NCDOT NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

NCDEQ NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY

VOLUME 1

# STUDY OF THE USE AND EFFICIENCY OF THE DREDGE MANTEO

VOLUME 2

# STUDY OF ACQUISITION OF DEDICATED DREDGING CAPACITY

VOLUME 3

# STUDY OF DREDGING SERVICES COST-BENEFIT ANALYSIS

FINAL REPORT | APRIL 2018


moffatt & nichol

# VOLUME 1: STUDY OF THE USE AND EFFICIENCY OF THE DREDGE MANTEO

## EXECUTIVE SUMMARY

This volume evaluates the operation, costs, and opportunities to improve use of the Dredge Manteo, a dredge vessel built in 2016 and operated by NCDOT's Ferry Division to maintain the navigable waterways and basins managed as part of the State's Ferry System. The Dredge Manteo is a 115-ft long by 36-ft wide hydraulic pipeline cutterhead dredge capable of producing approximately 1,100 pump horsepower with a discharge diameter of 14-inches. This study shall provide; (i) an approximation of the annual cost to the State to operate and maintain the dredge vessel, and (ii) a plan to allow use of the dredge vessel by other State departments and agencies. The analysis compares information provided by the NCDOT regarding the operational protocols of the Dredge Manteo with data gathered through US Army Corps of Engineers' (USACE) dredge estimation process, contractor interviews and analysis of commercial projects.

The table below summarizes the aggregated monthly and annual operating costs associated with labor, equipment ownership, equipment rental, materials, maintenance, and survey costs from data provided by NCDOT for the four maintenance events conducted during FY2016/2017. The monthly calculations are normalized for the 113 working days reported for each cost category. Based on the four dredging events, the annual operating cost is $1.67 million for FY2016/FY2017.

| Annual Cost Description | FY2016/2017 (113 Project Days) |
|---|---|
| **Annual Operating Cost** | $1,667,100 |
| **Estimated Production Potential** | 51,188 CY |
| **Cost per CY** | **$32.57** |

This study has identified several opportunities to improve the operational efficiencies.

- Increase the operational time to 24 hours a day;
- Increase the discharge pipe diameter to 14 inches (while maintaining the ability to utilize the existing 12 inch diameter pipe for specific sites);
- Increase the capacity of the material disposal sites;
- Provide dedicated staff and equipment to the Dredge Manteo for dredging operations; and
- Modify dredge windows

The implementation of these opportunities may allow the Dredge Manteo to be more competitive to pursue state or federal sourced dredge projects as shown in the table below. **If one assumes that the Dredge Manteo could operate for 6 months (average of the two environmental windows shown in the table) with these improvements, the annual cost would be $4.3M for an annual production of ~275,000 cy at a unit cost of**

**$15.90/cy**. Expansion of existing, or construction of new, disposal sites, both at South Dock and other sites, would also improve operational downtimes for Ferry Division projects.

| | November - March Environmental Window | | October - April Environmental Window | | Year Round | |
|---|---|---|---|---|---|---|
| | 12 hr/day | 24 hr/day | 12 hr/day | 24 hr/day | 12 hr/day | 24 hr/day |
| **Annual Labor** | $1,396,474 | $2,142,211 | $1,396,474 | $2,142,211 | $1,396,474 | $2,142,211 |
| **Annual Equipment Ownership** | $969,933 | $969,933 | $969,933 | $969,933 | $969,933 | $969,933 |
| **Annual Operational Cost** | $536,470 | $916,820 | $751,058 | $1,283,548 | $1,287,528 | $2,200,368 |
| **Annual Survey Costs** | $83,965 | $83,965 | $117,551 | $117,551 | $201,516 | $201,516 |
| **Total Annual Cost** | $2,986,843 | $4,112,930 | $3,235,017 | $4,513,244 | $3,855,452 | $5,514,029 |
| **Estimated Annual Production** | 134,975 CY | 230,640 CY | 188,964 CY | 322,896 CY | 323,939 CY | 553,945 CY |
| **Cost ($/CY)** | **$22.13** | **$17.83** | **$17.12** | **$13.98** | **$11.90** | **$9.95** |

# VOLUME 2: STUDY OF ACQUISITION OF DEDICATED DREDGING CAPACITY

## EXECUTIVE SUMMARY

In this volume, the acquisition of dedicated dredge capacity beyond the Dredge Manteo was evaluated based on anticipated existing and future forecasted dredging needs in, and potentially outside, the state that are not currently performed or could be performed by the Dredge Manteo. The potential expansion of the fleet was weighed against the cost to acquire, operate and maintain the additional dredge equipment in a manner that minimizes cost or promotes self-sufficiency, is cost competitive with the private dredge industry, and complies with labor and anti-competitive practices and law.

The historical dredging volumes for shallow draft navigation were separated into three project classifications to which existing and projected dredge needs could be evaluated and the type of equipment required to meet those needs identified. These three classifications are:

- Shallow Draft Inlets (Beach Compatible) including Oregon Inlet
- AIWW Crossings (Beach Compatible)
- Remainder of AIWW and Inland Channels (Non-Beach Compatible)

For Shallow Draft Inlets including Oregon Inlet, it is projected that the average dredge needs are 3.0 to 3.5 million cy/yr to support unrestricted navigation of the waterways while another 1 million cy/yr of dredging would satisfy the peak need (approximately 1.0 million cy/yr is required to maintain navigation through Oregon Inlet and the shallow draft channels to Wanchese and Manteo). Dredged material removed from the AIWW and the Inland Channels has been approaching 500,000 cy/yr over the last decade. This level of dredging provides the minimum required to maintain navigability for smaller vessels. However, dredging up to 1.0 million cy/yr, the average volume dredged during the 1990's, would improve navigability of the AIWW for larger vessels. If there is a desire the fully maintain the AIWW (peak need), then a total of 1.5 million cy/yr would need to be removed.

There are two deep draft projects (Cape Fear River and Morehead City Harbor) with federally authorized depths greater than 15 feet which serve North Carolina's two major ports, Wilmington and Morehead City, respectively. Dredging has remained constant around 3 million cy/yr but peak dredging needs may approach 4 million cy/yr.

The investment by the State to meeting the minimum entire shallow draft need is the purchase of one 14-inch pipeline dredge, one 20-inch pipeline dredge, and one special purpose dredge in addition to the Dredge Manteo. This $81.5 million investment is associated with a $25.7 million annual operating cost. To meet the average shallow draft need, the State would need to purchase one 14-inch, one 20-inch, and one 24-inch pipeline dredge, and one special purpose dredge in addition to the Dredge Manteo. The state would be investing $138.3 million to purchase them and subsequently $39.7 million annually to maintain this fleet. If there is a desire to match the peak need for shallow draft dredging,

then six dredges should be purchased; four pipeline dredges (one 14-inch, two 20-inch, and one 24-inch) and two special purpose dredges. This acquisition would cost $197.9 million and the state would need to fund a $61.0 million annual operating cost.

Two alternative investment scenarios were evaluated to meet some of the shallow draft dredging needs. The minimum investment approach considers the purchase of a special purpose hopper dredge, a 14-inch pipeline dredge, and a 20-inch pipeline dredge. For the approximately $81.5 million initial cost and an annual operating cost of $25.7 million/yr, the state would have three dredge plants capable of 2.5 million cy/yr production. This combination of dredge fleet addresses the average needs of Oregon Inlet while the 14-inch and 20-inch dredges could also support dredging of the remaining shallow draft inlets, the AIWW, AIWW crossings, and some interior waterways.

The other alternative approach considers purchasing a dredge fleet based on current funding levels from the Shallow Draft Navigation and Aquatic Weed Fund. One special purpose dredge and one 24-inch pipeline dredge could be operated with this fund. The initial cost for these two dredges is approximately $81.8 million and the annual operating cost is $26.3 million/yr. The special purpose hopper would perform year round dredging to meet the average needs at Oregon Inlet and other shallow draft inlets. The ocean certified 24-inch pipeline dredge would perform dredging of the AIWW and AIWW crossings as well as some deep draft work if needed.

The deep draft navigation needs of the state were also evaluated in combination with the shallow draft navigation investment. At a minimum, one 30-inch pipeline dredge could be acquired to maintain the inlet throat and inland channels for the Ports of Morehead City and Wilmington. The USACE would continue to maintain the ocean bar segment. The purchase of the 30-inch pipeline dredge would escalate the investment of the minimum and average shallow draft dredging needs by approximately $77.5 million, for a total initial cost of $159 million (annual operating cost of $44.4 million/yr) and $215.8 million (annual operating cost of $58.4 million/yr), respectively. The peak need for the deep draft maintenance dredging requires one medium capacity hopper dredge in addition to the average need with an initial cost of $67 million. When coupled with the peak shallow draft need, the total investment is over $342.4 million (annual operating cost of $95.1 million/yr).

Sources of funding for such a large purchase could be from a statewide bond measure to maintain navigable waterways; offset by a fee structure similar to the Shallow Draft Navigation Channel and Aquatic Weed Fund or other funding mechanism discussed in the BIMP to support inlet and beach restoration needs.

# VOLUME 3: STUDY OF DREDGING SERVICES COST-BENEFIT ANALYSIS

## EXECUTIVE SUMMARY

The State of North Carolina is evaluating the acquisition of additional dredges to supplement its current dredge, Dredge Manteo, in meeting existing and projected maintenance dredging needs of the State's waterways (NCGA, 2017). A cost benefit analysis of the state providing expanded dredge services in lieu of utilizing private contractors was performed. The initial capital investment, annual operating costs and unit costs of material dredged per cubic yard ($/cy) were the baseline indicators in this evaluation. The fixed and variable costs of dredging were defined and cost risk factors such as utilization and mobilization identified that influenced the annual operating costs.

Interviews with the other public agencies that own and operate dredges, the U.S. Army Corps of Engineers (USACE), and private dredge contractors were conducted to discuss the opportunities and constraints of the state operating an expanded fleet. Numerous public agencies outside of North Carolina operate non-ocean certified small pipeline dredges. These public agencies indicated that their unit price per yard ($/cy) of dredging is slightly lower, on the order of $1 to $2/cy, versus the unit cost of previously contracted work. The most favorable aspect of dredge ownership has been the ability to proactively schedule and manage their dredging needs as the Ferry Division has been able to do.

The USACE has been performing maintenance dredging of the State's shallow draft navigation channels at its current funded level and it is their opinion that they can handle the projected demands using their existing three dredge plants if the state and local governments could provide consistent scheduled funding. The unit cost for the USACE based on their current dredge fleet is generally commensurate with private dredge contractors. The USACE highlighted risk factors of the state assuming maintenance dredging of the USACE maintained channels. Maintaining permits, managing dredged material disposal areas, and providing maintenance funding and facilities were all identified as factors that affect annual operating costs. The USACE also indicated that they were not aware of a cost-share arrangement where the USACE and State would jointly purchase and operate a dredge.

Private contractors stressed that they have sufficient dredge plant capacity available to meet the needs of the state. Three primary obstacles or roadblocks mentioned related to dredging the State's waterways were the restrictive environmental dredge windows, the size of the projects, and the scheduling of work. All firms felt that better management of project funding and scheduling would permit them to better utilize their existing plants, resulting in opportunities to reduce overall project costs. The private contractors had mixed reactions on multi-year, multi-site or other concessionaire-type contract vehicles, with some indicating cost savings while others felt that these agreements would have minimal impact.

Two contracting approaches (MACC and concessionaire-type agreements) that the state may employ when enlisting dredging services from private contractors may provide potential cost savings of 5% to 10%. These savings are generally similar to the savings the

state may realize if the state operated their own expanded dredge fleet based on the analysis to date. The state, however, would have to come up with the initial capital investment.

Based on utilizing current funding streams such as the Shallow Draft Navigation Channel and Aquatic Weed Fund, the annual operating costs of a special purpose hopper and 24-in pipeline dredge may be feasible if the initial capital costs can be independently funded by the NCGA. This arrangement would allow field crews to be assigned work on the management of disposal sites during the 6 months when dredging cannot be performed. The state may also consider a phased approach to avoid completely consuming the Shallow Draft Navigation Channel Fund, with the purchase of a special purpose hopper. The special purpose hopper dredge has lower capital and annual operating costs and does not require significant expenditures on crew or support equipment to provide dredge services on a year round basis for shallow draft inlets and the AIWW crossings. The state and local sponsors would continue to contract dredge services to the USACE and/or private contractors to meet the remaining dredging needs until the state can purchase additional dredge plants.

However, legal/contracting issues and the cost of ocean certification should be investigated prior to making a final decision. These issues and additional landside support costs may be significant enough to eliminate potential cost savings. However, cost savings are only one part of the equation of the state's ability to manage the dredging needs of their waterways. NCDOT would have to develop a systematic approach to determining the needs and the priorities of the dredging program.

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VOLUME 1

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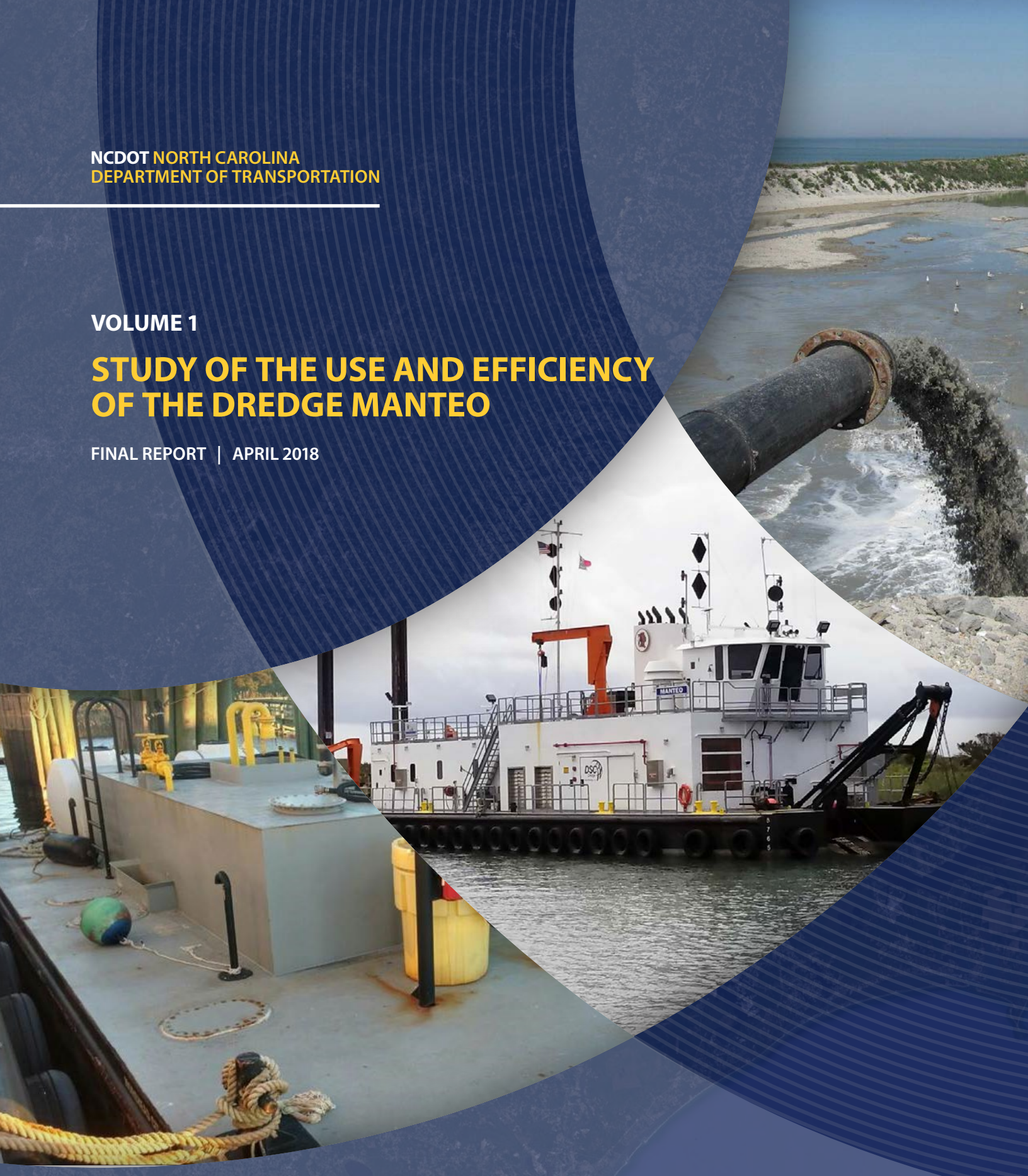


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# EXECUTIVE SUMMARY

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- Increase the operational time to 24 hours a day;
- Increase the discharge pipe diameter to 14 inches or larger (depending on dredge manufacturer recommendations) while maintaining the ability to utilize the existing 12-inch diameter pipe for specific sites;
- Increase the capacity of the material disposal sites;
- Provide dedicated staff and equipment to the Dredge Manteo for dredging operations; and
- Modify dredge windows

The implementation of these opportunities may allow the Dredge Manteo to be more competitive to pursue state or federal sourced dredge projects as shown in the table below. **If one assumes that the Dredge Manteo could operate for 6 months (average of the two environmental windows shown in the table) with these improvements, the annual cost would be $4.3M for an annual production of ~275,000 cy at a unit cost of $15.90/cy**. Expansion of existing, or construction of new, disposal sites, both at South Dock and other sites, would also improve operational downtimes for Ferry Division projects.

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# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# VOLUME 1: STUDY OF THE USE AND EFFICIENCY OF THE DREDGE MANTEO

## 1.0 PURPOSE AND NEED

The North Carolina General Assembly (NCGA) commissioned a three-part study to evaluate the State's participation in maintaining shallow draft navigation waterways through use of existing dredge equipment operated by the North Carolina Department of Transportation Ferry Division and through the potential acquisition of additional dredge plants to meet existing and projected maintenance dredging needs of the State's waterways (NCGA, 2017). This volume evaluates the operation, costs, and opportunities to improve use of the Dredge Manteo, a new dredge vessel operated by NCDOT's Ferry Division to maintain the navigable waterways and basins managed as part of the State's Ferry System. As identified in the enabling legislation, the study shall provide; (i) an approximation of the annual cost to the State to operate and maintain the dredge vessel, and (ii) a plan/estimate of additional dredging needs to allow use of the dredge vessel by other state departments and agencies, and (iii) also complete a cost comparison of the Dredge Manteo to complete this work versus private contractors. The analysis compares information provided by the NCDOT regarding the operational protocols of the Dredge Manteo with data gathered through US Army Corps of Engineers (USACE) dredge estimation process, contractor interviews and analysis of commercial projects.

## 2.0 DOCUMENTATION OF EXISTING NCDOT FERRY DIVISION DREDGING EQUIPMENT

The NCDOT owned and operated the Dredge Carolina since 1968 until retiring the vessel in 2016 when it commissioned the Dredge Manteo. The Dredge Carolina was an 850 pump horsepower hydraulic cutterhead dredge with a 12-inch discharge line. The Dredge Carolina operated for approximately 49 years as the primary tool for maintaining the navigable channels and facility ports of the ferry system. Generally, the NCDOT plans to replace equipment on a 30-year schedule; however, the equipment may be kept longer pending the maintenance needs and funding. As part of the previous maintenance responsibilities, the NCDOT acquired several support vessels and equipment plants to assist in the dredging operations. Maintaining the existing support vessels and operational protocols already in-place helps minimize the transition costs to the larger and more modern Dredge Manteo.

The Dredge Manteo is a 115-ft long by 36-ft wide hydraulic pipeline cutterhead dredge capable of producing approximately 1,100 pump horsepower with a discharge diameter of 14-inches. The NCDOT Ferry Division acquired the Dredge Manteo on April 28, 2016 as shown in Figure 2-1. Support equipment for the dredge includes a crane barge, three (3) tugs, two (2) deck barges, and a fuel barge. Two booster pumps, 10,000 ft of 12-inch High Density Polyethylene (HDPE) pipe, a fusing machine, and a storage trailer complete the support equipment inventory. Table 2-1 shows a list of dredge support vessels and equipment maintained by the Ferry Division. The table provides the type of equipment along with the general use, purchase year, and replacement price.

The equipment requires two (2) crews of eight (8) to safely and efficiently operate when projects do not require a booster. Each crew alternates operating the dredge 12 hr/day 7 days/week followed by 7 days off. Typically, the crew consists of personnel meeting the following NCDOT classifications:

- Master Captain (1 Full Time Equivalent (FTE) Position)
- Leverman (1 FTE Position)
- Engineer (1 FTE Position)
- Deckhands (5 FTE Position)

Boosters provide increased pump efficiency for moving consolidated sediments long distances when the operations require additional hydraulic horsepower. Generally, only material placement sites further than 5,000-ft from the dredge area require the use of a booster pump. When projects require one (1) booster pump, one (1) additional deckhand FTE position joins the support staff on a temporary basis to operate and monitor the pump equipment. If the project requires two (2) booster pumps, the additional deckhand FTE positions increase to three (3).

**Figure 2-1: Dredge Manteo (2016)**

**Table 2-1: NCDOT Ferry Division Dredge Support Equipment**

| Reference Name | Type | Age[1] | Purchase Year | Purchase Amount[2] |
|---|---|---|---|---|
| Dredge Manteo | 14-Inch Hydraulic Dredge (1100 HP) | 2 Years | 2016 | $7,900,000 |
| Skyco | Crane Barge | 10 Years | 2008 | $2,500,000 |
| Albemarle | 68-Ton Tug (650 HP) | 41 Years | 1977 | $312,000 |
| Buxton Jr. | 28 Ton Tug (330 HP) | 35 Years | 1983 | $145,000 |
| Dare | 13 Ton Tug (330 HP) | 35 Years | 1983 | $99,983 |
| NC-01 | 22-Ton Deck Barge | 54 Years | 1964 | Unknown |
| NC-02 | 23-Ton Fuel Barge | 50 Years | 1968 | $9,501 |
| NC-03 | 26-Ton Deck Barge | 50 Years | 1968 | $11,106 |
| Booster #1 | 2008 Model Booster | 10 Years | 2008 | $250,000 |
| Booster #2 | 2008 Model Booster | 10 Years | 2008 | $250,000 |
| Fusing Machine | McElroy 618 | 14 Years | 2004 | $47,000 |
| 10,000 LF of Pipe | 12" IPS SDR17 HDPE | 8 Years Minimum | Varies | $161,600 |
| Storage Trailer | 6'X10' Trailer | 14 Years | 2004 | $4,000 |

1. Equipment age referenced to 2018.
2. Purchase values reflect 2017 replacement costs

The support crews for the dredge equipment work seven (7) days a week on 12-hr shifts. The crews generally work during daylight hours and rotate through a crew change once per week. The crew change day entails minimal dredging operations to allow staff travel time to and from their point of origin. The Dredge Manteo contains housing facilities suitable for two (2) crews of eight (8) staff each with a full galley and two (2) full bathrooms (DSC, 2017). The available housing allows the crews to remain on the dredge vessel during nighttime hours and minimizes travel needs and costs.

The support crew operates independently of the dredging operations and takes on additional responsibilities during times of no dredging. The additional responsibilities include maintenance work for docking facilities utilized by the North Carolina Ferry System. This includes dolphin piling repairs and boat ramp preventative and corrective maintenance. The support crew also conducts any necessary bulkhead repair work within their capabilities. The Ferry Division manages approximately 23 ferry ramps and gantries and 8 bridge structures as part of the division's day to day operations. In addition, the support crew maintains approximately 415 dolphin piles used at the ferry terminals managed as part of the NCDOT. The support crew does not include hydrographic survey personnel, which must be provided through the Locations and Surveys Unit within NCDOT (Peele, 2017).

The dredge support crew operates all land based heavy equipment, such as front-end loaders or bull-dozers, along with the marine vessels. Generally, the Ferry Division rents all land based heavy equipment from other divisions within the NCDOT. Renting the equipment during times of need allows the Ferry Division to minimize costs and maintenance work required for the equipment. Most of the dredging operations do not require significant use of the land based equipment and renting the machinery allows the Ferry Division to defer the ownership and maintenance costs. However, the land based equipment assists in assembling the pipeline for disposal operations in addition to transporting materials and crew and maintaining the material placement sites. Table 2-2 shows the shore or land based equipment rented by the Ferry Division (Peele, 2017). It should be noted that these rental rates are internal rates computed by NCDOT for equipment that NCDOT currently owns.

**Table 2-2: Standard Equipment Rented by NCDOT Ferry Division**

| Equipment | Model | Age | Rental Rate ($/hour) |
|---|---|---|---|
| Excavator | 210LX | 15 Years | $37.00 |
| 16 ~ 18 Ton Crane | 671C | 22 Years | $17.30 |
| Forklift | SD60PLPG | 18 Years | $2.79 |
| 60,000 lb GVW Tractor | 2574 | 19 Years | $23.75 |
| 50,000 lb GVW Truck | L8000 | 22 Years | $11.40 |
| Crew Transport Truck | 2500 | 6 Years | $6.70 |
| 5,000 lb GVW Truck | F150 | 5 Years | $6.40 |
| Material Trailer | PT4593 | 10 Years | $5.10 |
| Push Boat & Trailer | 24MONOBEBTUG | 3 Years | $38.00 |
| Utility Trailer | PB28TR15600SS | 2 Years | $1.10 |
| Water Pump | 6JCB | 13 Years | $9.70 |

# 3.0 DOCUMENTATION OF NCDOT EXISTING DREDGING RESPONSIBILITIES & AGGREGATE COSTS

The NCDOT Ferry Division operates thirteen (13) ferry terminals and one (1) maintenance facility (Manns Harbor) in support of seven (7) full time ferry routes along the North Carolina coastal region. They also operate one (1) emergency route connecting Rodanthe to Stumpy Point. The Rodanthe – Stumpy Pont channel provides emergency access and egress to Hatteras Island when storm events cause washouts along Highway 12. The NCDOT Ferry Division, with the exception of Silver Lake, performs dredging of the basins and channels for the ferry routes, terminals, and the maintenance facility (Peele, 2017). Figure 3-1 shows the location of the ferry routes, ferry terminals, and Manns Harbor. The large majority of all major repair work for the Ferry Division's tugs and water based equipment, including the Dredge Manteo, occurs at the Manns Harbor shipyard.

## NCDOT Ferry Terminals/ Maintenance Facility

- Knotts Island
- Currituck
- Swan Quarter
- Hatteras Terminal
- South Dock/Ocracoke
- Silver Lake/Ocracoke
- Bayview
- Aurora
- Minnesott Beach
- Cherry Branch
- Cedar Island
- Southport
- Fort Fisher
- Manns Harbor

## Ferry Routes

- Knotts Island – Currituck
- Swan Quarter - Ocracoke
- Ocracoke – Cedar Island
- Hatteras – South Dock
- Bayview – Aurora
- Minnesott Beach – Cherry Branch
- Southport – Fort Fisher
- Stumpy Point – Rodanthe

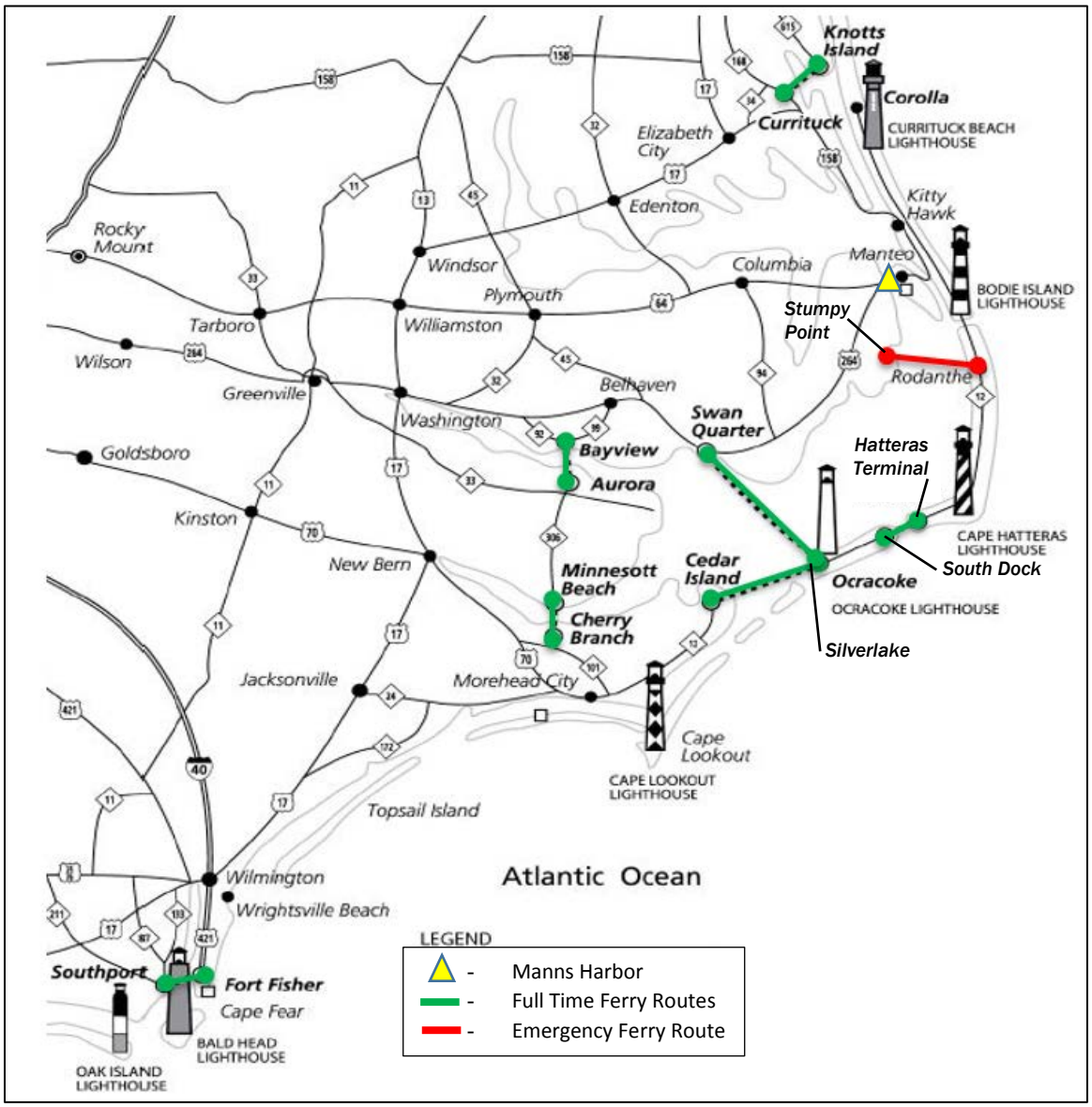


**Figure 3-1: NCDOT Ferry Routes**

After the NCDOT Ferry Division acquired the Dredge Manteo, maintenance dredging occurred in Fiscal Year (FY) 2016/2017 along one (1) ferry route and within one (1) facility basin. The ferry route maintenance event entailed the Southport – Fort Fisher channel and involved removal of approximately 30,000 cubic yards (CY). The facility work entailed three (3) maintenance events at the South Dock facility located on the north end of Ocracoke Island. The first maintenance event at the South Dock location, which was the first dredging project for the Manteo, occurred in response to shoaling impacts created by Hurricane Matthew and received full funding from the Federal Emergency Management Agency (FEMA). The maintenance event removed approximately 11,000 CY from the South Dock channel and basin as part of the hurricane recovery efforts.

The remaining two (2) dredging events occurring at the South Dock facility entailed scheduled or planned maintenance and removed approximately 9,400 CY (Peele, 2017). Table 3-1 provides a summary, including the aggregate costs and schedules, of the FY2016/2017 maintenance events completed by the Dredge Manteo. Table 3-1 also indicates the total days dredged, the calculated average production rate, the cost per cy, and the cost per project day. The difference between project days and days dredged includes periods of extended maintenance, crew change days, bad weather days, and times when the disposal sites could not accept material due to overfilling or effluent drainage issues. The costs described below were developed internally by NCDOT.

**Table 3-1: FY2016/2017 Project Summaries for Dredge Manteo**

| Project | Dates | Project Days[2] | Volume Removed | Aggregate Cost[3] |
|---|---|---|---|---|
| South Dock Basin[1] | 10/16/16 – 11/15/16 | 31 | 11,470 | $93,881 |
| Fort Fisher - Southport | 12/7/16 – 1/13/17 | 38 | 30,343 | $220,264 |
| South Dock Basin | 1/18/17 – 2/21/17 | 32 | 6,709 | $128,476 |
| South Dock Basin | 5/10/17 – 5/21/17 | 12 | 2,666 | $26,152 |
| **Total** | | **113** | **51,188** | **$468,773** |
| **Total Days Worked** | | **113** | | |
| **Total Days Dredged[4]** | | **51.5** | | |
| **Total Volume Removed (cy)** | | **51,188** | | |
| **Total Cost Recorded[1,3]** | | **$468,773** | | |
| **Average Production Rate (cy/day)** | | **994** | | |
| **Cost/CY** | | **$9.16** | | |
| **Cost/Project Day** | | **$4,148** | | |

1. Maintenance event as a result of Hurricane Matthew. Costs were reimbursed by FEMA.
2. Project days include all time spent on project, inclusive of mobilization/demobilization and site preparation efforts.
3. Aggregate costs do not include depreciation estimates for equipment owned by NC Ferry Division
4. Data provided and/or confirmed by NCDOT Ferry Division.

## 3.1 Operational Considerations and Constraints

The Ferry Division schedules routine maintenance events on an annual basis in efforts to streamline the work. The planning efforts help align the maintenance dredging activities with other maintenance requirements for the marine docks or boat ramp structures. Scheduling the work also helps detail the equipment availability in case of unforeseen or advanced dredging needs, such as those created by Hurricane Matthew in 2016. In general, previous experience and maintenance requirements drive the long-term maintenance schedule. However, due to the general location and coastal climate of the ferry facilities and routes, the Ferry Division must constantly monitor each location's conditions and shoaling activities. The Ferry Division has the NCDOT Locations and Surveys unit conduct annual surveys of facility basins and channels where shoaling impacts may be expected. The surveys help determine any changes in the shoaling patterns or provide support for the current schedule.

Environmental windows to protect birds, turtles and fisheries restrict the times of year that in-water operations such as dredging may occur as well as when upland placement is allowed. Restrictions for approximately half of the locations maintained by the Ferry Division limit dredging operations to the months of October through March, but other more restrictive limitations also exist. The authorizing permit for maintenance dredging at each respective facility prescribes when maintenance dredging may occur. Table 3-2 provides a summary of the currently permitted timeframes when maintenance dredging may occur for each of the Ferry Division's facilities and routes.

**Table 3-2: Allowable Dredging Timeframes for the NC Ferry Division Network**

| Location | Allowable Dredging Dates | # of Days[1] |
|---|---|---|
| Aurora | Year Round | 365 |
| Bayview | Year Round | 365 |
| Cedar Island | Year Round | 365 |
| Cherry Branch | October 1 – March 31 | 182 |
| Currituck | October 1 – February 28 | 151 |
| Fort Fisher | October 1 – March 31 | 182 |
| Knotts Island | October 1 – February 28 | 151 |
| Minnesott Beach | October 1 – March 31 | 182 |
| Manns Harbor | November 1 – January 31 | 92 |
| South Dock | October 1 – March 31 | 182 |
| Southport | October 1 – February 1 | 124 |
| Stumpy Point | November 1 – February 14 | 106 |
| Swan Quarter | October 1 – March 31 | 182 |

1. Date ranges do not consider Leap Year intervals.

Effective September 18, 2017 the National Marine Fisheries Service has issued a final rule to designate critical habitat for the Atlantic Sturgeon. The following rivers of North Carolina and South Carolina have been named: Roanoke, Tar-Pamlico, Neuse, Cape Fear, Northeast Cape Fear, Pee Dee, Black, Santee, North Santee, South Santee, and Cooper as shown in Figure 3-2. Additional water bodies including Waccamaw and Bull Creek are also included. It is important to note that the dredging window at Bayview/Aurora, Cherry Branch/Minnesott, and Southport/Fort Fisher terminals may be affected by this new designation. Additional scheduling efforts may ultimately need to be made to comply with this designation

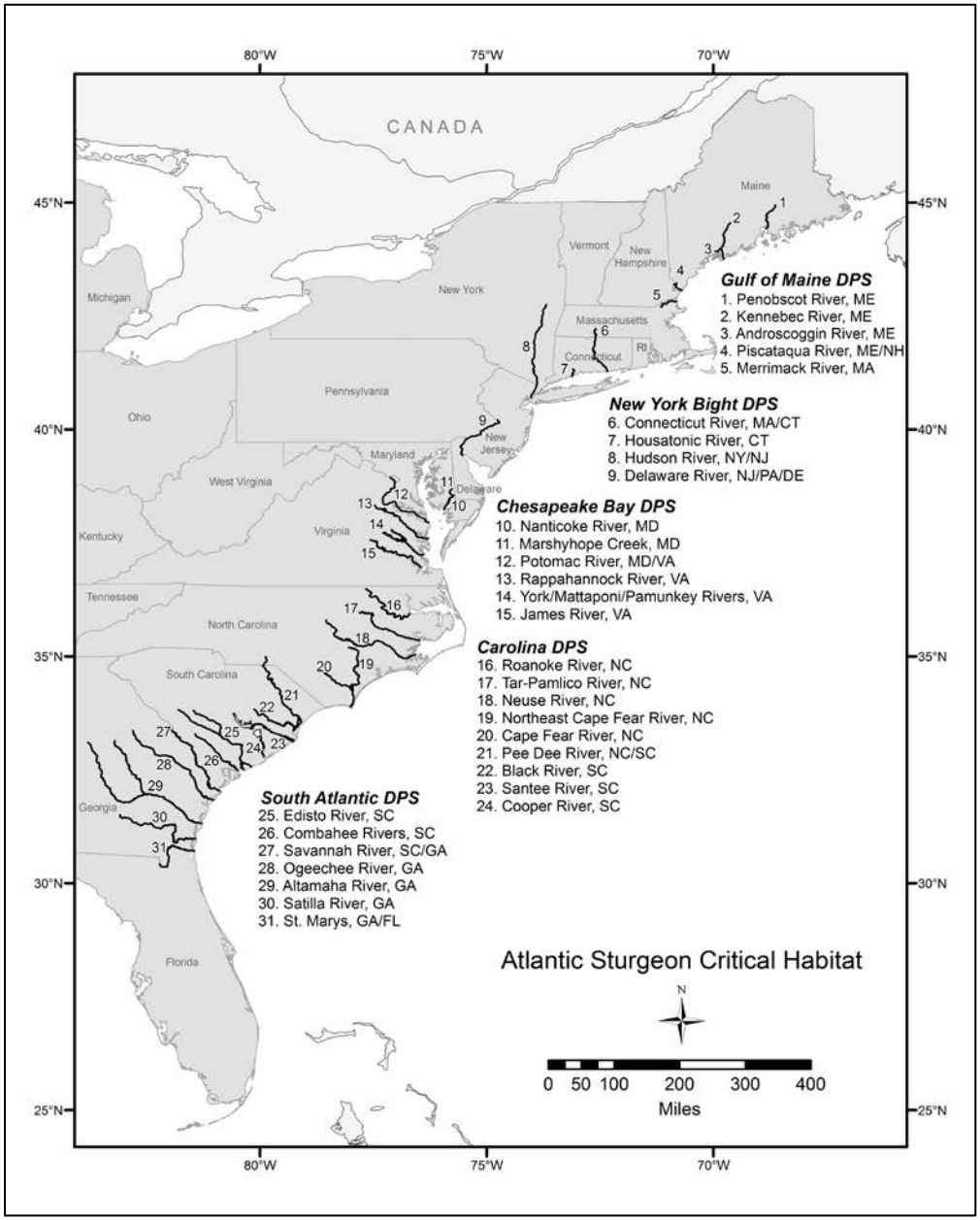


**Figure 3-2: Atlantic Sturgeon Critical Habitat (NMFS)**

The disposal sites that are currently permitted for use by the Ferry Division have also been a constraint on production. A majority of these sites are limited by the allowable size of the facility and the remaining capacity. Currently the Ferry Division performs maintenance operations (dike repair/raising, vegetation control/seeding, and water control structures) during the time of year where dredging is prohibited due to the environmental windows. Dikes are raised where feasible but active management strategies such as material dewatering/consolidation will need to be incorporated. Even with some maintenance operations implemented, disposal site capacity remains an issue for the Ferry Division as evidenced by ongoing downtime issues with the Dredge Manteo at South Dock.

# 4.0 ANNUAL OPERATING COST – DREDGE MANTEO

To fully evaluate the true production rate and operating costs of the Dredge Manteo, fixed and variable costs related to dredging and downtime were incorporated into the analysis. Fixed costs incur whether the dredge operates or not while variable costs are incremental costs that incur due to the operation of the dredge. Fixed costs may include:

- **Fixed Labor:** A full time crew is utilized by the Ferry Division to remain familiar enough with its operation and to instruct and supervise the more transient crew that will be hired and laid-off as projects are executed.
- **Ownership Cost:** Ownership cost is the monthly payment on the capital cost of the dredge and supporting equipment. The future replacement and salvage values of the equipment are included in this item.
- **Survey Cost**: Surveys are performed at regular intervals and more frequently at vulnerable areas; however, not all locations are surveyed each year.
- **Fixed Maintenance Cost**: Some maintenance expenses are independent of whether or not the dredge operates, such as dry-docking required to maintain class certification, and anti-corrosion maintenance such as paint etc.

Variable costs may include:

- **Rentals:** Ancillary plant such as crew boats, tender boats, incur costs when the dredge is operating.
- **Variable Maintenance:** Variable maintenance expenses are items like wear parts and maintenance requirements resulting from operation such as repairs and engine overhauls, etc.

The NCDOT Ferry Division provided labor, survey, equipment capital, and rental costs for the four dredge events in FY2016/FY2017. Supplementing that information were equipment maintenance costs associated with maintaining the Dredge Manteo and support vessels based on annual estimates provided by commercial contractors with similar operations. The equipment ownership costs were computed to determine the ownership cost for the actual project days.

## 4.1 Ownership Costs

The costs reported by the Ferry Division for the four dredge events do not include equipment ownership or replacement costs. The ownership costs are associated with acquisition and payment of equipment, typically an annuity over the lifetime of the equipment. Most equipment (plants) have a salvage value, an amount that it can be sold for at the end of its useful life. In a Discounted Cash Flow (DCF) Analysis, the Net Present Value (NPV) of future expenses and revenues are considered. The salvage costs effectively reduce the overall ownership costs as it is considered a revenue inflow as compared to all other items that are considered an outflow in the analysis. To estimate the ownership cost

using the NPV approach, the following assumptions on costs shown in Table 4-1 were used since available historical information was not available. The ownership costs only represent the acquisition expense and salvage value.

**Table 4-1: Ownership Cost Assumptions**

| Parameter | Description | Value | Note |
|---|---|---|---|
| Plant Value | The Acquisition Cost of the equipment | Actual | As provided by NCDOT |
| Useful Life | The design life of the Equipment | Actual | As provided by NCDOT |
| Acquisition Year | The year that the equipment was acquired or purchased | 2017 | Different equipment could have been purchased in different years, the assumption was to base everything off 2017 |
| Discount Rate | The interest rate used in discounted cash flow analysis to determine the present value of future cash flows | 3.0% | Can vary from 3% for no private engagement to 7% |
| Salvage Factor | The estimated resale value of the equipment at the end of its useful life. | 10% | Would actually depend on the total hours operated and on the actual Repair and Maintenance |

Once the NPV was obtained, the equivalent annual cost (EAC) was then computed. The EAC is the annual cost of owning, operating and maintaining an asset over its entire life. The result of the DCF calculation together with estimates for monthly costs are presented in Table 4-2.

**Table 4-2: Summary of Equivalent Annual Costs of Ownership**

| Equipment | 2017 Purchase Price | Life Expectancy (Years) | Equivalent Annual Cost |
|---|---|---|---|
| Dredge Manteo | $10,000,000 | 30 | $488,543 |
| Skyco Crane Barge | $3,500,000 | 30 | $170,990 |
| HDPE Pipe | $200,000 | 10 | $21,649 |
| Booster | $700,000 | 30 | $34,198 |
| Tug Albemarle | $4,000,000 | 30 | $199,747 |
| Tug Buxton Jr | $1,483,559 | 30 | $74,084 |
| Tug Dare | $1,483,559 | 30 | $72,478 |
| Fusion Machine-Trailer | $162,500 | 20 | $10,300 |
| NC-1 Deck Barge | $109,360 | 50 | $4,150 |
| NC-2 Fuel Barge | $109,360 | 50 | $4,150 |
| NC-3 Deck Barge | $109,360 | 50 | $4,150 |
| **Subtotal** | | | **$1,084,440** |
| **Total Monthly Ownership Cost** | | | **$90,370** |

## 4.2 Maintenance Costs

Equipment maintenance costs associated with maintaining the Dredge Manteo and support vessels were based on annual estimates provided by commercial contractors with similar operations to obtain a maintenance budget. Based on review of the respective estimates, the analysis assumes an annual maintenance fund of $375,000 for the dredging operations extending 12 months on a 24-hour per day basis. For example, for a program allowing dredging on a 12-hr per day basis the monthly maintenance cost should be $15,600 ($375,000 /12 / 2). If the program only allows dredging 6-months per year the total annual maintenance cost would equal $93,600 ($15,600 * 6). For the Dredge Manteo FY2016/2017 operations, dredging occurred 12-hrs per day for 3.77 months. Therefore, the monthly maintenance cost equals $58,900. The analysis also assumes the maintenance work would be conducted by NCDOT staff and equipment at the Manns Harbor shipyard. However, future maintenance work may be contracted out.

## 4.3 Annual Operation Costs

Table 4-3 summarizes the aggregated annual operating costs associated with labor, equipment ownership, equipment rental, materials, maintenance, and survey costs from data provided by NCDOT for the four maintenance events conducted during FY2016/2017. Using the monthly maintenance and ownership costs discussed above and normalized for the 113 working days, the annual operating cost is $1.67 million for FY2016/FY2017.

The maintenance operations removed approximately 51,188 CY during this period yielding an overall unit cost for the FY2016/2017 work of $32.57/cy. As discussed in Volume 3, a review of unit costs associated with small pipeline dredge with placement projects completed in the last five years by private contractors under USACE contracts indicates a range from $12 to $16/cy. The wide gap in unit pricing per yard between the Dredge Manteo and typical unit costs reflects the challenges of fitting out the new dredge including the crew's experience with the operational characteristics of the Dredge Manteo as well as issues related to the management of upland disposal sites. The latter issue has an especially significant and direct bearing since the Dredge Manteo was idle for several weeks while effluent in the upland disposal area at South Dock settled before operations resumed.

**Table 4-3: Summary of Annual Operating Costs**

| Annual Cost Description | FY2016/2017 (113 Project Days) |
|---|---|
| **Annual Operating Cost** | $1,667,100 |
| **Estimated Production Potential** | 51,188 CY |
| **Cost ($/CY)** | **$32.57** |

The US Army Corps of Engineers Cost Engineering Dredge Estimating Program (CEDEP) was set up and executed to provide a better understanding of the operational characteristics of the Dredge Manteo for these four dredge events. The USACE developed CEDEP to provide a consistent means for estimating projects throughout the Civil Works division (USACE, 2016). The program assists in estimating the production rate and unit cost of dredging projects taking into account dredged material characteristics, plant performance parameters, pipeline size and distance, operator experience and effective worktime. Overhead, profit, and other factors are also accounted for in CEDEP. In order to calibrate CEDEP to match the production achieved by the Dredge Manteo during FY2016/2017 as shown in Table 4-4, the following assumptions were made:

- Sand is primary dredged material
- Average dredge cut is 5 feet
- 12-inch pipeline
- 7000 ft Pump Distance with One Booster.
- 1 shift per day per 12-hour operation, 7 days a week
- 9-person crew
- $3/gal for Fuel

**Table 4-4: CEDEP Manteo Calibration – All Jobs**

| **Manteo Calibrated - All 4 Jobs 2016/2017** | |
|---|---|
| **Annual Operating Cost** | $1,586,100 |
| **Estimated Production Potential** | 51,906 CY |
| **Cost ($/CY)** | **$30.56** |

In order to calibrate the CEDEP model, a downtime of 64% was required to match the measured production for the Dredge Manteo; highlighting its impact on unit cost. Typical downtime for a pipeline dredge may range from 20 to 30% for weather and maintenance/breakdown repair issues. CEDEP predicted a slightly lower unit cost for the given production. The $2/cy differential is mainly attributable to the ownership cost calculation. The one dredge event at South Dock in the January-February 2017 timeframe had a significant influence on the unit cost as it reflects the small volume dredged (6,709 cy) during the 32 days the dredge plant was onsite and sat idle waiting for the upland disposal site to accept the material.

Since the dredge project at South Dock in October 2016 reflects the first operational use of the Dredge Manteo; the January 2017 dredging project was affected by the long idle period due to the disposal site; and the May 2017 event was of smaller dredged volume, the CEDEP model was also calibrated to the December 2016 dredging project at Southport. This project was not influenced by aforementioned training or plant idling issues and is indicative of a constant production that should normally be performed by the plant. Table 4-5 shows that the production potential of the Dredge Manteo increases by approximately 18,000 cy a year and the unit cost of dredging decreases to $22.90/cy. Downtime is also

reduced to 52%. As noted previously this rate is higher than the industry average for pipeline dredging. Therefore, with no improvements, the annual operating costs for the Dredge Manteo are estimated to be $1.59 million/yr. In Section 6.0, opportunities to increase efficiency and maximize production will be discussed.

**Table 4-5: CEDEP Manteo Calibration – Southport Job**

| **Calibrated - Southport December 2016 - January 2017** | |
|---|---|
| **Annual Operating Cost** | $1,586,100 |
| **Estimated Production Potential** | 69,260 CY |
| **Cost ($/CY)** | **$22.90** |

# 5.0 DOCUMENTATION OF FUTURE DREDGING WORK EXPECTED BY NCDOT FERRY DIVISION

The maintenance schedule established by the Ferry Division provides outyear projections extending approximately 20-years for maintenance work. The schedule identifies the anticipated budget and timetable for conducting the maintenance events at each facility or channel maintained by the Ferry Division. Table 5-1 and Table 5-2 show the annual estimated maintenance budget extending from FY2018 through FY2037. Table 5-1 shows the annual total budget for the maintenance operations. Table 5-2 provides a synopsis of the annual, maximum, and minimum budgets, average cy/yr and average days worked per year. During years when the maintenance budget exceeds $1 million, the Dredge Manteo may operate approximately 1/3$^{rd}$ of the year and remove 115,000 cy of material based on the unit cost of $9.16/cy from Table 3-1. The budgetary numbers represent current day (2017) values and neglect potential inflation adjustments. The values also neglect all ownership and maintenance cost requirements (Peele, 2017). NCDOT staff update the schedules periodically to account for the inflation adjustments and changes in the maintenance needs.

Aside from the planned maintenance events listed in Table 5-1, additional dredging needs may arise pending the future availability of federal funds and the approval of expansion needs. The Ferry Division monitors the federal activities through communications with the USACE Wilmington District and has assessed the potential to take over some federal channel maintenance responsibilities. The Ferry Division also evaluates how expansions of the current channels may reduce the long-term maintenance requirements of the existing channels.

**Table 5-1: NCDOT Ferry Division 20-Year Maintenance Dredging Estimated Budget**

| Fiscal Year[1] | Budget[2,3] | Fiscal Year[1] | Budget[2,3] | Fiscal Year[1] | Budget[2,3] |
|---|---|---|---|---|---|
| **2018** | $790,000 | **2025** | $1,000,000 | **2032** | $700,000 |
| **2019** | $475,000 | **2026** | $700,000 | **2033** | $1,025,000 |
| **2020** | $700,000 | **2027** | $550,000 | **2034** | $200,000 |
| **2021** | $550,000 | **2028** | $675,000 | **2035** | $200,000 |
| **2022** | $700,000 | **2029** | $475,000 | **2036** | $1,000,000 |
| **2023** | $675,000 | **2030** | $1,050,000 | **2037** | $200,000 |
| **2024** | $550,000 | **2031** | $550,000 | | |

1. Fiscal years begin in the previous year indicated. (i.e. FY18 begins on July 1, 2017 and ends on June 30, 2018.)
2. Budget values exclude equipment ownership and maintenance costs.
3. Budget based on the current funding level in FY17 of $633,124.

**Table 5-2: Dredge Manteo Summary Outyear Workload Cost**

| FY2018 to FY2036 Summary Workload Cost | | |
|---|---|---|
| **Annual Average Value** | **Maximum Annual Value** | **Minimum Annual Value** |
| $650,000 | $1,050,000 | $200,000 |
| 71 days/year | 115 days/year | 22 days |
| 70,620 cy/year | 114,600 cy/year | 21,800 cy/year |

1. Estimated values based on the out-year budget expectations for the NC Ferry Division maintenance dredging needs.
2. Budgets exclude ownership and employee benefit costs.

The Ferry Division provided the following list of sites where they may provide dredge services to offset work previously conducted by the USACE or support expansion of the division's current operations.

- South Dock Entrance Channel – The Ferry Division has acquired permits to expand a portion of the South Dock entrance channel by 75 ft which will increase the dredge quantity to approximately 20,000 cy. The expansion should help reduce the maintenance frequencies for the South Dock facility by providing increased storage capacity for shoaling material. The maintenance events should occur less frequently but should also require removal of more material than current projects. Placement of the dredge material will occur in the disposal site and then be moved to the inlet adjacent to the South Dock facility.

- Sloops Channel – This alternate channel currently provides the primary ferry access between Hatteras Island and the South Dock ferry terminal. Maintenance dredging has not been required to date, but may be expected within the next few years. It is estimated that the dredging volume for this channel will be approximately 30,000 cy. The NC Wildlife Resource Commission (WRC) has initiated the process of obtaining permits for this work, including authorizing fill placement on Bird Island. To access the Bird Island disposal island, a Land Craft Unit (LCU) is required.

- Big Foot Slough – The USACE currently maintains Big Foot Slough; however funding trends suggest federal participation may waiver. With a dredging volume of approximately 170,000 cy required, the Dredge Manteo could complete a portion of the maintenance work, but could not manage the entire project. The marine climate and wave conditions create an unsafe working environment for the Dredge Manteo to maintain the overall channel. Work for the full channel would require a larger or more stable dredge to complete.

- Rollinson Channel – The USACE currently maintains Rollinson Channel. However, if federal funding dissipates the Dredge Manteo could potentially maintain most of the channel with a dredging volume of approximately 100,000 cy required. Material placement would be directed to Cora June Island.

- Atlantic Intracoastal Waterway (AIWW) Crossings – The USACE currently maintains the crossings of the AIWW with the State's shallow draft inlets. As discussed in Volume 2, the projected demand to maintain these crossings to historical levels is 200,000 to 400,000 cy per year. The Dredge Manteo could support dredging some of these inlet crossings shown in Figure 5-1.

- Nine Foot Shoal Channel – This channel is adjacent to Big Foot Slough Channel and feeds into it leading into Ocracoke. Portions of Big Foot Slough frequently shoals, restricting its use by the Ferry Division. The NCDOT Ferry Division maintains the Nine Foot Shoal channel for use by its ferries when Big Foot Slough is not passable or when maintenance dredging by the USACE is underway. The Dredge Manteo could support scheduled maintenance of Nine Foot Shoal.

- Town of Southport – The Town of Southport, NC has requested the assistance of the Dredge Manteo to perform dredging in the Southport Boat Basin. While the majority of this channel is under the USACE's responsibility, the end of the basin, which includes a dock area, is not. The current plan is for the Town of Southport to remove the existing dock structure, have NCDOT dredge the basin, and then they can install a new dock that works better for them. A viable disposal site for the dredge material is still being discussed. Tentative schedule for this project is Fall 2018.

As can be seen from above, under the current operational constraints of the Dredge Manteo, there would be a few years over the next 20 years that the Dredge Manteo could not meet the needs of even the Ferry Division. For this reason, opportunities to increase production capacity were investigated.

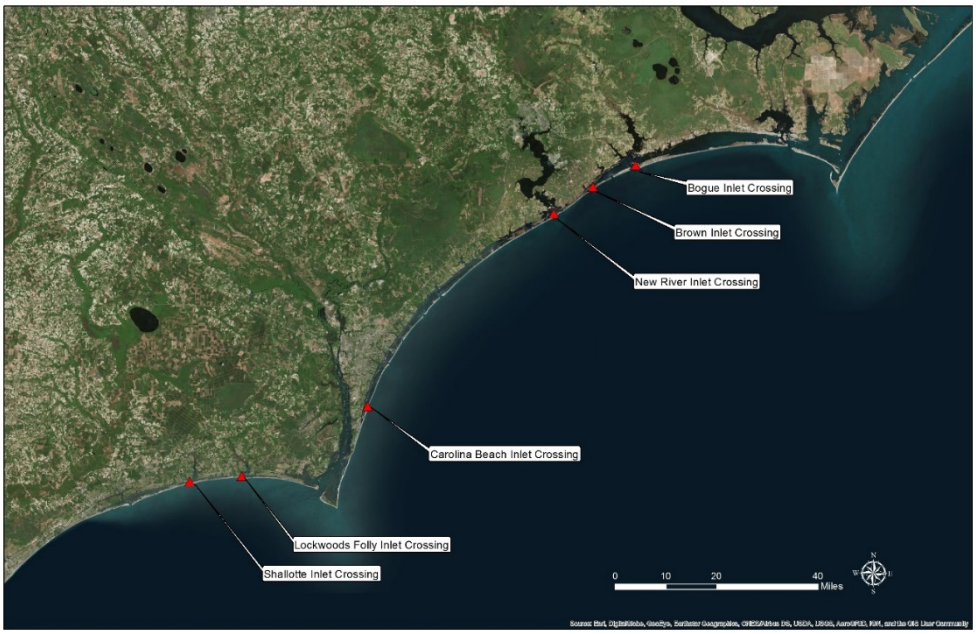


**Figure 5-1: North Carolina Inlet Crossings**

# 6.0 RECOMMENDATIONS FOR INCREASING THE DREDGE MANTEO PRODUCTION

Potential operational improvements to maximize the efficiency in terms of plant production rate were identified and assessed using CEDEP. The identification of improvements was initially based on interviews conducted with Ferry Division staff. Staff proactively monitors the production rates and operational costs for the Dredge Manteo after each project and identified the following operational, material, and physical changes to the dredge plant and associated equipment to increase production rates.

- Increase the operational time to 24 hours a day;
- Increase the discharge pipe size;
- Increase the capacity of the material disposal sites where possible;
- Provide dedicated staff and equipment to the Dredge Manteo for dredging operations; and
- Modify dredge windows

## 6.1 Increase Operational Time to 24 Hours Per Day

Increasing the operational time to 24 hours a day may provide a significant increase in production and cost effectiveness for dredge operations. Making this change would require an increase in crew requirements. The current 12-hour operation time requires two (2) shifts of 8 FTE positions that alternate every 7 days. An increase to 24 hours a day would double this requirement to four (4) shifts of 9 FTE positions. Utilizing the calibrated CEDEP model (based on 52% downtime shown in Table 6-1 without significant disposal site downtimes and assuming the use of a booster to move material, on average, 1.3-miles to one of the disposal islands), the difference in estimated production potential and unit cost for the Dredge Manteo based on 12 and 24 hour operations was determined. Table 6-1 highlights the breakdown of these costs for three operating windows; the November through March environmental window stipulated by most regulatory agencies; a relaxed environmental window that has been accepted by the regulatory agencies for several state shallow draft navigation and beach nourishment projects (October – April), and a year round window. If year round dredging were to occur, the Ferry Division may need to hire additional FTE positions to continue providing maintenance of ferry ramps, gantries, and dolphin repair using the Skyco. This additional cost is not reflected in the annual labor cost for year round operation shown in Table 6-1.

**Table 6-1: Projected Efficiency without Dredge Disposal Site Downtimes**

| | November - March Environmental Window | | October - April Environmental Window | | Year Round | |
|---|---|---|---|---|---|---|
| | 12 hr/day | 24 hr/day | 12 hr/day | 24 hr/day | 12 hr/day | 24 hr/day |
| **Annual Labor** | $1,396,474 | $2,142,211 | $1,396,474 | $2,142,211 | $1,396,474 | $2,142,211 |
| **Annual Equipment Ownership** | $949,933 | $949,933 | $949,933 | $949,933 | $949,933 | $949,933 |
| **Annual Operational Cost** | $536,470 | $916,820 | $751,058 | $1,283,548 | $1,287,528 | $2,200,368 |
| **Annual Survey Costs** | $83,965 | $83,965 | $117,551 | $117,551 | $201,516 | $201,516 |
| **Total Annual Cost** | $2,966,843 | $4,092,930 | $3,215,017 | $4,493,244 | $3,835,452 | $5,494,029 |
| **Estimated Annual Production** | 99,165 CY | 169,450 CY | 138,831 CY | 237,230 CY | 237,996 CY | 406,980 CY |
| **Cost ($/CY)** | **$29.92** | **$24.15** | **$23.16** | **$18.94** | **$16.12** | **$13.50** |

The results from this analysis shown in Table 6-1 suggest the production rate of the Dredge Manteo may be increased approximately 70% by adding a nighttime crew to the operations. The increase in labor and operational costs is offset by the increase in production. The unit cost of dredging also decreases, falling somewhat in line with historical unit costs recorded for shallow draft navigation projects in North Carolina. For the November-March environmental window, the Dredge Manteo may dredge an additional 70,000 cy of material, providing capacity for the Division to perform additional dredging as discussed in Section 5.0 and also highlighted in Volume 2. During maintenance years for Aurora, Bayview, and Cedar Island – locations without dredge windows (depending on the outcome of the Atlantic Sturgeon Critical Habitat designation), scheduling by the Ferry Division may allow the Dredge Manteo to support other state and local agencies/municipalities or the federal government.

## 6.2 Increase the Discharge Pipe Size

The discharge pump system for the Dredge Manteo accommodates a 12-inch or 14-inch pipeline connection. The existing pump in the Manteo provides a 14-inch discharge line but a reducer is used at the connection between the onboard line and the existing HDPE pipe to join the discharge system to 12-inch pipeline segments that the Division uses for placement. Figure 6-1 shows the onboard pipeline terminus and reducer for the 12-inch HDPE pipe.

The 12-inch reducer allows the Ferry Division to utilize the shore pipe obtained during the Dredge Carolina operations. The Ferry Division operated the Dredge Carolina, a 12-inch hydraulic cutterhead, from 1968 to 2016 as the predecessor to the Dredge Manteo. As part of the Dredge Carolina operations, the Ferry Division acquired approximately 10,000 linear feet of 12-inch HDPE pipe. Utilizing the Dredge Manteo with the 12-inch discharge pipe provides a cost savings by not replacing the existing pipe inventory. The cost to replace the 12-inch discharge pipe with a 14-inch pipe would be approximately $200,000. To evaluate the potential increase in production by switching the 12-inch pipe with 14-inch pipe, the CEDEP program was executed utilizing the same parameters discussed in Section 6.1. The production rates increase from 45,000 to 75,000 cy per year depending on the operating

window and a 12 or 24-hour operation. The unit rate decreases to $10 to $12/cy for a year round 12-hour work day; commensurate with rates for projects completed in North Carolina over the past five years by private contractors that can achieve year round use due to operating up and down the East and Gulf coasts. Table 6-2 highlights the breakdown of these costs for a 14-inch discharge pipe. Given this marked increase in production, NCDOT should consult the manufacturer of the Dredge Manteo to confirm the 14-inch diameter for the discharge pipe or determine the size discharge pipeline that provides optimal production and efficiency

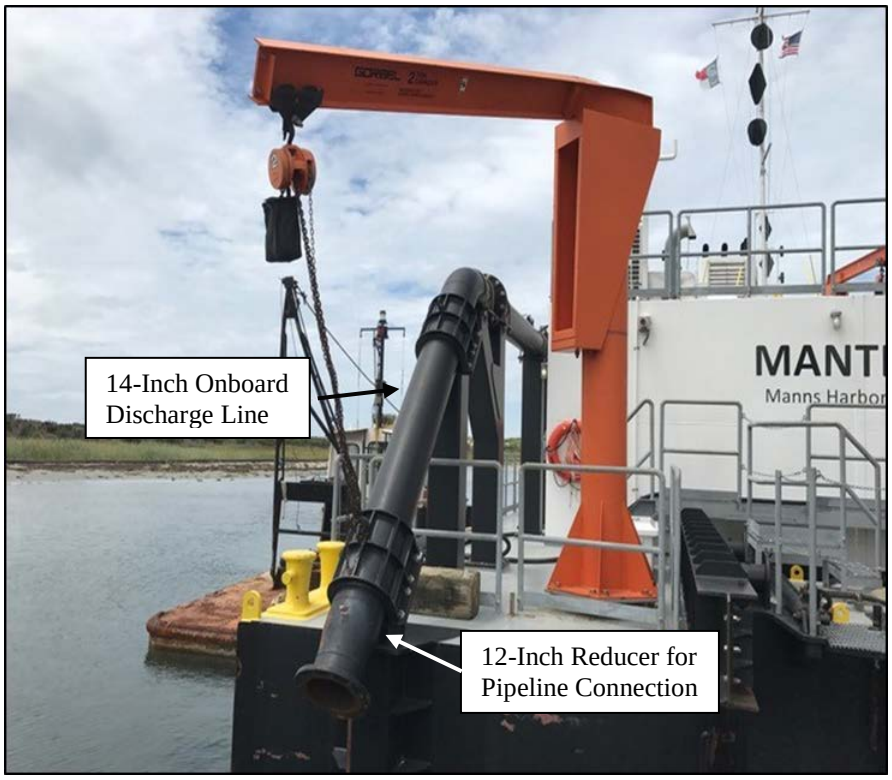


**Figure 6-1: Dredge Manteo Pipe Terminus**

**Table 6-2: Projected Efficiency without Dredge Disposal Site Downtimes with 14-inch Pipe**

| | November - March Environmental Window | | October - April Environmental Window | | Year Round | |
|---|---|---|---|---|---|---|
| | 12 hr/day | 24 hr/day | 12 hr/day | 24 hr/day | 12 hr/day | 24 hr/day |
| **Annual Labor** | $1,396,474 | $2,142,211 | $1,396,474 | $2,142,211 | $1,396,474 | $2,142,211 |
| **Annual Equipment Ownership** | $969,933 | $969,933 | $969,933 | $969,933 | $969,933 | $969,933 |
| **Annual Operational Cost** | $536,470 | $916,820 | $751,058 | $1,283,548 | $1,287,528 | $2,200,368 |
| **Annual Survey Costs** | $83,965 | $83,965 | $117,551 | $117,551 | $201,516 | $201,516 |
| **Total Annual Cost** | $2,986,843 | $4,112,930 | $3,235,017 | $4,513,244 | $3,855,452 | $5,514,029 |
| **Estimated Annual Production** | 134,975 CY | 230,640 CY | 188,964 CY | 322,896 CY | 323,939 CY | 553,945 CY |
| **Cost ($/CY)** | **$22.13** | **$17.83** | **$17.12** | **$13.98** | **$11.90** | **$9.95** |

## 6.3 Increase the Capacity of the Material Disposal Sites

Modifying the disposal site capacity for receiving dredge material may lead to improved efficiency of maintenance dredging operations. The Ferry Division has experienced dewatering delays at multiple disposal site locations but the South Dock facility, which is actively maintained a minimum of two times a year, is the leading candidate to realize operational efficiencies. The South Dock facility has one of the most restrictive disposal sites within the NC Ferry system, with approximately 6.7 acres available for material placement. Table 6-3 shows the available spoil site acreage for the maintained facilities in the ferry system.

**Table 6-3: Disposal Site Acreages**

| Facility | Disposal Site Acreage[1] |
|---|---|
| Aurora | 4.25 |
| Bayview | 4.23 |
| Cedar Island | - |
| Cherry Branch | 8.3 |
| Currituck | 4 |
| Ft. Fisher | 23.48 |
| Hatteras | - |
| Knotts Island | 6.37 |
| Minnesott Beach | - |
| Ocracoke | - |
| Rodanthe | - |
| Manns Harbor (Shipyard) | 4.5 |
| South Dock | 6.7 |
| Southport | 9 |
| Stumpy Point | 67 |

1. Values provided by the NC Ferry Division.

During the referenced January 2017 maintenance project for South Dock, delays encompassed 16 days and cost approximately $49,000. For comparison, the complete project was only 36 days. Therefore, the delays incurred from the site containing insufficient storage capacity nearly doubled the construction period necessary to complete the work. The total project cost equaled approximately $128,500. As a result, the delays experienced due to the lack of storage capacity also increased the project cost by approximately 40%. Assuming each biannual maintenance event for the South Dock facility compares with the referenced January 2017 event, increasing the spoil site capacity may reduce the project costs by approximately $98,000 per year.

The disposal site capacity maybe increased through a design modification to enlarge the spoil site or by removing the existing material during non-working timeframes as shown in Figure 6-2. Increasing the disposal site acreage requires a capacity analysis, design upgrades to the containment system, and modification of regulatory permits. The National Park Service (NPS) owns the South Dock material placement site and allows the Ferry Division to utilize the space. Enlarging the disposal site would have to be reviewed and

approved by NPS; a process that will most likely take a few years to enact. Staff at the Ferry Division have indicated that preliminary plans for enlargement of the site are in their initial stages.

A short term improvement that provides immediate benefits is the active site management of the existing site during operational and non-operational times. The key considerations in site management are controlling the pattern of deposition and maintaining effluent quality during the dewatering process. Moving the position of the inlet disposal operations to achieve an even distribution of sediments and minimize building up of coarser grain material is one method. Adjusting the ponding depth via the weir may also improve solid retention time. However, monitoring of seepage through the containment dikes will need to be performed during operations to prevent instability.

During the non-operational period, material from the site could be removed and placed on erosional beaches near South Dock, which may decrease/improve operational downtimes. The need to protect NC Highway 12 has been highlighted in several studies completed by NCDOT (M&N, 2003, 2004). Removing material from the disposal site and placing it on the beach would provide a means to minimize damage to NC Highway 12 and the existing Ferry Division infrastructure. A permit modification may be required to remove the material but the effort (permitting and construction costs) to remove and place material may offset the cost of the expanding the disposal site. Coordination with the Division of Highways (DOH) would be necessary if material is to be removed because DOH is responsible for determining the need and funding for the removal and placement of material in this site.

Removing the material may also help with decreasing the maintenance dredging frequency for the South Dock facility. Currently, material spilling or sloughing from the disposal site shoals into the navigation channel at South Dock and compounds the natural shoaling effects created by the areas background sediment transport patterns. Removing the material may substantially alleviate this issue.


**Figure 6-2: South Dock Ferry Facility (Ocracoke Island)**

## 6.4 Provide Dedicated Staff and Equipment to Dredge Manteo

The operational capacity of the Dredge Manteo could also be increased by providing a dedicated staff to conduct the maintenance dredging. Currently, the staff assigned to the Dredge Manteo shares responsibilities to repair and maintain the ferry divisions docking facilities. This includes the dolphin piles, channel markers, docks, and other support infrastructure used to improve passenger loading and unloading experiences. Under current workload capacities, combining the facility repair and maintenance dredging responsibilities helps maximize the dredge crew's productivity. However, in order to maximize the production capacity of the Dredge Manteo a dedicated crew should be considered to streamline maintenance dredging efforts.

Providing a dedicated staff for the Dredge Manteo, including the support equipment, would eliminate the need to balance priorities between maintenance dredging and facility repair needs. Information provided by the Ferry Division during the FY2016/2017 fiscal year shows that the facility repair needs redirected the dredge crew for a combined 67-day period. The repair work created two separate delays, each extending only one day, for the maintenance dredging work on November 16 and November 25th. The dredge crew repaired the Minnesott Beach gantry on November 16th and replaced a hydraulic cylinder

at Fort Fisher on November 25th. An additional five (5) day delay occurred from December 1 through December 5th to replace hydraulic cylinders at the Cherry Point facility. The Ferry Division maximized the scheduling benefits of the crew by having the repair work completed in tandem with the maintenance dredging activities. However, the dredge efficiency could be improved by limiting the supplemental duties of the crew and support equipment.

In addition, it is posited that the dedicated staff could possibly be used to upfit disposal sites outside the normal environmental window for dredging. A total of 6 additional FTE positions would be required to manage the sites, which consists of dewatering activities, material management, and dike raising. The State would have to acquire its own permits to complete these actions, but given the effects on production outlined above, it would be an effort well worthwhile.

## 6.5 Modification to Environmental Window

Another opportunity to improve Dredge Manteo efficiency is to conduct dredging at many of its facilities on a year round basis. Modifying the dredge window does require modifying and/waiving standard or special conditions of state and federal regulatory permits. Currently, state and federal permit authorizations prohibit year round dredging at most of the Ferry Division's facilities due to potential environmental impacts to turtles, nesting birds, etc. at many of the dredge disposal sites. However, several municipalities in the state have been granted extensions to the environmental window based on biological studies conducted in support of expanding the dredge window. NCDOT would most likely need to initiate an internal or third-party biological review in cooperation with state and federal resource agencies to investigate the viability of potential year round dredging or expansion of the current environmental windows. Increasing the allowable dredging period to 12-months could potentially double the Dredge Manteo production potential. As seen in Table 6-2 above, for 24-hr operations, going from an environmental window of Nov-Mar to Oct-Apr to Year Round allows for an estimated annual production volume of 230,640 cy, 322,896 cy, and 553,949 cy respectively.

# 7.0 COST SHARING & PARTNERING OPPORTUNITIES AVAILABLE FOR THE DREDGE MANTEO

As discussed in Volume 2, several state agencies including the North Carolina Department of Environmental Quality, Divisions of Water Resources (DENR), Marine Fisheries (DMF), and Coastal Management (DCM), the North Carolina Wildlife Resource Commission (WRC), and the North Carolina State Parks were contacted to identify future demand. The dredging needs of these state agencies presents an opportunity for the Dredge Manteo to assist in dredging these waterways.

WRC maintains public access boat ramps on state and federal lands within the coastal regions of North Carolina. These boat ramps provide access to the inland waterway and the AIWW. Minor maintenance dredging by WRC using private dredge contractors is performed on an as-needed basis to maintain these facilities. Representatives of WRC indicate that on average, 5,000 cy might be dredged at these facilities each year over the next five to ten years. The NC Ferry Division could develop a Memorandum of Understanding (MOU) between the two state agencies to perform this work as needed.

DENR has provided funding assistance to support dredging of federally authorized waterways such the Manteo to Wanchese and North Navigation Channels (Part of the Manteo Shallowbag project linked with Oregon Inlet), the Cape Lookout Access Channel, and Walter Slough. All three channels are authorized and maintained by the USACE but are dredged when federal funds are appropriated. Since DENR last provided funding in the early 2000's, the USACE has funded and maintained Shallowbag and Walter Slough, with the former scheduled for dredging in 2018 and the later dredged in 2017. The Cape Lookout channel has not been dredged for almost 20 years, with the USACE indicating that it is not scheduled to dredge the channel in the next five years. The dredging needs for these channels is listed in Table 7-1.

**Table 7-1: Anticipated Dredge Volumes for Ferry Division Channels**

| Location | Dredge Volume |
|---|---|
| South Dock Entrance Channel Expansion | ~20,000 cy |
| Alternative Channel (Barney Slough) | 30,000 cy |
| Rollinson Channel | ~100,000 cy |
| Big Foot Slough | 170,000 cy |

By incorporating the additional night shift and the average of the dredging windows, the projected production of the Manteo could support an additional ~200,000 cy above its current workload (if all recommended improvements are implemented). It is feasible for the Manteo to include the South Dock Entrance Channel Expansion, the Alternative Channel (Barney Slough), and Rollinson Channel, or only Big Foot Slough.

In terms of federally authorized projects, the AIWW crossing projects represent an opportunity to further utilize the Dredge Manteo's additional capacity.

If federal funds are appropriated for dredging of these waterways and federal dredge plant is not available, then the State may be able to pursue the work through normal federal procurement requirements; meaning the State would have to respond to a federal solicitation as would a private dredge contractor. Circumventing this route, using a MOU for procurement services is possible (as was completed for state funds to be used for the federal dredge plant to complete the projects using the current Shallow Draft Navigation and Aquatic Weed Control Funds) but would have to be legally enabled and reviewed to comply with federal labor and anti-competition laws. Representatives of the USACE indicated they were not aware of an agreement or MOU for procurement of services between the State and the Federal Government where the federal government would pay the State. The other impediment that may bar the use of the Dredge Manteo for federal projects is permitting. Currently, the USACE is the permit holder for nearly all shallow draft projects within the state. As was completed for the Shallow Draft Inlet (SDI-5) permitting project, the State and/or local entities would need to acquire their own permits for these dredging projects in order to complete their own projects. The NC Ferry Division should then be able to perform the work as the USACE currently does with its own MOU with the State and then be able to fund ongoing maintenance projects. As stated above, there are a number of legal and procurement laws and protocols that would have to be studied legally to determine which paths forward are feasible.

# 8.0 COST COMPARISON BETWEEN DREDGE MANTEO AND PRIVATE DREDGE CONTRACTORS

Table 4-3 indicated that the unit cost per yard of dredging for the Dredge Manteo based on its four FY2016/FY2017 projects is approximately $32.57. If the NC Ferry Division implemented some or all of the recommendations discussed in Section 6.0, the unit rate may be reduced between 45% and 57%, with unit costs ranging between $13.98/cy to $17.83/cy. The most beneficial increase in production potential, and corresponding decrease in unit cost, is associated with switching to a 24-hour operation and increasing the size of the discharge pipe.

Private dredging contractors that perform dredging of shallow and deep draft navigation projects in the State of North Carolina were contacted to review their operational procedures of similar size dredges to that of the Dredge Manteo and discuss the typical range of unit costs for projects of similar nature to projects the Dredge Manteo currently performs. Most private contractors sited privacy and competition concerns and would not divulge unit price structures. However, the contractors did indicate operating on a 24-hr/day cycle and performing work on larger volume projects is ideal to achieve cost savings. Several dredgers indicated that investments in support infrastructure is vital to maintaining peak efficiency – something they inferred has been an issue with state-operated dredges in the past.

Since most private dredge contractors were not forthcoming on the operating costs, the unit costs of small pipeline dredges that performed shallow draft navigation and beach nourishment projects (projects with upland or beach disposal) from 1980 to 2015 for the USACE Wilmington District were reviewed and plotted in Figure 8-1. The data points were plotted and 3% and 6% inflation lines included to analyze increasing trends in unit cost. Based on the most recent data, the unit cost ranges between $12 to $14/cy with a forecasted increase up to $16/cy. Data from regional USACE pipeline dredge projects between FY2011 and FY2017 in Figure 8-2 shows that unit prices trend closer to $12 to $14/cy for projects under 100,000 cy and reduce downwards to $8 to $10/cy for larger projects. Since most of the Dredge Manteo work completed in FY2016/FY2017 is under 50,000 cy, the operating cost for the Dredge Manteo is approximately $8 to $12/cy higher on average than industry trends based on current 12 hr/day work day and use of 12-inch discharge pipe with a reasonable downtime (Table 4-5). If the suggested improvements are incorporated, then the unit cost decreases and is comparable to current industry rates.

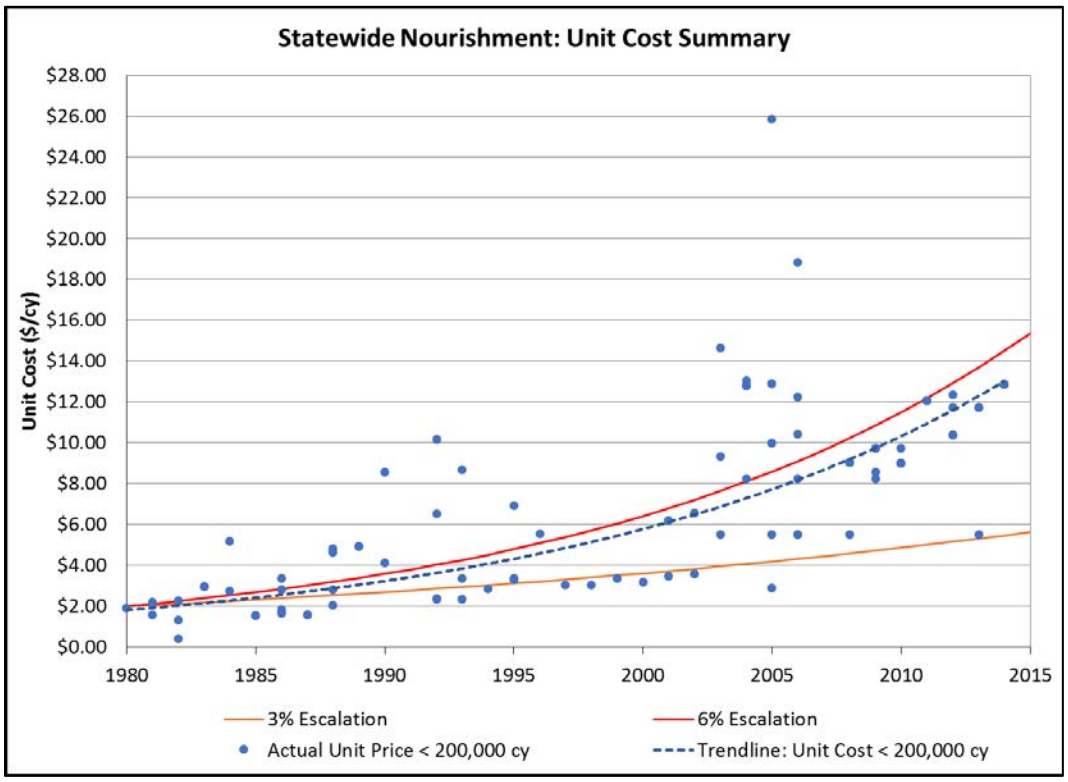


**Figure 8-1: Unit Cost for Dredging Projects Less Than 200,000 cy**

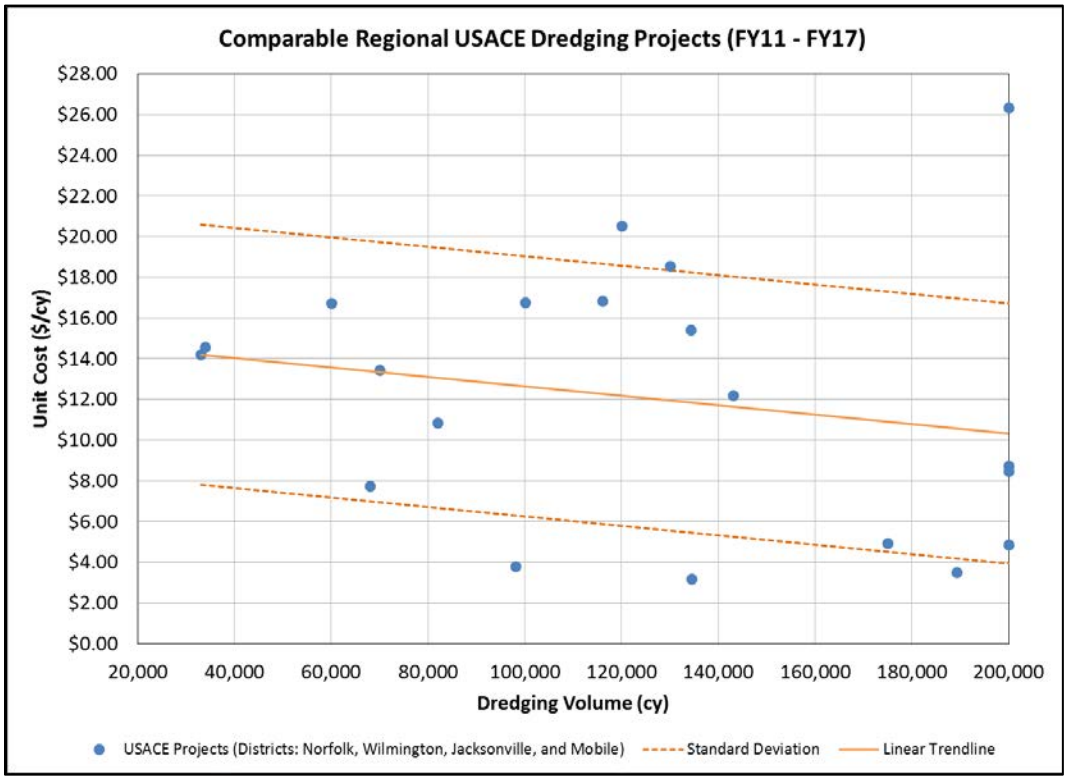


**Figure 8-2: Regional USACE Pipeline Dredge Projects**

## 9.0 SUMMARY OF STUDY FINDINGS AND CONCLUSIONS

The evaluation of the current operations of the Dredge Manteo by the NCDOT Ferry Division is based on a limited number of dredging events since the dredge plant came online in 2016. The limited data and inefficiencies associated with fitting out a new dredge skews the analysis of operating costs for the new dredge. As the dredge crew becomes more experienced with the operation of the dredge, it is anticipated that the production potential and corresponding unit cost per yard of dredging would be reduced. This study has identified several opportunities to improve the operational efficiencies. Dedicated crew(s) that work 24-hrs/day would realize an increase in production as well as maintain a high degree of familiarity with the dredge plant in lieu of shifting staff to provide maintenance work during the dredge operational window. An increase to 24 hrs/day would double the existing need of two (2) crews to four (4) crews. Each crew requires a total of 9 FTE positions that work 12-hrs/day 7 days/week. The replacement of existing 12-inch diameter discharge pipe with 14-inch pipe (or larger) would also provide a marked increase in production potential as would expanded environmental operating windows and expanded/upfitted disposal sites minimize downtime. In summary, the Dredge Manteo's annual operating cost is estimated to range from $4.1 million to $4.5 million, with dredging production capacities ranging from 231,000 to 323,000 cy/yr at a unit cost ranging from $13.98/cy to $17.83/cy depending on the range of improvements that are funded.

The implementation of these opportunities would allow the Dredge Manteo to be more competitive to pursue state or federally authorized dredge projects. Suggested improvements include the following:

- Going to a 24-hr/day operation
- Replacing the 12-inch discharge line with a 14-inch line (or larger depending on dredge manufacturer recommendations) while maintaining the ability to utilize 12-inch pipeline for specific sites
- Investigate expansion of the environmental window
- Have the State/local entities acquire their own permits for shallow draft navigation projects as was done for the SDI-5 project
- Have the State/local entities acquire their own permits to maintain, operate and potentially expand current disposal sites.
- Have the Attorney General's Office investigate the legal issues surrounding the acquisition of these permits as well as the development of an MOU that would allow local entities and the State fund completion of the construction of these projects as currently done with the USACE and the State through the Shallow Draft Navigation Channel and Aquatic Weed Fund.

**If all of these improvements are implemented, it is expected that the Dredge Manteo could operate at an annual cost of $4.3 million/yr with an annual production of approximately 275,000 cy at a unit rate of $15.90/cy**.

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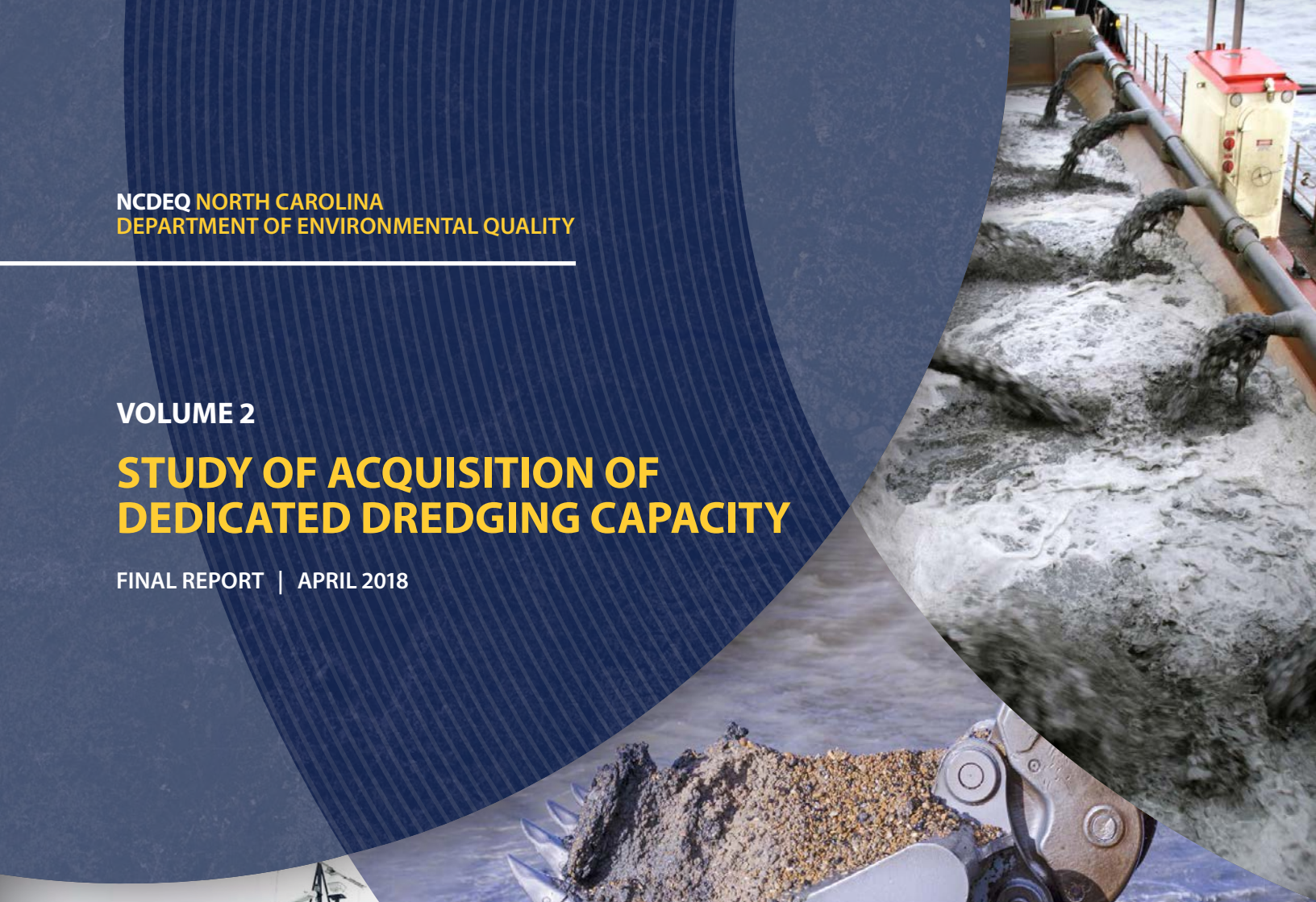
NCDEQ NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY

VOLUME 2

# STUDY OF ACQUISITION OF DEDICATED DREDGING CAPACITY

FINAL REPORT | APRIL 2018



moffatt & nichol

# EXECUTIVE SUMMARY

In this volume, the acquisition of dedicated dredge capacity beyond the Dredge Manteo was evaluated based on anticipated existing and future forecasted dredging needs in, and potentially outside, the state that are not currently performed or could be performed by the Dredge Manteo. The potential expansion of the fleet was weighed against the cost to acquire, operate and maintain the additional dredge equipment in a manner that minimizes cost or promotes self-sufficiency, is cost competitive with the private dredge industry, and complies with labor and anti-competitive practices and law.

The historical dredging volumes for shallow draft navigation were separated into three project classifications to which existing and projected dredge needs could be evaluated and the type of equipment required to meet those needs identified. These three classifications are:

- Shallow Draft Inlets (Beach Compatible) including Oregon Inlet
- AIWW Crossings (Beach Compatible)
- Remainder of AIWW and Inland Channels (Non-Beach Compatible)

For Shallow Draft Inlets including Oregon Inlet, it is projected that the average dredge needs are 3.0 to 3.5 million cy/yr to support unrestricted navigation of the waterways while another 1 million cy/yr of dredging would satisfy the peak need (approximately 1.0 million cy/yr is required to maintain navigation through Oregon Inlet and the shallow draft channels to Wanchese and Manteo). Dredged material removed from the AIWW and the Inland Channels has been approaching 500,000 cy/yr over the last decade. This level of dredging provides the minimum required to maintain navigability for smaller vessels. However, dredging up to 1.0 million cy/yr, the average volume dredged during the 1990's, would improve navigability of the AIWW for larger vessels. If there is a desire the fully maintain the AIWW (peak need), then a total of 1.5 million cy/yr would need to be removed.

There are two deep draft projects (Cape Fear River and Morehead City Harbor) with federally authorized depths greater than 15 feet which serve North Carolina's two major ports, Wilmington and Morehead City, respectively. Dredging has remained constant around 3 million cy/yr but peak dredging needs may approach 4 million cy/yr.

The investment by the State to meeting the minimum entire shallow draft need is the purchase of one 14-inch pipeline dredge, one 20-inch pipeline dredge, and one special purpose dredge in addition to the Dredge Manteo. This $81.5 million investment is associated with a $25.7 million annual operating cost. To meet the average shallow draft need, the State would need to purchase one 14-inch, one 20-inch, and one 24-inch pipeline dredge, and one special purpose dredge in addition to the Dredge Manteo. The state would be investing $138.3 million to purchase them and subsequently $39.7 million annually to maintain this fleet. If there is a desire to match the peak need for shallow draft dredging, then six dredges should be purchased; four pipeline dredges (one 14-inch, two 20-inch, and

one 24-inch) and two special purpose dredges. This acquisition would cost $197.9 million and the state would need to fund a $61.0 million annual operating cost.

Two alternative investment scenarios were evaluated to meet some of the shallow draft dredging needs. The minimum investment approach considers the purchase of a special purpose hopper dredge, a 14-inch pipeline dredge, and a 20-inch pipeline dredge. For the approximately $81.5 million initial cost and an annual operating cost of $25.7 million/yr, the state would have three dredge plants capable of 2.5 million cy/yr production. This combination of dredge fleet addresses the average needs of Oregon Inlet while the 14-inch and 20-inch dredges could also support dredging of the remaining shallow draft inlets, the AIWW, AIWW crossings, and some interior waterways.

The other alternative approach considers purchasing a dredge fleet based on current funding levels from the Shallow Draft Navigation and Aquatic Weed Fund. One special purpose dredge and one 24-inch pipeline dredge could be operated with this fund. The initial cost for these two dredges is approximately $81.8 million and the annual operating cost is $26.3 million/yr. The special purpose hopper would perform year round dredging to meet the average needs at Oregon Inlet and other shallow draft inlets. The ocean certified 24-inch pipeline dredge would perform dredging of the AIWW and AIWW crossings as well as some deep draft work if needed.

The deep draft navigation needs of the state were also evaluated in combination with the shallow draft navigation investment. At a minimum, one 30-inch pipeline dredge could be acquired to maintain the inlet throat and inland channels for the Ports of Morehead City and Wilmington. The USACE would continue to maintain the ocean bar segment. The purchase of the 30-inch pipeline dredge would escalate the investment of the minimum and average shallow draft dredging needs by approximately $77.5 million, for a total initial cost of $159 million (annual operating cost of $44.4 million/yr) and $215.8 million (annual operating cost of $58.4 million/yr), respectively. The peak need for the deep draft maintenance dredging requires one medium capacity hopper dredge in addition to the average need with an initial cost of $67 million. When coupled with the peak shallow draft need, the total investment is over $342.4 million (annual operating cost of $95.1 million/yr).

Sources of funding for such a large purchase could be from a statewide bond measure to maintain navigable waterways; offset by a fee structure similar to the Shallow Draft Navigation Channel and Aquatic Weed Fund or other funding mechanism discussed in the BIMP to support inlet and beach restoration needs.

# TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

# VOLUME 2: STUDY OF ACQUISITION OF DEDICATED DREDGING CAPACITY

## 1.0 PURPOSE AND NEED

The North Carolina General Assembly (NCGA) commissioned a three-part study to evaluate the State's participation in maintaining shallow draft navigation waterways through the use of existing dredge equipment operated by the North Carolina Department of Transportation Ferry Division and through the potential acquisition of additional dredge plants to meet existing and projected maintenance dredging needs of the State's waterways (NCGA, 2017). In this volume, the acquisition of dedicated dredge capacity beyond the Dredge Manteo will be evaluated based on anticipated existing and future forecasted dredging needs in, and potentially outside, the state that are not currently performed or could be performed by the Dredge Manteo. The Shallow Draft Navigation Study (NCGA, 2005) and Beach and Inlet Management Plan (NCDEQ, 2016) identified future dredging needs that would support expansion of the State's dredge fleet. The potential expansion of the fleet must be weighed against the cost to acquire, operate and maintain the additional dredge equipment in a manner that minimizes cost or promotes self-sufficiency, is cost competitive with the private dredge industry, and complies with labor and anti-competitive practices and law.

This volume summarizes the existing and forecasted dredging needs within the state and identifies the number and type of equipment that would be required to perform the work based on location, USCG certification, and environment. Data collected from government entities and the private dredge industry was used to develop a range of acquisition, operating, and maintenance costs for the dredge, support equipment and facilities that will be compared with costs supplied by the state for the Dredge Manteo.

Potential funding resources were identified to support the purchase of state-owned dredging equipment outside of the State's Shallow Draft Navigation Channel Dredging and Aquatic Weed Fund. In discussions with legislative representatives, the enabling legislation for this study was clarified to recognize that the Shallow Draft Navigation Channel and Aquatic Weed Fund could be used to complete dredging projects as is done with the USACE currently. The fund could not be used for the initial purchase of the dredges and associated equipment. Options to increase the cost effectiveness of the state-owned dredges through partnerships with the US Army Corps of Engineers or the sale of dredged services was evaluated. Public Private Partnerships (P3s) were also evaluated.

North Carolina inlets have tremendous economic value. Taking the total from Table 1-1, inlets provide approximately $874 million in direct expenditures through business and tourism, ocean access for commercial and recreational fishermen, and the marina and boat building industries. Inlets provide a direct source of employment and generate over 16,000 jobs in the coastal communities. Citizens of the state and visitors derive considerable benefits from the coastal region.

## Table 1-1: Economic Impact of North Carolina Beaches and Inlets (BIMP 2016)

| Sector | Direct Impact Expenditures | Total Impact Output/Sales/ Business Activity | Total Impact Employment | Total Local Tax Revenue | Total State Tax Revenue | Total Federal Tax Revenue | Annual Consumer Surplus |
|---|---|---|---|---|---|---|---|
| Beach Recreation (2013-2014) | $1,662,190,984 | $4,741,454,600 | 48,718 | $155,806,220 | $163,107,645 | $375,840,980 | $89,672,622 |
| Shore and Pier Fishing (2013-2014) | - | - | - | - | - | - | $48,995,668 |
| Marine Recreational Services (2013-2014) | $11,046,413 | $23,202,475 | 1,929 | $880,340 | $839,947 | $1,790,992 | - |
| Commercial Fishing (2015) | $59,532,630 | $96,617,338 | 3,462 | $1,320,711 | $1,921,371 | $4,405,610 | - |
| Seafood Packing and Processing (2015) | $182,090,002 | $234,173,385 | 1,047 | $1,929,825 | $2,067,701 | $5,179,471 | - |
| Charter/Head Boat Fishing (2015) | $38,375,865 | $67,515,681 | 1,388 | $1,618,364 | $1,830,175 | $4,031,208 | $70,367,700 |
| Recreational Boating/Fishing (2015) | $79,074,771 | $159,853,665 | 1,997 | $6,575,790 | $6,492,187 | $13,232,600 | $5,826,607 |
| Boat Building (2015) | $211,262,212 | $327,436,125 | 1,811 | $6,575,632 | $6,170,470 | $16,726,255 | - |
| Marinas (2015) | $70,372,449 | - | 1,586 | - | - | - | - |
| Deep Draft Port Activity (2015) | $222,081,263 | $416,844,855 | 2,973 | $4,291,516 | $5,976,508 | $22,443,697 | - |
| **NC TOTALS** | **$2,536,026,589** | **$6,067,098,124** | **64,911** | **$178,998,398** | **$188,406,004** | **$443,650,812** | **$214,862,598** |

## 2.0 SHALLOW DRAFT NAVIGATION WATERWAYS

The State of North Carolina has over 308 miles of the Atlantic Intracoastal Waterway (AIWW), seven navigable inlets, and numerous shallow draft navigation channels in the rivers and tidal estuaries that require frequent maintenance dredging to provide safe and reliable access. In addition, the state has over 38 miles of deep draft navigation channels in the Cape Fear River and Morehead City Harbor that provide vital links for ocean-going commerce and military response.

Dredging of these waterways in North Carolina is performed by the Wilmington District of the United States Army Corps of Engineers (USACE), the State of North Carolina Division of Environment and Natural Resources (DENR), the North Carolina Department of Transportation (NCDOT) Ferry Division, and by private interests. The USACE maintains federally authorized waterways and partners with the state or local governments to provide maintenance dredging of some non-federal shallow draft waterways. In North Carolina, the USACE is responsible for shallow draft projects with dredging depths of less than 20 feet; classified by location as Inlets or Inland. Inlet and channel dredging comprised most of the dredging activity, while dredging of the AIWW and inland channels and rivers constitutes the remainder.

The International Rules formalized by the Regulations for Preventing Collisions at Sea, 1972 are applied to waters outside of the established navigational lines of demarcation (COLREGS) (USCG, 2011). This demarcation line defines where inland and international navigation regulations apply. For this report, dredging projects that include an inlet (channel and ocean bar) are designated as projects performed outside the COLREGS line. The one exception is Masonboro Inlet, which is classified as an inland waterway since the COLREGS line lies seaward of the jetty. The AIWW channel and inlet crossings (where the AIWW crosses an inlet) as well as rivers and other inland waterways are designated as Inland Projects. Inlet and Inland classifications by project location are shown in Table 2-1.

**Table 2-1: Shallow Draft Navigation Projects in North Carolina**

| Inlets (Bar and Channels) | Inland (AIWW, Rivers, and Other Waterways) |
|---|---|
| Bogue Inlet and Channels | AIWW Through Channel and Inlet Crossings |
| Carolina Beach Inlet and Channels | Atlantic Beach Channels |
| Drum Inlet | Avon Harbor |
| Hatteras Inlet/Rollinson Channel | Beaufort Harbor |
| Lockwoods Folly Inlet | Cape Fear River |
| Manteo (Shallowbag Bay)/Oregon Inlet | Channel from Back Sound to Lookout Bight |
| New River Inlet | Edenton Harbor |
| New Topsail Inlet and Channels | Far Creek |
| Ocracoke Inlet/Silver Lake | Lockwoods Folly River |
| | Masonboro Inlet |
| | Mile Hammock |
| | Shallotte River |
| | Stumpy Point Bay |
| | Waterway Connecting Pamlico Sound to Beaufort Harbor |
| | Waterway Connecting Swanquarter Bay with Deep Bay |
| | Wrights Creek |

In sheltered inland waterways, the choice of dredging equipment is broader than in the exposed ocean inlets where dredge equipment operates outside of the COLREGS lines. The disposal method, either upland, in-water, or beach placement also determines the type of dredge equipment selected to perform the work. For inland NC waterways where the material being dredged is not beach compatible, sidecast or pipeline dredges are normally used. For inland channels where material is suitable for beach placement, a pipeline dredge is preferred. A suitable pipeline, sidecast or special purpose hopper dredge typically performs dredging at the inlets and is classified to work outside the COLREGS line. A special purpose dredge is more adept at navigating shallow ocean bars while pipeline dredges, with their deeper drafts, have difficulty accessing these areas.

The two major classifications were sorted by disposal method to create a subset of three shallow draft navigation project classifications to which existing and projected dredge needs could be evaluated and the type of equipment required to meet those needs identified. These three classifications are:

- Shallow Draft Inlets (Beach Compatible) including Oregon Inlet
- AIWW Crossings (Beach Compatible)
- Remainder of AIWW and Inland Channels (Non-Beach Compatible)

The tidal dynamics of Oregon Inlet result in a constant movement of sediments that are deposited into the channel at a rapid rate. Due to the significant volume of material and the type of dredge required to perform the work, a separate classification was developed to assist in evaluating dredge equipment needs.

# 3.0 HISTORICAL DREDGING VOLUMES – SHALLOW DRAFT NAVIGATION WATERWAYS

## 3.1 Federal, State, and Locally Maintained Shallow Draft Waterways

Historical levels of maintenance dredging for federal, state, and locally maintained shallow inlets, channels, and inland waterways were identified in the Beach and Inlet Management Plan (BIMP) legislated by the NCGA in 2009 and updated in 2016. Dredging and beach nourishment databases were compiled for the BIMP in 2009 and updated in 2016 from multiple sources (federal, state, local municipalities, universities, and other organizations or individuals familiar with NC beach and inlet projects).

All values in the dredging database consider projects or parts of projects where sediment was not used for beach nourishment specifically, meaning it was instead placed in a disposal island or offshore disposal site. The beach nourishment database compiles all projects where material was placed in the nearshore or on the beach itself. Pertinent information from the two databases was combined to summarize the historical dredge volumes for statewide dredging by shallow draft navigation project classifications.

Figure 3-1 to Figure 3-4 show the total volumes for shallow draft inlets (including Oregon Inlet), shallow draft inlets (excluding Oregon Inlet), AIWW crossings, and AIWW and Inland waterways that occurred statewide from 1975 to 2015, respectively. Shallow draft inlet dredging has historically averaged 3.0 to 4.0 million cy/yr since the mid-1980's, reflecting an uptick in inlet dredging for navigation and beach nourishment needs. A downward trend in the volume has occurred over the last five years, to around 1.5 million cy/yr as federal monies for maintenance dredging have been reduced.

Figure 3-2 highlights the contribution of Oregon Inlet to the overall shallow draft inlet dredging volume. With the exception of 2012, when dredging for Oregon Inlet was not started until after the passage of Hurricane Sandy, the volume of maintenance dredging at Oregon Inlet has hovered around 1 million cy/yr. This near constant dredge volume reflects the realities of maintaining a navigation channel in a significantly dynamic environment. Since 2013, state and local funds have, in part, offset some loss of federal monies, allowing maintenance activities to continue at near historical levels.

The undulating trend associated with dredge volumes for the AIWW crossings is also related to the timing of federal funds. The material dredged from these crossings varies from 100,000 to 800,000 cy, with higher volumes associated with a large one-time infusion of federal monies. Dredging of the AIWW and Inland Waterways has also decreased drastically, reflecting the volume trend, from an average of 1.6 million cy/yr in the early 1990's to a low of 500,000 cy/yr during the past 5 years. Since the AIWW and Inland Waterways are solely maintained by the USACE, the decreased volume is reflective of limited federal government funding.

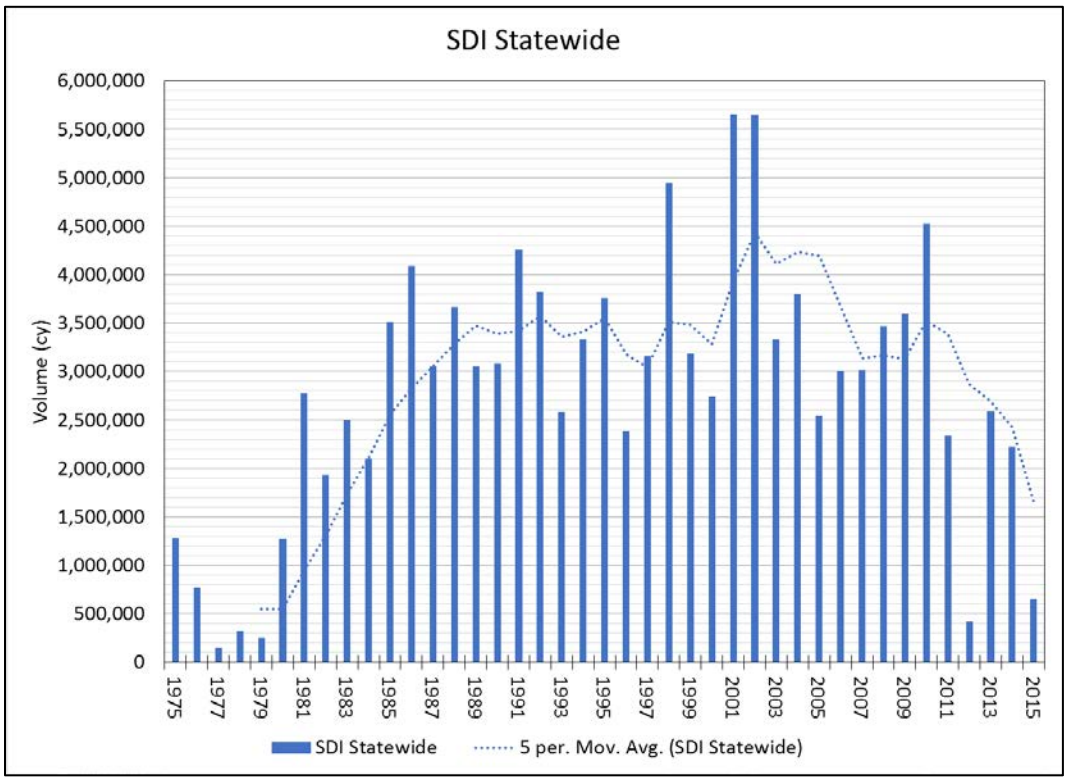



**Figure 3-1: Shallow Draft Inlets Statewide Dredge Volumes**

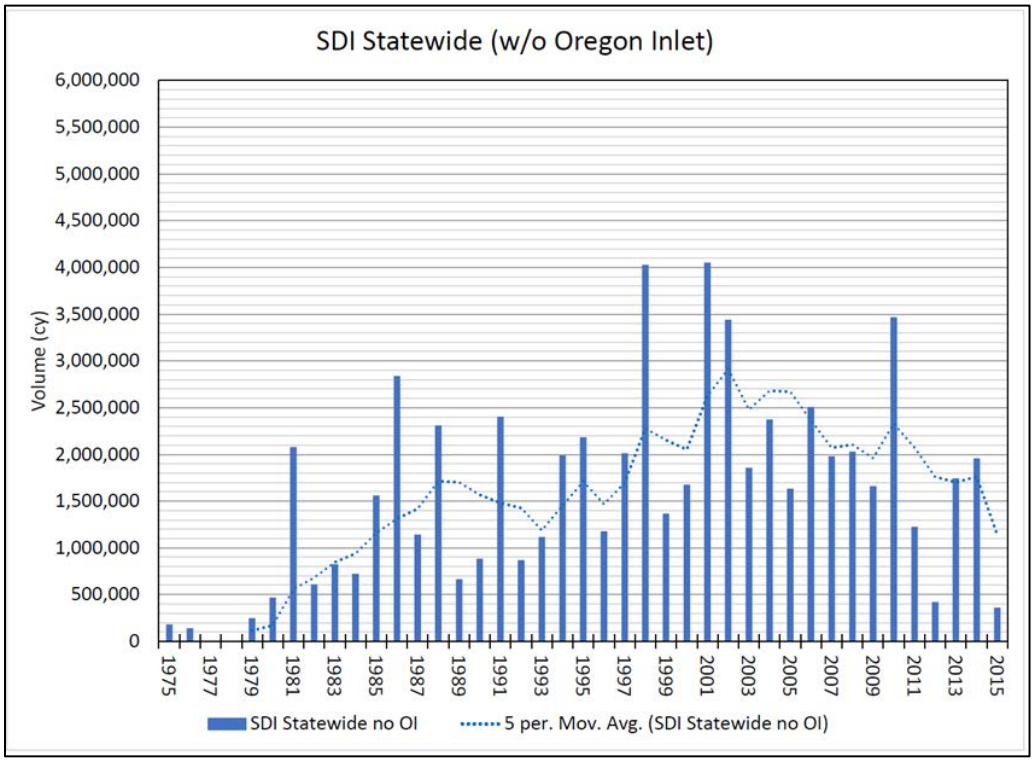



**Figure 3-2: Shallow Draft Inlets (w/o Oregon Inlet) Statewide Dredge Volumes**

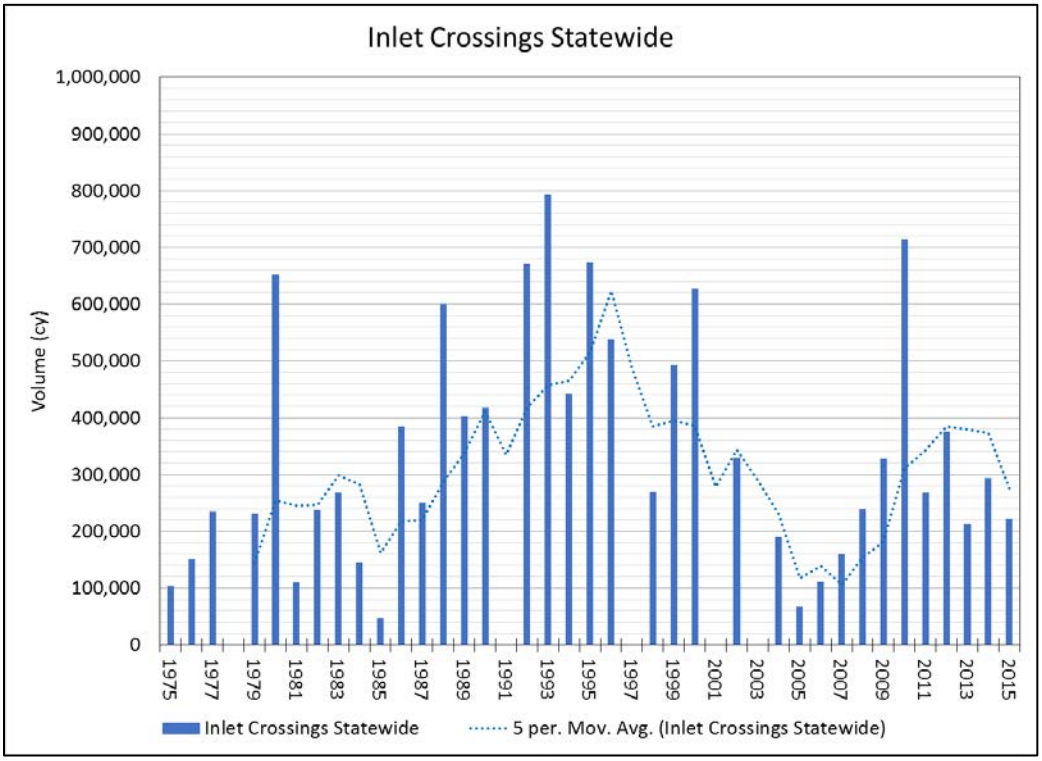



**Figure 3-3: AIWW Crossings Statewide Dredge Volumes**

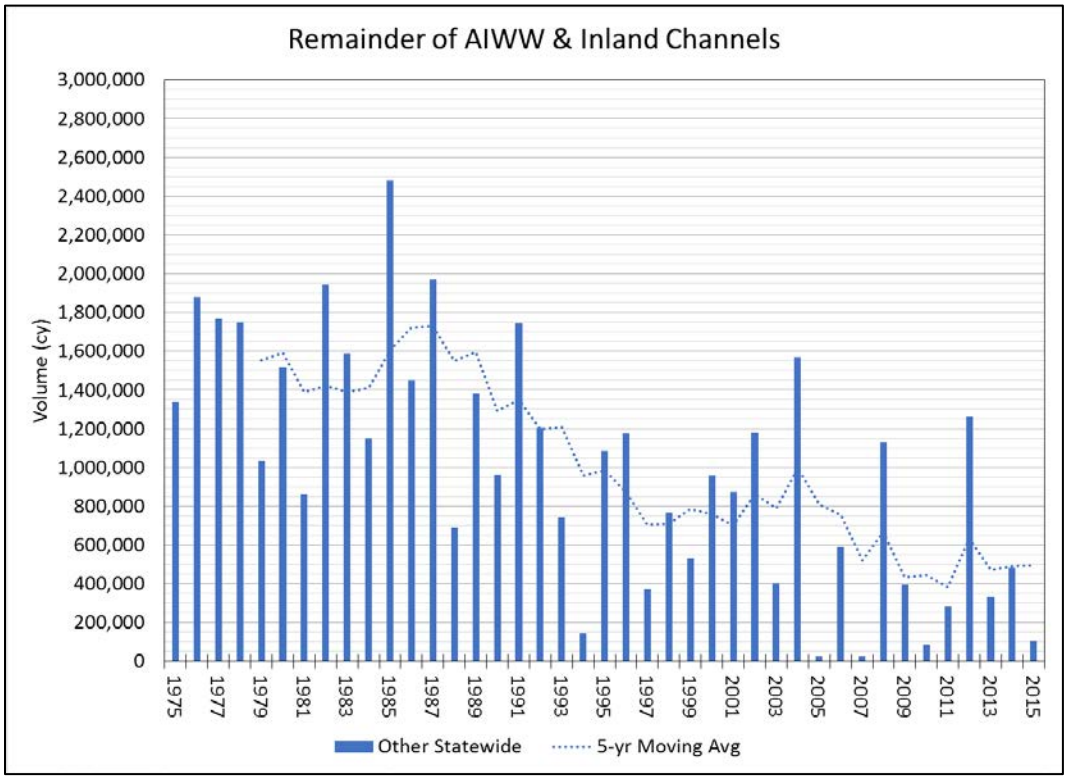



**Figure 3-4: AIWW and Inland Water Channels Statewide Dredge Volumes**

The downturn in maintenance dredging, both in frequency and in volume, has diminished the navigability of the shallow draft waterways, precluding some vessels from accessing them. The shoaled waterways ultimately lead to reduced usage, which in turn produces less economic activity from commercial fisheries and other waterborne commerce as well as discretionary spending by recreational boaters. As seen in Table 1-1, these inlets have a significant economic effect on North Carolina.

## 3.2 NC DOT Ferry Division Waterways and Facilities

The NCDOT Ferry Division operates thirteen (13) ferry terminals and one (1) maintenance facility (Manns Harbor) in support of seven (7) full time ferry routes along the North Carolina coastal region. They also operate one (1) emergency route connecting Rodanthe to Stumpy Point. The Rodanthe – Stumpy Pont channel provides emergency access and egress to Hatteras Island when storm events cause washouts along Highway 12. The NCDOT Ferry Division, with the exception of Silver Lake, performs dredging of the basin and channels for the ferry routes, terminal, and the maintenance facility (Peele, 2017). Figure 3-5 shows the facilities and ferry routes maintained by the Division. Figure 3-5 also includes the Manns Harbor shipyard, a facility operated by the Ferry Division to provide repair services to the Division's fleet of water based equipment. A summary of the facilities and their dredging frequency and average quantities are provided below.

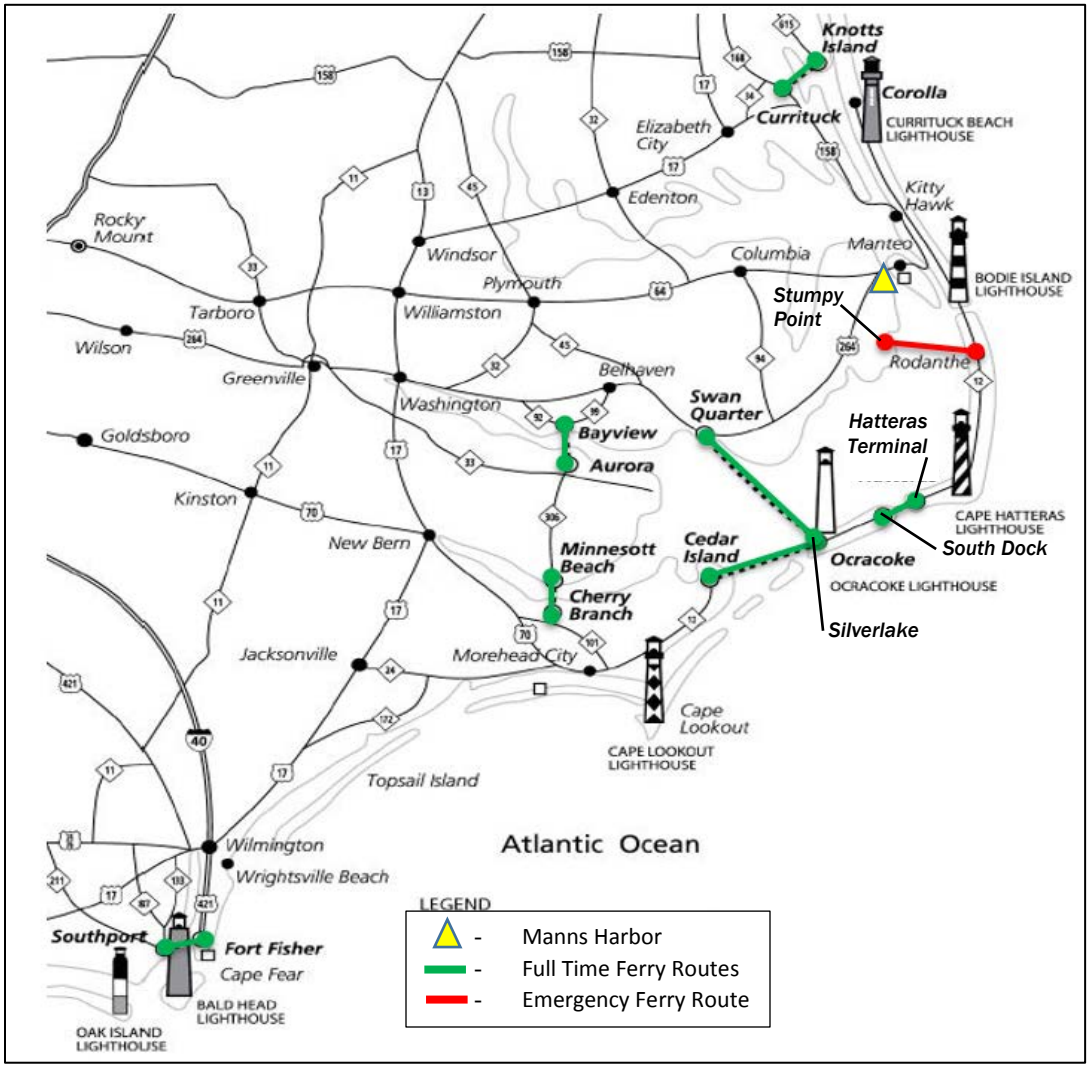



**Figure 3-5: NCDOT Ferry Facilities and Routes**

### *3.2.1 Aurora (Pamlico River-South Side)*

This project area is located on the south side of the Pamlico River near Aurora. The approach channel is 1,850 ft long, 100 ft wide, and 10 ft deep. The turning basin is 400 ft by 400 ft and 10 ft deep. The project area is dredged every eight years, removing approximately 40,000 cy each time.

### *3.2.2 Bayview (Pamlico River-North Side)*

This project area is located on the north side of the Pamlico River near Bayview. The approach channel extends out 2,500 ft and is 100 ft wide and 10 ft deep. The turning basin is of the same dimensions as the one on the south side of the river at Aurora. The project area is dredged around every eight years, removing approximately 20,000 cy of material each time.

### *3.2.3 Hatteras Terminal*

This project area is located on the north side of Hatteras Inlet on Hatteras Island. The approach channel is 1,200 ft long, 150 ft wide, and 6 ft deep which is maintained by the USACE. This project area is dredged every five years by the USACE, removing approximately 40,000 cy of material each time. There is a 600 ft by 200 ft turning basin that is maintained at 6 ft depth which is the responsibility of the Ferry Division; however, there is no disposal site for this material, and thus it has not been dredge recently.

### *3.2.4 Cedar Island*

Cedar Island ferry terminal is located in the southern portion of Pamlico Sound, slightly north of Drum Inlet. The approach channel is 600 ft long, 200 ft wide, and 12 ft deep. The turning basin is 400 ft by 400 ft and is 12 ft deep. The project area is dredged every thirteen years, removing approximately 20,000 cy of material each time.

### *3.2.5 Cherry Branch*

Cherry Branch ferry terminal is located on the south side of the Neuse River in Cherry Branch, NC. The approach channel is 2,100 ft long, 150 ft wide, and 10 ft deep. The turning basin is 957 ft by 400 ft and is 10 ft deep. The project area is dredged every ten years. Approximately 15,000 cy of material is removed each time.

### *3.2.6 Currituck*

Currituck ferry terminal is located on the west side of Currituck Sound near Coinjock Bay. This project involves a 500 ft long approach channel that is 100 ft wide and 10 ft deep. The turning basin at this terminal is 250 ft by 300 ft. Currituck is dredged every six years, removing approximately 10,000 to 15,000 cy each time.

### *3.2.7 Ft. Fisher*

Ft. Fisher ferry terminal is located just south of Kure Beach. The project consists of a 5,200 ft long and 100 ft wide approach channel with a 350 ft by 350 ft turning basin that is 14 ft deep. This area is dredged every five years. Approximately 180,000 cy, on average, were planned to be removed each time.

### *3.2.8 Knotts Island*

Knotts Island ferry terminal is located just south of the Virginia border near the Virginia Beach area. The approach channel is 100 ft wide, 10 ft deep, and 300 ft long. The turning basin is 250 ft by 400 ft. This project area is dredged about every six years. Approximately 10,000 to 15,000 cy of material is removed each time.

### *3.2.9 Manns Harbor*

Manns Harbor is located west of Roanoke Island on the opposite side of the Croatan Sound. The approach channel consists of a 4,500 ft long, 10 ft wide, and 9 ft deep channel. The turning basin is 1,200 ft by 150 ft and is also 9 ft deep. The project area undergoes dredging every eleven years, removing approximately 25,000 cy of material in the process.

### *3.2.10 Minnesott Beach*

Minnesott Beach ferry terminal is located on the north side of the Neuse River at Minnesott Beach. A 1500 ft long, 100 ft wide, and 9 ft deep approach channel exists with a 200 ft by 175 ft turning basin that is also 9 ft deep. The project area is slated to be dredged every ten years and historically approximately 15,000 cy of material was removed with each dredge cycle. Currently there is not an upland disposal site and therefore dredging is not planned.

### *3.2.11 Silver Lake – South Side Ocracoke*

This project area is located on the south end of Ocracoke Island, at Silver Lake Harbor. Big Foot Slough and Teaches Hole Channels are separate from this project area. The channel is 2,500 ft long, 60 to 150 ft wide, and 10 ft deep. The turning basin is of variable size but maintained at 10 ft deep. This project area along with Big Foot Slough and Teaches Hole Channels are maintained by the USACE and not the ferry division.

### *3.2.12 South Dock – North Side Ocracoke*

This project area is located on the south side of Hatteras Inlet on Ocracoke Island. It consists of a 2,400 ft long, 100 ft wide, and 10 ft deep approach channel. The turning basin is 400 ft by 400 ft and 10 ft deep. This project area is dredged twice a year. Recent estimates indicate approximately 10,000 to 15,000 cy from the approach channel and 35,000 cy from the basin is removed each time. Sloops Channel currently provides the primary ferry access between Hatteras Island and the South Dock ferry terminal. Maintenance dredging has not been required to date, but may be expected within the next few years. It is estimated that the dredging volume for this channel will be approximately 30,000 cy.

### *3.2.13 Southport*

Southport ferry terminal is located on the inland side of the Cape Fear River across from Bald Head Island. The project consists of a 1250 ft approach channel that is 100 ft wide and 14 ft deep. The turning basin is 400 ft by 400 ft. This area is dredged approximately every five years, removing around 120,000 cy each time.

#### *3.2.14 Rodanthe - Stumpy Point*

The Rodanthe – Stumpy Point channel provides emergency access and egress to Hatteras Island during periods of significant washouts along Highway 12. Highway 12 provides the only vehicular connection between Rodanthe and the Dare County mainland. Rodanthe is federally designated and is maintained by the USACE. Stumpy Point is maintained by the NCDOT Ferry Division and the channel is dredged every three years, with approximately 15,000 to 20,000 cy removed each time.

#### *3.2.15 Swan Quarter*

Swan Quarter ferry terminal is located in the Pamlico Sound near the mouth of the Pamlico and Tar Rivers. The approach channel consists of an 800 ft long, 600 ft wide, and 12 ft deep channel. The turning basin is 1400 ft long, 50 ft wide, and 12 ft deep. The project area is dredged every fifteen years. Approximately 15,000 cy of material is removed each time.

The Ferry Division does not anticipate an increase in the frequency of dredging at these terminal sites based on their projected 20-year dredged schedule, barring the need for additional dredging based on post-storm requirements.

### 3.3 Waterways and Facilities of Other NC State Agencies

Several state agencies including the North Carolina Department of Environmental Quality, Divisions of Water Resources (DWR), Marine Fisheries (DMF), and Coastal Management (DCM), the North Carolina Wildlife Resource Commission (WRC), and the North Carolina State Parks were contacted to review historical dredging activities and identify future demand.

DENR, DCM and DMF do not maintain marine facilities where maintenance dredging of shallow draft navigation channels is required. Historically DENR has provided funding for the maintenance of shallow draft navigation channels when there was strong public support to maintain these channels. This assistance was previously provided through the division's budget or by a special appropriation of the NCGA. The creation of the Shallow Draft Navigation Channel Dredging and Aquatic Weed Fund has formalized this funding assistance.

The historical projects where DENR provided funding assistance were the Manteo to Wanchese and North Navigation Channels (Part of the Manteo Shallowbag project linked with Oregon Inlet), the Cape Lookout Access Channel, and Walter Slough. All three channels are authorized and maintained by the USACE but are dredged when federal funds are appropriated. Since DENR last provided funding in the early 2000's, the USACE has funded and maintained Shallowbag and Walter Slough, with the former scheduled for dredging in 2018 and the later dredged in 2017. The Cape Lookout channel has not been dredged for almost 20 years, with the USACE indicating that it is not scheduled to dredge the channel in the next five years.

WRC maintains public access boat ramps on state and federal lands within the coastal regions of North Carolina. These boat ramps provide access to the inland waterway and the AIWW. Minor maintenance dredging is performed by WRC using private dredge contractors on an as-needed basis to maintain these facilities. Representatives of WRC indicate that on average, 5,000 cy will be dredged at these facilities each year over the next five years.

### 3.4 Waterways and Facilities of Other States

Inquiries to states along the US Eastern Seaboard were made to determine their dredging needs and interest in having dredge services provided by a NC state-owned dredge. Representatives from the Coastal Zone Management Program, Department of Environmental Quality of the Commonwealth of Virginia indicated that the Commonwealth has many waterways in the middle and eastern shore peninsulas of the Chesapeake Bay where shallow draft dredging is needed to maintain navigation and improve the overall hydraulics of the estuarine system. Several reports have been prepared indicating the condition of these waterways. Dredging volumes for each waterway may range from 5,000 cy to upwards of 75,000 cy. Many of the waterways have not been dredged since their initial authorization.

The USACE had been performing dredging of some non-federal waterways but the Commonwealth is aware that USACE priorities and funding limitations in Virginia have resulted in a focus on maintaining the main navigation channels in the Chesapeake Bay, James River, Ports of Richmond and Norfolk, and main inlets. Funding for shallow draft dredging from the Commonwealth and the Virginia Port Authority is not sufficient for the need, but at this time, there does not appear to be a significant need that would provide potential work for state-owned dredges from North Carolina to complete the work. With numerous local dredge companies nearby (e.g., Norfolk Dredging and Cottrell Contracting), private companies seem more than capable to meet this need.

The State of South Carolina, through the Office of Ocean and Coastal Resource Management, indicated that it has not conducted a shallow draft navigation channel needs assessment and therefore could not quantify the need for utilizing a NC state-owned dredge. OCRM representative did indicate that maintenance dredging of marinas along the AIWW is common and that local municipalities and/or private entities may be interested in utilizing dredge services to maintain access to the AIWW.

Overtures to the representatives of the Waterways Program, Georgia Department of Transportation, were made to discuss their shallow draft dredging needs. As of this report, a response has not been received. The waterways program provides land for upland disposal sites used by the USACE to maintain the AIWW. However, maintenance dredging of the AIWW in Georgia is conducted by the USACE. Boaters utilizing the AIWW in Georgia indicate that the state's segment is one of the shallowest of the four state region (North Carolina to Florida), suggesting that there is need for dredging. However, funding for maintenance dredging on the AIWW in Georgia is very limited due to lack of federal monies.

# 4.0 PROJECTED DREDGING VOLUME – SHALLOW DRAFT NAVIGATION INLETS

The volume of dredging associated with shallow draft waterways has decreased over the past few years as federal appropriations from the USACE has diminished. Without routine dredging, the shoaling of these waterways will continue, resulting in diminished use. The economic impact of shoaling on these waterways and inlets on commercial and for-hire fishing, boat building, and recreational boating in the State of North Carolina was quantified in the BIMP, which indicated that the State of North Carolina may lose upwards of $200 million in economic activity and 1,500 jobs (BIMP, 2016) for the shallow draft inlets alone.

The projected volume of dredging is based on the extrapolation of historical dredging events that maintained shallow draft navigation waterways and inlets to authorized water depths or water depths that support usage. Based on the historical data shown in Figure 3-1 to Figure 3-4, and evaluating the five year running average over the entire period of record, a projected volume of dredging required to maintain each of the shallow draft channel classifications was defined. The minimum dredge need for Shallow Draft Inlets including Oregon Inlet over the recent history is approximately 2 million cy/yr. The average need is projected at 3.0 to 3.5 million cy/yr to support navigation of the waterways including Oregon Inlet, while another 1 million cy/yr of dredging would satisfy the peak need.

Approximately 1 million cy/yr is required to maintain navigation through Oregon Inlet and shallow draft channels to Wanchese and Manteo. This volume of material is the average need to maintain navigation in Oregon Inlet and may change once the new bridge at Oregon Inlet becomes operational.

Dredged material removed from the AIWW and the Inland Channels has been approaching 500,000 cy/yr over the last decade. This level of dredging provides the minimum required to maintain navigability for smaller vessels. However, dredging up to 1.0 million cy/yr, the average volume dredged during the 1990's, would restore navigability of the AIWW for larger vessels. If there is a desire the fully maintain the AIWW (peak need), then a total of 1.5 million cy/yr would need to be removed.

Historically, the AIWW crossings have seen larger swings in dredge volume, all attributed to funding. These crossings provide an important link between the AIWW and the shallow draft inlets so maintaining their authorized depths will require annual average dredging volumes of 200,000 cy (minimum need) to 400,000 cy (average need). Peak dredge volumes for these crossing may be 600,000 cy/yr. Therefore, the total volume needs of the combined AIWW crossings and AIWW/ Inland Channels is 0.7 million cy/yr, 1.4 million cy/yr, and 2.1 million cy/yr, for the minimum, average, and peak demands, respectively.

# 5.0 HISTORICAL AND PROJECTED DREDGE VOLUMES – DEEP DRAFT CHANNELS

There are two deep draft inlets and channels (Cape Fear River and Morehead City Harbor) with federally authorized depths greater than 15 feet that serve North Carolina's two major ports, Wilmington and Morehead City, respectively. Maintenance dredge volumes have remained constant around 3 million cy/yr to support continued passage of ocean going vessels without draft restrictions or transit delays as shown in Figure 5-1. Therefore, the 3 million cy/yr represent both the minimum and average dredging need. The most challenging aspect of these dredging projects has been maintaining authorized depths at inlet throats and ocean bar sections of the Wilmington Harbor and Morehead City Harbor projects where shoaling is a constant issue. Shoaling has led to increased draft restrictions since the dredging volumes have not successfully maintained authorized dredge depths.

Federal funding for NC's deep draft channels has been decreasing. These port navigation projects are ranked nationally based on thru tonnage and NC's ports have been ranked lower in recent years compared to other ports nationwide. The NCGA has established, but not appropriated, monies for a Deep Draft Port Fund. If NCGA appropriated funds, dredging volumes may remain at constant levels or potentially increase to average historical levels, approaching 4 million cy/yr. It should be noted that the 2016 BIMP update recommended that roughly $17.5 million be set aside in this fund.

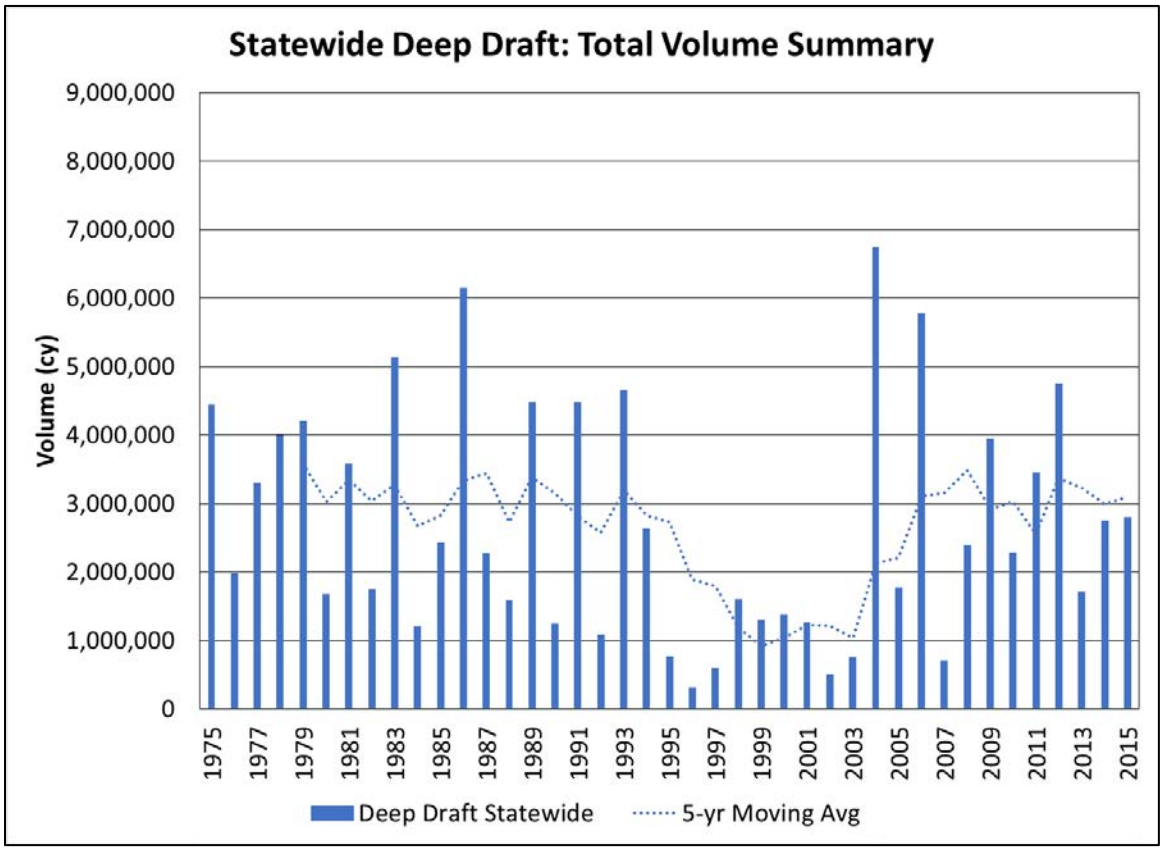



**Figure 5-1: Statewide Deep Draft Dredging Volumes**

# 6.0 DREDGE EQUIPMENT

## 6.1 Types of Dredge Equipment

Dredging along the North Carolina coast to maintain shallow draft navigation has historically used four main types of dredging equipment: pipeline dredges, hopper dredges, sidecast dredges and a USACE special purpose dredge. The special purpose dredge is a small-capacity hopper dredge specially designed to avoid turtle impacts and minimize draft requirements. Dredging of deep draft navigation projects in North Carolina is primarily performed using hopper dredges for the ocean bar and pipeline dredges for the inland throats and interior channels.

Hopper dredges (Figure 6-1) are the most common hydraulic dredge used offshore, consisting of a self-propelled, ocean-certified vessel that is capable of storing dredged material onboard in hoppers and transporting it to a disposal site. The material is pumped into the hoppers through a pipe and draghead. The draghead configuration varies depending on the material being dredged, but is frequently a trailing suction configuration with a draghead supported by dragarms trailing the ship. The bottom sediment is entrained like a vacuum cleaner by plain suction. The dredged material can be dumped through bottom doors onto the seafloor at a given placement location, or some hopper dredges have pump off capabilities where the material can be pumped via pipeline from the hoppers to the shore. Hopper dredges can be readily moved and can operate in wave conditions that are not feasible for other dredge types. Hopper dredge capacities may range from 200 cy to 14,800 cy for the newly christened hopper dredge Ellis Island.

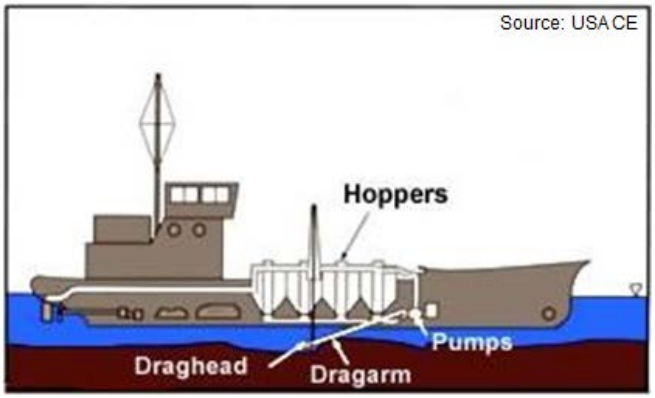



**Figure 6-1: Typical Hopper Dredge**

Some trailing suction dredges, called sidecasts (Figure 6-2), do not have hoppers and instead discharge the dredged material through extended, cantilevered arms. The dredged material is cast off to the side of the dredging vessel through a boom some distance from the channel from which it was removed. This method allows continuous operation and limited increase in draft during operation since the material is not carried on the vessel as with hopper dredges. Since the dredges are smaller and do not move the material a great distance, dredging is usually required multiple times per year where a sidecast dredge is utilized.

**Figure 6-2: Typical Sidecast Dredge**

Pipeline dredges use pipelines to pump material from the location of dredging. The dredging action may be by plain suction, cutterhead, bucket wheel, or dust pan. Cutterheads, which are the most common and versatile, have a rotating cutter which loosens bottom materials at the suction intake of the pipeline (Turner 1996). A conventional cutterhead pipeline dredge is held in position by two spuds at the stern (Figure 6-3). One spud is pushed into the bottom and the dredge is moved in a sideways arc to dredge the channel width using two swing anchors. It can operate continuously and discharge the dredged material directly by pipeline to water, beach, or upland disposal areas. One of its limitations is its inability to work in severe wave climates greater than 3 feet although heavier pipeline dredges with special equipment can operate in seas up to 6 feet. Pipeline dredges are classified by the size of the discharge diameter.

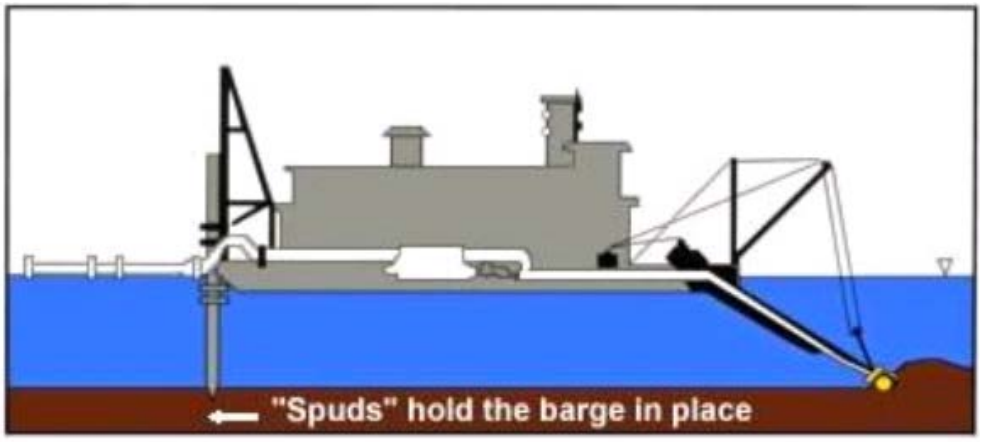



**Figure 6-3: Typical Cutterhead Pipeline Hydraulic Dredge**

## 6.2 USACE Dredges

The Wilmington District maintains the USACE's small draft dredging fleet for the Atlantic coast. Currently, this includes operation of three dredges (Currituck, Merritt, and Murden) suitable for shallow draft navigation channel and inlet dredging. These specialized dredges are capable of operating in ocean-exposed inlet conditions and shallow draft waters. There are no readily available commercial dredges with the combination of ocean certification (work outside COLREGS line) and the capability of this level of shallow water operation. This combination is optimal to dredge the shallow inlets along the North Carolina coast due to the wave conditions at the inlets. These dredges are also outfitted with specialized trailing suction heads to avoid turtle impacts and allow for nearly year-round operation. Dredging of the interior, sheltered channels is primarily accomplished by the USACE through contracts with commercial dredging firms.

The Currituck is a unique 315 cubic yard, shallow draft, split hull hopper dredge, capable of filling its hopper in approximately 30 minutes. The Currituck can deposit dredge material in less than 8 feet of water, allowing material to be deposited in the surf zone. The Murden is the USACE's newest shallow draft, split hull hopper dredge. It's similar to the Currituck in design, but is more maneuverable and has a larger 512-yard capacity. Due to their ability to handle elevated sea states, the Currituck and Murden, shown in Figure 6-4, have been widely used by the USACE at Oregon Inlet. The USACE also operates the sidecast dredge Merritt, which it uses to maintain inlets and to dredge pilot channels for pipeline and hopper dredges. It can move approximately 250 cubic yards per hour.


**Figure 6-4: Special Purpose Dredges Currituck and Murden**

Since 2013, the Currituck has spent 27% of its time, the Murden over 37% of its time, and the Merritt over 96% of its time dredging in North Carolina. For the past ten years, the Currituck has primarily dredged the shallow draft inlets, the AIWW crossings, and portions of Morehead City Harbor. The Murden was commissioned in 2013 and has primarily been used to maintain the ocean bar and channel at Oregon Inlet along with some dredging at other shallow draft inlets. The Merritt has spent a considerable amount of time at Oregon Inlet and other shallow draft inlets to maintain navigability at these rapidly shoaling waterways. The USACE typically operates in 12 hour shifts, 5 to 7 days per week depending on scheduling and project status.

## 6.3 Private Contractors

The USACE typically contracts to private dredging companies for maintenance dredging work along the AIWW, Inland Waterways, and the ocean bar segment of inlets. The state and local municipalities also contract with private dredgers for non-federal waterways and beach nourishment projects. Contract dredgers have used primarily pipeline dredges ranging in diameter from 12 to 30 inches for maintenance dredging due to their efficiency in moving larger amounts of material (upwards of 2 to 3 times that of a hopper dredge). However, these companies also operate hopper dredges for dredging of the ocean bar of several shallow draft and deep draft inlets as well as beach nourishment projects in areas such as Carteret, Dare and New Hanover Counties. To provide the most efficient operations, reduce per unit cost, and meet the schedule of project, private dredge contractors typically work 24-hour shifts, 5 to 7 days a week.

# 7.0 EXPANSION OF DREDGE CAPACITY

The competing maintenance dredging needs and associated timing of federal, state, and local municipalities funding along the US Eastern Seaboard has made it more challenging for the USACE and the privately owned dredge fleet to provide maintenance dredging of shallow and deep draft waterways in the state. The opportunity for the state to own and operate a dredge fleet was evaluated as a means to potentially compensate for the perceived lack of dredge plant availability. Based on the projected maintenance dredging needs discussed and utilizing output from the US Army Corps of Engineers Cost Engineering Dredge Estimating Program (CEDEP), the number, type, and size of dredge plant and associated support equipment to dredge the three shallow draft waterway classifications were identified. The number and size (capacity of pipe diameter) of dredges was determined for three scenarios from Section 4.0: the recent/minimum, average, and peak volume need. All were based on a review of the 5-yr moving average shown in Figure 3-1 through Figure 3-4. Estimated production potential and unit cost/cy, based on the three environmental windows discussed in Volume 1 for each potential dredge plant, were developed using CEDEP as was done for the Dredge Manteo. In addition, annualized Operation and Maintenance (O&M) costs for each dredge plant were determined, taking into consideration escalation and a 30-year service life.

## 7.1 Dredge Plant for Shallow Draft Inlets

Dredging of shallow draft inlets will require a dredge plant to operate outside of the COLREGS line where it is subject to variable wave conditions during some portions of the job. Typically, a 24-inch diameter pipeline dredge is the minimum size plant that is able to accommodate higher wave conditions. The Charleston operated by Norfolk Dredging and the Savannah operated by Marinex are ocean certified 24-inch pipeline dredges. A 20-inch ocean certified pipeline dredge is not operating in US waters though dredge manufacturers indicate such a vessel could be built. The estimated potential production of 20- and 24-inch dredges was developed using CEDEP for three dredging window scenarios as discussed in Volume 1: November through March, October through April, and Year Round. The following assumptions were used to calibrate the CEDEP program for this analysis of the 20- to 24-inch diameter pipeline dredges based on experience and normal anticipated use conditions.

- 3 Mile Pump Distance with Booster. This distance is based on historical information and interviews with USACE and private dredge companies.
- Sand is primary dredged material
- Average dredge cut is 5 feet
- Downtime is 30% for 20-inch pipeline and 24-inch pipeline dredge
- $3 /gal fuel
- 28-person crew for 20-inch pipeline dredge and 42-person crew for 24-inch dredge pipeline (including shore crew and monitors)

Table 7-1 and Table 7-2 show the estimated production potential and unit dredge cost for the 20- and 24-inch pipeline dredges respectively for the three operating scenarios. A breakdown of the annual operating costs by labor, equipment ownership, operations, and survey costs are provided. Labor costs are static among the three operating windows based on the assumption staff is utilized full time during non-dredging periods. This approach applied to all the dredges evaluated in this study.

**Table 7-1: Production and Cost Summary for 20" Pipeline Dredge**

| | November - March Environmental Window | October - April Environmental Window | Year Round |
|---|---|---|---|
| **Annual Labor** | $5,194,620 | $5,194,620 | $5,194,620 |
| **Annual Equipment Ownership** | $1,434,624 | $1,434,624 | $1,434,624 |
| **Annual Operational Cost** | $1,935,970 | $2,710,358 | $4,646,328 |
| **Annual Survey Costs** | $150,000 | $210,000 | $360,000 |
| **Total Annual Cost** | $8,715,214 | $9,549,602 | $11,635,572 |
| **Estimated Annual Production** | 824,525 CY | 1,154,335 CY | 1,978,860 CY |
| **Cost ($/CY)** | **$10.57** | **$8.27** | **$5.88** |

**Table 7-2: Production and Cost Summary for 24" Pipeline Dredge**

| | November - March Environmental Window | October - April Environmental Window | Year Round |
|---|---|---|---|
| **Annual Labor** | $7,458,252 | $7,458,252 | $7,458,252 |
| **Annual Equipment Ownership** | $2,802,480 | $2,802,480 | $2,802,480 |
| **Annual Operational Cost** | $3,002,770 | $4,203,878 | $7,206,648 |
| **Annual Survey Costs** | $150,000 | $210,000 | $360,000 |
| **Total Annual Cost** | $13,413,502 | $14,674,610 | $17,827,380 |
| **Estimated Annual Production** | 1,655,015 CY | 2,317,021 CY | 3,972,036 CY |
| **Cost ($/CY)** | **$8.10** | **$6.33** | **$4.49** |

The special purpose dredge has historically been utilized at Oregon Inlet within the State of North Carolina. This type of dredge could also be utilized for routine maintenance dredging of the other shallow draft inlets within the state. The estimated potential production of the special purpose dredge was developed using CEDEP for three dredging window scenarios as discussed in Volume 1: November through March, October through April, and Year Round. The following assumptions were used to calibrate the CEDEP program for this analysis based on experience and normal anticipated use conditions.

- 2 mile Haul Distance
- Speed During Haul: 9 mph
- 350 cy Capacity
- 1 Draghead
- Sand is primary dredged material

- Average dredge cut is 5 feet
- 5 Minute Gravity Dump
- 8 – person crew
- $3 /gal fuel

Table 7-3 shows the estimated production potential and unit dredge cost for the special purpose dredge for the three operating scenarios. A breakdown of the annual operating costs by labor, equipment ownership, operations, and survey costs are provided.

**Table 7-3: Production and Cost Summary for Special Purpose Dredge**

| | November - March Environmental Window | October - April Environmental Window | Year Round |
|---|---|---|---|
| **Annual Labor** | $4,579,572 | $4,579,572 | $4,579,572 |
| **Annual Equipment Ownership** | $1,980,000 | $1,980,000 | $1,980,000 |
| **Annual Operational Cost** | $2,203,040 | $3,084,256 | $5,287,296 |
| **Annual Survey Costs** | $150,000 | $210,000 | $360,000 |
| **Total Annual Cost** | $8,912,612 | $9,853,828 | $12,206,868 |
| **Estimated Annual Production** | 499,660 CY | 699,524 CY | 1,199,184 CY |
| **Cost ($/CY)** | **$17.84** | **$14.09** | **$10.18** |

Prior to 2014, Oregon Inlet was dredged on a 2 to 3-month interval primarily using the USACE sidecast dredge Merritt, special purpose dredge Currituck, and pipeline dredges operated by private contractors to remove the approximately 1 million cy/yr. With the ocean bar and channel shoaling in at accelerated rates after each dredge event, the USACE had to use the Merritt to dredge pilot channels to facilitate access of the pipeline and special purpose dredges to the ocean bar for the next dredge cycle – thereby increasing costs and inefficiencies. Pipeline dredges were also having difficulty in maintaining operations at the ocean bar due to pipeline lengths, water depths and elevated wave conditions.

The Oregon Inlet Task Force Advisory Committee worked with the USACE to develop a multi-year dredge effort; which culminated in an agreement in October 2015 to provide consistent dredge service. The special purpose dredge Murden was engaged by the USACE for this consistent operation based on its ability to remove and dispose of material and minimize downtime due to sea conditions (Schiffman, 2018). If the State were to assume maintenance of Oregon Inlet, a special purpose dredge similar to the Murden would have to be purchased and operated to maintain this current proactive dredging approach. Table 7-3 indicates that the production potential of a special purpose dredge might meet the needs of dredging at Oregon Inlet assuming year round operation.

The production potential for each dredge based on the average of the two environmental windows was used to determine the number of dredges required to meet the minimum, average, and peak needs for the shallow draft inlets from Section 4.0 (see Figure 3-1 and Figure 3-2) and is summarized in Table 7-4. **To meet the minimum dredging needs one**

**20-inch pipeline dredge and one Special Purpose dredge is required. To meet the average dredging needs one 24-inch pipeline dredge and one special purpose dredge dedicated to Oregon Inlet would be required. To meet the peak needs, one special purpose hopper dredge or sidecast dredge would be required in addition to the average needs above.**

**Table 7-4: Summary of Shallow Draft Inlets Dredge Requirements**

| Type of Dredge | Production (cy/yr) | | Shallow Draft Inlets (Including Oregon Inlet) | | |
|---|---|---|---|---|---|
| | | | Min | Avg | Peak |
| | Avg. Dredge Window | Year Round | 2.0 Mcy/yr | 3.0 Mcy/yr | 4.0 Mcy/yr |
| **14-inch Pipeline Dredge** | 276,800 | NA | - | - | - |
| **20-inch Pipeline Dredge** | 989,400 | NA | 1 | - | - |
| **24-inch Pipeline Dredge** | 1,986,000 | NA | - | 1 | 1 |
| **Sidecast Dredge** | NA | 1,689,200 | - | - | 1* |
| **Special Purpose Hopper Dredge** | NA | 1,199,200 | 1 | 1 | 2* |
| **Total Need** | | | **2** | **2** | **3*** |

*Peak need can be met by adding one of these two dredges: 1 Sidecast Dredge or 1 Special Purpose Hopper Dredge for a total of 3 dredges

## 7.2 Dredge Plant for AIWW Crossings and AIWW/Inland Waterways

Maintenance dredging of these waterways is typically accomplished with pipeline dredges ranging in size from 10 to 20 inches. For this assessment, it is assumed that the state would leverage its operational experience and existing infrastructure associated with the Dredge Manteo to purchase additional pipeline dredges within this size range.

The estimated potential production of a 14-inch dredge was developed using CEDEP for three dredging window scenarios as discussed in Volume 1: November through March, October through April, and Year Round. The following assumptions were used to calibrate the CEDEP program for this analysis based on Dredge Manteo operational characteristics (including current downtime estimate) and normal anticipated use conditions.

- 7,000 ft Pump Distance with 1 Booster.
- Sand is primary dredged material
- Average dredge cut is 5 feet
- Downtime is 52%
- $3 /gal fuel
- 9 – person crew

Table 7-5 show the estimated production potential and unit dredge cost for a 14-inch pipeline dredge for the three operating scenarios. A breakdown of the annual operating costs by labor, equipment ownership, operations, and survey costs are provided.

**Table 7-5: Production and Cost Summary for 14-inch pipeline dredge**

| | November - March Environmental Window | | October - April Environmental Window | | Year Round | |
|---|---|---|---|---|---|---|
| | 12 hr/day | 24 hr/day | 12 hr/day | 24 hr/day | 12 hr/day | 24 hr/day |
| **Annual Labor** | $1,396,474 | $2,142,211 | $1,396,474 | $2,142,211 | $1,396,474 | $2,142,211 |
| **Annual Equipment Ownership** | $969,933 | $969,933 | $969,933 | $969,933 | $969,933 | $969,933 |
| **Annual Operational Cost** | $536,470 | $916,820 | $751,058 | $1,283,548 | $1,287,528 | $2,200,368 |
| **Annual Survey Costs** | $83,965 | $83,965 | $117,551 | $117,551 | $201,516 | $201,516 |
| **Total Annual Cost** | $2,986,843 | $4,112,930 | $3,235,017 | $4,513,244 | $3,855,452 | $5,514,029 |
| **Estimated Annual Production** | 134,975 CY | 230,640 CY | 188,964 CY | 322,896 CY | 323,939 CY | 553,945 CY |
| **Cost ($/CY)** | **$22.13** | **$17.83** | **$17.12** | **$13.98** | **$11.90** | **$9.95** |

The dredge requirements for the minimum, average, and peak volumetric needs (see Figure 3-3, Figure 3-4, and Section 4.0) were based on the estimated production as shown in Table 7-5 and the 20-inch pipeline dredge as shown in Table 7-1 and is summarized in Table 7-6. The analysis assumed the dredges operated 24 hr/day during the averaged environmental window. **Based on this analysis, the minimum need for the AIWW Crossings and AIWW/Inland Waterways combined is the purchase of one 14-inch pipeline dredge in addition to the Dredge Manteo. To meet the average needs of the AIWW Crossings and AIWW/Inland Waterway combined, one 14-inch dredge and one 20-inch dredge would be required in addition to the Dredge Manteo. To meet the peak needs of the AIWW Crossings and AIWW/Inland Waterways combined, one 20-inch pipeline dredge would be required in addition to the average need stated above.**

**Table 7-6: Summary of AIWW Crossings and AIWW/Inland Waterways Dredge Requirements**

| Type of Dredge | Production (cy/yr) | | AIWW Crossings & AIWW/Inland Waterways | | |
|---|---|---|---|---|---|
| | | | Min | Avg | Peak |
| | Avg. Dredge Window | Year Round | 0.7 Mcy/yr | 1.4 Mcy/yr | 2.1 Mcy/yr |
| **14-inch Pipeline Dredge** | 276,800 | NA | 1 | 1 | 1 |
| **20-inch Pipeline Dredge** | 989,400 | NA | - | 1 | 2 |
| **24-inch Pipeline Dredge** | 1,986,000 | NA | - | - | - |
| **Sidecast Dredge** | NA | 1,689,200 | - | - | - |
| **Special Purpose Hopper Dredge** | NA | 1,199,200 | - | - | - |
| **Total Need** | | | **1** | **2** | **3** |

The State may also consider the purchase of a sidecast dredge to assist its expanded dredge fleet in maintaining the AIWW crossings and dredging pilot channels for the pipeline dredge plants. There have been times in the past where shoaling conditions within a channel became so severe that the only way to even begin dredging was to utilize a sidecast dredge during high tide. It is desirable, though, that if the State were to purchase its own fleet, that it would proactively maintain the channels so that a special purpose dredge could always operate.

The estimated potential production of a sidecast dredge was developed using CEDEP for the three dredging window scenarios: November through March, October through April, and Year Round. The following assumptions were used to calibrate the CEDEP program for this analysis based on experience and normal anticipated use conditions.

- 12-inch Dredge
- Sand is Primary Dredged Material
- Average Dredge Cut is 5 feet
- 424 CY/hr Production
- 332 Working Hours
- Downtime is 5% Due to Weather
- $3 /gal fuel
- 7 – person crew

Table 7-7 shows the estimated production potential and unit dredge cost for a sidcast dredge for the three windows. A breakdown of the annual operating costs by labor, equipment ownership, operations, and survey costs are provided.

**Table 7-7: Production and Cost Summary for Sidecast Dredge**

| | November - March Environmental Window | October - April Environmental Window | Year Round |
|---|---|---|---|
| **Annual Labor** | $3,849,168 | $3,849,168 | $3,849,168 |
| **Annual Equipment Ownership** | $313,920 | $313,920 | $313,920 |
| **Annual Operational Cost** | $717,393 | $1,004,350 | $1,721,743 |
| **Annual Survey Costs** | $150,000 | $210,000 | $360,000 |
| **Total Annual Cost** | $5,030,481 | $5,377,438 | $6,244,831 |
| **Estimated Annual Production** | 703,840 CY | 985,376 CY | 1,689,216 CY |
| **Cost ($/CY)** | **$7.15** | **$5.46** | **$3.70** |

One option to minimize the costs and operation of another dredge would be to continue contracting out this dredge operation to the USACE, with the Dredge Merritt providing these services on an as needed basis when the special purpose dredge could not be utilized. Another option would be to outfit a special purpose dredge with the ability to also conduct sidecast operations.

## 7.3 Dredge Plant for Deep Draft Waterways

Dredging of the ocean bar for the deep draft waterways (Cape Fear River and Morehead City Harbor) has been primarily performed using ocean certified hopper dredges with capacities ranging from 3,500 cy to 12,000 cy. Dredging of the inlet throats and interior channels of these deep draft waterways is typically performed with 24- to 30-inch pipeline

dredges. This work has traditionally been contracted by the USACE to private dredge contractors.

The estimated potential production of a medium capacity (3,500 cy) hopper dredge was developed using CEDEP for three dredging window scenarios: November through March, October through April, and Year Round to supplement the pipeline estimating complete previously. The following assumptions were used to calibrate the CEDEP program for this analysis based on experience and normal anticipated use conditions.

- 4 Mile Haul Distance for Medium Capacity
- Medium Capacity: 2,500 cy/Load
- Medium Capacity Speed During Haul: 8 mph
- Sand is primary dredged material
- Average dredge cut is 5 feet
- Medium Capacity Pumpout Rate: 1,800 cy/hr
- Medium Capacity Crew: 23 (includes shore crew and government observation crew)
- Downtime is 30%
- $3 /gal fuel

Table 7-8 shows the estimated production potential and unit dredge cost for the medium capacity hopper dredge plant for the three operating scenarios. A breakdown of the annual operating costs by labor, equipment ownership, operations, and survey costs are provided.

**Table 7-8: Production and Cost Summary for Medium Capacity Hopper Dredge**

| | November - March Environmental Window | October - April Environmental Window | Year Round |
|---|---|---|---|
| **Annual Labor** | $6,323,256 | $6,323,256 | $6,323,256 |
| **Annual Equipment Ownership** | $4,395,358 | $4,395,358 | $4,395,358 |
| **Annual Operational Cost** | $2,306,710 | $3,229,394 | $5,536,104 |
| **Annual Survey Costs** | $150,000 | $210,000 | $360,000 |
| **Total Annual Cost** | $13,175,324 | $14,158,008 | $16,614,718 |
| **Estimated Annual Production** | 1,096,800 CY | 1,535,520 CY | 2,632,320 CY |
| **Cost ($/CY)** | **$12.01** | **$9.22** | **$6.31** |

The estimated potential production of a 30-inch pipeline dredge was developed using CEDEP for three dredging window scenarios: November through March, October through April, and Year Round to supplement the pipeline estimating previously completed. The following assumptions were used to calibrate the CEDEP program for this analysis based on experience and normal anticipated use conditions.

- 3 Mile Pump Distance with Booster. This distance is based on historical information and interviews with USACE and private dredge companies.
- Sand is primary dredged material
- Average dredge cut is 5 feet
- Downtime is 30%
- $3 /gal fuel
- 44-person crew (including shore crew and monitors)

Table 7-9 shows the estimated production potential and unit cost for the 30-inch pipeline dredge plant for the three operating scenarios. A breakdown of the annual operating costs by labor, equipment ownership, operations, and survey costs are provided.

**Table 7-9: Production and Cost Summary for 30 inch Pipeline Dredge**

| | November - March Environmental Window | October - April Environmental Window | Year Round |
|---|---|---|---|
| **Annual Labor** | $8,089,867 | $8,089,867 | $8,089,867 |
| **Annual Equipment Ownership** | $3,617,784 | $3,617,784 | $3,617,784 |
| **Annual Operational Cost** | $5,685,425 | $7,959,595 | $13,645,020 |
| **Annual Survey Costs** | $150,000 | $210,000 | $360,000 |
| **Total Annual Cost** | $17,543,076 | $19,877,246 | $25,712,671 |
| **Estimated Annual Production** | 2,343,775 CY | 3,281,285 CY | 5,625,060 CY |
| **Cost ($/CY)** | **$7.48** | **$6.06** | **$4.57** |

The minimum and average dredge needs for the two deep draft ports are both 3 million cy/yr and the peak dredge needs increase to 4 million cy/yr and is summarized in Table 7-10. **To generally meet the minimum and average needs, one 30-inch ocean certified pipeline dredge would be required. To meet the peak needs, one medium capacity ocean certified hopper dredge would be required in addition to the average needs as stated above. The minimum and average need assumes the USACE will continue to maintain the outer ocean bar while the State assumes maintenance of inlet throat and the inner channels with the pipeline dredge. The peak needs assume the State assume responsibility for all dredging operations including the outer ocean bar.**

**Table 7-10: Summary of Deep Draft Waterways Dredge Requirements**

| Type of Dredge | Production (cy/yr) | | Deep Draft Waterways | | |
|---|---|---|---|---|---|
| | | | Min | Avg | Peak |
| | Avg. Dredge Window | Year Round | 3.0 Mcy/yr | 3.0 Mcy/yr | 4.0 Mcy/yr |
| **30-inch Pipeline Dredge** | 2,812,500 | NA | 1 | 1 | 1 |
| **Medium (3,500 cy Capacity) Hopper Dredge** | 1,316,200 | NA | - | - | 1 |
| **Total Need** | | | **1** | **1** | **2** |

## 7.4 Capital and Operation/Maintenance Cost Dredge Capacity Expansion

Table 7-11 summarizes the potential expansion of the dredge fleet by the State to meet the projected minimum, average, and peak dredging needs to maintain shallow and deep draft waterways in the state. As can be seen, there are more than enough dredging needs currently within North Carolina to cover the dredge fleets shown below with no excess capacity under current environmental windows. However, it should be noted that for this analysis, the pipeline and hopper dredges were assumed able to operate for 6 months (average of the two environmental windows). The special purpose and sidecast dredges were assumed to be able to operate year-round based on the current authorization that the USACE has as well as the 1999 South Atlantic Regional Biological Opinion that states up to 10 vessels of this type could operate along the eastern seaboard. Expansion of the environmental windows for the hopper and pipeline dredges beyond this 6 month average is unlikely without significant effort. The initial cost of a dredge depends on the type of dredge purchased, its size, and its capabilities as well as its age and condition. There is not a significant U.S. market for dredges that are suitable to work in the State's unique waterway environment, so this analysis assumes the purchase of a new dredge utilizing historical cost information from CEDEP then adjusted with vessel purchase price information from the USACE for the Murden and private dredge contractors. This cost baseline provides a consistent way to evaluate the cost of a new build dredge based on vessel type, class, and size.

**Table 7-11: Expanded Dredge Capacity**

| Type of Dredge | Production (cy/yr) | | State of North Carolina Waterways | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Shallow Draft Inlets (Including Oregon Inlet) | | | AIWW Crossings & AIWW/Inland Waterways | | | Deep Draft Waterways | | | Shallow Draft Inlets, AIWW Crossings, AIWW/Inland Waterways, and Deep | | |
| | Avg. Dredge Window | Year Round | Min | Avg | Peak | Min | Avg | Peak | Min | Avg | Peak | Min | Avg | Peak |
| | | | 2.0 Mcy/yr | 3.0 Mcy/yr | 4.0 Mcy/yr | 0.7 Mcy/yr | 1.4 Mcy/yr | 2.1 Mcy/yr | 3 Mcy/yr | 3 Mcy/yr | 4 Mcy/yr | 5.7 Mcy/yr | 7.4 Mcy/yr | 10.1 Mcy/yr |
| 14-inch Pipeline Dredge | 276,800 | NA | - | - | - | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 |
| 20-inch Pipeline Dredge | 989,400 | NA | 1 | - | - | - | 1 | 2 | - | - | - | 1 | 1 | 2 |
| 24-inch Pipeline Dredge | 1,986,000 | NA | - | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| 30-inch Pipeline Dredge | 2,812,500 | NA | - | - | - | - | - | - | 1 | 1 | 1 | 1 | 1 | 1 |
| Sidecast Dredge | NA | 1,689,200 | - | - | 1* | - | - | - | - | - | - | - | - | - |
| Special Purpose Hopper Dredge | NA | 1,199,200 | 1 | 1 | 2* | - | - | - | - | - | - | 1 | 1 | 2 |
| Medium (3,500 cy Capacity) Hopper Dredge | 1,316,200 | NA | - | - | - | - | - | - | - | - | 1 | - | - | 1 |
| Total Need | | | 2 | 2 | 3* | 1 | 2 | 3 | 1 | 1 | 2 | 4 | 5 | 8 |

*Peak need can be met by adding one of these two dredges, 1 Sidecast Dredge or 1 Special Purpose Hopper, for a total of 3 dredges

Using an assumption of a new build dredge provides for a balanced comparison of dredge types and sizes in regards to capital cost, service life, production capability and resulting unit price of dredged material. New build costs including support equipment and the associated annual operation and maintenance (O&M) costs for the minimum, average, and peak dredging are shown in Table 7-12, Table 7-13, and Table 7-14. Within the tables, the first five columns consider the initial costs of purchasing the fleet. The annual payment cost and the resulting unit price contribution is based on financing the initial cost at 3% interest over 30 years. The total annual costs shown in the last column includes the

amortized cost to replace the dredge in the future but does not include the annualized payment of the initial dredge purchase. If the State desired to recoup the capital cost of the dredge, then the additional unit price contribution shown in Table 7-12 through Table 7-17 would need to be added to the unit price for the annual cost for each dredge plant shown in the tables in Sections 7.1 – 7.3 to determine the total unit price the State would have to charge.

**Table 7-12: Initial Capital and O&M Costs for Minimum Demand – Shallow Draft Inlets, AIWW Crossings, and AIWW/Inland Waterways**

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 1 | $25,000,000 | $1,275,481 | $1.06 | 1,200,000 | $12,206,868 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | $275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 1 | $34,600,000 | $1,765,266 | $1.77 | 1,000,000 | $9,132,408 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| **TOTAL** | | **3** | **$81,450,000** | **$4,155,519** | **$6.88** | **2,475,000** | **$25,652,363** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

**Table 7-13: Initial Capital and O&M Costs for Average Demand – Shallow Draft Inlets, AIWW Crossings, and AIWW/Inland Waterways**

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 1 | $25,000,000 | $1,275,481 | $1.06 | 1,200,000 | $12,206,868 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | 275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 1 | $34,600,000 | $1,765,266 | $1.77 | 1,000,000 | $9,132,408 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| Initial Cost of 24" Pipeline Dredge | $37,800,000 | 1 | $56,800,000 | $2,897,894 | $1.45 | 2,000,000 | $14,044,056 |
| Initial Cost of Equipment for 24" Pipeline Dredge | $19,000,000 | | | | | | |
| **TOTAL** | | **4** | **$138,250,000** | **$7,053,413** | **$8.33** | **4,475,000** | **$39,696,419** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

**Table 7-14: Initial Capital and O&M Costs for Peak Demand – Shallow Draft Inlets, AIWW Crossings, and AIWW/Inland Waterways**

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 2 | $50,000,000 | $2,550,963 | $1.06 | 2,400,000 | $24,413,736 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | 275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 2 | $69,200,000 | $3,530,533 | $1.77 | 2,000,000 | $18,264,816 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| Initial Cost of 24" Pipeline Dredge | $37,800,000 | 1 | $56,800,000 | $2,897,894 | $1.45 | 2,000,000 | $14,044,056 |
| Initial Cost of Equipment for 24" Pipeline Dredge | $19,000,000 | | | | | | |
| **TOTAL** | | **6** | **$197,850,000** | **$10,094,160** | **$8.33** | **6,675,000** | **$61,035,695** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

## Table 7-15: Initial Capital and O&M Costs for Minimum Demand – Shallow Draft Inlets, AIWW Crossings, AIWW/Inland Waterways, and Deep Draft

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 1 | $25,000,000 | $1,275,481 | $1.06 | 1,200,000 | $12,206,868 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | 275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 1 | $34,600,000 | $1,765,266 | $1.77 | 1,000,000 | $9,132,408 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| Initial Cost of Equipment for 30" Pipeline Dredge | $26,500,000 | 1 | $77,500,000 | $3,953,993 | $1.41 | 2,800,000 | $18,710,161 |
| Total Initial Cost for 30" Pipeline Dredge | $77,500,000 | | | | | | |
| **TOTAL** | | **4** | **$158,950,000** | **$8,109,511** | **$8.29** | **5,275,000** | **$44,362,523** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

## Table 7-16: Initial Capital and O&M Costs for Average Demand – Shallow Draft Inlets, AIWW Crossings, AIWW/Inland Waterways, and Deep Draft

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 1 | $25,000,000 | $1,275,481 | $1.06 | 1,200,000 | $12,206,868 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | 275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 1 | $34,600,000 | $1,765,266 | $1.77 | 1,000,000 | $9,132,408 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| Initial Cost of 24" Pipeline Dredge | $37,800,000 | 1 | $56,800,000 | $2,897,894 | $1.45 | 2,000,000 | $14,044,056 |
| Initial Cost of Equipment for 24" Pipeline Dredge | $19,000,000 | | | | | | |
| Initial Cost of 30" Pipeline Dredge | $51,000,000 | 1 | $77,500,000 | $3,953,993 | $1.41 | 2,800,000 | $18,710,161 |
| Initial Cost of Equipment for 30" Pipeline Dredge | $26,500,000 | | | | | | |
| **TOTAL** | | **5** | **$215,750,000** | **$11,007,405** | **$9.74** | **7,275,000** | **$58,406,579** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

## Table 7-17: Initial Capital and O&M Costs for Peak Demand – Shallow Draft Inlets, AIWW Crossings, AIWW/Inland Waterways, and Deep Draft

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 2 | $50,000,000 | $2,550,963 | $1.06 | 2,400,000 | $24,413,736 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | 275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 2 | $69,200,000 | $3,530,533 | $1.77 | 2,000,000 | $18,264,816 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| Initial Cost of 24" Pipeline Dredge | $37,800,000 | 1 | $56,800,000 | $2,897,894 | $1.45 | 2,000,000 | $14,044,056 |
| Initial Cost of Equipment for 24" Pipeline Dredge | $19,000,000 | | | | | | |
| Initial Cost of 30" Pipeline Dredge | $51,000,000 | 1 | $77,500,000 | $3,953,993 | $1.41 | 2,800,000 | $18,710,161 |
| Initial Cost of Equipment for 30" Pipeline Dredge | $26,500,000 | | | | | | |
| Initial Cost of Medium Hopper (3,500 CY Capacity) Dredge | $50,000,000 | 1 | $67,000,000 | $3,418,290 | $2.63 | 1,300,000 | $15,375,972 |
| Initial Cost of Equipment for Medium Hopper (3,500 CY Capacity) Dredge | $17,000,000 | | | | | | |
| **TOTAL** | | **8** | **$342,350,000** | **$17,466,443** | **$12.37** | **10,775,000** | **$95,121,827** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

In addition to the capital outlay for the purchase of dredge and equipment, the maintenance facility at Manns Harbor would need to be expanded. For each dredge in operation, approximately 0.4 to 0.6 acres would be required for berthing, laydown area, and storage area for one additional dredge. Depending on the number of dredges purchased, 3 to 6 acres of land, marine infrastructure, and buildings would be required. This cost has to be added to the dredge plant cost. If the state were to consider the purchase of deep draft hopper dredges, the existing facilities at Manns Harbor would not be adequate without significant dredging to expand and deepen the harbor due to draft issues. Passage through Oregon Inlet would also be a challenge for these larger ships. Facilities at Morehead City or Wilmington harbors would have to be constructed and the entire dredge fleet may have to be moved to these locations. The expense for that relocation and development of land could cost approximately $6 - $10 million.

# 8.0 APPROACHES TO FUNDING EXPANDED DREDGE CAPACITY

The initial purchase price of an expanded dredge fleet ranges from $81.5 to $197.9 million excluding the purchase of a 30-inch pipeline dredge and medium capacity hopper dredge for deep draft waterways. Including deep draft navigation increases the cost range from $159.0 to $342.4 million. Sources of funding for such a large initial purchase may be from a general appropriation, a statewide bond measure to maintain navigable waterways; an offset by a fee structure similar to the Shallow Draft Navigation Channel and Aquatic Weed Fund; or another funding mechanism as discussed in the BIMP to support inlet and beach restoration needs.

As for the annual operation costs, the current Shallow Draft Navigation and Aquatic Weed Fund generates roughly $19 million/yr. With the local sponsor match, the total would rise to approximately $25.3 million/yr. This current funding level could meet a level somewhere between the minimum and average dredge needs requirement. If the state purchased a special purpose dredge and a 24-in pipeline dredge, the annual costs would be roughly $26.3 million/yr. If the state were to have an interest in providing dredging services to the deep draft ports as well, and were to accept the recommendation from the 2016 BIMP update to set aside $17.5 million annually to make up for the current federal funding shortfall, the annual costs for a 30-in pipeline dredge could almost be covered. The initial purchase cost would require another funding source.

Outside of a direct purchase of a dredge or dredges by the state, this study reviewed potential partnerships with the USACE and private entities to cost-share the purchase and operation of the dredge plant. Discussions with representatives of the USACE Wilmington District were held to assess the feasibility of the USACE to cost-share the purchase of equipment or having the USACE utilize a state owned dredged to maintain federal authorized channel projects. Based on how the USACE budget is appropriated by Congress, representatives of the District are not aware of a cost-sharing mechanism that would allow such as purchase.

For a state owned dredge to participate in USACE work, the state would have to either compete for the work in an open bidding process, or the state would have to acquire its own permits, or modify its MOU with the USACE to assign the work to the state owned dredge and use federal and any local sponsor funds to pay for the state executed dredging. It is not likely that this would be allowable under the USACE current procurement regulations, where federal fair labor and anti-competition laws would have to be upheld.

The only example that could be identified where a dredge owned by a public agency (other than the USACE) was employed on federal dredge work outside the COLREGS line is the Dredge Oregon, owned by the Port of Portland. The Oregon reportedly maintains segments of the federal channel as well as Port berths. It is our understanding that this longstanding arrangement was achieved legislatively (i.e. Act of Congress).

A cost-sharing purchase of a dredge or dredges with adjoining states or the use of NC state owned dredges to perform work for other states was assessed. Arrangements such as

interstate compacts may be one avenue to fund purchases or cross sell services between states. These types of arrangement are more common on port, rail and highway projects but pose challenges when setting up and executing dredging projects since each state has their own organized labor rules and regulations that would be difficult to normalize.

Conflicts with federal and adjoining state labor rules and regulations could be alleviated by setting up a non-profit or B-Corporation to provide services directly to the USACE and local governments. This corporation would then be able to pursue work consistent with private dredge contractors through the open solicitation process. The state operation would have to be cost competitive with the industry in order to secure work. The private dredge contractor industry would most likely take a dim view of the state providing services in this manner, raising objections to potential predatory pricing in securing work inside and outside the state.

One other consideration with the state providing dredge services is the potential conflict that may arise if the emergency dredge services are required after the passage of a large storm. If the state owned dredge is under contract with a local municipality but is needed to dredge a channel to facilitate access to a facility of state or regional economic importance, the state may face a decision to violate the terms of a contract and the potential financial repercussions that decision may have.

## 9.0 SUMMARY AND CONCLUSIONS

The shallow draft navigation waterways in the State of North Carolina provide a significant economic benefit to the state. Dredging of these waterways including the AIWW, AIWW crossings, and Shallow Draft Inlets was historically performed to maintain their authorized channel depths or provide unrestricted navigation. As funding from the federal government was reduced, the USACE, who is primarily responsible for maintenance dredging of these waterways, has consequently reduced its level of waterway maintenance. It is projected for the average need, 3.0 to 3.5 million cy/yr of dredging will be required to maintain the shallow draft inlets in the state, 0.5 to 1 million cy/yr of material will need to be dredged from the AIWW/Inland Channels, and 200,000 to 400,000 cy must be dredged from the AIWW crossings. To meet the peak demand for the shallow draft inlets, AIWW/Inland Channels, and AIWW crossing, an additional 1 million cy/yr, 500,000 cy/yr, and 200,000 cy/yr, respectively would have to be dredged above the average demand. Demand for maintenance dredging from other states was also noted, but it is apparent that the minimum, average and peak dredging needs for NC alone would require multiple dredges operating at full capacity under current environmental windows. In addition, nearby states have similar environmental windows which would prohibit the selling of dredge services.

The minimum investment approach for shallow draft waterway maintenance is the purchase of a special hopper dredge, one 14-inch pipeline dredge, and one 20-inch pipeline dredge. For the approximately $81.5 million, or $4.2 million annualized over 30 years, the state would have three dredge plants capable of dredging up to 2.5 million cy/yr. This combination of dredge fleet addresses the needs of Oregon Inlet while the 14-inch and 20-inch dredges could support dredging of the remaining shallow draft inlets, the AIWW, AIWW crossings, and some interior waterways.

If the State wanted to expand and meet the average shallow draft need, then they would need to purchase one 14-inch, one 20-inch, and one 24-inch pipeline dredge and one special purpose dredge. The state would be investing considerable capital (~$138.3 million) to subsequently operate (~$39.7 million/yr) the dredge fleet.

Since the state appropriates $19 million to the Shallow Draft Navigation Channel and Aquatic Weed Fund each year, with up to 33% additional funds from local sponsors, the number and type of dredge plants that could operate with this fund was determined to be one special purpose dredge and one 24-inch pipeline dredge. The operating costs for these two dredges is approximately $26.3 million/yr. The special purpose hopper could perform year round dredging to meet the average needs at Oregon Inlet and other shallow draft inlets. The ocean certified 24-inch pipeline dredge would perform dredging of the AIWW and AIWW crossings as well as some deep draft work if needed during emergency conditions.

Meeting the peak shallow draft demand would require the purchase of six dredges; four of which are pipeline dredges (one 14-inch, two 20-inch, and one 24-inch), and two special purpose dredges. This $197.9 million acquisition means the state would need to fund the

$61.0 million/yr operating cost. Maintaining this large fleet may require a new maintenance and storage yard outside of Manns Harbor.

The deep draft navigation needs of the state were also evaluated in combination with the shallow draft navigation investment. At a minimum, one 30-inch pipeline dredge would be acquired to generally maintain the inlet throat, inland channels, and turning basins for the Ports of Morehead City and Wilmington. This acquisition would require an initial investment of $77.5 million with an annual operating cost of $18.7 million/yr. This assumes the USACE will continue to maintain the outer ocean bar were the material is disposed of in the Ocean Dredged Material Disposal Site (ODMDS). The peak need for deep draft maintenance dredge requires 1 medium capacity hopper dredge in addition the minimum and average needs as stated. The purchase of this dredge plant would escalate the investment of the peak needs scenario by approximately $67 million. The annual operating cost would also increase by $15.4 million/yr. When coupled with the peak shallow draft need, the total investment is over $342.4 million, with annual operating costs of $95.1 million/yr.

Opportunities to offset the capital or operating costs of these dredge plants through partnerships with the USACE or adjoining states were reviewed. From a federal perspective, a cost-sharing arrangement or example could not be identified based on discussions with USACE representatives. Issues related to federal procurement rules including anti-competition clauses and the overall federal appropriation structure to fund the USACE were identified.

A non-profit or B-corporation to provide dredging services to local municipalities in the state could be created. The corporation would secure and provide services similar to a private dredge contractor and would require the operation to be competitive with the industry. The private dredge industry may view the State's desire to provide dredge services as anti-competitive, which could result in private contractor not bidding on projects and negative impacts on price structures for dredging projects.

## 10.0 REFERENCES

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NCDOT NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

NCDEQ NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY

VOLUME 3

# STUDY OF DREDGING SERVICES COST-BENEFIT ANALYSIS

FINAL REPORT | APRIL 2018

moffatt & nichol

# EXECUTIVE SUMMARY

The State of North Carolina is evaluating the acquisition of additional dredges to supplement its current dredge, Dredge Manteo, in meeting existing and projected maintenance dredging needs of the State's waterways (NCGA, 2017). A cost benefit analysis of the state providing expanded dredge services in lieu of utilizing private contractors was performed. The initial capital investment, annual operating costs and unit costs of material dredged per cubic yard ($/cy) were the baseline indicators in this evaluation. The fixed and variable costs of dredging were defined and cost risk factors such as utilization and mobilization identified that influenced the annual operating costs.

Interviews with the other public agencies that own and operate dredges, the U.S. Army Corps of Engineers (USACE), and private dredge contractors were conducted to discuss the opportunities and constraints of the state operating an expanded fleet. Numerous public agencies outside of North Carolina operate non-ocean certified small pipeline dredges. These public agencies indicated that their unit price per yard ($/cy) of dredging is slightly lower, on the order of $1 to $2/cy, versus the unit cost of previously contracted work. The most favorable aspect of dredge ownership has been the ability to proactively schedule and manage their dredging needs as the Ferry Division has been able to do.

The USACE has been performing maintenance dredging of the State's shallow draft navigation channels at its current funded level and it is their opinion that they can handle the projected demands using their existing three dredge plants if the state and local governments could provide consistent scheduled funding. The unit cost for the USACE based on their current dredge fleet is generally commensurate with private dredge contractors. The USACE highlighted risk factors of the state assuming maintenance dredging of the USACE maintained channels. Maintaining permits, managing dredged material disposal areas, and providing maintenance funding and facilities were all identified as factors that affect annual operating costs. The USACE also indicated that they were not aware of a cost-share arrangement where the USACE and State would jointly purchase and operate a dredge.

Private contractors stressed that they have sufficient dredge plant capacity available to meet the needs of the state. Three primary obstacles or roadblocks mentioned related to dredging the State's waterways were the restrictive environmental dredge windows, the size of the projects, and the scheduling of work. All firms felt that better management of project funding and scheduling would permit them to better utilize their existing plants, resulting in opportunities to reduce overall project costs. The private contractors had mixed reactions on multi-year, multi-site or other concessionaire-type contract vehicles, with some indicating cost savings while others felt that these agreements would have minimal impact.

Two contracting approaches (MACC and concessionaire-type agreements) that the state may employ when enlisting dredging services from private contractors may provide potential cost savings of 5% to 10%. These savings are generally similar to the savings the

state may realize if the state operated their own expanded dredge fleet based on the analysis to date. The state, however, would have to come up with the initial capital investment.

Based on utilizing current funding streams such as the Shallow Draft Navigation Channel and Aquatic Weed Fund, the annual operating costs of a special purpose hopper and 24-in pipeline dredge may be feasible if the initial capital costs can be independently funded by the NCGA. This arrangement would allow field crews to be assigned work on the management of disposal sites during the 6 months when dredging cannot be performed. The state may also consider a phased approach to avoid completely consuming the Shallow Draft Navigation Channel Fund, with the purchase of a special purpose hopper. The special purpose hopper dredge has lower capital and annual operating costs and does not require significant expenditures on crew or support equipment to provide dredge services on a year round basis for shallow draft inlets and the AIWW crossings. The state and local sponsors would continue to contract dredge services to the USACE and/or private contractors to meet the remaining dredging needs until the state can purchase additional dredge plants.

However, legal/contracting issues and the cost of ocean certification should be investigated prior to making a final decision. These issues and additional landside support costs may be significant enough to eliminate potential cost savings. However, cost savings are only one part of the equation of the state's ability to manage the dredging needs of their waterways. NCDOT would have to develop a systematic approach to determining the needs and the priorities of the dredging program.

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# VOLUME 3: STUDY OF DREDGING SERVICES COST-BENEFIT ANALYSIS

## 1.0 PURPOSE AND NEED

The North Carolina General Assembly (NCGA) commissioned a three-part study to evaluate the State's participation in maintaining shallow draft navigation waterways through use of existing dredge equipment operated by the North Carolina Department of Transportation Ferry Division and through the potential acquisition of additional dredge plants to meet existing and projected maintenance dredging needs of the State's waterways (NCGA, 2017). This volume discusses the results of a cost benefit analysis of the state providing expanded dredge services in lieu of utilizing private contractors for existing and projected work. The analysis details if cost savings may be realized by the state by providing dredge services in lieu of private contractors. The annual operating costs and unit cost of material dredged per cubic yard ($/cy) are the baseline indicators applied to evaluation of state-operated vs private-operated dredges. The scope of the study also includes an evaluation of private contractor's ability to support the projected state dredging needs as well as identification of approaches to structure contracts to maximize benefits to the state.

# 2.0 DREDGE OWNERSHIP

## 2.1 Dredge Purchase Cost

The initial cost of a dredge depends on the type of dredge purchased, its size, and its capability, as well its age and condition. For the purposes of this study, M&N utilized the purchase cost information in the US Army Corps of Engineers Cost Engineering for Dredge Estimating Programs (CEDEP) to evaluate the cost of different dredges: 14-inch, 20-inch, 24-inch, and 30-inch pipeline dredges, special purpose and medium capacity (3,500 cy) hopper dredges, and a sidecast dredge discussed in Volume 2 of the report. This program provides a consistent way to evaluate the cost of a new build dredge based on vessel type, class, size, and power inputs. The cost information provided by CEDEP was checked against publically available cost data of similar recently purchased dredge plants.

## 2.2 New vs. Used Dredges

Using an assumption of a new build dredge provides for a balanced comparison of dredge types and sizes in regard to capital cost, service life, production capability and resulting unit price of delivered material. Older dredges would be less expensive in initial purchase, but would generally be less capable, have higher maintenance costs and a shorter usable life. For this study, the purchase of new dredges was assumed.

## 2.3 Required Certification

There are several key restrictions the state will need to take into account when considering the purchase of a dredge.

- A vessel dredging in the navigable waters of the U.S. has to be a U.S. built, U.S. flagged, and U.S. controlled dredge. These requirements stem from the Foreign Dredge Act of 1906, The Shipping Act of 1916 and the Merchant Marine Act of 1920 (a.k.a. the “Jones Act”). These requirements limit the field of existing dredges the state could consider purchasing. The fact that any new build dredge has to be built in the U.S. is a significant factor in the cost of construction.
- U.S. Coast Guard regulations require any commercial vessel longer than 79 ft (24m) to have a load line certificate to operate seaward of the COLREGS line (the boundary line that defines where inland and international navigation regulations apply). Certifications in the U.S. are made by the American Bureau of Shipping (ABS). In general, this requires the dredge to be built to certain stability and navigational safety standards. Once the vessel is operational, a load line certificate is typically issued on 5-year terms, subject to annual "topside" surveys to verify that critical closures (hatches, vents, etc.) are in good working condition and the vessel is not damaged or modified in such manner as to compromise its seaworthiness. At the end of the 5-year term, the vessel must be dry docked to inspect the underwater hull, seachests and valves, etc., before a new certificate can be issued. Based on limited feedback from private dredge contractors, the

additional construction cost associated with ABS certification of dredges ranges from $2 to $5 million. For those dredge activities that occur outside of the COLREGS line, only ABS load lined (or "classed") dredges were considered in this analysis.

## 2.4 Cost of Dredge Operations

### *2.4.1 Fixed Costs*

Fixed Costs are costs that are incurred whether the dredge operates or not and are estimated on an annual basis and are based on CEDEP. They include:

- Depreciation & Interest: The depreciation and interest is an annual payment on the capital cost of the dredge. Depreciation and interest payments for various type and size dredges in this analysis were based on CEDEP. The service life assumed is 30 years, with a 3% interest rate and 10% assumed salvage value.

- Insurance: The cost of insurance includes coverages such as hull, liability, marine pollution etc. These costs do not include worker insurances such as workers comp, USL&H and Jones Act coverage, which are built into the labor rate estimates.

- Fixed Labor & Overhead: Dredges of the size and type considered in this study require a select number of crew to be full time with the dredge whether it is working or not. This study assumes full time crew for all the dredges; the same labor operation applied by the NCDOT Ferry Division today. Currently, NCDOT Ferry Division staff also devote time to maintaining equipment, managing upland disposal areas, etc. As dredge plant capacity expands, it is anticipated that some dredge crew will provide other support services to the overall NCDOT mission.

- Fixed Maintenance: Some maintenance expenses are independent of whether or not the dredge operates, such as dry-docking required to maintain class certification, and anti-corrosion maintenance such as paint etc. Fixed maintenance expenses in this study are based on the information collected from private dredge contractors.

### *2.4.2 Variable Costs*

Variable Costs are incremental costs that are incurred due to the operation of the dredge and are evaluated on an operating day basis using CEDEP. They include:

- Labor: Labor estimates are based on crew sizes for individual dredges. Labor rates assume local rates including benefits with insurance and tax mark-ups.

- Fuel: Fuel estimates are based on the installed pump horsepower (hp) and assumed load factor of the various dredges.

- Variable Maintenance: Variable maintenance expenses for each of the dredges analyzed include items such as wear parts and maintenance requirements resulting from operation (i.e. engine overhauls, etc.).

- Pipe Wear: Pipe used in dredging wears out due to abrasion as a function of the quantity and type of material pumped through it. Dredge pipe typically wears over many millions of cubic yards and therefore is used over many dredge projects. Dredging contactors use a variety of often complicated means to allocate the cost of pipe wear to individual projects. This cost was added to the overall maintenance costs in CEDEP.

### *2.4.3 Utilization*

Fixed costs of dredge ownership are typically allocated to various projects based on operating days. For example, if one project is one third of the annual operating days of the year, that project would incur one third of the annual fixed cost of dredge ownership. Therefore, a critical element of the daily operating cost of the dredge is the number of operating days per year that the fixed cost of dredge ownership is allocated over.

Since the unit cost of dredging is simply the daily operating costs of the dredge divided by its average productivity per day, this same relationship between utilization and daily costs applies to unit costs as well. This relationship between utilization and cost holds for any of the dredges evaluated and is a critical driver of cost effectiveness for contract dredges or any owner of a dredge. Higher utilization levels increase the number of days and amount of work over which the fixed annual cost of ownership can be spread, thus lowering the overall unit cost.

In addition to funding, one of the biggest challenges in executing dredging projects is permitting. A significant risk to be evaluated in the decision to buy a dredge is how permitting complications might delay or change the nature of work. Once the state owns a dredge, there are fixed costs that will be incurred whether it is used or not. Permitting delays could negatively impact dredge utilization (and thus costs) or project scope changes could impact the selected dredge's efficiency. If the state were to purchase its own dredge fleet, it would likely need to acquire the same permits that the USACE currently holds for these projects or else a MOU/MOA would need to be developed with the USACE to allow use of their permits to complete the work. If dredging a local or municipal project, those parties would be responsible for obtaining their own permits.

Once an investment is made in a dredge, it will be critically important that the volume of work anticipated to be performed on an annual basis actually materializes or the cost-effectiveness of the dredge will degrade with the lesser scope. Since it is likely that issues will arise with getting projects permitted and funding levels are uncertain, it is important to understand the cost risk of lower utilization.

### *2.4.4 Mobilization*

Mobilization includes the costs associated with moving and setting up equipment from one project location to the next. In the case of the state-owned dredge, this cost is expected to be dominated by the cost of labor and ancillary equipment rentals to move pipelines as well as the dredge labor in the period between finishing one project and starting the next. Mobilization costs are included in the CEDEP analysis by adjusting the downtime to a total of 30%. This factor was estimated based on experience and comparisons to recently completed project costs of mob/demob versus total project costs.

# 3.0 CASE EXAMPLES – OWNERSHIP OF DREDGES BY OTHER AGENCIES

Several public agencies that own and operate their own dredges were interviewed to understand the opportunities and constraints associated with dredge ownership. This feedback provided insight into the concerns leading up to purchasing their own dredge, the operational and revenue structure implemented by each agency, and the pitfalls or issues encountered since purchase.

## 3.1 Barnstable County Massachusetts

Barnstable County encompasses all of Cape Cod (Upper and Outer Capes) and surrounding islands. The County has upwards of 125 waterways and harbors that connect to Buzzards and Cape Cod Bays, and Nantucket and Vineyard Sounds. Many of these waterways and harbors support commercial and recreational boating access, and ferry operations for intra-island and intra-cape destinations including Block Island, Martha's Vineyard, Nantucket, and Provincetown.

Wayne Jaedtke, dredging manager for Barnstable County Massachusetts, was interviewed. Prior to 1994, routine maintenance dredging of these shallow draft waterways was performed by the State of Massachusetts with 75% state funding and 25% funding by local towns. Many of these projects consisted of small dredge quantities, resulting in high mobilization costs that delayed implementation. The state was also grappling with budget shortfalls that further delayed projects. In 1993, Barnstable County conducted a needs assessment and cost benefit analysis to operate a municipal dredge program on behalf of the towns. The report recommended that a maintenance dredging program operated by the County would be cost effective and beneficial. The County approached the state legislature and Massachusetts Department of Environmental Management (DEM) to request financial assistance in the form of a $1-million-dollar capital grant for the purchase of the dredge and associated support equipment. This money replaced the state funding for municipal dredge projects on the Cape.

The County purchased the "Codfish", an Ellicott 670 Series Dragon Model 14-inch cutter head dredge capable of dredging 245 cubic yards per hour to a depth of 26 feet. The County also purchased a steel "push" boat to move the dredge, tending anchors, a utility workout and a rubber tired loader. Other equipment purchases included a crane barge and a 800hp booster pump. Large purchases, such as the booster pump, are typically funded through state grants.

The County established a Dredge Advisory Committee in October 1994, with representation from fourteen municipalities, DEM, and County staff. The advisory committee is response for developing the dredge schedule and recommending the dredge rate for each fiscal year. The program operates as an enterprise account, where the funds earned on dredging are used to pay their expenses. Dredge rates are adjusted annually in an effort to match revenue to expenses. For FY 2016, the County charges $9.00 per cubic yard for short pipeline work and $13.00 per cubic yard for long pipeline work that requires

a booster pump. Towns obtain the permits and hire the County to do their dredging at these predetermined flat rates.

The County employs four (4) full time staff and several part time staff. The FY16 budget is $1.7 million dollars consisting of a $700,000 wages/fringe benefits, $180,000 in contractual services for part time assistance, $221,500 in supplies and materials, $120,000 in charges, obligations and equipment, and $468,000 in other expenditures.

Over the past 21 years the County dredge "Codfish" has removed 1,890,732 cubic yards of material from 288 projects. 95% of the material was used to rebuild the beaches around Cape Cod. Projects range in size from 1,000 cy to 20,000 cy. In a typical year, they do roughly 100,000 cubic yards of dredging during the dredge season (October 1 to April 1). The crew are County employees who work year-round. During downtime, they perform maintenance on the equipment.

In 2016, the County elected to purchase a second dredge to provide sufficient capacity to dredge the waterways and possibly extend dredging into freshwater. The second dredge will allow positioning of one dredge on the east cape and one on the south cape, providing a more responsive dredge schedule (and less mobilization). Purchase of the new dredge is funded by a capital reserve account established in the dredge enterprise fund. The $1,897,500 Ellicott 14" Bay Dragon Dredge "Sand Shifter" was initially delivered to the County in the summer of 2017 for assembly and fit out. Issues with electronics and hydraulic systems has delayed implementation until March 2018. The "Sand Shifter" will not require a second crew to operate; only a second crew to relocate the dredge while the main dredge crew is finishing up another dredge project with the Codfish. The County is however, facing an issue where to store the dredges as they typically remain at their last dredge project site until needed.

### 3.2 Santa Cruz Port District

From the creation of the harbor in 1964 until 1986, maintenance dredging of the harbor and entrance channel was performed by the US Army Corps of Engineers (USACE) on a frequent basis though year-round access of the entrance channel was not maintained due to high sedimentation rates. In 1986, Santa Cruz Port District, in a joint venture with the USACE, purchased a dredge to provide year-round access to the harbor and provide sand bypassing to downdrift beaches. The District modified the dredge material placement in 2007 due to hydrogen sulfide gas generated from decomposing organic material in the dredged material. Depending on hydrogen sulfide levels, the material is placed either on downdrift beaches or in designated near- or offshore disposal areas.

The "Seabright", a 16-inch DSC cutterhead suction dredge, was purchased in 1986 for $3.2 million ($1.7 million paid by the District) and is operated from November to April each year by District Staff. The District hired labor through a local dredge union on an as-needed basis and operated the dredge one shift per day. Dredge volumes averaged from 220,000 to 270,000 cy/yr to maintain the authorized -22 feet Mean Lower Low Water authorized channel depth. The District's budget, which is funded by slip rentals, launch

fees, in-harbor business leases and other sources, to operate the "Seabright" was roughly $1.5 million, resulting in an average price per cubic yard of $5.50 to $7.00.

In April 2015, the District commissioned a new custom-built DSC 16-inch dredge with hull mounted pump. The approximately $4.9 million dredge "Twin Lakes" was delivered in July 2016 and commenced operations in November 2016. The "Seabright" was sold for $5,000 on the open market. Purchase of the dredge was financed through restructuring of the District debt. The Fiscal Year 2018 dredging budget for the District is approximately $1.6 million, of which $1.14 million is related to staffing and services, $300,000 to maintain and repair equipment, and $200,000 for permitting and environmental controls. Based on one year of operations, the average dredge cost remains generally consistent at $6 to $7/cy, excluding debt servicing.

### 3.3 City of Virginia Beach, Virginia

The City of Virginia Beach purchased a dredge in 1987 to maintain Rudee Inlet and provide suitable material for beach fill placement along the City's shoreline. Prior to 1987, the Commonwealth of Virginia and the City jointly maintained the inlet using an older dredge that was managed by the Virginia Beach Erosion Commission. The City took full responsibility of the inlet after the Commission was dissolved in 1989. The US Army Corps of Engineers assists in maintaining the open ocean portion of the channel (ocean bar) at Rudee Inlet; dredging which may occur up to four times per year or after significant storm events that can rapidly shoal the channel.

The City operates the "Rudee Inlet II" a Ellicott 970 14-inch cutter suction dredge on two 10 hour shifts per day, 7 days a week with a six person crew for each shift. They operate almost exclusively in Rudee Inlet and Rudee Lake. The USACE dredges at the mouth of the breakwaters and approach channel with a special purpose hopper dredge (Currituck or Murden), where the city dredge cannot operate due to the wave climate and offshore certification issue. In addition, the USACE has performed some contract dredging inside Rudee inlet. The City does dredge Lynnhaven Inlet and other areas on an as-needed basis. The City is considering dredging waterways within residential communities; a service that would be paid by creating a special taxing district for specific neighborhoods. The City typically dredges 200,000 to 250,000 cubic yards annually.

The budget for the City's dredge operations typically averages approximately $1.6 million though expenditures approached $2 million in 2016. Approximately $1.3 million of the total budget supports the salaries and fringe benefits of 21 staff members. The remaining budget is relegated to insurance, rental/leased equipment, and fuel charges. A reserve budget was not identified, indicating that the City draws money for major purchases from its main capital fund. The average cost per yard to maintain the inlet ranges from $6 to $8.

### 3.4 Conclusions from Discussions with Other Public Dredge Owners

The overall impression, after speaking to several agencies that own and operate dredges, is that they all seemed pleased with a publicly-owned dredge as compared to contracting

dredging services. In particular, places like Barnstable County, Santa Cruz, and Virginia Beach feel that they are much more cost effective than contracting private dredging services. In addition, having the people and equipment in-house appears to be very helpful in maintaining funding (i.e. it is presumably easier to decide to stop contracting private dredging services than to stop funding on an internal dredging program).

However, one theme was consistent as an issue with nearly all those interviewed. Changing permit requirements including disposal scenarios and time-of-year operating windows are a concern. For example, if a dredge is purchased that can service a scope-of-work that requires six months of operation, and suddenly environmental windows limit dredging to three months, two dredges would be needed. This would double the capital cost of a dredging program and make it more difficult to staff cost effectively. Similarly, if a dredge is purchased with one disposal scenario in mind and then the disposal option changes, the type of dredge needed may have to change.

# 4.0 EVALUATION OF CAPABILITY OF OTHER INTERESTS TO SUPPORT STATE'S DREDGING NEEDS

Maintenance dredging of shallow and deep draft navigation projects in the State of North Carolina are primarily performed by the USACE and private dredge contractors. The ability of both entities to support the projected dredge needs of the state was vetted through a series of telephone calls with the USACE and three private dredge contractors. As a representative sample, the three private dredge contractors interviewed have fleet sizes ranging from three to eight plants and maintain 10-inch to 30-inch pipeline dredges and various size hopper dredges. Representatives of the USACE discussed their dredge operation, schedules and rate structure (daily operating and average unit costs). The private dredge contractors provided insight on dredge capacity and other operational and contractual issues but declined to provide cost structure information.

## 4.1 Shallow Draft Navigation Support - USACE

As discussed in Volume 2, the USACE operates two special purpose hopper dredges (Currituck and Murden) and one sidecast dredge, the Merritt. These dredges, which the USACE categorized as "national assets" perform work along the US Eastern Seaboard and Gulf Coast based on authorized shallow draft navigation work that is scheduled and funded each year. The three USACE operated dredges are assigned projects based on need, priority of need, and funding of work from each USACE District within the North and South Atlantic Divisions and contributing sponsors such as the State of North Carolina or local municipalities. Non-federal work may be accommodated depending on the timing of the request and the availability of dredges.

Representatives stressed that timing of monies from local sponsors is critical as monies that arrive late in the fiscal year are problematic to scheduling work as dredges are assigned to other Districts earlier in the year to keep them fully utilized. Representatives stated that if the local sponsors were proactive in planning and funding work each year in lieu of being reactionary, the USACE could more readily accommodate scheduling of the dredge plants each fiscal year. The USACE indicated that they could handle all of the State's shallow draft dredging needs using the existing special purpose dredges and the sidecast dredge; however, they cannot guarantee that their assets will stay within the state. They did indicate that another special purpose dredge would be required if the state desired to reuse the dredged material for beneficial use. The USACE commented that there may be spare dredge plant capacity with one of the special purpose dredges once the new bridge is opened at Oregon Inlet; assuming the frequency of dredging at the inlet is reduced. However, the USACE is not planning the purchase of new dredges within the next five years. If they purchase a new dredge, it will most likely be another special purpose hopper dredge as the USACE states that they are not competitive with private industry when using a pipeline dredge. The USACE provided their day rate (12 hr/day) for the three dredge plants; approximately $16,200 for the Currituck, $17,500 for the Merritt, and $21,600/day for the Murden as of October 2017. On average, the USACE's unit rate for all three dredges is $10/cy with the sidecast dredge ranging from $3 to $6 /cy while the special purpose dredges range from $8 to $14/cy as shown in Figure 4-1.

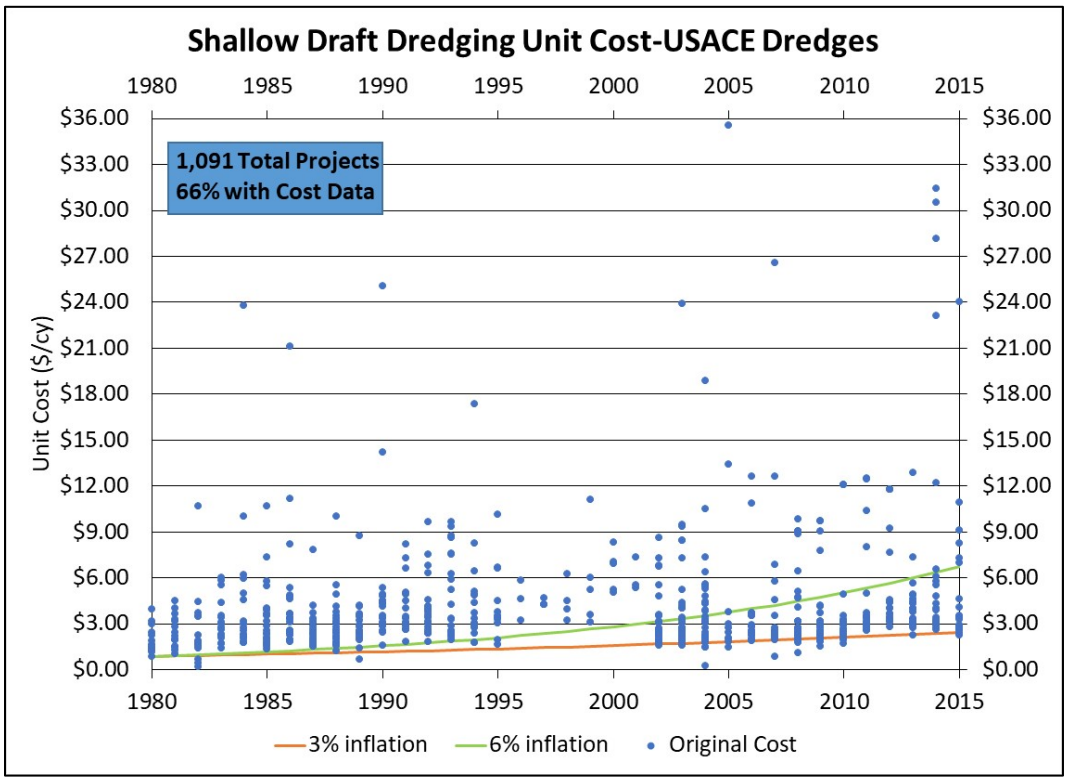


**Figure 4-1: USACE Shallow Draft Dredging Unit Cost**

The USACE provided comment on the potential expansion of the State's dredge fleet and the risk factors associated with this endeavor. If the state assumes dredging of shallow draft navigation channels currently performed by the USACE, then the state would be responsible for maintaining the permits, managing the dredged material disposal sites, and expanding their maintenance facilities to service the expanded fleet. This additive effort has to be factored into the cost of dredge operations including potential delays in permitting that may affect utilization. If the state provided dredge services outside of the COLREGS line, it would require them to maintain the vessel certification discussed in Section 1.3. Storage of the dredge fleet was also raised as state's current facility at Mann's Harbor cannot accommodate multiple vessels.

Regarding any potential Corps cost-sharing of a dredge purchase with the state, the USACE stated that there is no clearly defined mechanism for this arrangement. They did express an opinion that the likelihood of such an arrangement occurring is probably slim as numerous issues would have to be resolved related to funding sources, ownership, maintenance, daily operations, personnel, and workload priorities (State vs Federal).

## 4.2 Shallow Draft Navigation Support – Private Dredge Contractors

All private contractors indicated they have sufficient dredge plant capacity available to meet the projected demand for dredging of the AIWW and AIWW crossings, Inland waterways, and Shallow Draft Inlets. Firms that did not have ocean certified vessels

indicated they would not provide services outside of the COLREGS line due to the high cost of ocean certification and therefore were not interested in providing dredging services associated with deep draft navigation and some shallow draft inlet navigation projects. With regard to Oregon Inlet, one dredge firm indicated they would need to evaluate the project specifications prior to making a decision to pursue work. They did mention that they would probably not pursue the work if it required a special purpose hopper dredge similar to the USACE Currituck/Murden for dredging east of the Herbert C. Bonner bridge.

Other obstacles or roadblocks mentioned by the private contractors related to dredging the State's waterways include clear/precise construction documents, environmental dredge windows, project size, and scheduling of work. All contractors expressed a desire to see the environmental window increased, with several suggesting an expansion of environmental monitoring to minimize potential impacts to endangered species. All firms indicated that projects larger than $1.5 to $2.0 million are ideal for dredge efficiency and could be achieved by combining projects; leading to potential lower costs. Reinforcing a comment made by the USACE, better management of project scheduling allows private dredge contractors the ability to better manage plant utilization.

Each firm was also asked about other contractual approaches that would reduce cost to the state or local sponsors. The small contractors favored multi-year contracts; indicating savings upwards of 10% or more, while the medium to large contractors stated that since their dredges are assigned to specific projects each year, they would have to remobilize from another location. Increased mobilization costs may offset potential savings from a multi-year contract. The larger firms also indicated that small business set aside requirements for certain projects reduce the field of firms that may bid on a project.

When asked about the potential expansion of the State's dredge operations that is being evaluated, all commented that the state should thoroughly vet the risk factors associated with fleet expansion. These include operating dredges 24 hr/day, maintaining the huge capital investment in plant and equipment, retaining experienced crew and optimizing the use of support staff to reduce overall cost without affecting the ability to perform work.

Although the private contractors did not convey cost information, historical unit costs were collected as part of the Beach and Inlet Management Plan update completed in 2016 (NCDEQ, 2016). The data from the BIMP was collected from the USACE, State, and local sponsors for contracted work by private firms. These unit prices consisted of regional private contracted dredge work for projects under and over 200,000 cy. The data for projects under 200,000 cy (Figure 4-2); primarily work performed by small to medium pipeline dredges, was sorted by dredge equipment to identify the range of unit costs for 14-inch and 20-inch pipeline work. The unit price range for a 14-inch pipeline ranged from $12 to $16/cy while the unit costs for a 20-inch pipeline dredge ranged from $10 to $14/cy. For larger pipeline dredges such as a 24-inch plant, the unit price ranged from $8 to $12/cy as shown in Figure 4-3. Unit pricing for a medium capacity hopper dredge was also parsed from the data at $12 to $16/cy.

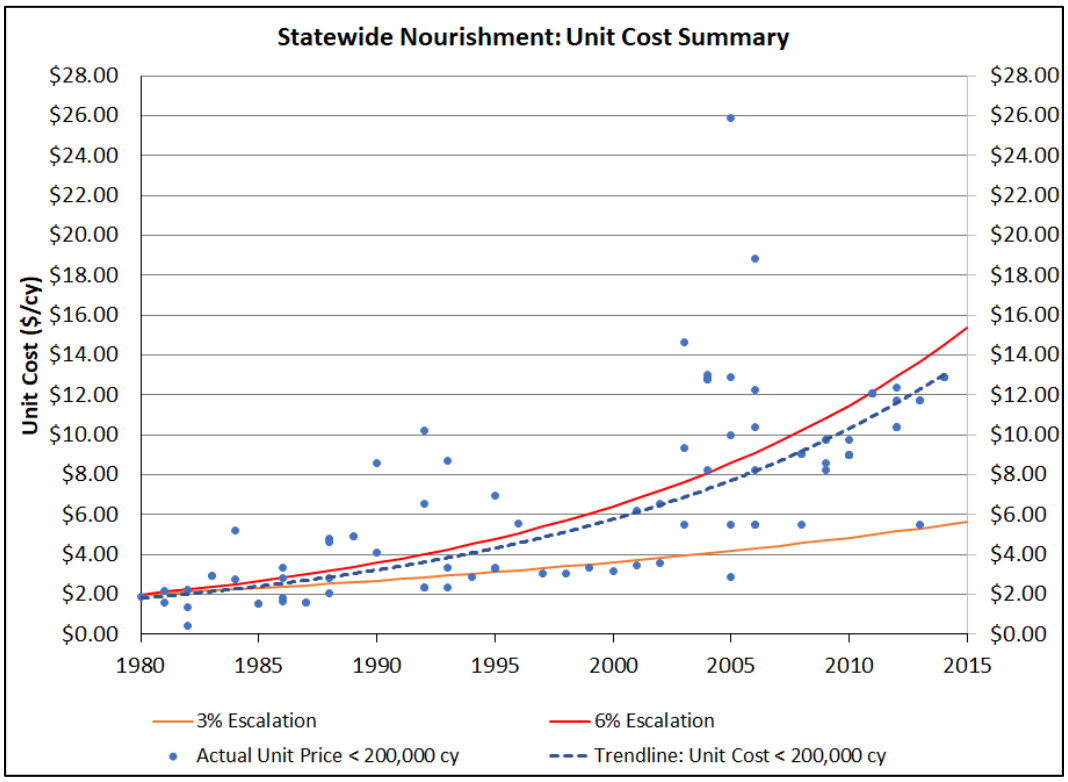


**Figure 4-2: Private Industry Small Pipeline Dredge Unit Cost**

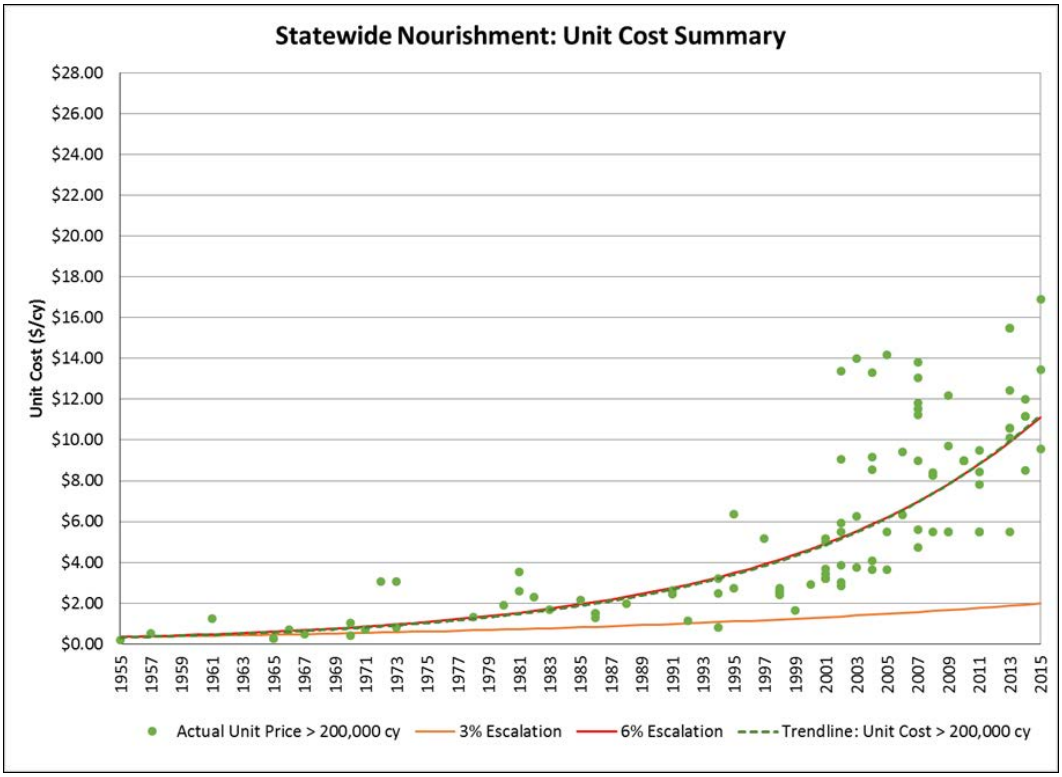


**Figure 4-3: Private Industry Large Pipeline and Hopper Dredge Unit Cost**

# 5.0 DREDGING SERVICES COST-BENEFIT ANALYSIS

To evaluate if a State-owned dredge fleet would be a more or less cost-effective way to execute the dredging needs of the State compared to the current system, the annualized gross production cost associated with the production potential of each dredge plant was computed using algorithms contained within the US Army Corps of Engineers Cost Engineering Dredge Estimating Program (CEDEP). A number of factors contribute to the calculation of the annual production cost including the actual number of months within the year that dredging occurs, the net dredging capacity (production capacity) of the combined dredging equipment, the crew and shift/hours worked, and the equipment ownership costs as discussed in Section 2.4.

The annualized operating cost components are added up and divided by the production volume potential to obtain the unit cost or the $/cy. This unit price is then compared to the historical unit prices for pipeline and special purpose/sidecast dredge projects completed in the state, with emphasis on unit price trends in the past last five years.

## 5.1 Capital Costs of Dredge Plant

The minimum investment approach for shallow draft waterway maintenance is the purchase of a special hopper dredge, a 14-inch pipeline dredge, and a 20-inch pipeline dredge as shown in Table 5-1. For the approximately $81.5 million or $4.2 million annualized over 30 years, the state would have three dredge plants capable of dredging up to 2.5 million cy/yr. This combination of dredge fleet addresses the needs of Oregon Inlet while the 14-inch and 20-inch dredges could also support dredging of the remaining shallow draft inlets, the AIWW, AIWW crossings, and some interior waterways. The aggregate unit cost of purchase, $6.88/cy, may be partially or fully recouped with each dredge project in lieu of a general appropriation to fund the initial purchase.

**Table 5-1: Initial Capital and O&M Costs for Minimum Demand – Shallow Draft Inlets, AIWW Crossings, and AIWW/Inland Waterways**

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 1 | $25,000,000 | $1,275,481 | $1.06 | 1,200,000 | $12,206,868 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | $275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 1 | $34,600,000 | $1,765,266 | $1.77 | 1,000,000 | $9,132,408 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| **TOTAL** | | **3** | **$81,450,000** | **$4,155,519** | **$6.88** | **2,475,000** | **$25,652,363** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

Table 5-2 shows the initial capital costs of four dredge plants and support that may be purchased to meet the average projected shallow draft navigation waterway needs of the state. The combined total production rate for the 4 dredges is slightly under 4.5 million cy. The purchase price for a special purpose dredge hopper dredge similar to the Murden (with

sidecast capability added) would be $25 million if purchased outright or paid out over a 30-year period at $1.3 million/yr, with the total payment at the end of 30 year equaling $39.2 million. In order for the state to offset this purchase price in their dredge operation, an additional $1.06 would be added to the unit dredge price. Similarly, computations for the 14-inch, 20-inch, and 24-inch pipelines dredges are shown. The total annual payment of $7.05 million equates to $211.6 million paid over the lifetime of the loan. The unit price component, in aggregate, of the purchase price is approximately an $8.33/cy unit price.

**Table 5-2: Initial Capital and O&M Costs for Average Demand – Shallow Draft Inlets, AIWW Crossings, and AIWW/Inland Waterways**

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 1 | $25,000,000 | $1,275,481 | $1.06 | 1,200,000 | $12,206,868 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | 275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 1 | $34,600,000 | $1,765,266 | $1.77 | 1,000,000 | $9,132,408 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| Initial Cost of 24" Pipeline Dredge | $37,800,000 | 1 | $56,800,000 | $2,897,894 | $1.45 | 2,000,000 | $14,044,056 |
| Initial Cost of Equipment for 24" Pipeline Dredge | $19,000,000 | | | | | | |
| **TOTAL** | | **4** | **$138,250,000** | **$7,053,413** | **$8.33** | **4,475,000** | **$39,696,419** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

If dredge plant was purchased to maintain the average deep draft navigation projects in addition to the average shallow draft navigation needs, the total purchase cost would exceed $215.8 million or $11.0 million in annual payments as shown in Table 5-3. The aggregate unit price contribution would rise to $9.74/cy for a potential dredge production of 7.3 million cy/yr. Table 5-4 and Table 5-5 show corresponding capital costs and corresponding annual payments for the peak shallow draft fleet only and the combined peak shallow draft and deep draft fleet. The capital investment is $197.9 million for the peak shallow draft only fleet and $342.4 million for peak demand associated with shallow and deep draft waterways.

## Table 5-3: Initial Capital and O&M Costs for Average Demand – Shallow Draft Inlets, AIWW Crossings, AIWW/Inland Waterways, and Deep Draft

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 1 | $25,000,000 | $1,275,481 | $1.06 | 1,200,000 | $12,206,868 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | 275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 1 | $34,600,000 | $1,765,266 | $1.77 | 1,000,000 | $9,132,408 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| Initial Cost of 24" Pipeline Dredge | $37,800,000 | 1 | $56,800,000 | $2,897,894 | $1.45 | 2,000,000 | $14,044,056 |
| Initial Cost of Equipment for 24" Pipeline Dredge | $19,000,000 | | | | | | |
| Initial Cost of 30" Pipeline Dredge | $51,000,000 | 1 | $77,500,000 | $3,953,993 | $1.41 | 2,800,000 | $18,710,161 |
| Initial Cost of Equipment for 30" Pipeline Dredge | $26,500,000 | | | | | | |
| **TOTAL** | | **5** | **$215,750,000** | **$11,007,405** | **$9.74** | **7,275,000** | **$58,406,579** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

## Table 5-4: Initial Capital and O&M Costs for Peak Demand – Shallow Draft Inlets, AIWW Crossings, and AIWW/Inland Waterways

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 2 | $50,000,000 | $2,550,963 | $1.06 | 2,400,000 | $24,413,736 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | 275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 2 | $69,200,000 | $3,530,533 | $1.77 | 2,000,000 | $18,264,816 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| Initial Cost of 24" Pipeline Dredge | $37,800,000 | 1 | $56,800,000 | $2,897,894 | $1.45 | 2,000,000 | $14,044,056 |
| Initial Cost of Equipment for 24" Pipeline Dredge | $19,000,000 | | | | | | |
| **TOTAL** | | **6** | **$197,850,000** | **$10,094,160** | **$8.33** | **6,675,000** | **$61,035,695** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

## Table 5-5: Initial Capital and O&M Costs for Peak Demand – Shallow Draft Inlets, AIWW Crossings, AIWW/Inland Waterways, and Deep Draft

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 2 | $50,000,000 | $2,550,963 | $1.06 | 2,400,000 | $24,413,736 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 14" Pipeline Dredge | $10,000,000 | 1 | $21,850,000 | $1,114,771 | $4.05 | 275,000 | $4,313,087 |
| Initial Cost of Equipment for 14" Pipeline Dredge | $11,850,000 | | | | | | |
| Initial Cost of 20" Pipeline Dredge | $20,000,000 | 2 | $69,200,000 | $3,530,533 | $1.77 | 2,000,000 | $18,264,816 |
| Initial Cost of Equipment for 20" Pipeline Dredge | $14,600,000 | | | | | | |
| Initial Cost of 24" Pipeline Dredge | $37,800,000 | 1 | $56,800,000 | $2,897,894 | $1.45 | 2,000,000 | $14,044,056 |
| Initial Cost of Equipment for 24" Pipeline Dredge | $19,000,000 | | | | | | |
| Initial Cost of 30" Pipeline Dredge | $51,000,000 | 1 | $77,500,000 | $3,953,993 | $1.41 | 2,800,000 | $18,710,161 |
| Initial Cost of Equipment for 30" Pipeline Dredge | $26,500,000 | | | | | | |
| Initial Cost of Medium Hopper (3,500 CY Capacity) Dredge | $50,000,000 | 1 | $67,000,000 | $3,418,290 | $2.63 | 1,300,000 | $15,375,972 |
| Initial Cost of Equipment for Medium Hopper (3,500 CY Capacity) Dredge | $17,000,000 | | | | | | |
| **TOTAL** | | **8** | **$342,350,000** | **$17,466,443** | **$12.37** | **10,775,000** | **$95,121,827** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

The state would be investing considerable capital ($138.3 million) to purchase and subsequently operate ($39.7 million) a dredge fleet that matches the average shallow draft dredging needs of the state. Funding for the Shallow Draft Navigation Channel and Aquatic Weed Fund is approximately $19 million with a 25% to 33% matching cost share provided by the local sponsor. The total annual funding equates to roughly $23.5 million. The number and type of dredge plants that could be purchased and operated with this fund was evaluated. As shown in Table 5-6, the annualized capital investment cost and annual operating cost of a special purpose dredge and a 24-inch pipeline is approximately $4 million and $26 million a year, respectively. Therefore, the annual operating cost (not including the purchase price) of these two dredges would generally align with the annual funding as shown in Table 5-6. The special purpose hopper could perform year round dredging to meet the average needs at Oregon Inlet and other shallow draft inlets. The ocean certified 24-inch pipeline dredge could perform dredging of the AIWW and AIWW crossings as well as shallow draft inlets (the required draft of the 24-in dredge may be a bit challenging in some locations but the special purpose dredge could be used to create a pilot channel). Between these two plants, most of the shallow draft inlet demand would be fulfilled. The 24-in dredge could also be used for some deep draft work if needed during emergencies. In summary for this option, either a general appropriation of $81.8 million or an increased annual funding stream of $4.2 million would need to be realized.

**Table 5-6: Initial Capital and O&M Costs – Current Funding Source**

| | Initial Cost | # of Dredges | Total Initial Cost | Annual Payment ($/YR)* | Additional Unit Cost ($/CY)* | Production Rate (CY/YR) | Total Annual Cost |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | $25,000,000 | 1 | $25,000,000 | $1,275,481 | $1.06 | 1,200,000 | $12,206,868 |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | $0 | | | | | | |
| Initial Cost of 24" Pipeline Dredge | $37,800,000 | 1 | $56,800,000 | $2,897,894 | $1.45 | 2,000,000 | $14,044,056 |
| Initial Cost of Equipment for 24" Pipeline Dredge | $19,000,000 | | | | | | |
| **TOTAL** | | **2** | **$81,800,000** | **$4,173,375** | **$2.51** | **3,200,000** | **$26,250,924** |

*These costs are provided in case the state would like to annualize the initial purchase cost of the dredge and equipment

## 5.2 Annual Operating Costs and Unit Pricing

Annual operating and unit costs per cubic yard for each dredge plant for the average demand at the State's shallow draft navigation channels is highlighted in Table 5-7. The annual operating cost is approximately $39.7 million associated with approximately 4.5 million cy/yr production volume. The unit cost per yard based on the annual operating cost and production volume ranges from $7.0 for a 24-inch pipeline dredge to $15.70 for a 14-inch pipeline dredge. A special purpose dredge has an operating unit cost of approximately $10.20.

Historical unit costs to compare with the estimated unit pricing were collected as part of the Beach and Inlet Management Plan update completed in 2016 as discussed in Sections 4.1 and 4.2. As portrayed in Table 5-7, the estimated unit costs generally align with the historical cost data. However, the estimated unit costs do not include the annualized capital cost contribution discussed in Section 5.1 if the initial purchase cost is annualized. This aggregated contribution may range from $1/cy to $4/cy per dredge, which would increase

the estimated unit pricing to exceed or be on the higher end of the historical range. Smaller pipeline dredges (<20-inch) are more difficult to work efficiently and face more competitive pressures from private contractors. Since the capital investment in a special purpose dredge is lower than most pipeline dredges, the unit costs for this dredge plant would be aligned with historical pricing.

Table 5-8 through Table 5-10 show the unit cost comparisons for the average shallow draft and deep draft needs, the peak shallow draft navigation needs, and the peak shallow draft and deep draft navigation need. In addition, Table 5-11 shows the unit cost comparison for dredge plants operating on the current state funding source. For deep draft projects, the unit costs for large pipeline dredges and medium hopper dredges are commensurate with historical pricing information.

**Table 5-7: Unit Cost Comparison for Average Shallow Draft Dredge Need**

| | # of Dredges | Total Initial Cost | Production Rate (CY/YR) | Total Annual Cost | Unit Cost | Historical Unit Cost USACE Special Purpose/Sidecast | Historical Unit Cost Private Contract Small Pipeline/Hopper |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | 1 | $25,000,000 | 1,200,000 | $12,206,868 | $10.2 | $8.00 to $14.00 | NA |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | | | | | | | |
| Initial Cost of 14" Pipeline Dredge | 1 | $21,850,000 | 275,000 | $4,313,087 | $15.7 | NA | $12.00 to $16.00 |
| Initial Cost of Equipment for 14" Pipeline Dredge | | | | | | | |
| Initial Cost of 20" Pipeline Dredge | 1 | $34,600,000 | 1,000,000 | $9,132,408 | $9.1 | NA | $10.00 to $14.00 |
| Initial Cost of Equipment for 20" Pipeline Dredge | | | | | | | |
| Initial Cost of 24" Pipeline Dredge | 1 | $56,800,000 | 2,000,000 | $14,044,056 | $7.0 | NA | $8.00 to $12.00 |
| Initial Cost of Equipment for 24" Pipeline Dredge | | | | | | | |
| **TOTAL** | **4** | **$138,250,000** | **4,475,000** | **$39,696,419** | | | |

**Table 5-8: Unit Cost Comparison for Average Shallow and Deep Draft Dredge Need**

| | # of Dredges | Total Initial Cost | Production Rate (CY/YR) | Total Annual Cost | Unit Cost | Historical Unit Cost USACE Special Purpose/Sidecast | Historical Unit Cost Private Contract Pipeline/Hopper |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | 1 | $25,000,000 | 1,200,000 | $12,206,868 | $10.2 | $8.00 to $14.00 | NA |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | | | | | | | |
| Initial Cost of 14" Pipeline Dredge | 1 | $21,850,000 | 275,000 | $4,313,087 | $15.7 | NA | $12.00 to $16.00 |
| Initial Cost of Equipment for 14" Pipeline Dredge | | | | | | | |
| Initial Cost of 20" Pipeline Dredge | 1 | $34,600,000 | 1,000,000 | $9,132,408 | $9.1 | NA | $10.00 to $14.00 |
| Initial Cost of Equipment for 20" Pipeline Dredge | | | | | | | |
| Initial Cost of 24" Pipeline Dredge | 1 | $56,800,000 | 2,000,000 | $14,044,056 | $7.0 | NA | $8.00 to $12.00 |
| Initial Cost of Equipment for 24" Pipeline Dredge | | | | | | | |
| Initial Cost of 30" Pipeline Dredge | 1 | $77,500,000 | 2,800,000 | $18,710,161 | $6.7 | NA | $8.50 to $10.50 |
| Initial Cost of Equipment for 30" Pipeline Dredge | | | | | | | |
| **TOTAL** | **5** | **$215,750,000** | **7,275,000** | **$58,406,579** | | | |

## Table 5-9: Unit Cost Comparison for Peak Shallow Draft Dredge Need

| | # of Dredges | Total Initial Cost | Production Rate (CY/YR) | Total Annual Cost | Unit Cost | Historical Unit Cost USACE Special Purpose/Sidecast | Historical Unit Cost Private Contract Small Pipeline/Hopper |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge<br>Initial Cost of Equipment for Special Purpose (Murden) Dredge | 2 | $50,000,000 | 2,400,000 | $24,413,736 | $10.2 | $8.00 to $14.00 | NA |
| Initial Cost of 14" Pipeline Dredge<br>Initial Cost of Equipment for 14" Pipeline Dredge | 1 | $21,850,000 | 275,000 | $4,313,087 | $15.7 | NA | $12.00 to $16.00 |
| Initial Cost of 20" Pipeline Dredge<br>Initial Cost of Equipment for 20" Pipeline Dredge | 2 | $69,200,000 | 2,000,000 | $18,264,816 | $9.1 | NA | $10.00 to $14.00 |
| Initial Cost of 24" Pipeline Dredge<br>Initial Cost of Equipment for 24" Pipeline Dredge | 1 | $56,800,000 | 2,000,000 | $14,044,056 | $7.0 | NA | $8.00 to $12.00 |
| **TOTAL** | **6** | **$197,850,000** | **6,675,000** | **$61,035,695** | | | |

## Table 5-10: Unit Cost Comparison for Peak Shallow and Deep Draft Dredge Need

| | # of Dredges | Total Initial Cost | Production Rate (CY/YR) | Total Annual Cost | Unit Cost | Historical Unit Cost USACE Special Purpose/Sidecast | Historical Unit Cost Private Contract Pipeline/Hopper |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge<br>Initial Cost of Equipment for Special Purpose (Murden) Dredge | 2 | $50,000,000 | 2,400,000 | $24,413,736 | $10.2 | $8.00 to $14.00 | NA |
| Initial Cost of 14" Pipeline Dredge<br>Initial Cost of Equipment for 14" Pipeline Dredge | 1 | $21,850,000 | 275,000 | $4,313,087 | $15.7 | NA | $12.00 to $16.00 |
| Initial Cost of 20" Pipeline Dredge<br>Initial Cost of Equipment for 20" Pipeline Dredge | 2 | $69,200,000 | 2,000,000 | $18,264,816 | $9.1 | NA | $10.00 to $14.00 |
| Initial Cost of 24" Pipeline Dredge<br>Initial Cost of Equipment for 24" Pipeline Dredge | 1 | $56,800,000 | 2,000,000 | $14,044,056 | $7.0 | NA | $8.00 to $12.00 |
| Initial Cost of 30" Pipeline Dredge<br>Initial Cost of Equipment for 30" Pipeline Dredge | 1 | $77,500,000 | 2,800,000 | $18,710,161 | $6.7 | NA | $8.50 to $10.50 |
| Initial Cost of Medium Hopper (3,500 CY Capacity) Dredge<br>Initial Cost of Equipment for Medium Hopper (3,500 CY Capacity) Dredge | 1 | $67,000,000 | 1,300,000 | $15,375,972 | $11.8 | NA | $12.00 to $16.00 |
| **TOTAL** | **8** | **$342,350,000** | **10,775,000** | **$95,121,827** | | | |

## Table 5-11: Unit Cost Comparison – Current Funding Source

| | # of Dredges | Total Initial Cost | Production Rate (CY/YR) | Total Annual Cost | Unit Cost | Historical Unit Cost USACE Special Purpose/Sidecast | Historical Unit Cost Private Contract Small Pipeline/Hopper |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge<br>Initial Cost of Equipment for Special Purpose (Murden) Dredge | 1 | $25,000,000 | 1,200,000 | $12,206,868 | $10.2 | $8.00 to $14.00 | NA |
| Initial Cost of 24" Pipeline Dredge<br>Initial Cost of Equipment for 24" Pipeline Dredge | 1 | $56,800,000 | 2,000,000 | $14,044,056 | $7.0 | NA | $8.00 to $12.00 |
| **TOTAL** | **2** | **$81,800,000** | **3,200,000** | **$26,250,924** | | | |

# 6.0 CONTRACTUAL ISSUES FOR DELIVERY OF STATE'S DREDGING NEEDS BY PRIVATE INDUSTRY

Approaches to streamline the contractual process if the state utilized private contractors to support maintenance dredging of shallow draft navigation channels were investigated. One such contract vehicle is a multiple-award construction contract (MACC) that is widely used within the federal government, specifically the Armed Services, US Army Corps of Engineers, and the US Coast Guard. This contracting vehicle would allow the state to award multiple contracts for dredging, in order to have established contractors in place to complete projects without the need for a full open solicitation. Once the parent contract was established, the state would solicit proposals for task orders, with the selection based on best value, low bid, or a combination of the two criterion. Utilizing a combined criterion for the selection of individual task orders would not limit contractors to a low bid where the type of dredge project may require a particular type of plant to complete the work most efficiently but at higher cost. Most parent MACC contracts are structured to guarantee each selected contractor with a minimum amount of work but also require contractors to bid on most task orders, if not all, to maintain competitive pricing at the task order level.

Another contract approach is the use of concessionaire-type contracts where the state pays a fixed amount to a private contractor each year to perform the required dredging and other maintenance items. This form of performance based contracting, sometimes referred to as draught guarantee contracts, are typically awarded on a multi-year basis (generally 10-years or more) to the lowest bidder. This contracting approach may be most applicable to maintaining the Ferry Division channels and facilities that have clearly defined maintenance needs, but may be expanded to shallow draft inlets and channels that have formalized management plans in place. These contract vehicles place the onus on the concessionaire to streamline the contracting process, achieve savings through scheduling and efficient utilization of the dredge plant, and assume the role of support services including permitting and disposal site management. The contract may include a demand risk clause that requires the concessionaire to assume the risk to maintaining the waterways to allow commercial traffic to be maintained. This latter clause is typically attributed to waterways where a user fee may be collected from commercial vessels transiting the waterways. Based on several studies of port concessionaire agreements, which includes marine infrastructure and dredging projects, the life cycle benefit cost of the concessionaire type agreement is 10 to 20%. This level of cost saving was mentioned by some private contractors when discussing the use of multi-year contracts.

# 7.0 ISSUES SPECIFIC TO STATE OWNERSHIP

## 7.1 Opportunities and Constraints of Dredge Purchase

A summary of opportunity and constraints associated with state-owned dredge ownership is summarized below.

**Opportunities**

- Purchasing a dredge prevents an individual project from having to support the long distance mobilization of a private industry dredge. It also may prevent time delays for projects due to the lack of available equipment.

- Purchasing a dredge will encourage beneficial reuse of material because once the capital investment is made the incremental cost of an additional project is less than it would be to contract that project separately.

- Purchasing a dredge removes the uncertainty associated with the bid market in the dredge industry. Because a limited number of dredges exist, the timing of market demands in other parts of the country brings uncertainty in the number of bidders and bid prices for an individually contracted project.

**Constraints**

- Purchasing a dredge capable of offshore operations is a substantial and long term investment.

- For a state-owned dredge to be cost-effective, there would have to be a high confidence of being able to consistently fund, permit, and execute the volume of work necessary to justify the investment year after year for the life of the dredge.

- Purchasing one type / size of dredge makes some individual projects less cost effective while making others more cost effective. Contracting dredging services allows for the most appropriate dredge to be applied to the project at hand.

- Owning and operating a dredge exposes the state to substantial liabilities in terms of navigation mishaps, marine pollution and Jones Act injury claims.

It is unclear whether the state could cost effectively staff a large dredge fleet outside of the dredge operating window. Staff would need to be utilized by NCDOT to support dredged management of the Ferry Division disposal sites or be transferred to other NCDOT divisions. Maintaining experienced and long-term commitments from staff may be challenging.

## 7.2 Comparison to Other Public Entities

There are other public entities that operate dredges. In all cases but the USACE, they are inshore pipeline dredges (i.e. non-ocean certified). The USACE does operate a fleet of ocean certified special purpose hopper and sidecast dredges. The operation of the USACE dredges has been the subject of congressional debate since a 1978 law was passed phasing out government owned general purpose hopper dredges (nonspecial purpose). The cost structure for the USACE operation is very complicated: however, Congress concluded that contracting dredging services is more cost effective than maintaining and operating dredges. The federal government has also concluded that maintaining a minimum capability of dredges is in the national interest due to the critical role the nation's waterways play in national defense.

This study has not identified any models for the State of North Carolina to follow where a public entity owns and operates an offshore dredge in the interest of lowering the cost or increasing the convenience of executing the work.

## 7.3 Legal Liability and Self Insurance

Owning and operating a dredge brings potential liability exposures that may not be typical for other state activities. Major insurance requirements include hull, marine pollution, and specialized worker injury insurances under the Longshoreman & Harbor Workers Act (USL&H) and Merchant Marine Act (a.k.a. "Jones Act"). Although the state has addressed many of these issues through operation of the Dredge Manteo and the fleet of ferries within the Ferry Division, this issue will exponentially grow with the purchase of a large dredge fleet. Many owners of large marine fleets insure through P&I clubs (i.e. a kind of international group self-insurance). The degree to which the state would be able to self-insure a larger dredge fleet would require further research within the state government.

In conclusion, there are many legal and contracting issues that need to be investigated or resolved before the state could make the overall decision to purchase a significant dredge fleet with multiple types of dredges.

## 8.0 SUMMARY AND CONCLUSIONS

The outcome of interviews with public agencies that have purchased and currently operate one or two smaller pipeline dredges is that operating the dredges has streamlined scheduling of dredge services and positioned them to better manage their dredging needs. Representatives of these agencies stated that the cost of dredging is generally the same or slightly lower by $1 to $2/cy than when they procured dredging services from private contractors. Purchase and operation of ocean certified dredges was not considered by any agency interviewed due to the high cost of certification and insurance. USACE continues to provide these dredging services outside of the COLREGS line.

The USACE indicated that they could handle all of the State's shallow draft dredging needs using the existing special purpose dredges and the sidecast dredge. Their unit cost is, on average for all three dredges, about $10/cy with the sidecast dredge ranging from $3 to $6 /cy and the special purpose dredges ranging from $8 to $14/cy. Proactive planning including timing of dedicated funding sources by the local sponsors would allow the USACE to better manage the dredging needs.

The USACE stressed that if the state assumes dredging of shallow draft navigation channels currently performed by the USACE, then the state would be responsible for maintaining the permits, managing the dredged material disposal sites, and expanding their maintenance business to service the fleet. These risk factors affect utilization of the dredges. The USACE also indicated that they were not aware of a cost-share arrangement where the USACE and state would jointly purchase and operate a dredge. This arrangement would have to address funding sources, ownership, maintenance, daily operations, manning, and workload priorities (State vs Federal).

All private contractors indicated they have sufficient dredge plant capacity available to meet the projected demand for dredging of the AIWW and AIWW crossings, Inland waterways, and Shallow Draft Inlets. Several firms did mention that they would prefer not to provide services outside of the COLREGS line due to the high cost of ocean certification. Three primary obstacles or roadblocks mentioned by the private contractors related to dredging the State's waterways were the restrictive environmental dredge windows, the size of the projects, and scheduling. All firms indicated that projects larger than $1.5 to $2.0 million are ideal for dredge efficiency and could be achieved by combining projects. Better management of project scheduling by local sponsors was also identified as a means to more readily manage their plant utilization.

The private contractors had mixed reactions on multi-year contracts, with some indicating cost savings while others felt that this contractual agreement would have minimal impact. However, the large dredge contractors would prefer to see the number of small business set aside requirements reduced, which would allow them to increase their efficiency and reduce costs. When asked about the potential expansion of the State's dredge operations that is being evaluated, all commented that the state should thoroughly vet the risk factors associated with fleet expansion.

Two contracting approaches (MACC and concessionaire-type agreements) that the state may employ when enlisting dredging services from private contractors may provide potential cost savings of 5% to 10%. These savings are generally similar to the savings the state may realize if the state operated their own expanded dredge fleet based on the analysis to date. The state, however, would have to come up with the initial capital investment.

Based on current funding streams (Shallow Draft Navigation Channel and Aquatic Weed Fund), the purchase of a special purpose hopper and 24-in pipeline may be feasible if the initial costs can be funded. This limited arrangement would provide dedicated staff for year round of the special purpose dredge and dedicated staff for operation of the pipeline dredges. When pipeline dredge plants are not operating due to environmental window restrictions, the field crews can be assigned work on management of disposal sites.

**Table 8-1: Current Funding Source Approach**

| | # of Dredges | Total Initial Cost | Production Rate (CY/YR) | Total Annual Cost | Unit Cost | Historical Unit Cost USACE Special Purpose/Sidecast | Historical Unit Cost Private Contract Small Pipeline/Hopper |
|---|---|---|---|---|---|---|---|
| Initial Cost of Special Purpose (Murden) Dredge | 1 | $25,000,000 | 1,200,000 | $12,206,868 | $10.2 | $8.00 to $14.00 | NA |
| Initial Cost of Equipment for Special Purpose (Murden) Dredge | | | | | | | |
| Initial Cost of 24" Pipeline Dredge | 1 | $56,800,000 | 2,000,000 | $14,044,056 | $7.0 | NA | $8.00 to $12.00 |
| Initial Cost of Equipment for 24" Pipeline Dredge | | | | | | | |
| **TOTAL** | **2** | **$81,800,000** | **3,200,000** | **$26,250,924** | | | |

The state may also consider a phased approach to avoid completely consuming its current funding source by purchasing the special purpose hopper first and then purchasing the ocean certified pipeline dredge in the future. The special purpose hopper dredge has lower capital and annual operating costs, allows year round use, and does not require significant expenditures on crew or support equipment to provide dredge services for shallow draft inlets and the AIWW crossings. The state and local sponsors could continue utilizing the USACE and private contractors for the remaining work the special purpose hopper could not perform.

Legal/contracting issues and the cost of ocean certification should be investigated prior to making a final decision. These issues and additional landside support costs may be significant enough to eliminate potential cost savings. However, cost savings are only one part of the equation as the State's ability to manage scheduling and adding flexibility to the current system are important considerations. If the state is willing to increase funding levels, additional plants can be utilized to meet the average, peak and deep draft needs as well.

## 9.0 REFERENCES

NCDEQ. (2016). *North Carolina Beach and Inlet Management Plan - Update.*

NCGA. (2017). *Senate Bill 257: Appropriations Act of 2017. Sec. 34.29: Study/Use of Dredge Manteo.* Raleigh.

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