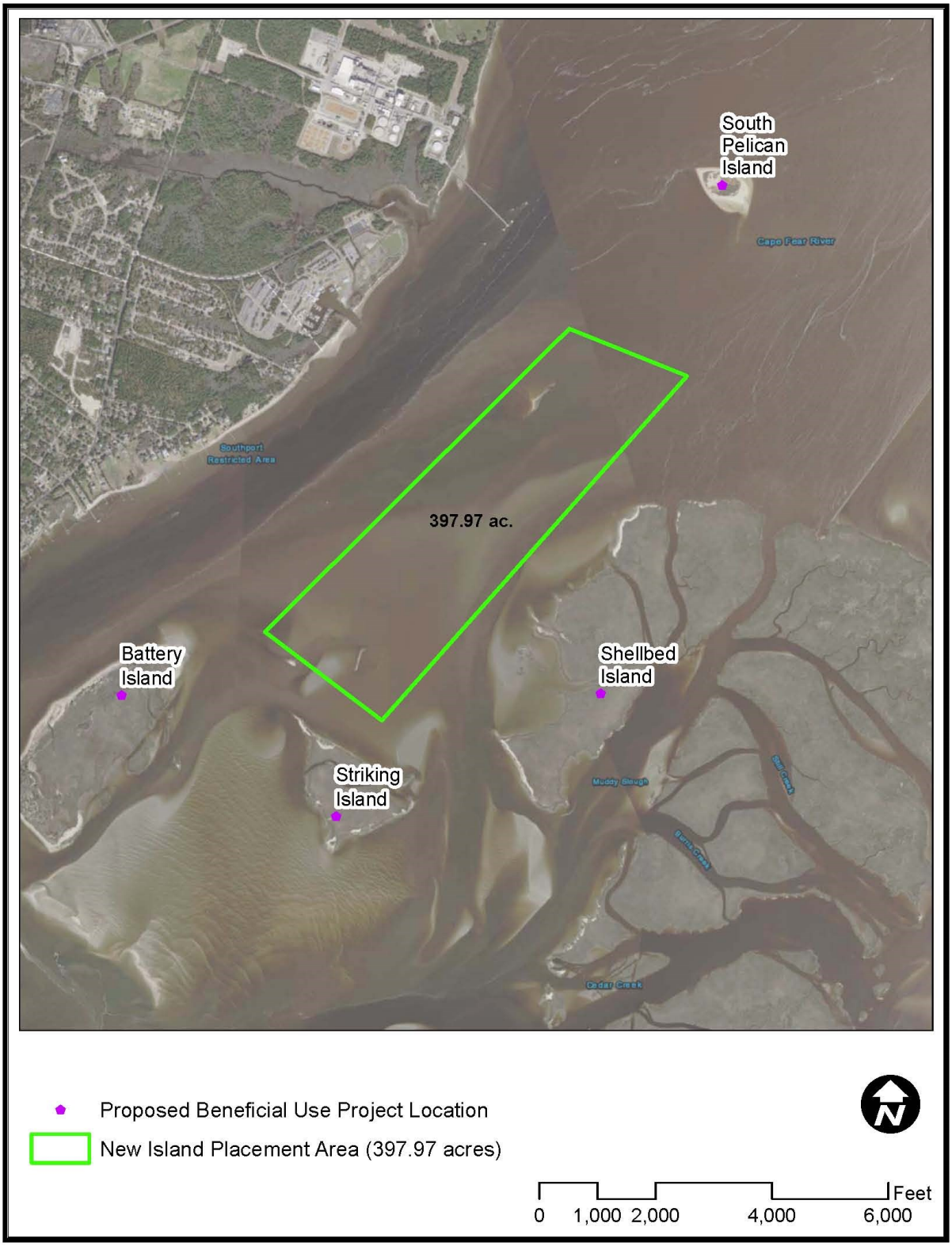


Figure A-10
Proposed Area for Creation of New Islands in Lower Cape Fear River

1.6 Wetland Restoration at Battery Island, Striking Island, and Shellbed Island

Battery, Striking, and Shellbed Islands are natural marsh islands located at the mouth of the Cape Fear River. These islands are characterized by high and intertidal saltmarsh with small islands of upland washed oyster shell banks, shrubs, and grassy areas. All three of these islands are recognized as Important Bird Areas (IBAs) due to the fact that they provide essential habitat for one or more avian species during their annual cycle (National Audubon Society 2010a). Recent observations have noted the appearance of unvegetated interior depressions on all three of these islands (Personal communication, W. Golder, Audubon NC February 2019). These interior areas are characterized by low-lying, un-vegetated mud. Although the cause of this interior marsh deterioration is not clear, its low elevation likely plays a key part. As saltwater pools accumulate and evaporate in these low areas, concentrated salt deposits can be left behind, which can lead to high levels of sediment salinity that can exclude less halophytic species (Watson and Burne 2009). These effects could continue to worsen with the expected increase in sea level rise.

De-stabilization of sediments on the outer boundaries of these natural marsh islands is a major threat to their longevity.

Wave action caused by high winds, storm activity, and vessel traffic (*i.e.* ship wakes) plays a major part in lateral erosion and de-stabilization of the outer edges of these marsh lands, which results in a net loss of island material over time (Adam 2002, Wolters et. al. 2005). One major advantage of using dredged material for this type of beneficial use is that it retains this sediment within the estuarine system by replenishing areas of marshlands that have eroded over time. Once these islands are restored, re-establishment of pioneer vegetation is vitally important to their development and recovery (van de Koppel et. al. 2005, Callaghan et. al. 2010). There is also growing evidence that marshes should be able to be able to accrete vertically at the projected rate of sea level rise through the vegetation-sedimentation feedback loop but this is contingent on a sufficient supply of sediment (Kirwan and Temmerman 2009).

Dredged material could be used to fill and elevate these low-elevation areas by using thin layer placement in order to establish a platform for restoration of vegetative cover and bird habitat. Thin layer placement is the purposeful placement of dredged material in order to produce a specific layer thickness or ground surface elevation that can range from a few centimeters to almost a meter. This method has been effective in artificially supplying sediments to subsiding marshes on the Gulf and Atlantic coasts (USACE 2007). There are several areas on each island where this activity could prove beneficial (Figure A-11). The total proposed wetland enhancement area for all three islands encompasses an area of 30 ac and would require approximately 72,500 to 145,000 cy of material (assuming a depth ranging between 0.5 to 1-yard). Care would need to be taken to ensure that existing vegetation is not overly smothered by dredged material. The precise size and scope of the project would be determined during the PED phase and would be dependent on the availability and proximity to suitable material.

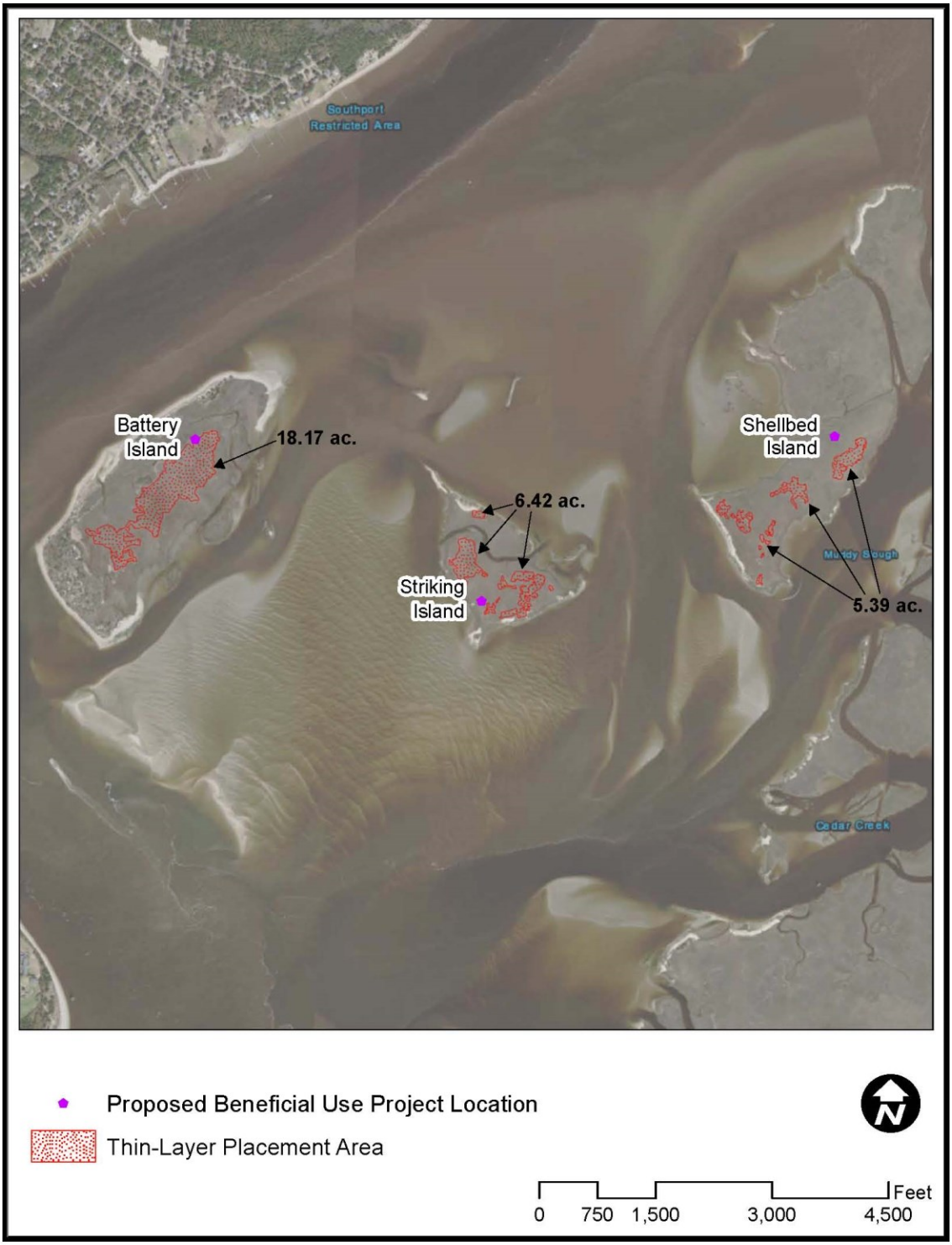


Figure A-11
Proposed Thin Layer Placement of Dredged Material on Battery (18.2 ac), Striking (6.4 ac), and Shellbed (5.4 ac) Islands

1.7 Beneficial Use Analyses

Design considerations for beneficial use projects typically require grain size/compatibility analyses and modeling of sediment transport and fate to determine the viability of proposed projects. In order to meet the scheduling goals and to reduce costs, the analyses of the proposed beneficial use projects will take place during the PED phase. The projects proposed in this section have been presented without detailed analysis, but with a commitment to perform this analysis during the PED phase and re-coordinate with resource agencies to ensure that all environmental standards are met. Final designs, environmental considerations, and implementation decisions would take place during the PED phase.

1.8 References

Adam, P. 2002. Salt Marshes in a Time of Change. Environmental Conservation. 29: 39-61.

Callaghan, D.P., T.J. Bouma, P. Klaassen, D. Van Der Wal, M.J.F. Stive, and P.M.J. Herman. 2010. Hydrodynamic forcing on salt-marsh development: Distinguishing the relative importance of waves and tidal flows Est., Coast. and Shelf Sci.. 89(1): 73-88. dx.doi.org/10.1016/j.ecss.2010.05.013.

FUGRO. 2019. Wilmington Harbor Deepening Update Report. Wilmington, North Carolina. 25 February 2019.

Kirwan, M., and S. Temmerman. 2009. Coastal Marsh Response to Historical and Future Sea-Level Acceleration. Quaternary Science Reviews. 28, 1801-1808.

Olsen Associates, Inc. 2018. Bald Head Island, N.C. Beach Monitoring Program. Monitoring Report No. 16.

National Audubon Society. 2010a. Battery Island Site Report https://netapp.audubon.org/iba/Reports/319.

National Audubon Society. 2010b. Ferry Slip Island Site Report https://netapp.audubon.org/iba/Reports/333.

National Audubon Society. 2010c. South Pelican Island Site Report https://netapp.audubon.org/iba/Reports/449.

Van De Koppel, J., D. Van Der Wal, J.P. Bakker, and P.M.J. Herman. 2005. Self Organization and Vegetation Collapse in Salt Marsh Ecosystems. The American Naturalist. 165, E1-12.

Watson and Burne. 2009. Abundance and diversity of tidal marsh plants along the salinity gradient of the San Francisco Estuary: implications for global change ecology. Plant Ecology: 205:113.

Wolters, M., J.P. Bakker, M.D. Bertness, R.L. Jefferies, and I. Moller. 2005. Saltmarsh Erosion and Restoration in Southeast England: Squeezing the Evidence Requires Realignment. Journal of Applied Ecology. 42: 844 851.

United States Army Corps of Engineers (USACE). 2007. Thin Layer Placement of Dredged Material on Coastal Wetlands: A Review of the Technical and Scientific Literature. ERDC/EL TN-07-1.

USACE. 2000. Wilmington Harbor Sand Management Plan Ocean Entrance Channels and Inner Harbor Between Lower Swash and Reaves Point.