

Town of Orleans, MA

Dredge Purchase Feasibility Study



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EXECUTIVE SUMMARY

This Study aims to address whether a municipally owned, operated, and managed dredge is a cost effective and efficient alternative to meet the Town's dredging needs, or whether more cost effective and/or efficient alternatives exist. The following report includes pertinent information about the steps required to develop and permit a dredging project, the equipment needed to complete the work, and regional case studies that offer insights about the benefits and drawbacks of dredge ownership. These sections are followed by an evaluation of the quantity and quality (type) of sediment that is currently available to be dredged from Town waterways, alternatives and estimated costs to accomplish the work, and the pros and cons of each scenario. This information is intended to inform meaningful conversation between Town officials, members of the Dredge Advisory Committee, and public stakeholders about the most amenable solution(s) to meet the Town's dredging needs.

Woods Hole Group acknowledges that several limiting factors and unknown variables exist which, once resolved, will help refine the costs and assumptions of the Study. Specifically:

- ***The Town does not currently hold permits to dredge Nauset Estuary or Pleasant Bay.*** The permits will help determine what areas can be dredged, how much material can be dredged, and what equipment and methods can be used to accomplish the work. This information will impact the volume estimates and cost estimates carried in the Study.
- ***It is unknown how well dredging equipment will perform in Nauset Estuary.*** Maximum current velocities measured in Nauset Estuary are near the upper limits of the safe operating conditions for the dredging equipment considered in this Study. Therefore, the Town should leverage the subsidized dredging rates offered by the Barnstable County Dredge (BCD) Program to complete one or more dredging projects in Nauset Estuary prior to deciding whether to invest in a dredge. The BCD uses the same type of equipment that the Town of Orleans would likely be interested in purchasing. This arrangement would allow the Town to evaluate how well the BCD equipment, staffed by an experienced crew, performs in dynamic areas of Nauset Estuary. The performance of the BCD will impact the recommendations made in the Study.
- ***It may take 4-5 years to secure all permits and complete 1-2 rounds of initial (BCD) projects in Nauset Estuary.*** After 4-5 years have passed, the Town will have significantly more information at its disposal and will need to revisit whether to invest in a municipal dredge, requiring revisions to the costing analysis in the Study.



As the Town of Orleans continues to evaluate the feasibility of a municipal dredge program, the following recommendations, at a minimum, should be considered:

- Provide opportunities for open collaboration between the Orleans DAC, Town officials, and public stakeholders to evaluate alternatives, solicit feedback, and facilitate next steps.
- Consider the need for administrative support staff to manage bookkeeping tasks, dredge records, active permits, contracts, etc.
- File for and secure consolidated, comprehensive dredging and disposal permits for each waterway, to allow for better adaptive management of waterways from year to year, based on need. The permits will contain critical information on the waterways permitted for dredging, the allowable volumes, disposal locations, and allowable dredge frequencies. Because the feasibility of the Town’s dredging program hinges on these fundamental components of the work, it is critical that the permits be issued before a decision is made on the purchase of a municipal dredge.
- The BCD and/or private dredge contractors will not schedule dredging projects until all permits have been secured by the Town. Once permits have been secured, the project will be scheduled by the BCD Advisory Committee (which ensures equitable, but not immediate, access to dredging services) or by the contractor. Given the acute need for dredging, The Town of Orleans should begin the process of collaborating with the BCD and/or private contractors to ensure that Town projects are recognized as a high priority when permitting is complete and scheduling can occur.
- Contract with the BCD for initial dredging in Nauset Estuary behind the barrier beach. Performance of the BCD in this highly dynamic waterway, using the same type of dredging equipment the Town is considering purchasing, with an experienced crew, will provide invaluable information on the challenges the Town will face with a municipal dredging program. Performance of the BCD in Nauset Estuary should be a factor in the Town’s decision to pursue a municipal dredging program.
- Update the financial model once the permits have been issued and performance of the BCD in Nauset Estuary has been evaluated. The financial model should be updated to reflect the permitted dredge volumes for each waterway and costs associated with getting the material to the permitted disposal/beneficial reuse locations. The model could also be updated at this time to reflect current equipment and labor costs.
- Continue to identify suitable dewatering and disposal/beneficial reuse sites for sandy and fine-grained material that could be used once the capacity of preferred areas have been filled.



1.0 INTRODUCTION

The Town of Orleans is home to a diverse coastline of estuarine systems, salt marshes, dynamic barrier beaches and fresh and saltwater ponds. These coastal resource areas support a vibrant commercial fishing community, recreational boating opportunities, and a variety of ecological habitats. Each year, tourists and vacationers travel to Cape Cod, where they join year-round residents recreating along the shore. The diverse recreational and commercial opportunities supported by the Town's coastal waterways and resource areas solidify the link between local environmental features and the regional economy. The Town identified Nauset Estuary, Pleasant Bay and Rock Harbor as the areas in greatest need of dredging due to the environmental setting, economic importance, public safety concerns, and historic management practices.

Over the past several years, frequent coastal storms and associated climate impacts have resulted in increased rates of erosion along beaches in the Town of Orleans, exacerbating shoaling in local harbors and waterways (Figure 1). Impacts to coastal and barrier beaches in Orleans have put residential communities and municipal assets at risk and have increased the need for a reliable source of sediment to complete beach nourishment, dune enhancement, and coastal resilience projects (Figure 2). Within Town waterways, shoaling has restricted boat traffic to narrow navigation channels, bringing mariners into conflict, and creating a significant public safety concern for municipal officials. Deteriorating conditions have forced emergency personnel to respond to incidents, often with little water to safely maneuver response vessels, putting first responders at risk.

The situation has continued to worsen because of a lack of resources for dredging projects in non-Federal (State and local) waterways. According to State government officials, the lack of resources likely stems from three principal sources:

- 1) The eligibility metrics for dredge projects currently used by the United States Army Corps of Engineers (USACE) generally exclude projects from consideration that do not involve waterways facilitating substantial amounts of commercial shipping.
- 2) A lack of available resources for dredging activities within the scope of limited municipal budgets with spending priorities such as education, public safety, and infrastructure.
- 3) The absence, until very recently, of a structure or program at the State level to fund or provide funding assistance for dredging projects. Recently, this situation has changed with the development and deployment of the Massachusetts Dredging Program by the Baker-Polito Administration, designed to assist cities and Towns with the cost of dredging waterways through locally sponsored projects.

These and other factors have led to a significant need for dredging and a troubling backlog of projects State-wide.



Figures 1, 2. Waves break along Nauset Beach, Orleans, MA during March 2018 coastal storm. Shoaling in Nauset Estuary, a constant impediment to navigation. Photo courtesy of the Town of Orleans and Spencer Kennard.

Waterways and Historic Dredge Permits in the Town of Orleans

Nauset Estuary

Nauset Estuary is a dynamic barrier, estuarine, and salt marsh system, where strong tidal currents and wind and wave exposure result in a continuously evolving shoreline and channel within the Towns of Orleans and Eastham. Nauset Estuary contains six public landings, commercial and recreational moorings, and private marinas and facilities. Over the past several decades as Nauset inlet has migrated north, shoaling has impacted navigation in the Estuary, which has become restricted to the hours immediately before and after high tide, creating a significant public safety concern for municipal officials. Several commercial fishing vessels have also been forced to moor in the limited, deep areas behind the barrier beach, a less efficient and more dangerous alternative than sheltered areas located further back in the Estuary. Records from the Massachusetts Department of Environmental Protection (DEP) and the Division of Conservation and Recreation (DCR) provide information on historical dredging activities in Nauset Estuary. A total of four (4) permits for small-scale dredging related activities in Nauset Estuary were issued between 1924 and 1974.

Pleasant Bay

Like Nauset Estuary, Pleasant Bay is a dynamic coastal system with extensive salt marsh and tidal flat resource areas. Many of the navigation channels in Pleasant Bay lead to small, terminal salt ponds that support commercial and recreation interests. These small embayments support private and public boating facilities, aquaculture ventures, and commercial fishing and boat building operations. Historic dredging permits exist for five locations within Pleasant Bay: the approach channels to Quanset Pond, Paw Wah Pond, Arey's Pond and Lonnie's Pond, and the navigation channel located in the Narrows. These areas have not been dredged since the 1940's-1970's, limiting access to the terminal ponds. Records from the Massachusetts DEP and DCR also provide information on historical dredging activities in Pleasant Bay. These records indicate that



a permit was issued in 1959 for dredging in channels leading to Quanset, The Narrows, Pah Wah, Arey's, and Lonnie's Ponds. A second permit for dredging The Narrows was issued in 1976.

Rock Harbor

Rock Harbor, a shallow, tidally-restricted harbor located on Cape Bod Bay, has commercial and recreational boating facilities that are important for both the Town of Orleans and the Town of Eastham. Coastal access is provided via municipal and State boat ramps. Permits for dredging Rock Harbor have been issued more frequently, about every 10-years, with the most recent dredging project completed in 2015. Rock Harbor maintenance dredging is a coordinated effort between the Towns of Orleans and Eastham, who funded 54% and 46% of the project, respectively, based on the total dredged volumes within each Town.

Municipal Action to Address Dredging Need

In recent years, the Town of Orleans has taken multiple steps to address coastal resource management, waterways management, and ongoing public safety concerns by:

- Actively addressing erosion and the need for beach nourishment and dune enhancement at Nauset Beach;
- Planning for phased retreat of municipal assets from Nauset Beach;
- Conducting studies to assess the feasibility of dredging in Town waterways; and
- Pursuing permits to dredge Town waterways and beneficially reuse dredged material to improve the resilience of Town beaches and coastal resource areas.
- Passing several Town Meeting warrant items in support of dredging Nauset Estuary and Pleasant Bay, which have included funding for analysis, studies, and permitting.

In Fall 2018, the Town of Orleans Select Board appointed a Dredge Advisory Committee (DAC) to help facilitate ongoing dredge-related projects. The DAC was formed with *the purpose of developing a Town-wide dredging improvement and maintenance plan that will promote improved navigation, boater safety, water quality and protection of natural resources in [the Town's] saltwater estuaries and fresh water ponds* (Town of Orleans, 2019).

In addition to reviewing ongoing dredge-related projects, the DAC was tasked with:

- Evaluating the feasibility of establishing a municipal dredge program in Orleans;
- Evaluating design alternatives for the Nauset Estuary Dredge project;
- Conducting a dredge feasibility assessment of sites located in Pleasant Bay; and
- Establishing a management plan for the maintenance of Rock Harbor.

To support these efforts, the Orleans Select Board allocated a working budget to the DAC in 2019 and established a timeline for pre-permitting tasks for Nauset Estuary, ongoing assessments, and the Dredge Purchase Feasibility Study described in the following report.



The Question Being Addressed

The Town of Orleans has a need to maintain safe and navigable channels in Nauset Estuary, Pleasant Bay and Rock Harbor to support a commercial fishing fleet, the recreational boating community, and to ensure first-responders are able to respond to on-water incidents quickly and safely. Additionally, public and private mooring fields and marinas depend on dredging to maintain safe depths at their docks and moorings. This study aims to address whether a municipally owned, operated, and managed dredge is a cost effective and efficient alternative for meeting the Town's dredging needs, or whether more cost effective and/or efficient alternatives exist.

Tasks Assigned to the Woods Hole Group

Woods Hole Group, an international environmental services and products organization headquartered in Bourne Massachusetts, was selected by the Town of Orleans to investigate dredging alternatives. Woods Hole Group offers a range of Coastal, Ecological, and Oceanographic consulting services, along with products for collecting ocean measurements, ocean forecasting, tracking wildlife with satellite communications, and vessel monitoring systems (VMS) for fisheries management. Working closely with the DAC and the Town, Woods Hole Group completed the following Tasks, which are documented in Chapters 2-6 of the Technical Report. Please refer to Appendix A for a copy of the proposal.

Task 1. Meetings and Stakeholder Engagement

- Facilitated a kick-off meeting with the Town Dredge Advisory Committee (DAC).
- Coordinated a round-table discussion with representatives from the Barnstable County Dredge (BCD) Program. Toured BCD dredging site to view equipment and dewatering operations.
- Facilitated a discussion with the Edgartown Dredge Advisory Board and conducted a site visit to view the municipal dredging equipment and project sites.
- Hosted a virtual project update meeting to keep the DAC informed of project deliverables.
- Conducted a close-out meeting to discuss results.

Task 2. Compile Information on Dredging Projects

- Reviewed historic permits for dredging in Town waterways.
- Estimated quantities of material that could reasonably be dredged from Town waterways based on take-off estimates from the most current hydrographic survey data.
- Evaluate the quality (type) of sediment to be dredged from Town waterways.

Tasks 3-4. Identification of Suitable Equipment & Operational Cost Forecast

- Identified and researched types of dredging equipment that could be used to maintain navigation channels within the specified region.



- Researched and compared costs of municipal dredge ownership vs. costs associated with collaborating with the Barnstable County Dredge program vs. costs associated with soliciting and retaining a private dredge contractor to complete projects in the Town of Orleans.
- Developed cost estimates for each Alternative.

Task 5. Feasibility Assessment

- Factored the estimated dredge volumes against the cost of each dredging alternative.
- Identified most cost-effective alternative(s).

Task 6. Final Report

- Drafted final technical report documenting Tasks 1 through 5.



2.0 DREDGING 101

Prior to evaluating dredging alternatives for the Town of Orleans, it is important to understand the inherent complexities of dredging, steps in the development of a dredging project, and the equipment required to complete the proposed work. Careful selection of dredging equipment, employment and retention of a skilled and experienced crew, budgeting for weather delays, down time, and maintenance, and the establishment of an effective management structure are all important considerations. The following sections describe the basic steps, equipment, and personnel necessary to develop and complete a dredging project.

Project Development, Permitting, Pre- and Post-Dredge Surveys

New, *improvement dredging* projects involve removal of previously undisturbed bottom sediments. *Maintenance dredging* projects involve the repetitive removal of naturally recurring deposited bottom sediment. Prior to construction of any dredge project, the project proponents must develop design-engineering plans clearly identifying the proposed project footprint. An important first step in this process is the completion of a pre-dredge bathymetric survey and sediment sampling program. This allows the engineering team to estimate the type of material to be dredged, identify any contaminants, and calculate the volume of material that must be removed from the project site to achieve designed depths. Once the quantity and quality of the material have been determined, alternatives for beneficial reuse of the material must be developed and an appropriate dewatering and/or disposal site identified.

Prior to construction, the project proponent must secure all necessary local, State, and Federal permits and abide by all time-of-year-restrictions (TOYs) outlined in the permits. Collaboration with local, State, and Federal regulatory and advisory Agencies while developing dredging projects can help save significant time and resources during the permitting process. Once the project has been constructed, a second bathymetric survey is conducted to confirm that designed depths have been established throughout the project footprint.

Dredge Superstructure

Two main types of dredging equipment, hydraulic cutter suction and mechanical, may help the Town of Orleans complete municipal dredging projects. Both types of dredging equipment rely on a central dredge superstructure, a large, barge-like vessel to manage dredged material.

Hydraulic Cutter Suction Dredging Equipment

A hydraulic cutter suction dredge uses a rotating cutter head attached to the end of a suction pipe to agitate material on the seafloor which creates a slurry of water, sand, and fine-grained material. Long hydraulic spuds anchor the dredge as it works its way through the project footprint. The suction pipe draws the slurry into a large, diesel-powered centrifugal pump located on the dredge superstructure (Figure 3). The centrifugal pump pushes the slurry of seawater and dredged material through a dredge pipeline, which extends from the dredging site to the dewatering site. At the dewatering site, the slurry of sediment and seawater exits the



dredge pipe (Figure 4). Dredged material falls out of solution, accumulates, and must be managed by ancillary excavation and/or loading equipment. An effluent of seawater and fine-grained material flows from the dewatering site back into the adjacent waterbody. Beach compatible sediment (sand) can then be used to nourish beaches located near the dewatering site or can be trucked to an approved upland stockpile for later use. Dredging higher concentrations of fine-grained materials (mud, silt) may require more complex dewatering equipment to avoid impacts to adjacent water bodies.



Figure 3. Components of a Barnstable County Dredge Superstructure, a Hydraulic Cutter Suction Dredge at rest in Saquatucket Harbor, Harwich, MA, May 2019.



Figure 4. Edgartown Municipal Dredge discharges dredged material at dewatering site. Dewatered material is then stockpiled for beneficial reuse, November, 2020.

Small-scale hydraulic cutter suction dredges (Ellicott 370, 670, or similar) can pump sandy sediments up to 3,500 linear feet (lf) of discharge pipe at an average of 200-400 cubic yards (CY) per hour under ideal circumstances and optimized conditions. Pumping distances greater than 3,500 lf require the use of in-line booster pump(s). Hydraulic cutter suction dredges are limited by the availability of suitable dewatering sites located within close proximity of the dredge site and the type of material being dredged. Sandy material, suitable for beach nourishment is more easily pumped, dewatered, and placed. Muddy material may require more elaborate dewatering structures to prevent fine-grained material still in solution from flowing back into adjacent waterways. Upland disposal of muddy material may be required if the material is found to be unsuitable for beach nourishment, typically at an additional cost. Significant amounts of gravel and cobble cannot be dredged using a hydraulic cutter suction dredge because of the risk of damage to internal components of the centrifugal pump and cutter head and limitations on pumping distance.

Mechanical Dredging Equipment

A mechanical, or bucket dredge operates using a clamshell bucket attached to a crane or utilizes a large excavator on the dredge superstructure to excavate material from the seafloor and load it into an adjacent scow or container (Figure 5). Production rates vary based on the size of the superstructure, capacity of the bucket, and capacity of the scow or container. Once the scow or containers have been filled, the material can then be transported and offloaded.

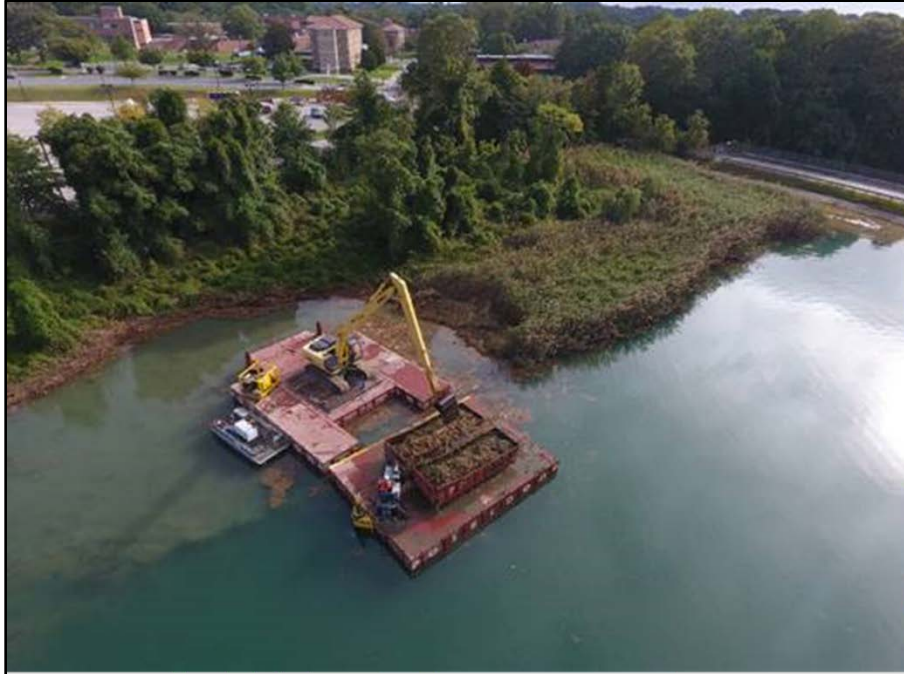


Figure 5. Posiedon P2 Barge System at work loading containers. Retrieved 21 July 2020.
<https://www.poseidonbarge.com/uses/dredging/>

Mechanical dredging equipment can safely dredge sand, cobble, and fine-grained material without risk of damage. Placement of the material can prove challenging, as most scows and containers do not have the ability to pump out the material for beneficial reuse. Rather, the material must be excavated out of the scow or container onto a beach for beneficial reuse, or loaded into trucks for upland stockpiling, disposal, or use at a nearby nourishment site.

Ancillary Equipment

In addition to the primary dredge superstructure, the following marine-based and land-based ancillary equipment is required to support dredging and dewatering operations.

Primary Push Boat

Dredge superstructures that do not have the capacity to navigate under their own power rely on push boats. Push boats are generally fastened to the stern of the cutter suction dredge superstructure where they provide the necessary power to mobilize the dredge from one project location to another and help position the dredge at the project site (Figure 6).



Figure 6. Barnstable County Dredge Push Boat, M/V “J.W. Doane” at the stern of the Barnstable County Dredge “Cod Fish”, January 2018.

Support Boat

A secondary support boat is necessary to mobilize discharge pipe and ancillary dredging equipment to the project site. The support boat may also assist the primary push boat in positioning the dredge in heavy current or navigating tightly restricted coastal waterways (Figure 7).



Figure 7. Typical marine support craft. Retrieved 29 June 2018.
<https://www.joshuapreston.co.uk/workboats/>



Support Skiff

A small support skiff is used to transport dredge personnel from shore to the dredge superstructure and between the dredging site and the dewatering site (Figure 8).



Figure 8. Typical support skiff. Retrieved 29 June 2018.

<http://www.carolinaskiff.com/boats/carolina-skiff/jv-th-series/17-jv-th>

Discharge Pipe

Discharge pipe is used to transport material that has been hydraulically dredged from the dredge site to the dewatering site (Figure 9). Dredge pipe is generally made from HDPE plastic or steel. Lengths of dredge pipe are connected to one another using steel fasteners and connectors. A variety of diffusers can be attached to the end of the dredge pipe to regulate the discharge of dredged material. During dredging operations, the discharge pipe is filled with water and sinks to the bottom of the water column, avoiding impacts to navigation in and around the dredge site. A series of floats mark the position of the pipe to alert mariners.



Figure 9. Length of HPDE discharge pipe coming ashore at local dewatering area, Yarmouth, MA, May 2019.

Fusion Machine

Fusion machines are used to heat fuse lengths of HDPE discharge pipe together, are typically self-contained, and can be gas-powered with on-board generators or electric-powered. Fusion machines allow for the construction of different lengths of pipe, which could differ between project locations and distance to the preferred dewatering site. The fusion machine may also be necessary to re-fuse the pipe into smaller sections for off-season storage (Figure 10).

Booster Pump

Booster pumps can be placed along dredge discharge pipelines to extend the maximum pumping distance of hydraulic cutter suction and hopper dredges (Figure 11). Booster pumps are large, diesel centrifugal pumps like those found on the dredge superstructure.

Wheeled Front-End Loader

Front-end loaders are used to manage dredged material at the dewatering site, transport dredged material along adjacent beaches, and place dredge material at permitted beach nourishment and dune enhancement sites (Figure 12).



Figure 10. Typical pipe fusion machine. Retrieved 21 July 2020.
<https://www.westerndredge.com/product/mcelroy-618-fusing-machine/>



Figure 11. Typical skid-mounted booster pump. Retrieved 29 June 2018.
<https://www.westerndredge.com/product/10in-cat-booster-pump/>



Figure 12. Typical wheeled front-end loader supporting dredge operations, Mashpee, MA, March 2018.

Truck Fleet

A fleet of one-ton trucks (GMC Duramax HD, or similar) are generally used to support land-based operations at the dewatering site, haul equipment, and transport the dredge crew.

Heavy Equipment Trailers

Heavy equipment trailers are used to haul lengths of dredge pipe to the dewatering site and to storage locations when not in use. Trailers are also used to haul heavy equipment and equipment attachments to and from the dewatering site.

Heavy Equipment Attachments

Heavy equipment attachments including forks, buckets, and grapples are used to support land-based operations at the dewatering site, the placement and repositioning of dredge pipe, and the placement of dredged materials at approved locations.

Diesel Fuel

Dredging is a fossil fuel intensive industry requiring hundreds of gallons of diesel fuel per day to power the dredge superstructure under normal conditions. Additional fuel is required for booster pumps, support boats, and land-based support equipment.



Dredge Personnel

At a minimum, the following skilled and experienced personnel are required to support dredging operations:

- Dredge Superintendent – supervises dredging operations, manages dredge crew.
- Dredge Captain – operates primary push boat and ensures safety of dredge crew.
- Dredge Maintenance Engineer – maintains and repairs dredging equipment.
- Dredge Levermen / Equipment Operator – operates hydraulic dredging equipment on-board dredge.
- Dredge Deckhands – assist in all dredging, dewatering, and ancillary tasks.



3.0 REGIONAL CASE STUDIES

Municipal and regional dredge programs on the Cape and Islands have existed since the early 1990s, providing the Town of Orleans with an opportunity to review two case studies. During the winter of 2020, Woods Hole Group organized and facilitated a series of meetings and site visits between Town of Orleans officials, DAC members and the Barnstable County Dredge (BCD) Program and the Edgartown Municipal Dredge (EMD) Program, which are summarized in this chapter.

Barnstable County Dredge Program

The Barnstable County Dredge Program (BCD) serves municipalities on Cape Cod, Martha’s Vineyard, and Nantucket and provides an interesting case study in owning and operating regional dredging equipment. Prior to the establishment of the BCD, local municipalities often relied on private dredge contractors to maintain Federal and non-Federal waterways, mooring fields, and marinas. Individual municipalities were responsible for funding 25% of the cost of municipal dredge projects and the State of Massachusetts was responsible for funding the remaining 75%. Given the high cost of private dredge contracting and fluctuations in the availability of State funding, municipal dredging projects in Barnstable County were routinely delayed, if ever completed.

In 1993, a needs assessment and cost-benefit analysis conducted by Barnstable County determined that a County dredging program would benefit local municipalities and be cost-effective to operate. Barnstable County then requested a \$1 million-dollar capital grant from the Massachusetts Department of Environmental Management (now Department of Environmental Protection (DEP)) for the purchase of a dredge and ancillary equipment. The \$1 million-dollar capital grant awarded to the County was intended to serve as a replacement for any future State funding for municipal dredging projects on Cape Cod. Over time, the capital grant provided the State with significant cost savings while improving the municipalities’ ability to manage their own waterways. Shortly after the grant was awarded, Barnstable County took delivery of a hydraulic cutter suction dredge, which was named the “Cod Fish” (Figure 13).

Barnstable County Dredge Advisory Committee

The Barnstable County Dredge Advisory Committee was established in 1994 to provide operational and financial oversight of the BCD. The Advisory Committee is made up of representatives from all Cape Cod Towns, with the exception of Brewster, which has no navigable waterways, DEP, and County officials and is responsible for developing and maintaining an equitable dredge schedule and setting the county dredge rate. Each municipality is required to maintain their own permits for dredging – with several municipalities opting for consolidated, comprehensive permits which cover multiple dredging and dewatering locations.



Figure 13. Barnstable County Dredge at rest in Popponessett Bay, Massachusetts, March 2018.

This permitting structure gives Towns the flexibility to adaptively manage waterways from year to year based on need. Municipalities are required to have all required permits in-hand prior to scheduling a project with the BCD. Each municipality pays either a flat fee or a base rate per CY for BCD services based on the size of the project, which includes pre- and post-dredge surveys, dredging, and basic dewatering and rough placement of dredged material. A flat mobilization and demobilization fee is charged at 10% of the total project cost.

Barnstable County Dredging Equipment

The BCD “Cod Fish” is a hydraulic cutter suction pump dredge that can efficiently pump sandy and muddy sediments through up to 3,500 lf of pipe to the dewatering site. Production rates of 1,000-1,500 CY per day can be expected depending on the pumping distance. For distances over 3,500 lf, a secondary, in-line booster pump is required. Use of the BCD is limited by 2 important factors: suitable, nearby dewatering sites and the type of material being dredged. Sandy material, suitable for beach nourishment is more easily pumped, dewatered, and beneficially reused. Muddy material requires a more elaborate dewatering structure, but can also be pumped, dewatered, and beneficially reused or trucked for upland disposal. Significant amounts of coarse gravel and cobble cannot be dredged using a hydraulic cutter suction pump dredge because of the risk of damage to the cutter head and internal components of the pump. Dredging operations are supported by a fleet of support boats and land-based equipment to position the dredge pipe, manage the dewatering site, and relocate dredge spoils.

Reserve Fund and Purchase of Replacement Dredging Equipment

The State of Massachusetts capital grant to purchase BCD dredging equipment allowed Barnstable County to proactively establish a reserve fund to account for unexpected breakdowns,



variable annual dredge volumes, maintenance, and to save for the future replacement of aging equipment. In 2017, 24 years after the establishment of the Barnstable County Dredge Advisory Committee, the County invested \$1.8 million in the construction of a new, larger Ellicott 870 Dragon Cutterhead Dredge. The County expected that the Ellicott 870, named the “Sand-Shifter” would be responsible for larger-scale dredging projects, or those requiring pumping distances in excess of 8,000 lf, and that the “Cod Fish” would continue to operate on smaller scale projects. After a series of unexpected breakdowns and subsequent retrofits to the new equipment, the county expects to operate both dredges during the 2020-2021 dredge season.

Barnstable County Dredge Completed Projects and Cost Savings

Since 1994, the BCD has dredged over 1.6 million CY of material from waterways in 16 municipalities on the Cape and Islands at 38% to 68% below private market rates. With rare exceptions, nearly all dredged material is sand, which is beneficially reused on nearby beaches. The all-inclusive, flat rate per CY allows municipalities to avoid the high costs associated with mobilizing and demobilizing private dredging equipment and conducting pre- and post-dredge surveys required by private dredge contractors and regulatory agencies. Pre- and post-dredge surveys conducted by the BCD crew are an effective means of determining the net volume (total CY) dredged and subsequently, the final cost of the project to the municipality.

Over an 18-year period from 2000 – 2017, the County completed an average of 10 projects, annually, pumped an average of 92,633 CY of material annually, and saved taxpayers an estimated \$13,939,255 (this cost savings is based on the historic practice of the State paying 75% and the local Town paying 25% of the cost of private municipal dredging projects at market rates). Barnstable County Dredge Operations from 2000 – 2017 are summarized in Table 1. The fiscal status of the Barnstable County Dredge from 2000 – 2017 is summarized in Table 2. A typical County project is on the order of 10,000 CY. Please refer to Appendix B for a copy of the most recent Report of the BCD, which includes a summary of completed dredging projects, quantities dredged, and fiscal status of the dredge in FY 2017.



Table 1. Barnstable County Dredge Operations from FY 2000 – FY 2017.

Year	Cubic Yards Dredged	Total Projects
2000	123,281	4
2001	113,339	6
2002	75,385	15
2003	84,973	9
2004	N/A	10
2005	52,000	12
2006	94,070	11
2007	82,928	10
2008	60,553	11
2009	91,731	8
2010	104,782	8
2011	170,835	6
2012	102,827	11
2013	72,331	13
2014	106,774	15
2015	102,418	10
2016	58,874	9
2017	77,658	7
Total	1,574,759	175
Average	92,633 CY / year	10 projects / year

**Table 2. Fiscal Summary of the Barnstable County Dredge 2000 – 2017.**

Year	Cost per CY	Market Rate per CY	Cost Below Market Rate	Operating Revenue	Cost Savings to Taxpayers*
2000	\$4.55	\$12.00	38%	\$468,914	\$1,082,529
2001	\$4.55	\$12.00	38%	\$588,240	\$1,047,051
2002	\$4.55	\$12.00	38%	\$444,725	\$678,465
2003	\$4.55	\$12.00	38%	\$554,780	\$764,757
2004	\$4.55	\$12.00	38%	\$409,622	N/A
2005	\$5.55	\$12.00	46%	\$524,703	\$468,000
2006	\$6.45	\$14.00	46%	\$558,167	\$856,037
2007	\$6.45	\$14.00	46%	\$631,698	\$870,744
2008	\$6.45	\$16.00	40%	\$611,094	\$726,636
2009	\$7.00	\$16.00	44%	\$628,671	\$1,100,772
2010	\$7.00	\$16.00	44%	\$635,817	\$943,038
2011	\$7.00	\$16.00	44%	\$660,228	\$1,537,515
2012	\$7.00	\$16.00	44%	\$798,440	\$411,308
2013	\$11.00	\$16.00	68%	\$835,284	\$867,972
2014	\$11.00	\$16.00	68%	\$929,859	\$830,701
2015	\$11.00	\$18.00	61%	\$737,742	\$716,926
2016	\$11.00	\$18.00	61%	\$631,289	\$506,202
2017	\$11.00	\$18.00	61%	\$867,242	\$530,602
-	-	Total	N/A	\$11,516,515	\$13,939,255
-	-	Average	47%	\$639,806	\$819,956

*Based on the State paying 75% and Towns paying 25% of the market rate of private municipal dredging projects

**Established to finance the purchase of replacement dredging equipment

BCD Consultation with Town of Orleans Dredge Advisory Committee

To allow the Town of Orleans Dredge Advisory Committee (DAC) to better understand the operational and financial structure of an existing regional dredge program, Woods Hole Group facilitated a round table discussion between the following individuals:

- Jack Yunits, County Administrator, Barnstable County
- Stephen Tebo, Assistant County Administrator, Barnstable County
- Town of Orleans Dredge Advisory Committee Members
- Town of Orleans Officials (Town Administration, DPW Director, Harbormaster)

Mr. Jack Yunits, Barnstable County Administrator, offered a review of the Barnstable County Dredge program (BCD), lessons learned over 25 years of BCD ownership, and the advantages and disadvantages of the regional dredge program. An overview of the initial program funding, formation and organization of the County Dredge Advisory Board, and past and future program management plans were discussed. Mr. Yunits stated that the BCD is in the process of reevaluating operations as part of establishing a new 5-year business plan to improve efficiencies



and help the program run like an enterprise. The BCD has since hired a consultant to assist in this effort. BCD is particularly interested in improving time, labor, and cost evaluations for jobs by assessing the actual days required to complete past jobs, accounting for exact transit time, mechanical issues, and weather delays. Mr. Yunits noted that the County is soliciting 5-year plans from Towns to address county-wide dredging needs. While BCD only books shovel-ready projects with permits in hand, the 5-year plans should cover all project timelines, regardless of status, to assist the County in assessing future dredging needs.

Stephen Tebo, Assistant County Administrator, then led a technical discussion summarizing the County's equipment inventory, maintenance schedule and costs, and staffing requirements. Mr. Tebo stated the BCD currently staffs 5 employees, with retention through the offseason. The County has developed an improved preventative maintenance program and built an inventory of spare parts and equipment. Mr. Tebo also addressed questions on employee training, push boat operations, booster pumps and pipe length, and operations in high velocity currents.

Following the round table discussion, Stephen Tebo accompanied the group to Sesuit Harbor, Dennis, where the BCD Codfish was actively dredging the approach channel to the harbor (Figures 14-16). Jason Bevis, the BCD Foreman, was on site and provided an overview of dredge operations and additional details on logistics, shallow water operations, fuel and transport considerations, booster pumps, and pipe management. Mr. Bevis responded to questions on booster pump usage, and explained the challenges associated with the placement of booster pumps (onshore or offshore), the added logistics of delivering the +/- 100 gallons of diesel fuel required to operate each booster pump each day, additional staffing requirements, and management of longer pipelines.

Meeting minutes and additional photos from the round table discussion and site visit are included in Appendix C.



Figure 14. Town of Orleans DAC visits active BCD site at Sesuit Harbor, February 13, 2020.



Figure 15. BCD excavator managing dredged materials at the dewatering site on Cold Storage Beach, Dennis, MA during active operations on February 13, 2020.



Figure 16. Active BCD dewatering site on Cold Storage Beach, Dennis during operations in Sesuit Harbor, February 13, 2020.



Edgartown Municipal Dredge Program

The Town of Edgartown has facilitated a municipal dredge program for 26 years, providing a valuable municipal case study for the Town of Orleans. As an Island town, the navigability of harbors and waterways is critical for economic viability. Concerns for public safety, commercial and recreational interests, as well as the use of dredge material for flood protection and wildlife habitat improvement, motivated the Town to explore options for managing their own waterways. In 1996, the Town of Edgartown formed the Dredging Management Plan Committee to assess the best course of action for maintaining the Town's waterways and protecting ecological and economic resources. The Dredge Committee concluded that the most time- and cost-efficient method for achieving those goals was to lease or purchase a dredge. At the 1996 Annual Town Meeting, voters approved the proposal, and the Edgartown Dredge Program (EDP) was established.

The 1996 Dredging Master Plan highlighted how the Program's goals aligned with local goals set in the *Edgartown Harbor Plan*, *Edgartown Harbor Economic Development Plan*, *the Town's Master Plan and Open Space Plan*, *the Martha's Vineyard Commission Regional Island Plan*, *the Massachusetts Coastal Zone Management Program Policies and Commonwealth tidelands policy as detailed in MGL Chapter 91 and regulations 310 CMR 9*. These consistencies helped the Town obtain funding from the Massachusetts Department of Environmental Management (now MADEP) Office of Waterways grants to support dredging operations for the first several years of the program. In addition to the annual municipal funding, the Program has cultivated public-private partnerships to aid in the long-term viability of the program.

Edgartown Dredge Advisory Committee and Permitting

Over the years since the EDP was established, the Edgartown Dredging Management Plan Committee evolved into the Edgartown Dredge Advisory Committee (EDAC). The Committee's primary responsibility today is to make recommendations to the Select Board on *all matters concerning the sites, operation, and personnel associated with the dredge*. In 2012, the Dredge Advisory Committee was *reselected and reformatted to consist of five Select Board-appointed members: one from the Marine Advisory Board, one from the Shellfish Committee, one from the Conservation Commission, and two other at-large members*.

In 2009, the Town decided to streamline the permitting process by combining all existing dredging and beneficial reuse permits into one comprehensive permit. The comprehensive permit covers the removal of up to 200k CY from seventeen (17) previously permitted dredge sites and eighteen (18) beach nourishment sites. Additional dredging and beneficial reuse sites are added to the permit on an as-needed basis. In addition to reducing permitting costs, the comprehensive permit allows for the *combining of projects, reduction in mobilization and demobilization costs and savings on sediment testing*. It also provides increased flexibility in determining project timing and order, minimizing navigational and environmental disruption.



Edgartown Municipal Dredging Equipment

The Edgartown Dredge Program includes capital equipment, management, and staffing. An Ellicott 370 hydraulic dredge was initially leased, then purchased by the Town in 1997. After 21 years of operation, the maintenance costs began to exceed the value of the dredge work. The Committee decided to purchase a new dredge in 2017. After conducting site visits to meet with vendors and inspect the equipment in person, a new Ellicott 370 was purchased (Figure 17). The Committee decided on a model without automation, similar to the previous model.

In addition to the dredge superstructure, the Town owns support equipment and facilities. The Municipal Dredge Department owns three (3) support craft, including a steel push boat and two Carolina skiffs. The Dredge Department has its own Deere Loader with support beam and bucket, over 7,000 ft of 14" dredge pipe, a pipe fusion machine, and designated plant with trailers, maintenance, and adequate storage facilities.



Figure 17. The cutter head of the Town of Edgartown Ellicott-370 hydraulic dredge, in the municipal lot for annual maintenance.



Edgartown Completed Projects and Operating Costs

Historically, the Edgartown Dredge Advisory Committee set a goal of two completed projects annually. An unofficial record of completed dredge projects and annual volume of material removed in the last 15 years is summarized in Table 3. Since 2008, the Edgartown Dredge Program has removed over 207k CY of material from municipal waterways, an average rate of 17,280 CY annually since 2008. Nearly all the material has been clean, beach-compatible sand, and used for beneficial reuse and has been dredged from sheltered waters where wind and strong currents are not generally a factor. The Town estimates a savings of 71% over market costs of commercial dredging.

Table 3. Estimated volume of material dredged annually by the Edgartown Municipal Dredge Program.

Year	Cubic Yards Dredged	Total Projects*
2008	(Included in 2009 Total)	1
2009	67,000	1
2010	63,500	3
2011	22,000	1
2012	15,780	4
2013	25,900	4
2014	9,200	2
2015	-	-
2016	3,975	1
2017	-	-
2018	-	-
Total	207,355 CY	17 projects
Average	17,280 CY/year	1.4 project/year

*Total projects include dredge projects only. Completed nourishment projects are not included in this count.

Table 4 summarizes the annual operational and maintenance costs of the EDP provided in the 2018 Master Plan. The average annual cost of the program from 2006-2018 was \$232,000. In 2012, the Program was officially classified as a Town Department and the budget was approved as a permanent line item in the Town Budget. This year, the EDAC has reported FY21 budget of \$271,397 operating budget for a single dredge, no booster pumps, payroll for a crew of 3 and 1 part-time administrator (Dredge Superintendent has been filled by a qualified volunteer).

Beneficial reuse of dredged material is a key component in the Edgartown Dredge Program. The Town has successfully nourished miles of Town beaches with hundreds of thousands of CY of clean sand. The Town also commoditized the dredge material by selling it to private homeowners or associations and other municipalities at variable rates, from \$10-20 per CY based on demand.

The Dredge Program has also collaborated on inter-municipal projects, benefitting both the Program and neighboring Towns. For example, Edgartown and Oak Bluffs formed their first



dredging partnership in 2008, working towards a goal of improving tidal flow in Sengekontacket Pond. The Town of Oak Bluffs funded permitting costs for the project and the Edgartown Dredge Program completed the work. The Edgartown Dredge has also completed projects for the Towns of Tisbury and Chilmark. Private partnerships also contribute to the success of the Dredge Program. The Cow Bay Association provided vital funding for the dredge project that provided nourishment sand for public and private sections of Bend in the Road Beach and Cow Bay Beach.

The 2018 Dredge Advisory Committee Master Plan which includes full project descriptions, dredge and disposal maps, and detailed information on nourishment projects, is included in Appendix D.

Table 4. Edgartown Dredge Program Budget History from FY 2006 – 2018.

Year	Operation and Maintenance Costs	Warrant Articles for Permitting Costs
2006	\$223,646.00	\$30,000.00
2007	\$221,488.00	\$15,000.00
2008	\$221,000.00	\$15,000.00
2009	\$236,000.00	-
2010	\$236,000.00	-
2011	\$236,000.00	-
2012	\$136,000.00	-
2013	\$236,000.00	-
2014	\$244,000.00	-
2015	\$244,000.00	-
2016	\$260,161.00	-
2017	\$259,766.20	\$50,000.00
2018	\$260,847.40	-
Total 06'-18'	\$3,014,909.60	\$110,000

EDAC Consultation with Town of Orleans Dredge Advisory Committee

Woods Hole Group facilitated a round table discussion and site visit between the Town of Orleans DAC and the Town of Edgartown DAC on February 24, 2020. The following individuals were present:

- Ed Handy, Dredge Superintendent, Edgartown Dredge Advisory Committee
- Rick Hamilton, Town of Edgartown
- Juliet Mulinare, Town of Edgartown, Dredge Administrator
- Town of Orleans Dredge Committee Members
- Town of Orleans Officials (DPW Director, Harbormaster)



Mr. Ed Handy, Chair of the Edgartown Dredge Advisory Committee and Dredge Superintendent, opened the meeting with an overview of the Edgartown Dredge Program, detailing operations, funding, and scheduling. Ms. Juliet Mulinare, the Dredge Committee Administrator, elaborated on the staffing needs and funding for the Program. Both highlighted the cultivation and establishment of public-private partnerships to support the long-term viability of the Program. The Town has sold sand to private homeowners and homeowners associations, as well as neighboring towns, helping to offset annual operating costs and recuperate capital expenditures. The discussion highlighted that the Town of Edgartown is fortunate to have numerous permitted disposal sites at close distances to dredge sites, eliminating the need for a booster pump. Mr. Handy noted that material is often pumped directly to a dewatering site with road access and trucked to the disposal site. The Town has intentionally designed projects to avoid long pumping distances and the need for a booster pump.

Following the discussion, Handy led a tour of the Edgartown Town Barn and dredge maintenance facility. The Ellicott 370 superstructure and cutter head were on display, and the group was able to board and examine the dredge (Figures 18-19). The group then toured several dredge and dewatering sites across the Town, including Katama Landing, the Fuller Street Beach, and Bend in the Road Beach.

Meeting minutes and photos from the round table discussion and site visit are included in Appendix E.



Figure 18. The DAC on site at the Edgartown Barn inspecting the Ellicott 370 Superstructure on February 24, 2020.



Figure 19. The Edgartown Municipal Dredge Program's Ellicott 370 superstructure.



4.0 SEDIMENT QUANTITY AND QUALITY CHARACTERIZATION, DEWATERING AND DISPOSAL CONSIDERATIONS

Data Collection

To accurately assess the feasibility of establishing a municipal dredge program in the Town of Orleans, potential future dredge volumes, sediment characteristics, and potential suitable disposal sites need to be evaluated. Woods Hole Group conducted numerous data collection missions as part of past and ongoing projects with the Town of Orleans that help inform the estimated quantity and quality of material that could feasibly be dredged from the Town's waterways. The available data were compiled, reviewed for accuracy, and converted into a consistent format.

The data collection tasks completed by Woods Hole Group in Nauset Estuary include:

- Bathymetry survey (2017, 2018)
- Sediment core collection (2015, 2017, 2019)
- Eelgrass survey (2017)
- Shellfish survey (2019)

The data collection tasks completed by Woods Hole Group in Pleasant Bay include:

- Bathymetry survey (2017)
- Sediment core collection (2017)
- Eelgrass survey (2017)
- Shellfish survey (2017)

Datasets for Rock Harbor shared by the Town of Orleans include:

- Post-dredge bathymetry survey conducted by the Barnstable County Department of Dredging (2005) and CLE Engineering (2015).
- Final dredge material volumes (2005, 2015).

Information garnered from historic permits and projects as well as ongoing discussions with the Town of Orleans and regional stakeholder groups helped to inform the channel designs and layouts presented in the following sections.

Methods

Sediment Quantity

Estimated dredge volumes were calculated for the established channel dimensions and proposed dredge depths for each waterway using the following methods for Nauset Estuary and Pleasant Bay. The calculations were made using Hypack and Surfer analytical software packages, programs frequently used in dredge engineering applications. Hypack has advanced functionality specifically designed to improve the efficiency of dredge operations by integrating bathymetry



data with complex channel designs and real-time positioning. The volume calculations conducted for this study follow the same method that would be used for pre- and post- dredge surveys and final volume summaries. Input for each volume calculation included: channel bathymetry, channel width, channel length, channel side slope dimensions, design depth, and allowable overdredge depth. Overdredge depth refers to the allowable margin of error in excess of permitted depths. For all sections of Nauset Estuary and Pleasant Bay, 3:1 side slopes and 1-foot overdredge depths were carried through the calculations. For each section of channel, the compiled and quality-assessed bathymetry data were used to create an interpolated bathymetric grid used as the base survey for the calculation. Transects were then cast along the channel geometry at 100ft intervals. The survey data were compared to the channel template, essentially a cross-section of what the design channel would look like compared to the existing conditions. The volume of material within the designed channel and the 1-foot allowable overdredge was calculated and summed along all transects within the channel.

All calculations and design depths are presented in elevations relative to Mean Low Water (MLW) datum. Bathymetry data, originally surveyed in elevation in feet relative to the North American Vertical Datum (NAVD88), were converted to depths in feet relative to MLW for ease of cross-reference and appropriate permitting format. Woods Hole Group surveyed tide data from Nauset Estuary, Meetinghouse Pond (Arey's and Lonnie's Pond), and the longstanding NOAA tide data at Chatham Fish Pier (NOAA Station ID 8447435; Quanset Pond, Narrows, and Paw Wah) were used to convert the data from NAVD88 to MLW.

While this method of dredge material volume estimation is the most accurate available at present, margins of error remain. Most notably, bathymetry data were all collected in the last 2-3 years, but given the dynamic nature of the study sites, the actual volumes at present may vary due to the change in channel location and shoaling, particularly in Nauset Estuary.

It was not necessary to calculate estimated future dredge volumes for Rock Harbor, as actual dredged data exists for recent (2005, 2015) dredging events. The average volume from the two previous dredging events of record was used as the benchmark for this analysis.

Sediment Quality

Availability and detail of sediment quality data varied across Town waterways, though all areas except Meetinghouse Pond had a minimum of one recent sediment sample that was analyzed for grain size. The sample types included surficial sediment grabs, shallow cores, and deep sediment cores, which extended deeper than the proposed dredge depth. A description of the sediment type in each waterway was determined based on the average of the grain size data within the proposed dredge channel and design depth. The sediment quality data were then used to estimate the proportion of dredged material that is sand or fine-grained (silt and mud). Each 100 ft section of dredge channel, and the associated volume of material found therein, was then categorized as fine-grained material or sand.

Quantifying sediment quality has important implications for dredge project planning. Sediment quality influences the selection of appropriate equipment to dredge the material and the most



appropriate methods to beneficially reuse and/or dispose of the material. For instance, fine-grained material may require more elaborate dewatering structures than clean, beach compatible sand and contaminated material would require additional precautions and treatments during the dewatering and disposal process. The imagery in the following sections indicates locations where sediment samples were collected. Samples containing 0-10% silt are labeled as 'sand'. Samples containing 10-30% silt are labeled as 'silty sand'. Samples containing >30% silt are labeled as 'sandy silt; silt'.

Results

Nauset Estuary

The Town of Orleans is currently in the process of securing permits for dredging in Nauset Estuary. The channel alternatives presented in Figures 20-24 include volume estimates for a 50 ft-wide channel alternative as well as a larger, 100 ft channel width alternative. The 100 ft channel alternative was included at the request of the Town of Orleans DAC. It is important to note that it may not be feasible to construct the 100 ft-wide channel alternative while still meeting the regulatory standards to avoid, minimize, and mitigate impacts to coastal resource areas.

The main channel through Nauset Estuary is broken into five discrete sections for this analysis:

- 1) *Town Cove* extending 9,100 linear feet (lf) from Town Cove to Stony Island.
- 2) *Central Main* extending 2,200 lf from Stony Island to the Hole-in-the-Wall.
- 3) *Eastern Main* extending 2,200 lf east from the Hole-in-the-Wall
- 4) *Behind Barrier* extending 7,700 lf north to Nauset Inlet.
- 5) *Pricilla Spur* extending 4,600 lf south from the Hole-in-the-Wall to Pricilla Landing.

The results of the Nauset Estuary dredge volume calculations are summarized in Table 5. Discrete volumes are calculated to the designed -5ft MLW depth plus a 1-foot allowable overdredge depth for each section of channel. All volumes are expressed in cubic yards (CY).

- The 9,100 ft long *Town Cove* section yields approximately 6,260 CY in the 50ft channel width alternative and 14,123 CY of material in the 100 ft channel alternative (Figure 20). Town Cove is predominantly sandy, with some silt and silty sand in the southern most end of the channel near Goose Hummock.
- The *Central Main* channel is 2,200 ft long and predominantly sandy silt (Figure 21). The 50ft and 100ft channels in this reach contain 3,395 CY and 7,248 CY, respectively.
- The *Eastern Main* channel shown in Figure 22 is predominantly sand. The 2,200 ft long section yields 10,249 CY and 18,505 CY of material from the 50ft and 100ft channels, respectively.
- The *Behind Barrier* channel contains the largest volume of material that could be dredged in Nauset Estuary. The 7,700 ft long section yields an estimated 60,734 CY of material from the 50ft design alternative, and 109,575 CY from the 100ft alternative (Figure 23).



- The 4,600 ft *Pricilla Spur* leading to Priscilla Landing yields an estimated 9,146 CY of sandy silt (Figure 24). A 50ft channel is the only alternative under consideration for this section, due to the proximity of eelgrass habitat.

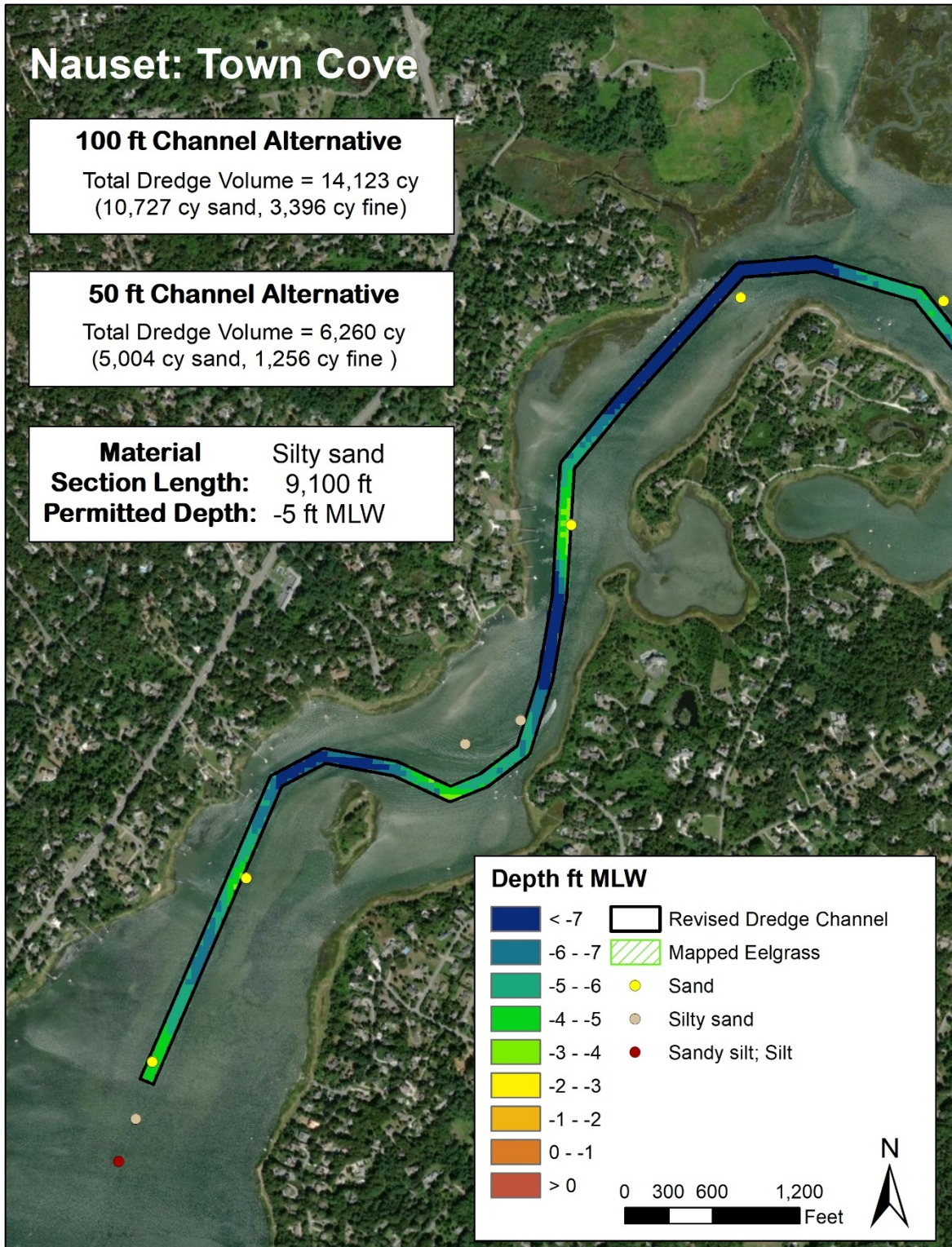


Figure 20. Overview of Nauset Estuary bathymetry, sediment quality, and dredge volume estimates in the Town Cove reach of the main channel.

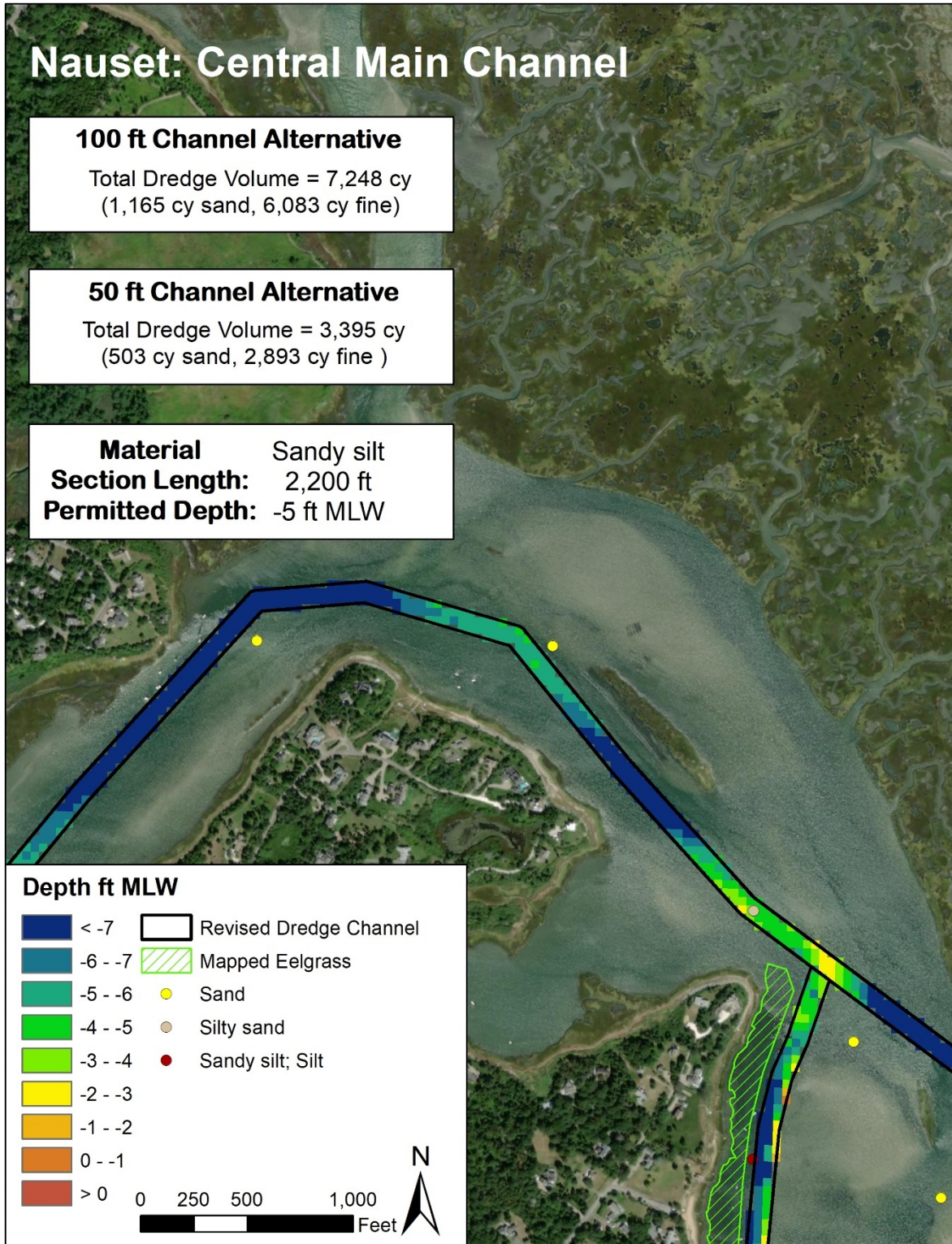


Figure 21. Overview of Nauset Estuary bathymetry, sediment quality, and dredge volume estimates in the central reach of the main channel.

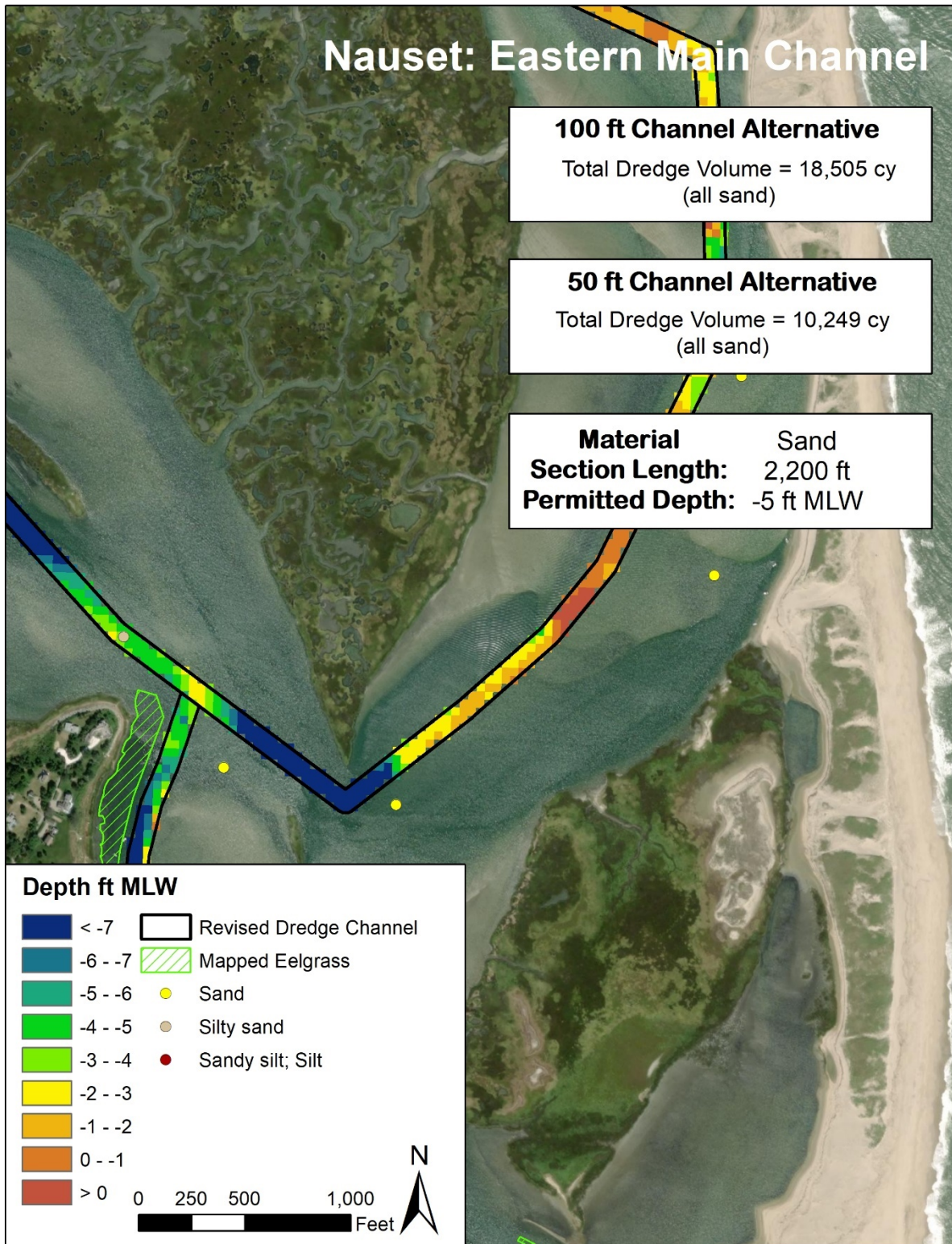


Figure 22. Overview of Nauset Estuary bathymetry, sediment quality, and dredge volume estimates in the eastern reach of the main channel.

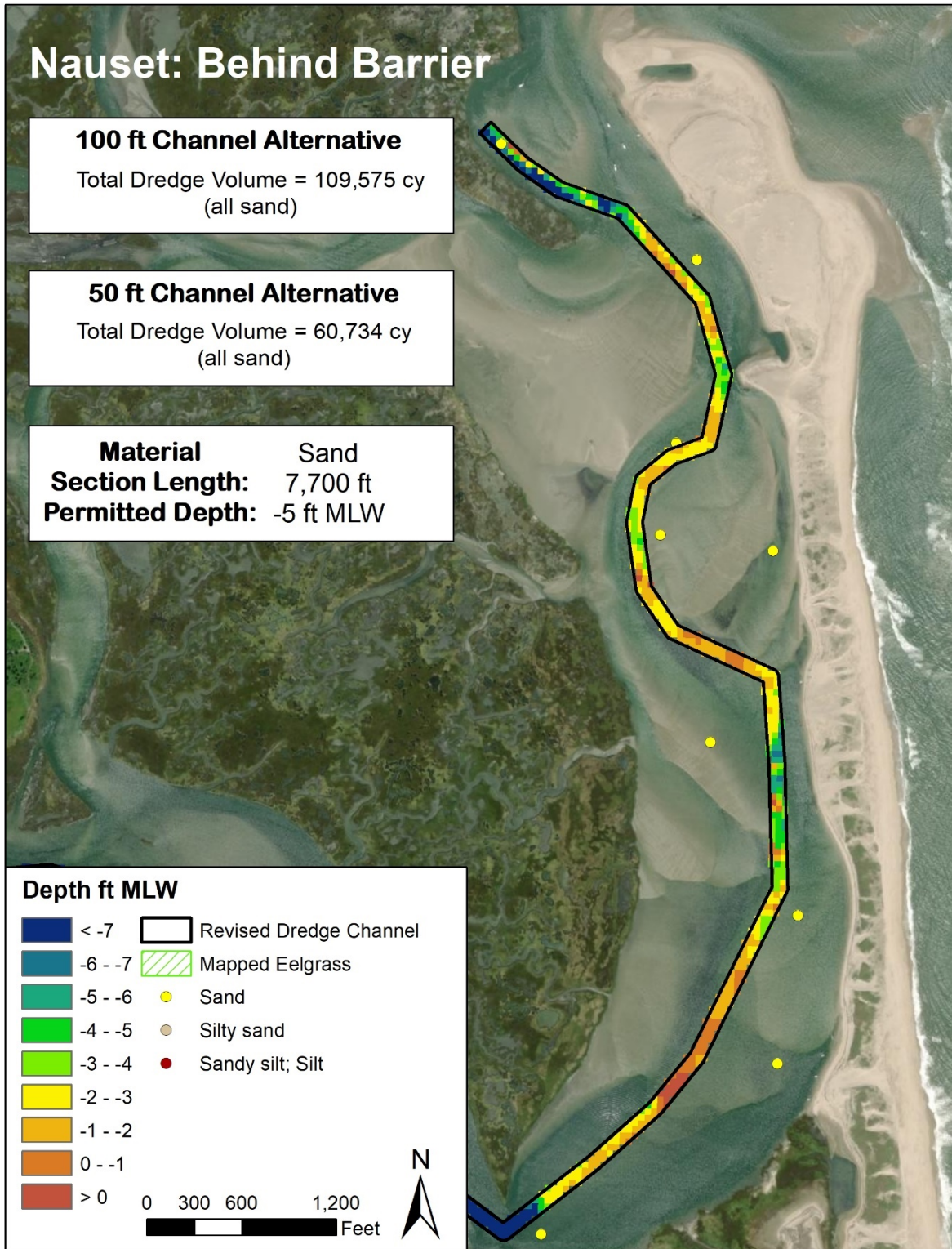


Figure 23. Overview of Nauset Estuary bathymetry, sediment quality, and dredge volume estimates in the main channel behind the barrier beach.

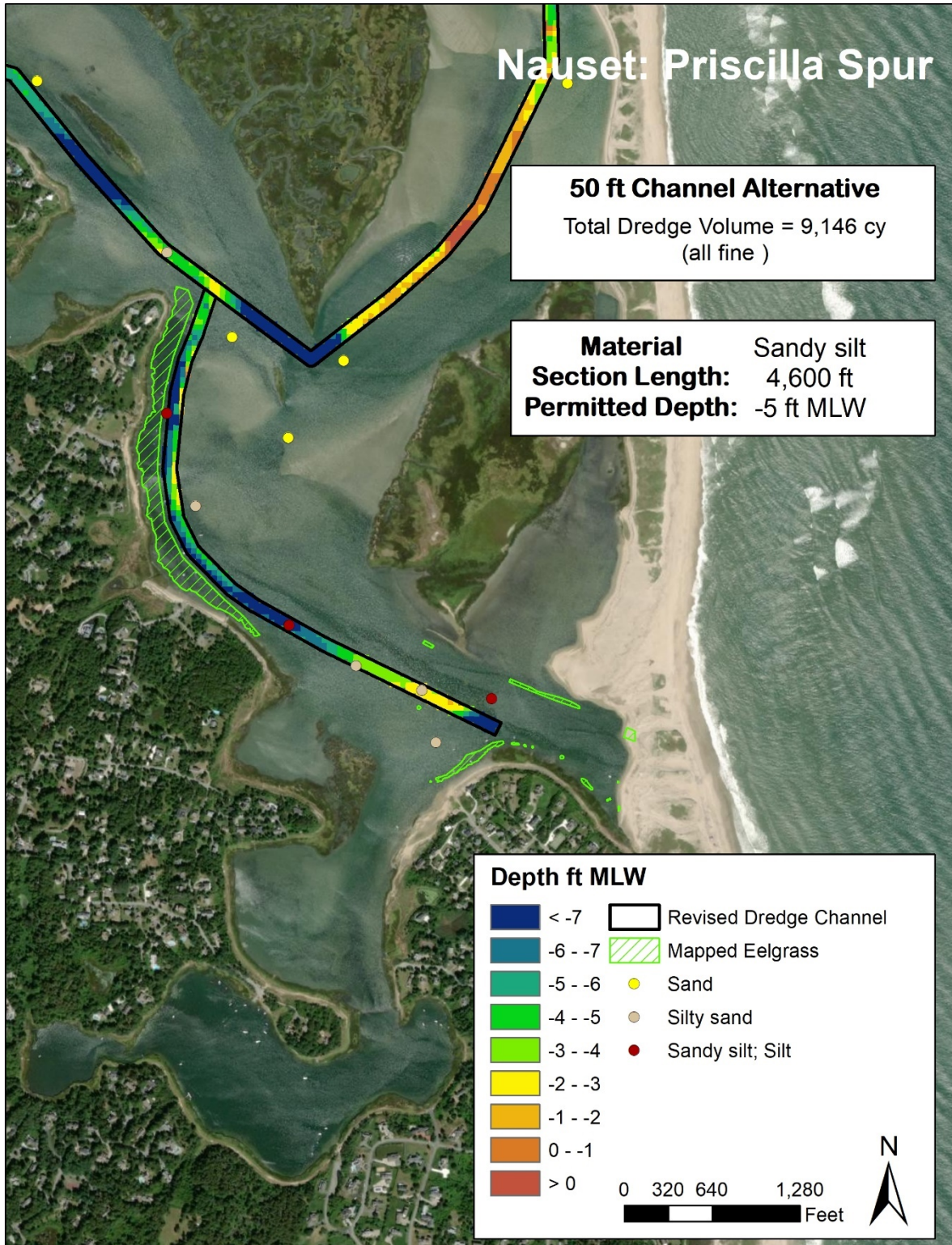


Figure 24. Overview of Nauset Estuary bathymetry, sediment quality, and dredge volume estimates in the Priscilla spur.



Table 5. Estimated dredge quantity and quality relative to 100ft-wide and 50ft-wide channel alternatives in Nauset Estuary.

Channel Section	Length (ft)	Width (ft)	Permitted Depth (ft MLW)	Over-dredge Depth (ft MLW)	Vol. Cal. Depth (ft MLW)	Dredge Volume (CY)	Sand Volume (CY)	Fines Volume (CY)	Material
Town Cove	9,100	100	-5	-6	-6	14,123	10,727	3,396	Silty sand
	9,100	50	-5	-6	-6	6,260	5,004	1,256	Silty sand
Central Main	2,200	100	-5	-6	-6	7,248	1,165	6,083	Sandy silt
	2,200	50	-5	-6	-6	3,395	503	2,893	Sandy silt
Eastern Main	2,200	100	-5	-6	-6	18,505	18,505	0	Sand
	2,200	50	-5	-6	-6	10,249	10,249	0	Sand
Behind Barrier	7,700	100	-5	-6	-6	109,575	109,575	0	Sand
	7,700	50	-5	-6	-6	60,734	60,734	0	Sand
Priscilla Spur	4,600	50	-5	-6	-6	9,146	0	9,146	Sandy silt
Total Volumes									
Total (100ft Alt.)						158,597	139,972	18,625	
Total (50 ft Alt.)						89,785	76,490	13,295	

Regarding Volume Calculations Behind the Barrier Beach

The 7,700 lf of channel behind the barrier beach accounts for 67-69% of the estimated total dredge volume in Nauset Estuary. This large volume of sand is a product of frequent shoaling within the channel layout. The estimates presented in this report are based on a channel layout that follows the existing 2020 channel as closely as possible, while still overlapping the bathymetric data collected in 2017 and 2018. This channel design is intended to minimize the volume of sand that will need to be dredged from behind the barrier beach, to maximize the efficiency of any future dredge project while reducing impacts to the resource areas.

The variation between data collected behind the barrier beach in 2017 and 2018 and existing conditions must be acknowledged. The strong tidal currents and movement of sand at the inlet and behind the barrier beach produce shoals that constantly evolve and influence the location of the navigation channel. To adapt to the dynamic environment behind the barrier, a designated *dredge zone* has been proposed that would allow a 50 ft or 100 ft channel alternative to follow the most well-defined navigation channel at the time of the dredging event, while remaining a defined distance from the landward edge of the barrier beach.



Pleasant Bay

Pleasant Bay is a state-designated Area of Critical Environmental Concern (ACEC), designated in 1987, 72% of the which is within the Town of Orleans. At present, new improvement dredging projects (projects in areas that have no history of previous dredging having occurred) are not permissible in ACECs in the State of Massachusetts until the project is “incorporated into a Resource Management Plan approved by participating municipalities and the Secretary of Environmental Affairs” (CZM, 2003) and the dredging is needed to maintain or restore historic safe navigation (310 CMR 10.24(5)(b)).

The Massachusetts Department of Environmental Protection (DEP) Waterways regulations (310 CMR 9.40) allow improvement dredging in ACEC’s, if the work is conducted for the sole purpose of fisheries or wildlife enhancement, or if the work is needed to restore safe navigation. Within the Pleasant Bay ACEC, “limited improvement dredging to maintain or restore historical navigable access” was approved in 2012 and incorporated into the Pleasant Bay Resource Management Plan (Pleasant Bay Resource Management Alliance, 2018) for areas in Chatham affected by the 2007 breach in the Nauset barrier beach. The 2013 Pleasant Bay Management Plan also identified areas in the Town of Orleans where maintenance dredging occurred in the past and where maintenance dredging will be allowed in the future. As noted in the Introduction, historic permits were issued for dredging in the following areas of Pleasant Bay:

- Quanset Pond
- The Narrows
- Paw Wah Pond
- Arey’s Pond
- Lonnie’s Pond.

Historic permits do not exist for Meetinghouse Pond, although the Orleans DAC has expressed interest in exploring opportunities for new, improvement dredging in the future. Woods Hole Group is currently working with the Town to secure permits for maintenance dredging in Pleasant Bay, using the historic permits to inform channel layout and design. The volume estimates were based on the previously permitted channel design footprints. These historic channel layouts were adjusted to avoid eelgrass habitat in the Narrows and Paw Wah.

Quanset Pond, Arey’s Pond, Paw Wah Pond, and Lonnie’s Pond have proposed dredge channels that are 30 ft wide and -3 ft MLW depth. The proposed channel for the Narrows is 100 ft wide and -6 ft MLW deep. Based on the most recent calculations, a total of 14,820 CY of material is available to be dredged from Pleasant Bay waterways, with volumes from individual channels ranging from 1,635 – 3,804 CY. The results of the Pleasant Bay dredge volume calculations are included in Figures 25-30 and summarized in Table 6.

- The 650 ft long entrance channel to *Quanset Pond* yields approximately 1,500 CY of sand and 100 CY of fine-grained material (Figure 25).



- In the approach channel to *The Narrows*, the existing depths are deeper than all other areas of Pleasant Bay considered in this study, with an average depth of -5 ft MLW. An estimated maximum of 3,500 CY of sand is available to be dredged from the Narrows, regardless of which channel configuration is ultimately selected (Figure 26).
- *Paw Wah Pond* yields an estimated 2,600 CY of sand and 170 CY of fines (Figure 27).
- *Arey's Pond* yields an estimated 2,500 CY of sand and 500 CY of fines (Figure 28).
- *Lonnie's Pond* has the largest estimated volume in Pleasant Bay: 400 CY of sand and 3,300 CY of fines (Figure 29).
- There was insufficient data to develop a dredge volume estimate for *Meetinghouse Pond*. As a placeholder, a hypothetical, future dredge channel footprint and qualitative sediment description are presented in Figure 30 (MEP, 2006).

The Town of Orleans has begun to address the feasibility of completing each dredging project in Pleasant Bay by identifying the most suitable type of equipment to complete the work and the most appropriate disposal alternatives for each site. This information in turn helps to inform the development of permit applications for each dredging site. The most recent Town decisions regarding how best to permit and accomplish the work at each site are outlined below:

- *Quanset Pond*: permit hydraulic dredging to private properties west of channel and mechanical dredging with dewatering and offloading at River Rd. Town landing
- *Narrows*: permit hydraulic dredging to private properties northwest of channel and mechanical dredging with dewatering and offloading to River Rd. Town landing
- *Pah Wah*: permit hydraulic dredging to private properties northeast of channel and mechanical dredging with dewatering and offloading to River Rd. Town landing
- *Arey's*: permit mechanical dredging with dewatering and offloading to River Rd. Town landing
- *Lonnie's*: permit mechanical dredging with dewatering and offloading to River Rd. Town landing

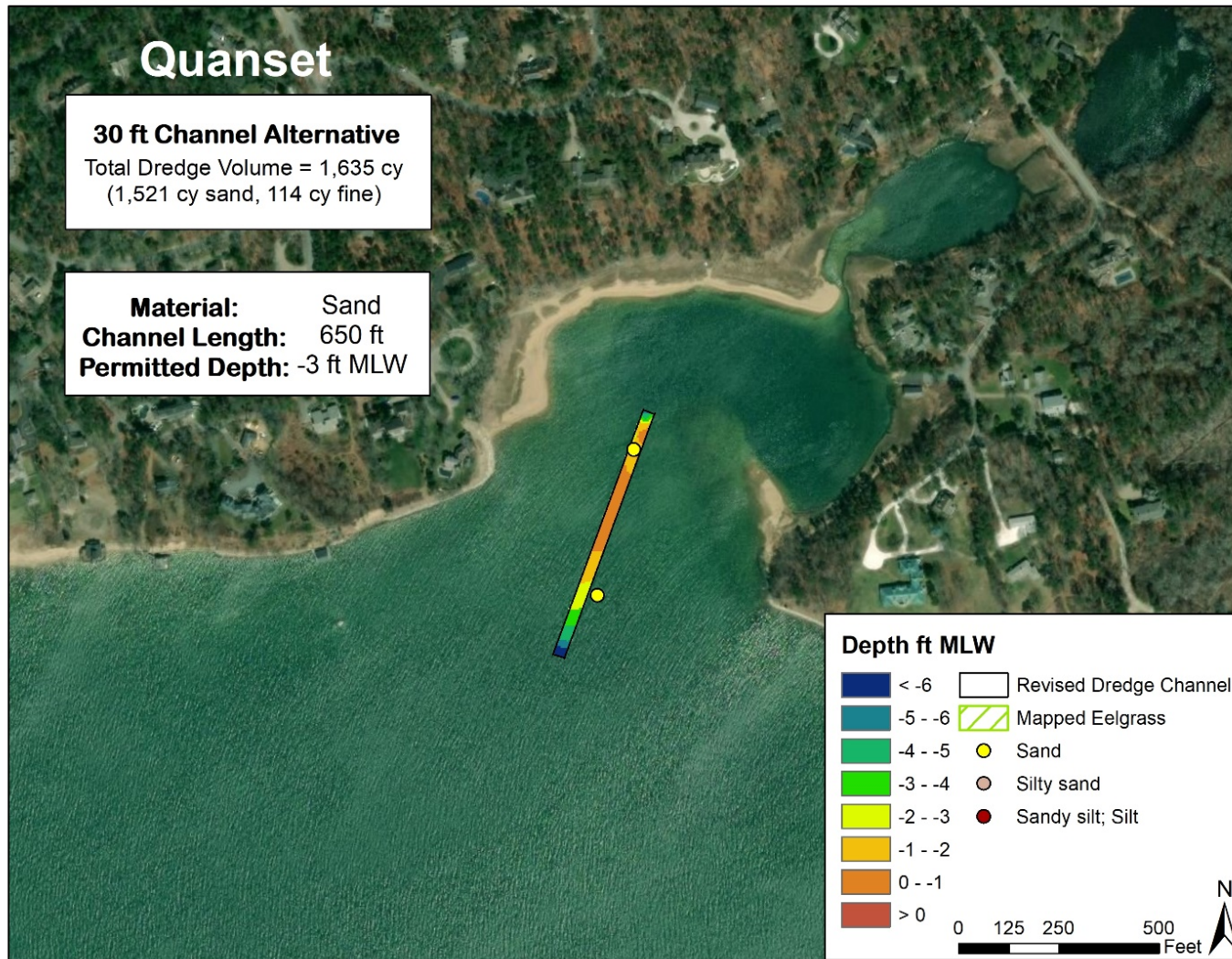


Figure 25. Overview of bathymetry, sediment quality, and dredge volume estimates in Quanset Pond, Pleasant Bay.

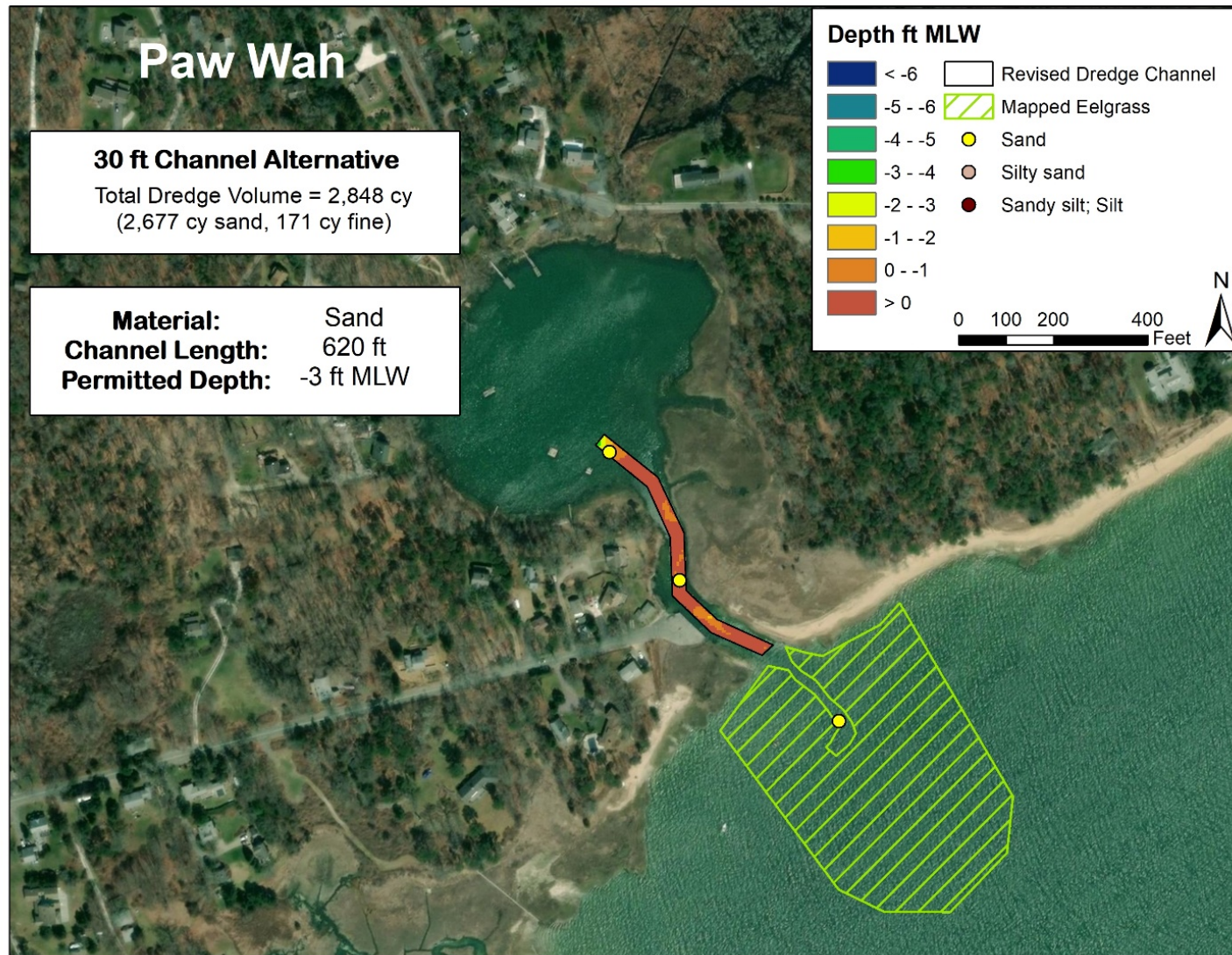


Figure 26. Overview of bathymetry, sediment quality, and dredge volume estimates in Paw Wah Pond, Pleasant Bay.

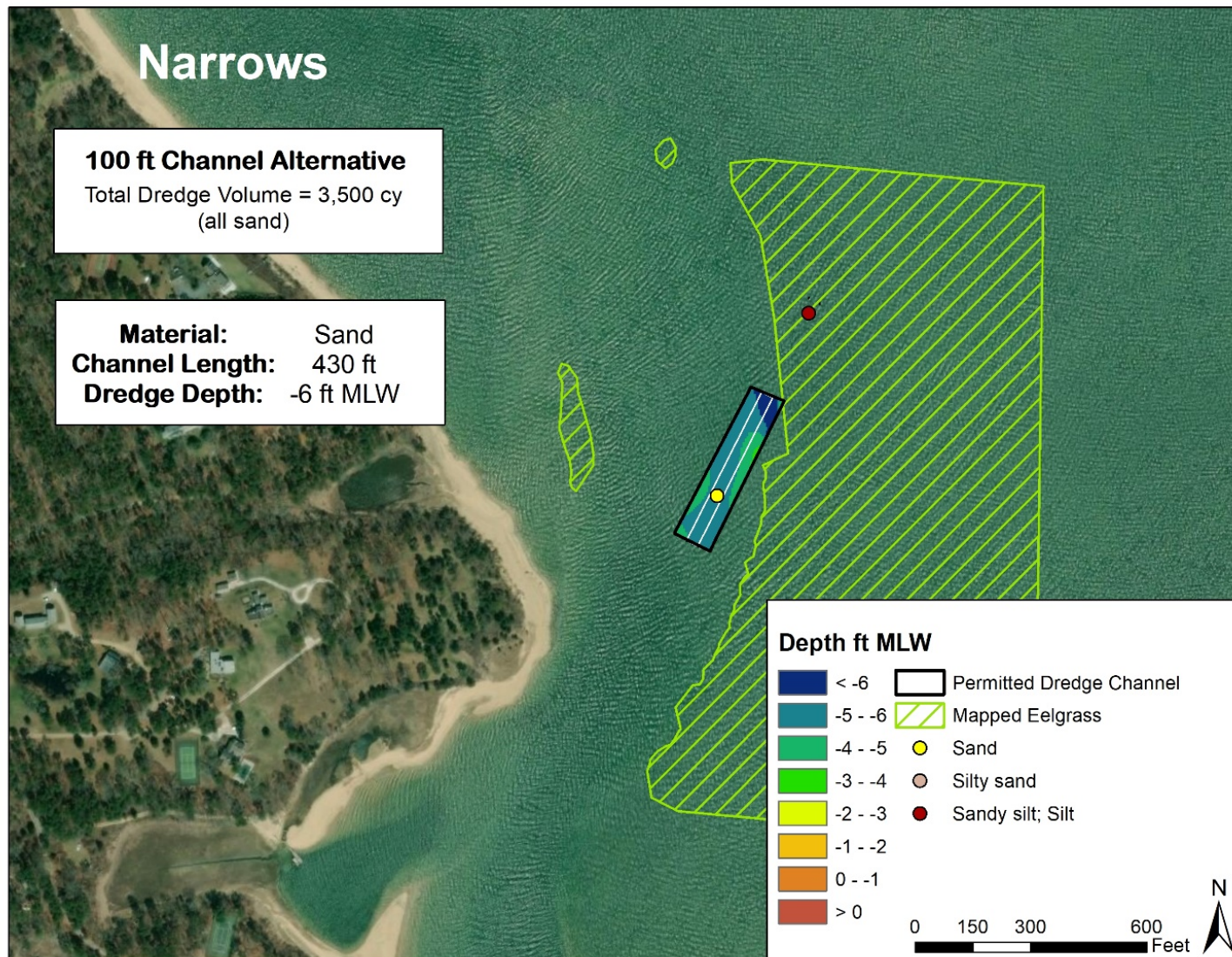


Figure 27. Overview of bathymetry, sediment quality, and dredge volume estimates at the Narrows, Pleasant Bay.

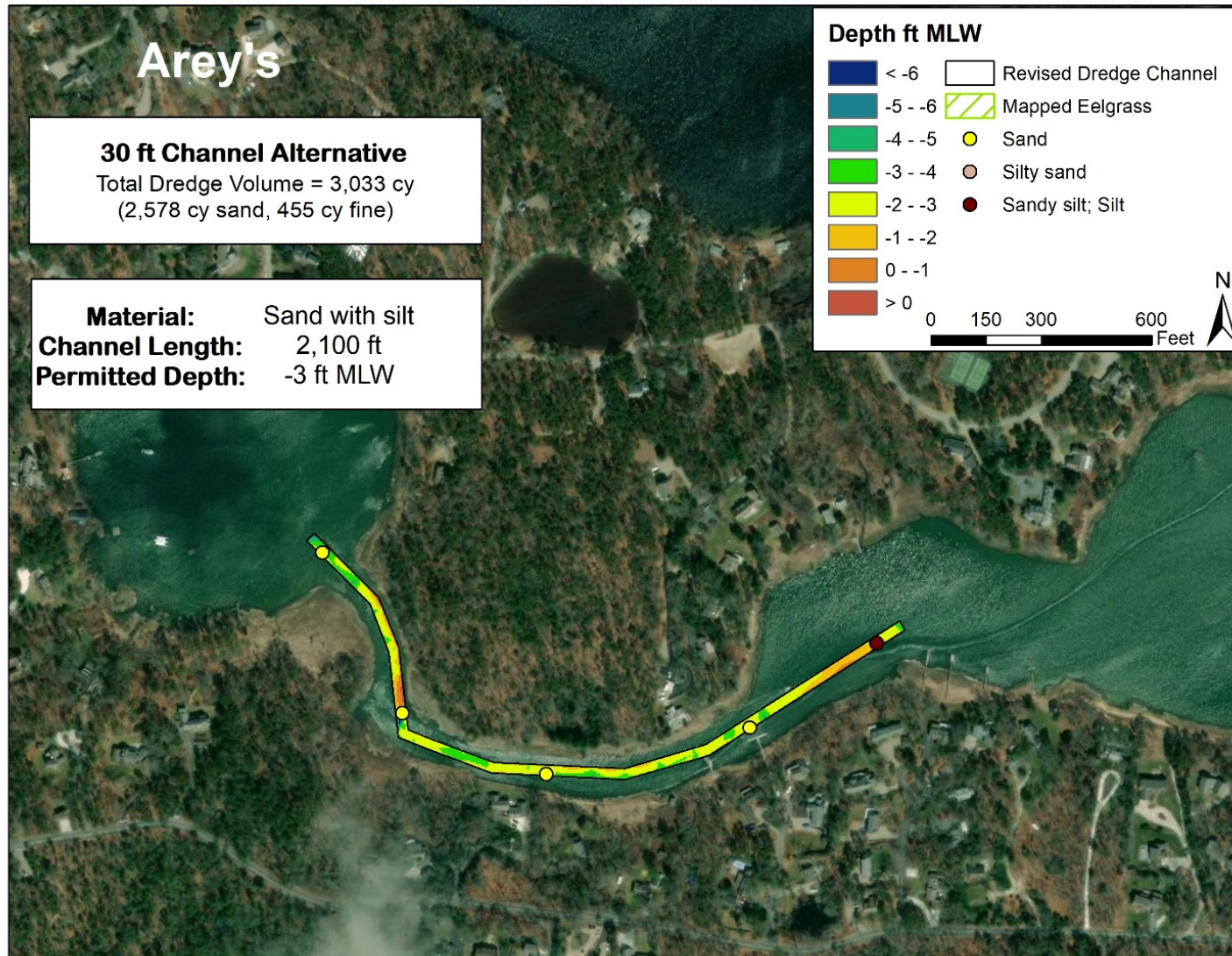


Figure 28. Overview of bathymetry, sediment quality, and dredge volume estimates in Arey's Pond, Pleasant Bay.

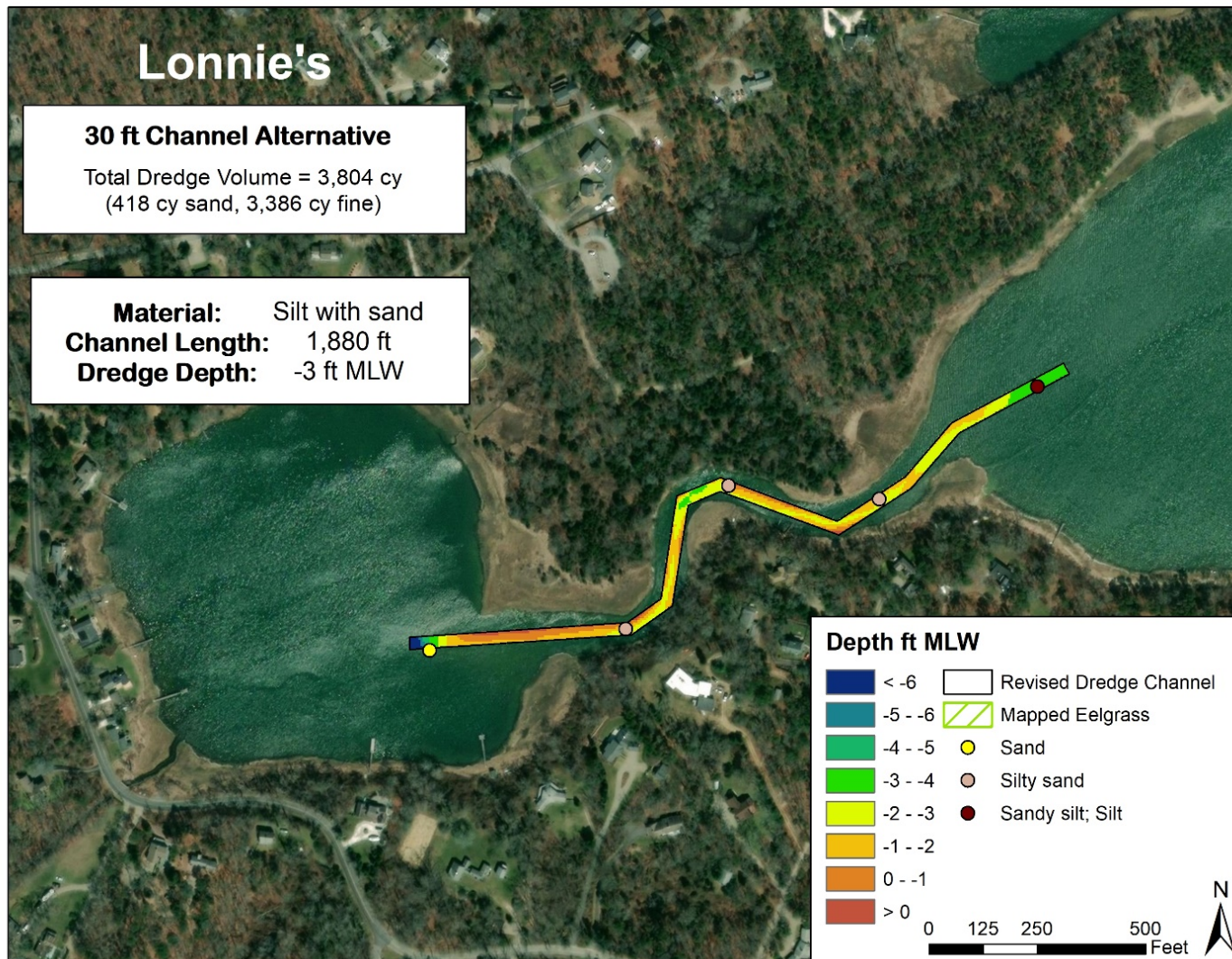


Figure 29. Overview of bathymetry, sediment quality, and dredge volume estimates in Lonnie's Pond, Pleasant Bay.

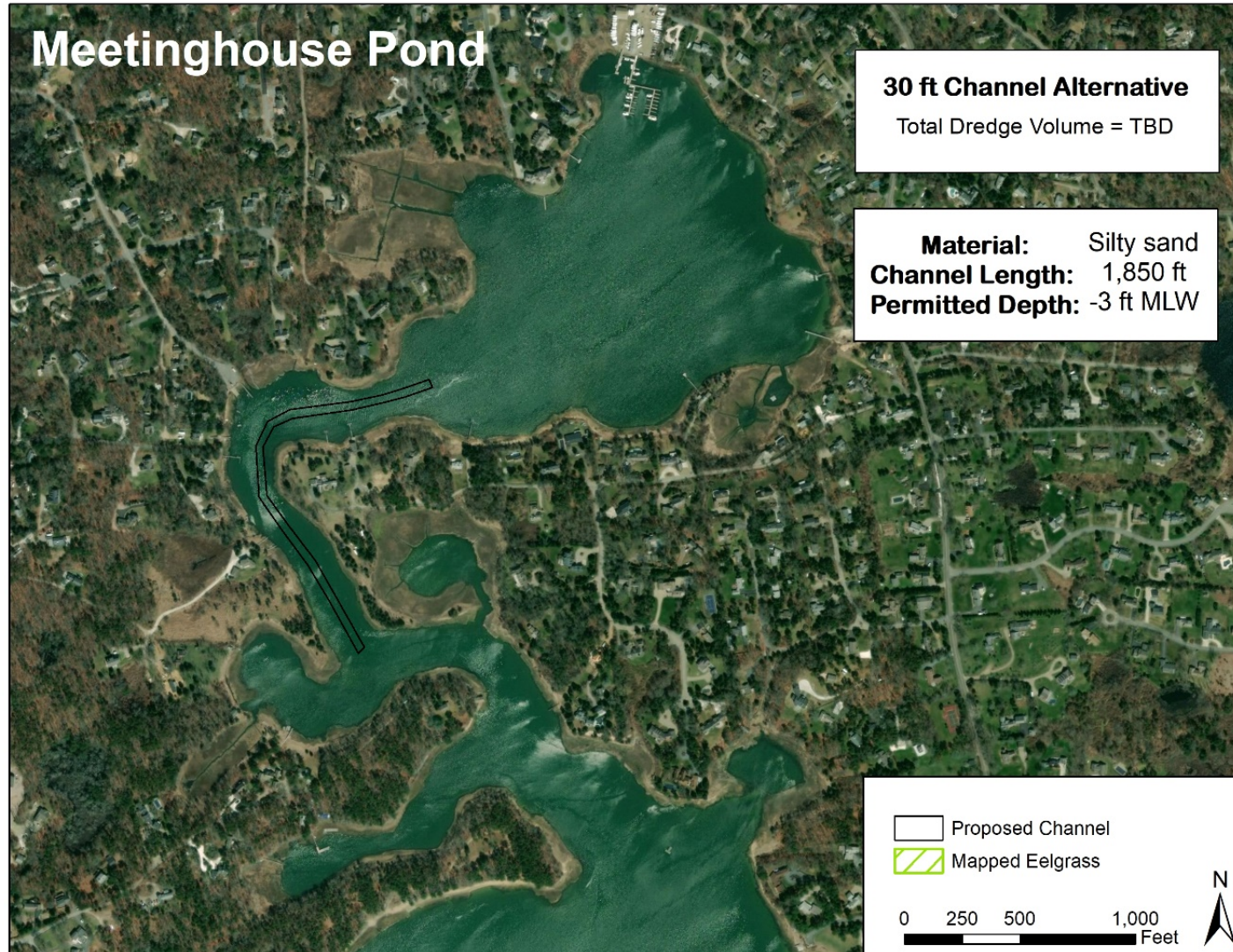


Figure 30. Proposed dredge channel in Meetinghouse Pond, Pleasant Bay.

**Table 6. Estimated dredge material quality and volume available to be removed from Pleasant Bay waterways**

	Length (ft)	Width (ft)	Permitted Depth (ft MLW)	Over-dredge Depth (ft MLW)	Vol. Cal. Depth (ft MLW)	Dredge Volume (CY)	Sand Volume (CY)	Fines Volume (CY)	Material
Quanset	650	30	-3	-4	-4	1,635	1,521	114	Sand
Narrows [†]	430	100	-6	-7	-7	3,500	3,500	0	Sand
Paw Wah	620	30	-3	-4	-4	2,848	2,677	171	Sand
Arey's	2,100	30	-3	-4	-4	3,033	2,578	455	Sand with silt
Lonnie's	1,880	30	-3	-4	-4	3,804	418	3,386	Silty sand
Meeting-house Pond [‡]	1,850	30	-3	-4	-4	TBD	TBD	TBD	Silty sand
Total Volumes									
Total						14,820	10,694	4,126	

[†] 100' and 30' wide channel alternatives are illustrated in Figure 27. Given existing depths, it is anticipated that no more than 3,500 CY of material may be dredged from the Narrows, regardless of channel configuration.

[‡] Determining Meetinghouse Pond sediment quality and quantity requires further data collection (bathymetric survey and sediment coring).

Rock Harbor

Rock Harbor has been dredged twice in the past fifteen years, in 2005 and 2015. The available data in Rock Harbor are actual post-dredging bathymetric surveys and sediment samples. The two historic dredging events in Rock Harbor resulted in 21k CY and 29k CY of sandy and fine-grained material in 2005 and 2015 respectively (Table 7, Figure 31). Using these two events, an estimated average dredging rate of 25k CY of material every 10 years is presumed. All dredge material from both historic events were barged offshore to the Cape Cod Bay Disposal Site.

The DAC has discussed advantages of dredging an approach channel to Rock Harbor, cut through Cape Cod Bay. Due to the sandy, moderately energetic environment of Cape Cod Bay, the channel would likely require frequent dredging and could be used as a sand borrow site. Dredge volume estimates and channel extents do not exist; as part of an ACEC, any new dredging in this section of Cape Cod Bay would have to fit within the management plan of the ACEC. No management plan currently exists for the Cape Cod Bay ACEC.



Table 7. Dredge material quality and volume removed from Rock Harbor, Orleans, MA

	Length (ft)	Width (ft)	Permitted Depth (ft MLW)	Over-dredge Depth (ft MLW)	Vol. Calc. Depth (ft MLW)	Dredge Volume (CY)	Sand Volume (CY)	Fines Volume (CY)	Material
2005	1,650	100	-3	-4	-4	21,061	0	21,061	Fines
2015	1,650	100	-3	-4	-4	29,404	0	29,404	Fines
Total Volumes									
Total (average)						25,233	0	25,233	

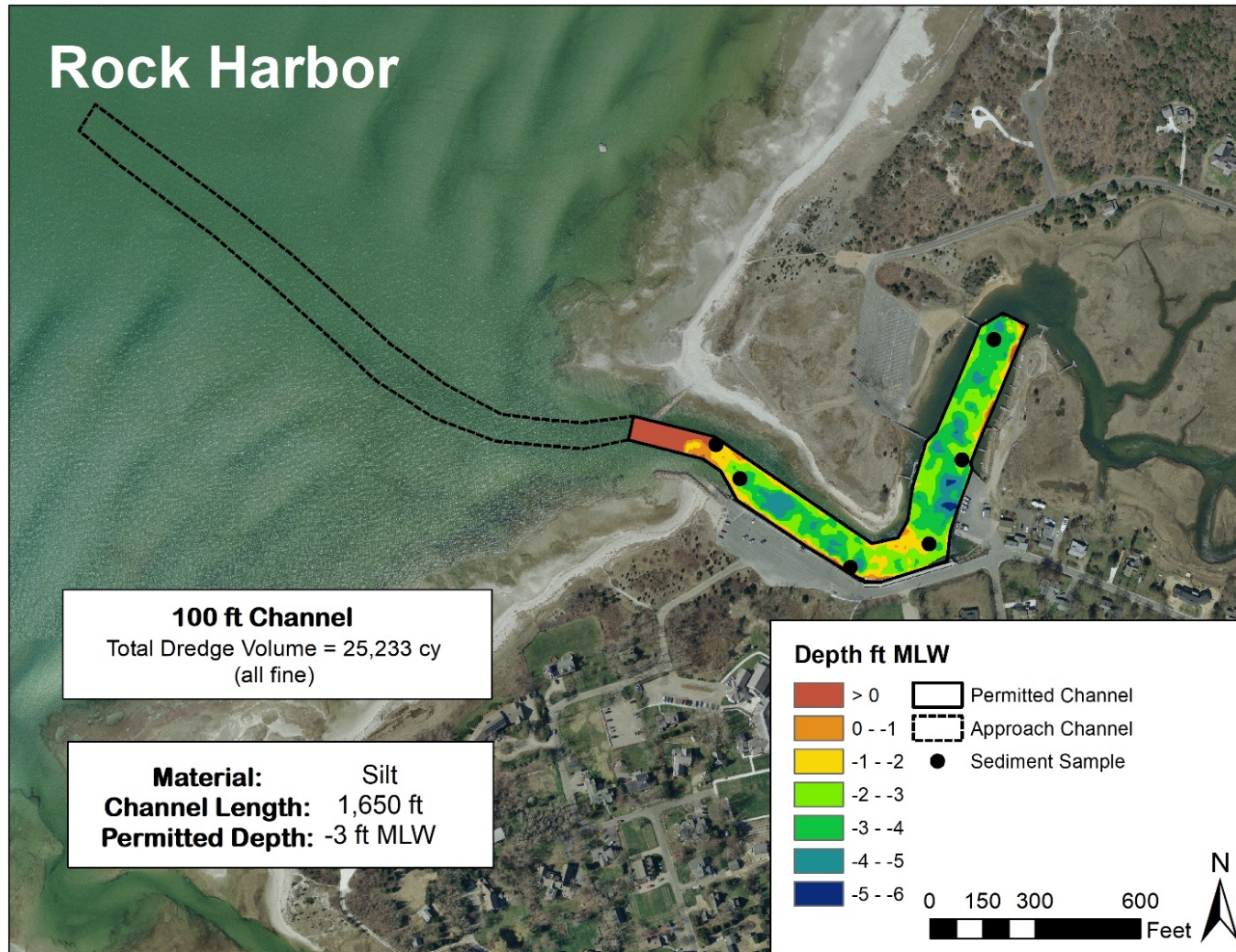


Figure 31. Overview of Rock Harbor bathymetry, sediment quality, and historic dredge volume.



Summary Statistics

Based on this assessment of sediment quantity and quality, a total estimated 87k – 150k CY of sand and 43k – 48k CY of fine-grained material are currently available to be removed from Town of Orleans waterbodies. Total expected volumes from individual waterbodies are summarized in Table 8. Nauset Estuary accounts for approximately 70 – 80% of all potential dredge material; with the section behind the barrier beach accounting for approximately 67 – 68% of that total.

Table 8. Summary of Dredge Volume Calculations for Town of Orleans Waterways.

Waterway	Sand Volume (CY)	Fines Volume (CY)
Nauset Estuary 50' Channel	76,490	13,295
Nauset Estuary 100' Channel	139,972	18,625
Pleasant Bay	10,694	4,126
Rock Harbor	0	25,233
Total Assuming 50' Nauset Channel	87,184	42,654
Total Assuming 100' Nauset Channel	150,666	47,984

30-Year Sediment Budget and Assumptions

In addition to the volume of sediment currently available for extraction, Woods Hole Group also developed an estimated *Sediment Budget*, extending out over a 30-year planning horizon. Estimated dredge frequencies for each section of channel described above are included in Table 9. The average expected dredge volumes for 4 unique dredging scenarios are summarized in Table 10. A complete breakdown of the year-over-year and annualized estimated dredge volumes are included in Appendix F, which includes the following assumptions:

- Nauset Estuary includes volume estimates for a 50 ft and a 100 ft wide channel, which have recently been updated to follow the deepest portion of the natural channel and stay 300 ft from the back side of the barrier beach.
- After the first round of dredging behind the barrier beach, it is assumed that 50% of the original estimated volume behind the barrier beach will need to be dredged annually.
- Given the short length of the dredge season and time needed to mobilize and demobilize equipment, it is assumed that dredging will only occur in (1) Town waterway per year (Nauset, or Pleasant Bay, or Rock Harbor).
- The required dredge frequency within each waterway is based on Woods Hole Group's best engineering assessment but may vary based on local conditions.

This information is important when considering a dredge purchase because year-over-year dredge volumes must be sufficient to justify the annual operating expenses of the equipment. Factoring the annual estimated dredge volume against the annual estimated operating costs of municipally-owned dredging equipment generates a cost per cubic yard – also known as the *dredge rate*, which serves as an important means of comparison between the various dredging alternatives (municipal dredge ownership vs. working with the BCD vs. soliciting a private dredge contractor) described in the following Chapter.

**Table 9. Estimated dredge frequency in Town of Orleans Waterways.**

Waterway	Dredge Frequency (Years)
Nauset Estuary	
Town Cove	15
Central Main Channel	10
Eastern Main Channel	8
Priscilla Spur	8
Behind Barrier	50% Total Volume Annually
Pleasant Bay	
Quanset Pond	30
The Narrows	30
Paw Wah Pond	30
Arey's Pond	30
Lonnie's Pond	30
Meetinghouse Pond	30
Rock Harbor	
Inner Harbor	10

Table 10. Estimated 30-year average dredge volume (4 unique alternatives).

Dredge Scenario	Average Dredge Volume (CY)
<i>Average Volume (50 ft Nauset Alternative)</i>	33,691
<i>Average Volume (100 ft Nauset Alternative)</i>	57,679
<i>Average Volume (50 ft Nauset Alternative) (Behind Barrier Excluded)</i>	6,360
<i>Average Volume (100 ft Nauset Alternative) (Behind Barrier Excluded)</i>	8,370

Disposal and/or Beneficial Reuse of Dredged Material

A final point to consider when analyzing present day and future dredge volumes is the disposal and/or beneficial reuse of the dredged material. Often, dredged material is clean and beach compatible – suitable for a wide range of beach nourishment, dune enhancement, and coastal resilience projects. Other times, dredged material is fine-grained or deemed incompatible for resilience projects, it must be dewatered and trucked for upland disposal or barged to offshore disposal sites. As a visual reference, a photo of a ~50k CY stockpile is included in Figure 32 to provide context of the size and extent of dewatering areas needed to support dredging operations. As a reminder, average dredge volumes in Orleans are estimated between 33k-57k CY annually (Table 10).

The Town of Orleans is currently evaluating the most appropriate alternatives for dewatering, disposal, and beneficial reuse of dredged material from Nauset Estuary, Pleasant Bay, and Rock Harbor. Often, the greatest limitation on beneficial reuse is the pumping distance of the dredging equipment (if dredging hydraulically) or the hauling distance to the landing (if dredging mechanically). Figure 33 illustrates the maximum pumping distances of standard hydraulic dredging equipment with one or two in-line booster pumps, in Nauset Estuary. Figures 34 and 35 illustrate the maximum pumping distance in Pleasant Bay and Rock Harbor without a booster



pump. These Figures are provided to help the Town evaluate locations that may be suitable for dewatering, disposal, or beneficial reuse of dredged material. It is important to note that the most suitable dewatering site(s) may require the use of more than one booster.



Figure 32. 50,000 CY stockpile of dewatered, dredged material.

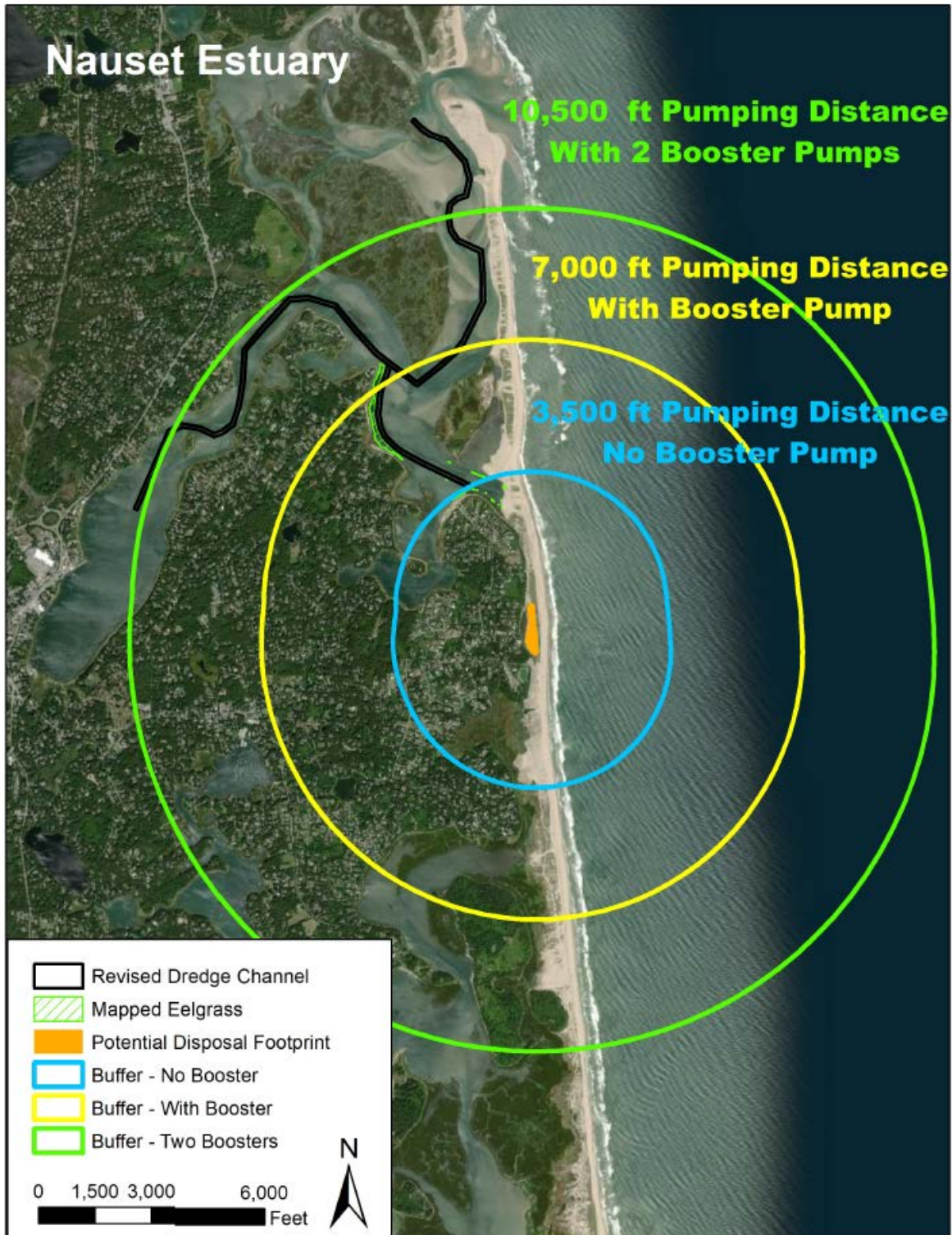


Figure 33. Nauset Estuary channel and proposed dewatering and disposal area at Nauset Beach. Buffer rings present the distance dredge material can be pumped using a hydraulic dredge with or without a booster pump.

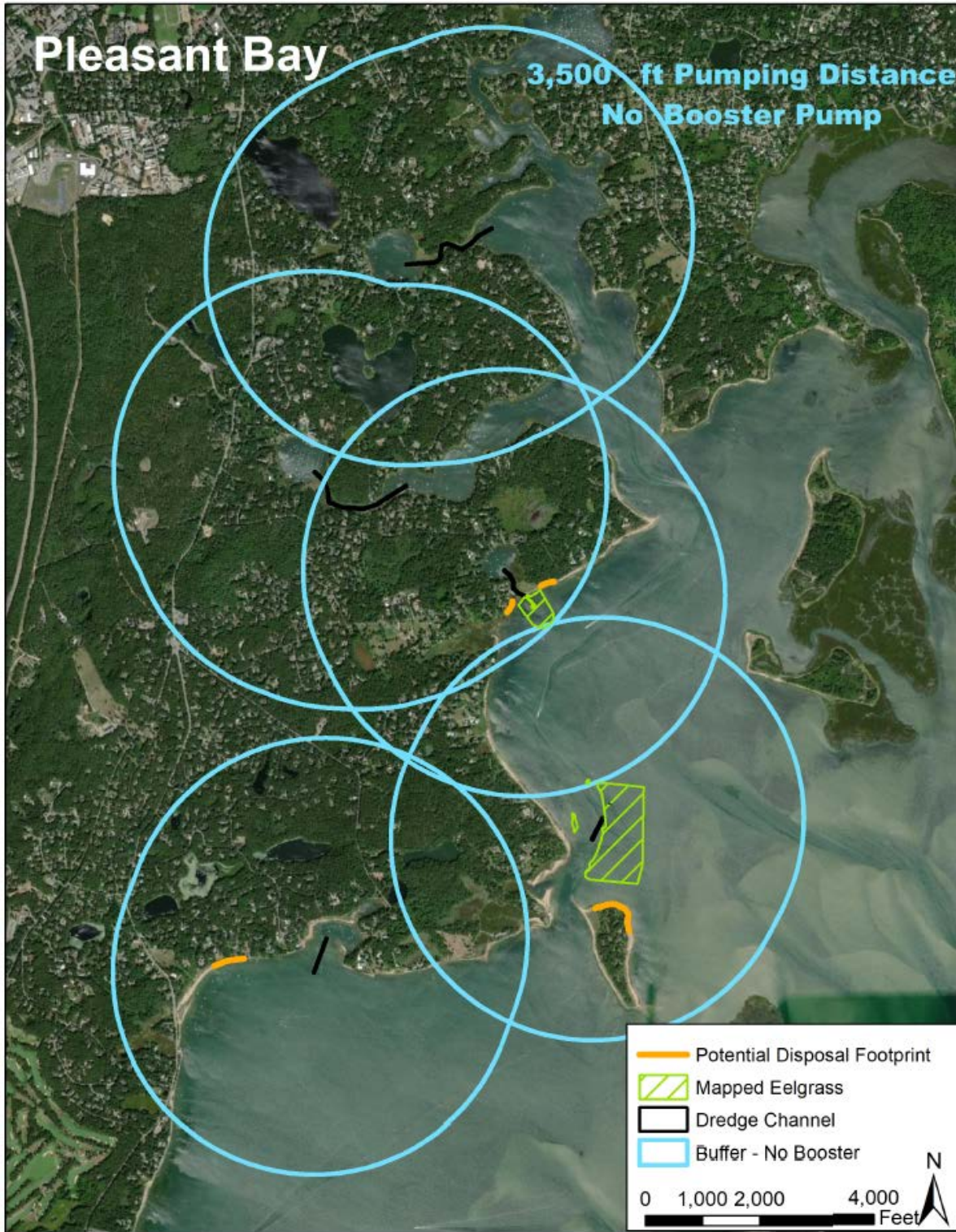


Figure 34. Potential dewatering and disposal areas in Pleasant Bay (orange) and the maximum pumping distance of material during hydraulic dredging without the use of a booster pump (blue).

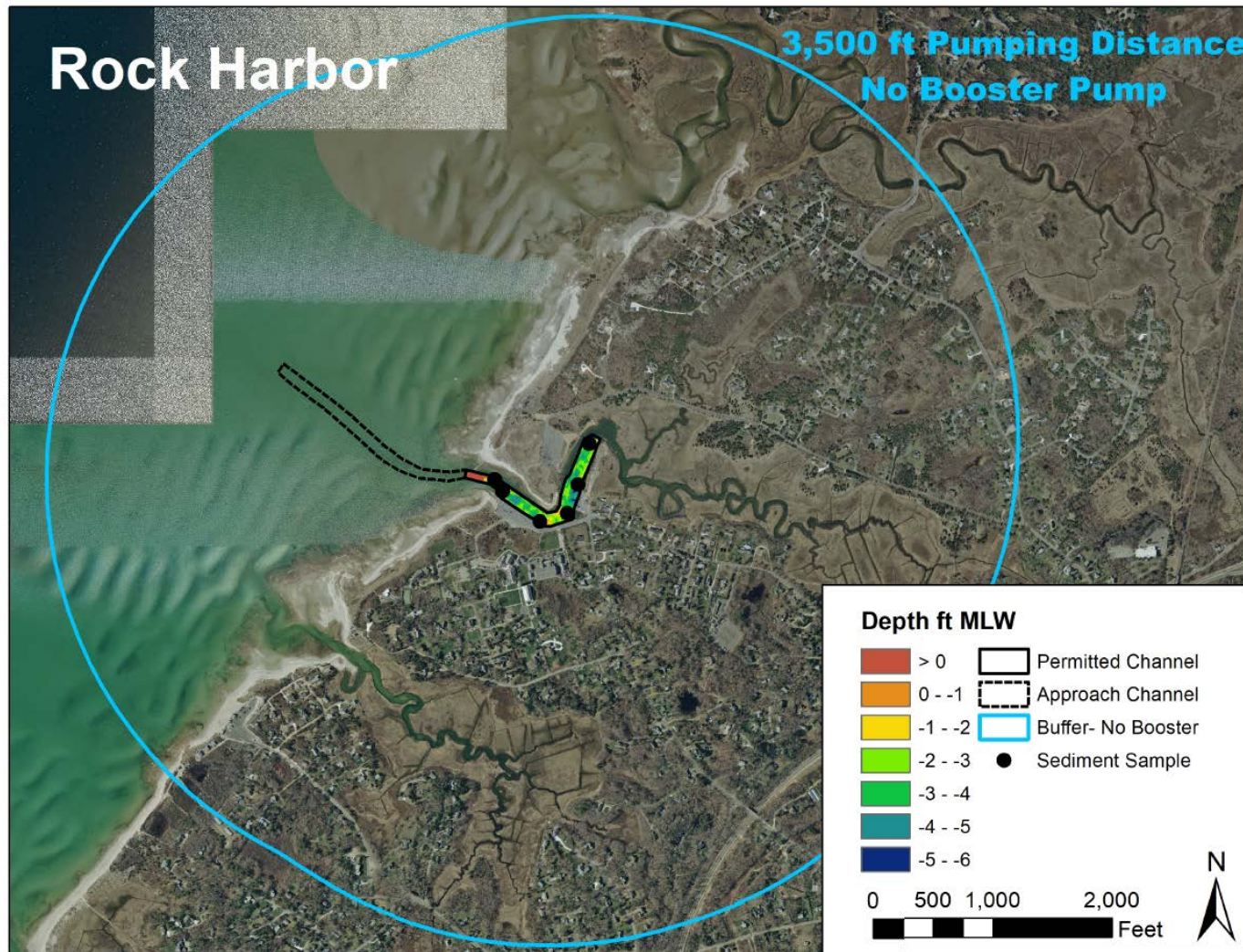


Figure 35. Existing dredge channel (solid line), idealized approach channel (dashed line) in Rock Harbor and maximum pumping distance of material during hydraulic dredging without the use of a booster pump (blue).



Regarding the Capacity of Dewatering Areas

- Dewatering areas in Pleasant Bay are small and limited in their capacity to accept large volumes of dredged material, especially fine-grained sediment from Lonnie’s and Aery’s Ponds. Therefore, it will be important to consider costs associated with dewatering and trucking material to an upland stockpile for later use and/or to an approved disposal area.
- This assessment assumed that any material that was not beneficially reused in the Pleasant Bay system would be trucked and stockpiled within the Town of Orleans. The assessment did not include a disposal fee, because it was assumed that the material would be stockpiled on Town land.
- It is estimated that the proposed dewatering area for the Nauset Estuary dredging project located north of Nauset public beach can store up to 80,000 CY of dredged material. The estimated dredge volumes associated with either a 50 ft or 100 ft channel (inclusive of volumes behind the barrier beach) exceed the estimated capacity of the dewatering area. Therefore, any remaining volume must be trucked to an upland stockpile or beneficially reused at another site.
- Once the capacity of any proposed dewatering/beneficial reuse area has been exceeded, future maintenance dredging may require management of dewatering area to accommodate additional sediment, or the establishment of new dewatering area(s).

Regarding Improvement Dredging Projects within Areas of Critical Environmental Concern

The Orleans DAC has expressed an interest in exploring opportunities to dredge the approach channel to Meeting House Pond in Pleasant Bay and the approach channel to Rock Harbor on Cape Cod Bay. Both channels are in State-designated Areas of Critical Environmental Concern (ACECs), which are defined by the Commonwealth of Massachusetts as:

“a place in Massachusetts that receives special recognition because of the quality, uniqueness, and significance of its natural and cultural resources. Such an area is identified and nominated at the community level and is reviewed and designated by the State’s Secretary of Energy and Environmental Affairs. The Department of Conservation and Recreation (DCR) administers the ACEC program on behalf of the Secretary”

At present, new improvement dredging projects (projects in areas that have no history of previous dredging having occurred) are not permissible in ACECs in the State of Massachusetts until the project is “incorporated into a Resource Management Plan approved by participating municipalities and the Secretary of Environmental Affairs” (CZM, 2003) and the dredging is needed to maintain or restore historic safe navigation (310 CMR 10.24(5)(b)). As such, improvement dredging in Meetinghouse Pond would require revisions to the Pleasant Bay Resource Management Plan, and improvement dredging in Rock Harbor would require documentation of shoaling in the channels to demonstrate that improvement dredging is needed to restore historic safe navigation. The Massachusetts Department of Environmental Protection (DEP) Waterways regulations (310 CMR 9.40) allow improvement dredging in ACEC’s, if the work is conducted for the sole purpose of fisheries or wildlife enhancement, or if the work is needed



to restore safe navigation Within the Pleasant Bay ACEC, “limited improvement dredging to maintain or restore historical navigable access” was approved in 2012 and incorporated into the Pleasant Bay Resource Management Plan (Pleasant Bay Resource Management Alliance, 2018) for areas in Chatham affected by the 2007 breach in the Nauset barrier.

Regarding Thin Layer Deposition (Salt Marsh Enhancement) as an Alternative for Beneficial Reuse of Dredged Material

The Massachusetts Wetland Protection Act 310 CMR 10.32 defines salt marsh as: *“a coastal wetland that extends landward up to the highest high tide line, that is, the highest spring tide of the year, and is characterized by plants that are well adapted to or prefer living in, saline soils. Dominant plants within salt marshes are salt meadow cord grass (Spartina patens) and/or salt marsh cord grass (Spartina alterniflora). A salt marsh may contain tidal creeks, ditches, and pools”*. General Provision 5(f) of 310 CMR 10.53 states that: *“there shall nor be any filling or dredging of a salt marsh”*.

At present, Thin Layer Deposition (TLD) is not considered a widely accepted practice for the beneficial reuse of dredged material in the State of Massachusetts, as any filling of salt marsh is not currently permitted. Thin layer deposition is currently being studied and employed by the USACE in other districts around the country to improve the resilience of salt marsh to projected sea level rise. However, it should not be relied upon as the preferred alternative for beneficial reuse of dredged material in Orleans without careful consultation with State regulatory agencies. For additional information regarding TLD, including case studies and state of the practice, please refer to the USACE Dredging Operations Technical Support Program (<https://tldp.el.erdc.dren.mil/>).

Regarding Dredging Freshwater Ponds

Voters in the Town of Orleans rejected Article 43 at the October 2020 Special Town Meeting Warrant to permit and dredge freshwater ponds, however, the DAC expressed interest in whether the equipment described in the following sections of the report could be used to dredge freshwater systems. The compact Ellicott 370 or mechanical dredging equipment described in the following sections of the report could possibly be used in a freshwater environment so long as the pond(s) have suitable access points, i.e., paved boat ramps, crane access, adjacent parking areas, open fields, etc. to support launching the dredge, retrieving the dredge, and dewatering and hauling dredged material to the disposal site. Ellicott 670 equipment would be too large for such purposes. It should also be noted that standard, compact dredges can only reach to a depth of approximately 20 ft, which may be insufficient to reach the bottom of larger freshwater ponds where nutrients tend to accumulate. Prior to dredging any freshwater pond, it would be necessary to evaluate all potential environmental impacts to the resource area(s) and coordinate with regulatory officials to identify all necessary permits. Evaluating the demand for and possible impacts associated with dredging freshwater ponds is not included in the scope of this assessment.



5.0 FEASIBILITY ASSESSMENT

Based on the sediment quantity and quality data summarized in Chapter 4 and a review of local environmental conditions, the Woods Hole Group worked with the DAC to identify 3 alternatives that could be used to address current and future dredging needs in the Town of Orleans. Alternative 1 involves purchasing, owning, and operating municipal dredging equipment based on the BCD and EDP models. Three sub-alternatives are included under Alternative 1, looking at different types of dredging equipment. Alternatives 2 and 3 involve contracting with the Barnstable County Dredge Program and/or the retention of a private dredge contractor to complete Town dredging projects in lieu of purchasing municipal dredging equipment. The 3 Alternatives are summarized below.

- **Alternative 1:** Purchase and Operation of Hydraulic or Mechanical Dredging Equipment
 - **Alternative 1A** – Ellicott 370 Hydraulic Cutter Suction Dredge
 - **Alternative 1B** – Ellicott 670 Hydraulic Cutter Suction Dredge
 - **Alternative 1C** – Poseidon P2 Barge Mechanical Dredging Platform
- **Alternative 2** – Collaboration with the Barnstable County Dredge Program
- **Alternative 3** – Retention of a Private Dredge Contractor

Alternative 1: Purchase and Operation of Municipal Dredging Equipment

Three different dredging platforms, the Ellicott 370 hydraulic cutter suction dredge, the Ellicott 670 hydraulic cutter suction dredge, and the Poseidon P2 Barge mechanical dredging system were considered based on their mobility, versatility, and ability to dredge and beneficially reuse sediment found in Town waterways (Figures 36-38) (Appendix G (Spec Sheets)). Woods Hole Group researched detailed costs associated with owning and operating each type of dredging equipment by soliciting direct feedback from dredge manufacturers and equipment suppliers.

It is important to note that the Town may be able to secure a lower cost for specific pieces of equipment through a competitive bid process or by investing in used equipment, though the latter is not common practice for a municipality. Further, estimated costs are expected to change over the course of time and are worth revisiting if/when the Town decides to explore a dredge purchase. It is worth noting that modifying the costs for a single line item or piece of equipment would only have a nominal impact on the estimated 30-year life-cycle costs.

Alternative 1 considered the capital purchase and operation of a hydraulic cutter suction dredge or a mechanical dredging platform to complete municipal dredging projects in the Town of Orleans over the expected 30-year useful life of the equipment. Alternative 1 is based on the equipment and staffing structure of the proven BCD model. Equipment costs for the purchase of the dredge superstructure, marine-based support craft, and land-based vehicular support for the Ellicott 370 hydraulic dredge, the Ellicott 670 hydraulic dredge, and the Poseidon P2 barge system are outlined in Tables 11-13.



In addition to up-front equipment costs, Alternative 1 considers the annual cost of staffing, maintaining, insuring, and fueling dredging equipment, plus mobilization, demobilization, maintenance, scheduling, and project planning. Total annual ancillary (personnel and overhead) costs for Alternatives 1A-1C are summarized in Table 12. Alternative 1 does not include costs associated with establishing and maintaining a regulatory body to govern dredging operations, set the dredge schedule, and administrative costs associated with managing the finances of the dredge program. The complete financial model and capital outlay for Alternatives 1A-1C, is included in Appendix H. A PowerPoint presentation describing how to read and interpret the financial model is included in Appendix I.



Figure 36. Ellicott 370 Dredge Superstructure. Retrieved on 29 September 2020 from <https://www.dredge.com/series-370-dragon-dredge/>

**Table 11. Ellicott 370 Hydraulic Dredge – Equipment Costs**

Dredge Superstructure	Estimated Cost
Ellicott 370	\$650,000
Hypack GPS Package	\$40,000
Comprehensive On-Site Training	Included
Delivery	Included
Total Superstructure Costs	\$690,000

Marine-Based Support Craft	Estimated Cost
Primary Push Boat	\$150,000
Support Boat (to haul pipe)	\$75,000
Support Skiff (to haul personnel)*	\$20,000
*Support Skiff Replacement (1x) Minus Trade-In	\$17,000
Booster Pump (2X)	\$500,000
Marine-Based Support Costs	\$762,000

Dredge Pipe	Estimated Cost
Dredge Pipe (11,000 linear feet (12-14"))	\$220,000
Attachments, Fittings, & Floats	\$135,000
Pipe Fusion Machine	\$45,000
Dredge Pipe Costs	\$400,000

Land-Based Vehicular Support	Estimated Cost
3x GMC Sierra 2500HD Duramax Pickups*	\$180,000
* Pickup Replacement (2x) Minus Trade-In	\$306,000
2x Heavy-Duty Equipment Trailers*	\$15,000
* Trailers' Replacement (1x) Minus Trade-In	\$12,750
CAT Wheeled Loader	\$125,000
Loader Attachments	\$10,000
Land-Based Support Costs	\$648,750

Total Equipment Costs (One-Time)	\$2,500,750
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Figure 37. Ellicott 670 Dredge Superstructure. Retrieved on 29 September 2020 from <https://www.dredge.com/series-670-dragon-dredge/>

**Table 12. Ellicott 670 Hydraulic Dredge – Equipment Costs**

Dredge Superstructure	Estimated Cost
Ellicott 670 Dragon	\$1,300,000
Hypack GPS Package	\$40,000
Comprehensive On-Site Training	Included
Delivery	Included
Total Superstructure Costs	\$1,340,000

Marine-Based Support Craft	Estimated Cost
Primary Push Boat	\$150,000
Support Boat (to haul pipe)	\$75,000
Support Skiff (to haul personnel)*	\$20,000
*Skiff Replacement (1x) Minus Trade-In	\$17,000
Booster Pump (2X)	\$500,000
Marine-Based Support Costs	\$762,000

Dredge Pipe	Estimated Cost
Dredge Pipe (11,000 linear feet (14-16"))	\$275,000
Attachments, Fittings, & Floats	\$135,000
Pipe Fusion Machine	\$45,000
Dredge Pipe Costs	\$455,000

Land-Based Vehicular Support	Estimated Cost
3x GMC Sierra 2500HD Duramax Pickups*	\$180,000
*Pickup Replacement (2x) Minus Trade-In	\$306,000
2x Heavy-Duty Equipment Trailers*	\$15,000
* Trailers' Replacement (1x) Minus Trade-In	\$12,750
CAT Wheeled Loader	\$125,000
Loader Attachments	\$10,000
Land-Based Support Costs	\$648,750

Total Equipment Costs (One-Time)	\$3,205,750
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Figure 38. Poseidon P2 Barge System. Retrieved o 29 September 2020 from <https://www.poseidonbarge.com/uses/dredging/>

**Table 13. Poseidon P2 Barge System – Equipment Costs**

Dredge Superstructure	Estimated Cost
Poseidon P2 Barge System	\$546,000
CAT Track Excavator	\$200,000
Comprehensive On-Site Training	\$2,400
Delivery	\$36,100
Total Superstructure Costs	\$784,500

Marine-Based Support Craft	Estimated Cost
Primary Push Boat	\$108,750
Support Skiff (to haul personnel)*	\$20,000
*Support Skiff Replacement (1x) Minus Trade-In	\$17,000
Dewatering-Disposal Containers	\$80,000
Marine-Based Support Costs	\$225,750

Land-Based Vehicular Support	Estimated Cost
3x GMC Sierra 2500HD Duramax Pickups*	\$180,000
* Pickup Replacement (2x) Minus Trade-In	\$306,000
2x Heavy-Duty Equipment Trailers*	\$15,000
* Trailers' Replacement (1x) Minus Trade-In	\$12,750
CAT Wheeled Loader	\$125,000
Loader Attachments	\$10,000
Land-Based Support Costs	\$648,750

Dewatering Support	Estimated Cost
Geotextile Liner	\$5,000
Concrete Perimeter	\$1,000
Sediment Curtains	\$10,000
De-watering Support Costs	\$16,000

Total Equipment Costs (One-Time)	\$1,675,000
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Table 14. Side-by-side Comparison of Annual Ancillary and Overhead Costs Associated with Alternatives 1A-1C (year 1).

Ancillary Costs: Ellicott 370	
Personnel	Estimated Cost
Dredge Superintendent	\$100,000
Dredge Captain	\$75,000
Dredge Leverman	\$65,000
Dredge Deckhand	\$50,000
Dredge Deckhand	\$50,000
Total Personnel Cost (Annual)	\$340,000
Overhead Cost	Estimated Cost
Maintenance	\$100,000
Insurance	\$25,000
Diesel Fuel Dredge	\$44,352
Diesel Fuel Boosters (x2) & Loader	\$96,768
Total Overhead Cost (Annual)	\$266,120
Total Ancillary Cost (Annual)	\$606,120

Ancillary Costs: Ellicott 670	
Personnel	Estimated Cost
Dredge Superintendent	\$100,000
Dredge Captain	\$75,000
Dredge Leverman	\$65,000
Dredge Deckhand	\$50,000
Dredge Deckhand	\$50,000
Dredge Deckhand	\$50,000
Total Personnel Cost (Annual)	\$390,000
Overhead Cost	Estimated Cost
Maintenance	\$100,000
Insurance	\$25,000
Diesel Fuel Dredge	\$56,448
Diesel Fuel Boosters (x2) & Loader	\$120,960
Total Overhead Cost (Annual)	\$302,408
Total Ancillary Cost (Annual)	\$692,408

Ancillary Costs: Poseidon P2	
Disposal Support	Estimated Cost
Trucking (hourly)	\$151,200
Disposal (per CY)	Variable
Disposal Costs	\$151,200
Personnel	Estimated Cost
Dredge Superintendent	\$100,000
Equipment Operator	\$75,000
Dredge Deckhand	\$50,000
Dredge Deckhand	\$50,000
Total Personnel Cost (Annual)	\$275,000
Overhead Cost	Estimated Cost
Maintenance	\$10,000
Insurance	\$10,000
Diesel Fuel Excavator & Loader	\$24,192
Total Overhead Cost (Annual)	\$44,192
Total Ancillary Cost (Annual) *Excludes Disposal Fees	\$470,392



Alternative 2: Contracting with the Barnstable County Dredge Program

To better understand prevailing BCD rates, Woods Hole Group spoke with BCD officials about the feasibility and costs associated with completing dredging projects in the Town of Orleans. As a service to municipalities on the Cape and Islands, the BCD program owns, operates, staffs, and maintains 2 hydraulic cutter suction dredges, regularly completing projects for local Towns at a subsidized rate well below the market average, providing a significant cost savings to local municipalities.

The BCD revised rate structure charges \$13/CY for projects over 40k CY that require an in-line booster pump, plus a 10% mobilization/demobilization fee based on the total cost of the project. In Orleans, up to 2 in-line booster pumps would be required to complete much of the proposed work in Nauset Estuary, adding an estimated \$2+ to the base rate to rent a second booster. Further, the Town or the County would need to furnish additional dredge pipe to support the long pumping distances in Nauset Estuary, adding additional cost to the base rate. Including the 10% mobilization/demobilization fee, the need to rent a second booster pump, and the need to furnish additional dredge pipe, Woods Hole Group estimates that the BCD dredge rate to complete high-priority (Nauset Estuary) projects in Orleans may be up to \$19 per CY. This is a conservative estimate and may change once permits have been issued and the project has been negotiated and scheduled with the BCD. Based on historic rate increases, this assessment assumes that subsidized, BCD dredge rates will increase \$2 per CY every 10 years over the course of the 30-year planning horizon.

Alternative 3: Retention of a Private Dredge Contractor

To better understand prevailing private dredge contracting rates, Woods Hole Group spoke with multiple dredging firms about the feasibility and costs associated with completing dredging projects in the Town of Orleans. Alternative 3 considers the possibility of soliciting and retaining a private dredging contractor to complete multiple dredging projects in the Town of Orleans. Alternative 3 assumes that the private dredge contractor would dredge multiple sections of channel per year for the duration of the contract period. It is assumed that a multi-year dredge contract would go out to bid 3 times over the 30-year planning period to account for changes in rates and to encourage competition within the private dredge industry. Inclusive of mobilization, demobilization, and basic dewatering or hauling to an approved stockpile within the Town of Orleans, private dredge contracting rates ranged from \$30-\$50 per CY. Given fluctuations in private dredge contracting rates, Woods Hole Group did not extrapolate rate increases over the 30-year planning horizon. The final dredging rate would be developed by the selected contractor and would be based on multiple factors including the proposed schedule, total number of projects, total quantity to be dredged, the quality of the material to be dredged, and the preferred alternative for disposal and/or beneficial reuse.

Alternative 1-3 Cost Per Cubic Yard Comparison

By factoring the annual costs of municipal dredge ownership against the estimated annual dredge volumes, Woods Hole Group was able to generate estimated dredge rates for municipally owned



and operated equipment. Tables 15-16 compare the estimated average rates for municipally owned equipment against the average rates of the BCD and the average rates carried by private dredge contractors. The rates are provided relative to the various channel alternatives (including and excluding volumes behind the Nauset estuary barrier beach) as described in the previous Chapter.

Table 15. Average dredge rates for Alternatives 1-3 Associated with Dredging in Rock Harbor, Pleasant Bay and Nauset Estuary (including volumes behind the barrier beach).

Dredging Alternatives	50 ft Nauset Alternative (Including Behind Barrier)	100 ft Nauset Alternative (Including Behind Barrier)
1A: Ellicott 370	\$26.80	\$15.65
1B: Ellicott 670	\$30.96	\$18.09
1C: Poseidon P2	N/A*	N/A*
2: Barnstable County Dredge	\$21.00	\$21.00
3: Private Dredge Contractor	\$30-\$50	\$30-\$50

*Poseidon P2 deemed unsuitable for dredging behind barrier beach.

Table 16. Average dredge rates of Alternatives 1-3 Associated with Dredging in Rock Harbor, Pleasant Bay and Nauset Estuary (excluding volumes behind the barrier beach).

Dredging Alternatives	50 ft Nauset Alternative (Excluding Behind Barrier)	100 ft Nauset Alternative (Excluding Behind Barrier)
1A: Ellicott 370	\$141.98	\$107.88
1B: Ellicott 670	\$164.02	\$124.62
1C: Poseidon P2	\$108.79	\$82.66
2: Barnstable County Dredge	\$21.00	\$21.00
3: Private Dredge Contractor	\$30-\$50	\$30-\$50

Tables 17 and 18 show that municipal dredge rates are inextricably tied to the amount of sediment available to be dredged – the greater the volume of sediment, the lower the rate; the lower the volume of sediment, the higher the rate. This is because municipal dredge rates are calculated by dividing the total annual operating expenses by the total CY of sediment dredged annually. The Barnstable County dredge rates and private dredge contracting rates remained consistent, regardless to the total dredge volume. This is because the BCD and private dredge contracting firms have established enterprise systems which set and revise prevailing dredge rates on a regular basis.

Alternative 1-3 Average Annual Cost and Total 30-Year Cost Comparison

Table 17 summarizes the estimated average annual costs (depreciation + ancillary + overhead) and the total estimated costs over the 30-year planning horizon for Alternatives 1A-1C. These figures represent the estimated cost of owning and operating municipal dredging equipment,



regardless of which channel alternative is ultimately selected and how many cubic yards of material are ultimately dredged. Tables 17-19 summarize the estimated total 30-year costs associated with contracting with the BCD to complete the required work or soliciting a private dredge contractor to complete the work. These figures represent the minimum estimated costs of utilizing the County dredge or a private contractor relative to the 4 channel alternatives as described in the previous Chapter.



Table 17. Average annual costs and total 30-year costs for Alternatives 1A-1C: Municipal Dredge Purchase

Dredging Alternative	Average Annual Cost	Total 30-Year Costs
1A: Ellicott 370	\$902,996	\$27,089,874
1B: Ellicott 670	\$1,043,180	\$31,295,213
1C: Poseidon P2	\$691,929	\$20,757,900

Table 18. Average annual costs and total 30-year costs for Alternative 2: Barnstable County Dredge

Dredge Scenario (Rock Harbor, Pleasant Bay, Nauset Estuary)	Total Dredge Volume (CY)	Average Annual Costs BCD	Total 30-Year Costs BCD
50 ft Nauset Alternative	1,010,716	\$707,501	\$21,225,036
100 ft Nauset Alternative	1,730,369	\$1,211,258	\$36,337,749
50 ft Nauset Alternative (Behind Barrier Excluded)	190,804	\$133,563	\$4,006,884
100 ft Nauset Alternative (Behind Barrier Excluded)	251,109	\$175,776	\$5,273,289

Table 19. Average annual costs and total 30-year costs for Alternative 3: Private Dredge Contractor

Dredge Scenario (Rock Harbor, Pleasant Bay, Nauset Estuary)	Total Dredge Volume (CY)	Average Annual Cost (High-Low Range)	Total 30-Year Cost (High-Low Range)
50 ft Nauset Alternative	1,010,716	\$1.1M - \$1.6M	\$35-50M
100 ft Nauset Alternative	1,730,369	\$2M - \$2.6M	\$60-85M
50 ft Nauset Alternative (Behind Barrier Excluded)	190,804	\$233,000 - \$300,000	\$7-9M
100 ft Nauset Alternative (Behind Barrier Excluded)	251,109	\$300,000 - \$400,000	\$9-12M



Alternative 1A-1C Summary

- Based on the financial model, Alternative 1A, municipal purchase and operation of an Ellicott 370 hydraulic cutter suction dredge would cost an estimated \$726,287 during the first year of dredging operations, covering all personnel, ancillary/overhead, and depreciation expenses. Average annual costs over the lifetime of the equipment would be \$902,996 and 30-year, full-lifecycle costs would total \$27,089,874 (Appendix H).
- Based on the financial model, Alternative 1B, municipal purchase and operation of an Ellicott 670 hydraulic cutter suction dredge would cost an estimated \$840,775 during the first year of dredging operations, covering all personnel, ancillary/overhead, and depreciation expenses. Average annual costs over the lifetime of the equipment would be \$1,043,180 and 30-year, full-lifecycle costs would total \$31,295,413 (Appendix H).
- Based on the financial model, Alternative 1C, municipal purchase and operation of a Poseidon P2 barge system mechanical dredge would cost an estimated \$596,622 during the first year of dredging operations, covering all personnel, ancillary/overhead, and depreciation expenses, but excluding any disposal fees. Average annual costs over the lifetime of the equipment would be \$691,929 and 30-year, full-lifecycle costs would total \$27,089,874 (Appendix H).

Alternative 2 Summary

- Based on the financial model, Alternative 2, contracting with the Barnstable County Dredge program to complete all municipal dredging projects over a 30-year period would cost an estimated \$133,563 - \$1,211,258 depending on the preferred channel alternative. Lifetime costs over a 30-year period would total \$4,006,884 - \$36,337,749 depending on the preferred channel alternative.

Alternative 3 Summary

- Based on the financial model, Alternative 3, soliciting a private dredge contractor to complete all municipal dredging projects over a 30-year period would cost an estimated \$233,000 – \$2,600,000 annually depending on the preferred channel alternative and final dredge rate set by the contractor. Lifetime costs over a 30-year period would total \$7,000,000 - \$85,000,000 depending on the preferred channel alternative and final dredge rate set by the contractor.

Assumptions of the Financial Model

Alternatives 1, 2, and 3 were considered over a 30-year planning horizon. All estimated expenses are derived from a combination of factual data and direct consultations with the BCD and private dredge contractors, coupled with appropriate and realistic financial assumptions made by Woods



Hole Group. To ensure full disclosure, the following section will provide details on the financial assumptions taken to complete this feasibility study.

Alternatives 1A-1C: Owning and operating municipal dredging equipment

- All staff and labor costs associated with Alternatives 1A-1C are derived from current BCD salary rates and include the cost of all relevant benefits (Appendix J). Woods Hole Group assumes, at minimum, a 2% increase in these costs for each year along the 30-year planning horizon.
 - Woods Hole Group also considered the hourly, ECD labor rates of \$40-\$45/hr., plus workman's compensation, paid out full time, 6 months/year to each member of the dredge crew. Compared to the BCD salary rates, this model may provide a marginal cost savings to the Town or Orleans. However, the marginal savings on personnel costs would have a negligible impact the total cost per CY for Alternatives 1A-1C.
- All ancillary and overhead costs associated with Alternatives 1A-1C are based on consultations with BCD officials, private dredge contractors, and equipment suppliers and are inclusive of the full fleet of equipment. Woods Hole Group assumes a 2% increase in these costs for each year along the 30-year planning horizon.
- Total diesel fuel expense is calculated assuming 63 total days of operation, annually, assuming 5 days/week operation and 20% down-time for weather, mobilization, demobilization, maintenance, and staging while in-season.
- Diesel fuel costs to support the dredge operation were estimated at \$4.00 per gallon. This rate exceeds the current market rate for diesel fuel. This conservative estimate for the cost of fuel was carried in the study for two reasons:
 - It is unlikely that a dredge purchase would occur in the short-term. Fuel costs are expected to rise over time.
 - Booster pumps and marine equipment staged in remote locations may incur an additional fuel delivery surcharge. To reduce the possibility of a fueling surcharge, the Town may choose to invest in portable transfer tanks to assist with refueling efforts, but the cost of said tanks is not included in this study.
- The Ellicott 370 fuel consumption was calculated at 176 gallons per day (22 gph) for the dredge, 176 gallons per day (22 gph) for each booster pump, and 32 gallons per day (4 gph) for the loader (560 gallons/day total @\$4.00/gallon).
- The Ellicott 670 fuel consumption was calculated at 224 gallons per day (28 gph) for the dredge, 224 gallons per day (28 gph) for each booster pump, and 32 gallons per day (4 gph) for the loader (704 gallons/day total @ \$4.00/gallon).
- The Poseidon P2 fuel consumption was calculated at 64 gallons per day (8 gph) for the excavator and 32 gallons per day (4 gph) for the loader (96 gallons/day total @ \$4.00/gallon).
- Trucking fees for the mechanical dredging alternative assume 3 trucks running in tandem 8 hours per day for the duration of the estimated 63 day dredging season @ \$100/hr./truck.
- Where applicable, trade in values are assumed to be 15% of initial purchase cost.



- Depreciation expenses for dredging and all ancillary equipment were calculated using the straight-line method and incorporate a useful life that we believe to be appropriate for each individual asset listed in Table 20, based on conversations with manufacturers.

Table 20. Expected useful life of dredging and ancillary equipment.

Asset	Useful Life (Years)
Dredge Superstructure (all models)	25
CAT Tracked Excavator (Mechanical Dredge only)	25
Booster Pump (Hydraulic Dredge only)	25
Primary Push Boat (Hydraulic Dredge only)	25
CAT 928 Wheeled Loader Attachments	25
Dredge Pipe, Attachments, Fusion Machine	25
Support Boat (haul pipe)	25
Support Boat (haul personnel)	15
Disposal Containers (Mechanical Dredge only)	15
CAT 928 Wheeled Loader	15
Heavy Duty Equipment Trailers	10
GMC Sierra 2500HD Duramax Pickup Truck	5

- Total annual expenses for Alternatives 1A-1C are derived by adding operating expenses (personnel & overhead) along with each year’s depreciation expenses (cost of owning the assets).
- For the purposes of this study, Woods Hole Group assumes a repayment method to the Commonwealth of Massachusetts matching the amount of each year’s depreciation expense (assume a 0% APR on the life of the loan).
- All costs listed represent what we believe to be the likely cash outflows for owning and operating each type of dredge.

Alternative 3: Outsourcing dredging projects to the BCD or a private dredge contractor

- It is important to note that these costs assume that either the BCD or a private dredge contractor would be available to complete dredging projects in Orleans on an ongoing basis, dredging the total anticipated 30-year dredge volume.
- Barnstable County must ensure equitable access to the dredging equipment among all municipalities, so may not be available to dredge Orleans waterways on an annual basis.
- Rates for the BCD were based on the prevailing rate of \$13/CY, plus \$2+ per CY for a second booster pump, plus the cost of purchasing additional pipe, plus a 10% mobilization/demobilization fee, or \$19/CY in year 1 increasing to \$21/CY in year 10 and \$23/CY in year 20. This estimate is conservative and may change based on the permits and ongoing consultation and negotiation with the BCD.
- Assumed increases are based on historic BCD rate increases.
- Rates for the private dredge contractors were developed through direct consultation with hydraulic and mechanical dredging professionals.
- Rates for private contractors to complete hydraulic and/or mechanical projects ranged from \$30-\$50/CY, which varied based on the type of sediment dredged, pumping



distance, preferred dewatering alternative, etc. Rate ranges are provided in Table 18 to highlight the range of average and cumulative costs of hiring a private dredge contractor.



6.0 FINDINGS AND RECOMMENDATIONS

Initial Town of Orleans Dredge Feasibility Study Findings

Based on the preliminary findings of the feasibility study, there appears to be both a significant need and a sufficient quantity of material within the 3 waterways included in the study to continue evaluating alternatives for a municipal dredge purchase, contracting with the BCD, or retaining of a private dredge contractor to complete multiple dredging projects in the Town of Orleans. It is assumed that the contents of this report will be thoroughly vetted by Town officials, the DAC, the Select Board, and citizen stakeholders prior to determining the most appropriate pathway forward. Dredging is an inherently complex industry and a thorough understanding of the required steps to develop a dredge project, the necessary equipment, and the experienced personnel needed to successfully implement the project are key considerations for any municipality interested in investing in dredging equipment, or working with public or private entities to complete the work.

Dredging 101 and Regional Case Studies

- The BCD Program serves as an important Case Study for the Town of Orleans. The BCD is governed by the BCD Advisory Committee, which monitors dredging operations, establishes the dredge schedule, and sets the dredge rate.
- Since the year 2000 the BCD, which was used as a model for this feasibility study, has dredged a total of 175 projects and pumped 1,574,759 CY of sandy, beach compatible material, an average of 92,633 CY annually. Projects have occurred in quiescent areas and harbors and in more dynamic inlets with faster currents.
- The BCD Program has consistently dredged sandy, beach compatible material at 38-68% below the market rate.
- The quick establishment of a reserve fund allowed the BCD program to invest in replacement dredging equipment in 2017, 25 years after the initial dredge purchase.
- The EDP serves as another important local Case Study. The EDP is governed by the Edgartown Dredge Advisory Board, monitors dredging operations, establishes the dredge schedule, and sets the dredge rate.
- The EDP primarily dredges sandy, beach compatible material used to nourish local beaches. Operations are completed without the use of a booster pump and only occur over short pumping distances. In recent years, the program has pumped an average of 17,000 CY annually. Sites for dewatering and beneficial reuse of dredged material are less than 3,500 ft from the dredge sites and are included in the Town's comprehensive permit for dredging and disposal.
- Dredging by the EDP generally occurs in quiescent waters with minimal currents. Dredging efforts are focused on sandy, beach compatible material. Fine-grained material unsuitable for beach nourishment is generally avoided.
- Public-private partnerships have helped the Edgartown Dredge Program recuperate some dredging expenses, though years of permitting, planning, and fund-raising efforts are often required to facilitate the development of effective partnerships.



When evaluating regional case studies, it is important to recognize the similarities and differences between the BCD, EDC, conditions in the Town of Orleans. The BCD dredges a variety of waterways, both sheltered and exposed, which result in weather delays due to wind, currents, and ice, while the EDP dredges primarily sheltered waterways, so wind and currents are generally not a factor and delays are minimal. The BCD operating budget includes labor costs for a full, professional, year-round dredge crew manning both the dredge and the dewatering site, along with administrative support, and a full time superintendent, while the EDP only staffs the dredge program seasonally with 3 persons and relies on a fourth for administrative support. The EDP is lucky to have a skilled dredge superintendent in a voluntary, unpaid role. Lastly, costs for the EDP have historically been lower than the BCD and lower than estimated costs for a similar Orleans municipal dredge program. Part of the reason for this is because all projects in Edgartown are completed without the need for a booster pump and because dewatering sites are located near the dredge sites. The BCD often operates their equipment in a similar capacity. The Town of Orleans does not have the luxury of dewatering areas located near proposed dredge sites. For instance, several locations in Nauset Estuary would require 2 in-line booster pumps, a significant investment in additional equipment that adds to the annual maintenance, insurance, fuel, and personnel costs carried in the financial model.

Estimated Dredge Volumes

Nauset Estuary

- Based on the most recent bathymetric and sediment quality data, it is estimated that a total of 89,785 CY of sediment is currently available to be dredged from Nauset Estuary, assuming a 50 ft channel width. If the channel width is increased to 100 ft in Nauset Estuary, the estimated volume currently available to be dredged from Nauset Estuary increases to 158,597 CY. These volume estimates are inclusive of volumes behind the barrier beach.
- Of the estimated dredge volumes from Nauset Estuary, it is estimated that 76,490 CY (50 ft channel alternative) and 139,972 CY (100 ft channel alternative) of material are sandy and suitable for beneficial reuse while 13,295 CY (50 ft channel alternative) and 18,625 CY (100 ft channel alternative) are silty and unsuitable for beneficial reuse. These volume estimates are inclusive of volumes behind the barrier beach.
- If dredging behind the barrier beach does not occur for any reason (feasibility, permitting, formation of a new inlet, etc.) initial volume estimate in Nauset Estuary will decrease by up to 60%.
- Sections of Nauset Estuary may require dredging annually (behind the barrier), or every 8, 10, or 15 years (all other sections).

Pleasant Bay

- Based on the most recent bathymetric and sediment quality data, it is estimated that 14,820 CY of sediment is currently available to be dredged from sites in Pleasant Bay. All volume calculations assume a 30 ft channel width (given historic permits), except for The Narrows which assumed a 100 ft channel width (based on historic permits).



- Of the estimated dredge volume for Pleasant Bay, 10,694 CY are assumed to be sandy and suitable for beneficial reuse while 4,126 CY of material are assumed to be silty and unsuitable for beneficial reuse.
- Dredging in various sections of Pleasant Bay is only expected to require dredging once over the next 30 years.

Rock Harbor

- Based on the results of the most recent dredging events (completed in 2005 and 2015), it is estimated that 25,233 CY of material will be available to be dredged during the next maintenance cycle in 2025.
- Based on previous dredging events, disposal methods, and attempts to nourish nearby public beaches, it is assumed that all 25,233 CY of material are silty and/or generally unsuitable for beneficial reuse on beaches located in close proximity to the dredging site.
- Dredging in Rock Harbor has historically occurred in regularly scheduled, 10-year intervals.

Municipal Sediment Budget

- Based on the most recent volume calculations and expected frequency of maintenance dredging events in each section of each waterway, Woods Hole Group anticipates that average annual dredge volumes within the Town of Orleans will total:

Including volumes behind the barrier beach

- Average Volume (assuming 50 ft Nauset Alternative) 33,691 CY
- Average Volume (assuming 100 ft Nauset Alternative) 57,679 CY

Excluding volumes behind the barrier beach

- Average Volume (50 ft Nauset Alternative) 6,360 CY
- Average Volume (100 ft Nauset Alternative) 8,370 CY

Dredging Alternatives

The Woods Hole Group identified and evaluated 3 Dredge Purchase Alternatives for the Town of Orleans. The Alternatives considered the most suitable hydraulic and mechanical equipment to effectively dredge sandy and fine-grained sediments from Town waterways. A summary of costs associated with each Dredge Purchase Alternative is included below:



- Alternative 1A – Purchase and Operation of Ellicott 370 Hydraulic Cutter Suction Dredge
 - Estimated Year-1 Costs: \$726,287
 - Estimated Average Annual Costs over a 30-year period: \$902,996
 - Estimated Lifetime Costs over a 30-year period: \$27,089,874

- Alternative 1B – Purchase and Operation of Ellicott 670 Hopper Dredging Equipment
 - Estimated Year-1 Costs: \$840,775
 - Estimated Average Annual Costs over a 30-year period: \$1,043,180
 - Estimated Lifetime Costs: \$31,295,213

- Alternative 1C – Purchase and Operation of Poseidon P2 Barge Mechanical Dredge
 - Estimated Year-1 Costs: \$596,622
 - Estimated Average Annual Costs over a 30-year period: \$691,929
 - Estimated Lifetime Costs: \$20,757,900

Based on this initial assessment, and the estimated annual dredge volumes outlined in previous chapters of the report, purchasing, owning, and operating municipal dredging equipment in the Town of Orleans is only cost-effective if a 100 ft wide dredge channel is able to be permitted in Nauset estuary *and* if dredging is determined to be both permissible and feasible behind the barrier beach. Without the 100 ft channel width and without annual maintenance dredging behind the barrier beach, in perpetuity, for the anticipated 30-year lifetime of the dredging equipment, remaining volumes from Pleasant Bay, Rock Harbor, and elsewhere in Nauset Estuary are not sufficient to support a municipal dredge purchase.

Given the long distances between dredge and dewatering/beneficial reuse sites as well as the relatively large estimated volumes of material that may be available to be dredged on an annual basis, hydraulic cutter suction dredges (Ellicott 370 or 670 as previously described), coupled with the use of 1-2 in-line booster pumps would be the most efficient means of completing the work. The time needed to dredge the estimated volume using mechanical dredging equipment would be too long and too costly to justify the purchase of mechanical dredging equipment.

The Ellicott 370 and 670 dredges can dredge 200 and 400 CY of sediment/hr., respectively under ideal conditions and can withstand maximum current speeds of 3.0 and 4.0 knots, respectively. Each dredge can pump dredged material up to 3,500 linear feet without a booster pump. For pumping distances greater than 3,500 linear feet, an inline booster pump would be required. For pumping distances over 7,000 linear feet, a second inline booster would be required. The dredges specified above have an hourly fuel burn that ranges from 22-28 gallons/hr., or 176-224 gallons/day. Each in-line booster pump would generate a similar hourly and daily fuel burn.

The initial assessment also weighed the costs associated with a municipal dredge purchase against using the Barnstable County Dredge and/or soliciting and retaining a private dredge contractor to complete the work. The cost model shows that using the BCD to complete municipal dredging projects in the Town of Orleans will always be cheaper than soliciting and



retaining a private dredge contractor to complete the work, so long as it is feasible for the BCD to complete the project within a reasonable timeframe and utilizing existing BCD equipment.

When directly comparing the costs of a municipal dredge purchase against the costs of using the BCD, only the 100 ft wide channel alternative in Nauset Estuary (inclusive of volumes from behind the barrier beach) allowed municipally-owned, hydraulic dredging equipment to operate at or below estimated BCD rates. Specifically, it is estimated that the Ellicott 370 would be able to dredge the 100 ft channel, including volumes behind the barrier at an average rate of \$18.50/CY over the 30-year lifecycle of the equipment. It is estimated that the Ellicott 670 would be able to dredge the 100 ft channel, including volumes behind the barrier beach at \$21.36/CY over the same period.

For comparative purposes, and as previously reported, average 30-year costs associated with using the BCD are estimated at \$21/CY. Costs associated with a private dredge contractor varied from waterway to waterway and ranged from \$30/CY up to \$50/CY, based on whether hydraulic or mechanical equipment would be used, environmental conditions, and preferred alternatives for dewatering and/or beneficial reuse of dredged material. A breakdown of the range of estimated costs for private dredging in each Town waterway is included in Table 21.

Table 21. Estimated Private Dredge Contractor Rates per CY for Orleans Waterways.

Mechanical Dredging Rates	\$ Range Per CY
<i>Rock Harbor</i>	\$35-40
<i>Pleasant Bay</i>	\$45-50
<i>Nauset Estuary (Town Cove Only)</i>	\$45-50

Hydraulic Dredging Rates	\$ Range Per CY
<i>Rock Harbor</i>	\$30-35
<i>Pleasant Bay</i>	\$40-45
<i>Nauset Estuary (Dewater North of Nauset Beach)</i>	\$40-50

Assumptions and Considerations

- This feasibility assessment assumed that State or other grant funding could be secured at 0% interest to assist with the purchase municipal dredging equipment, establish a dredge crew, and/or secure the services of the BCD, or a private dredge contractor.
- A number of grant opportunities are available to municipalities in the Commonwealth of Massachusetts for dredging projects, including:
 - *The Seaport Economic Council* dredging design and permitting grants provide pre-construction phase funding for saltwater dredging projects that contribute to the economic significance, recreational value, public safety and/or coastal resilience of Massachusetts’ harbors. Municipalities must provide a 20% match of overall project funding from municipal sources, federal grants, private funds, or contributions by partner organizations.



- *The Massachusetts Dredging Program* provides construction-phase funding to coastal municipalities for saltwater dredging. Grants are competitively awarded with a focus on shovel-ready projects that contribute to the economic significance, recreational value, public safety, and/or coastal resilience of the Commonwealth’s coastal harbors. A minimum 50% non-state match is required from municipal sources, federal grants, or private contributions.
- Whether the Town chooses to move forward with a dredge purchase, or solicit the services of the BCD, or a private contractor, it was assumed that the Orleans Dredge Advisory Committee would help to ensure equitable access to dredging services, prioritize projects of greatest need, and develop an annual schedule that would maximize the productivity and efficiency of municipal dredging equipment, the BCD, or a preferred dredge contractor.
- If the Town chooses to move forward with a municipal dredge purchase, it would be prudent to quickly establish a reserve fund to deal with unexpected repairs, which are commonplace in the dredging industry, replace aging equipment, and pay down loans or bonds taken to help facilitate the purchase.
- It is assumed that the Town will have all local, state, and federal permits in hand, detailing time of year restrictions, special conditions, and alternatives for dewatering and disposal and/or beneficial reuse of dredged material *prior* to proceeding with a decision to purchase a municipal dredge, contracting with the BCD, or a private dredge contractor to complete the work.
- Detailed requirements outlined in the permits will help to inform the selection of the most appropriate dredging and ancillary equipment. Updates to the cost model and feasibility analysis may be required based on conditions detailed in the permits.
- The feasibility assessment assumes that the Town will be able to recruit, train, and retain a skilled dredge crew with dredging industry experience. The need for an experienced crew, especially in Nauset Estuary cannot be emphasized strongly enough – for the safety of the crew, equipment, and success of any future project.
- During recent consultations, private dredge contractors expressed concern over assigning experienced dredge leverman and captains with 20+ years’ working in the industry to the Nauset Estuary project given the swift currents and dynamic conditions that regularly occur behind the barrier beach.
- If dredging behind the barrier beach in Nauset Estuary proves infeasible for any reason (permitting delays, insufficient depths, swift currents, wind and weather conditions, future breach and formation of a new inlet, etc.), the remaining sediment volumes in Nauset Estuary and other Town waterways are insufficient to support a municipal dredge purchase.
- If dredging equipment has been purchased and a breach occurs in the barrier beach, the need for dredging will be significantly reduced.
- The current costing analysis assumes velocities in Nauset Estuary will not exceed the safe operating thresholds of standard, non-custom dredging equipment. To safely operate dredging equipment in Nauset Estuary, it may be necessary to work around maximum tidal velocities, which will in turn decrease the productivity of the equipment



and increase costs. Woods Hole Group deployed a current meter in September 2020 to address this question. Results of the initial study are outlined in the following section.

Regarding Current Speeds in Nauset Estuary

Current speeds need to be considered when evaluating the environmental conditions that will impact any dredge project. To help address this question within the context of Nauset Estuary, which is expected to have the highest current velocities of any Town waterway, Woods Hole Group collected measurements of tidal currents, water level, and salinity over six spring tidal cycles from September 18th – 21st, 2020. A Lowell Instruments Tilt Current Meter and AquaTroll 200 CTD (Conductivity, Temperature, and Depth instrument) were deployed on a weighted bottom platform in the channel behind the barrier beach adjacent the commercial mooring field in Nauset Estuary.

The current meter and CTD were located approximately 0.25 feet above the Estuary bed, thus the measured current speeds and salinity data that were recorded were bottom (near-bed) values. In natural channels, current velocity increases as distance from the bottom increases. The logarithmic shape of this velocity profile allows current speeds to be calculated throughout the water column using the near-bed values. Estimates for the current velocity at the surface above the sensor (9 feet above the sensor during flood tide, 5 feet above the sensor during ebb), are summarized in Table 20. These values serve as a reference of the maximum current velocities that dredging equipment might encounter in this section of Nauset Estuary.

South-directed flooding currents were faster than north-directed ebbing currents. Mean near-bed flood current speed was 1.2 knots and reached a maximum of 1.9 knots on September 19th. The mean near-bed ebb current speed was 0.97 knots and reached a maximum of 1.5 knots. Estimated surface flood currents reached a mean of 2.6 knots and maximum of 4.2 knots. Estimated surface ebb currents had a mean of 1.9 knots and maximum of 2.9 knots. Salinity ranged from 10 psu to 32 psu. Salinity remained above 30 psu from 12:00 on September 20th to 13:30 on September 21st, likely due to sustained northeast winds, which temporarily dampened tidal exchange.

Table 22. Tidal current data summary.

	Flood (knots)	Ebb (knots)
Mean Bottom Velocity	1.2	0.97
Maximum Bottom Velocity	1.9	1.5
Mean Surface Velocity	2.6	1.9
Maximum Surface Velocity	4.2	2.9

These data are important when considering a municipal dredge purchase because different types and sizes of equipment have different thresholds for safety relative to current velocity. For instance, the standard Ellicott 370 dredge can safely operate in speeds up to 3.0 knots. The standard Ellicott 670 dredge can safely operate in speeds up to 4.0 knots. (As a reminder, the BCD owns and operates an Ellicott 670 and a larger 870). Based on this initial assessment, the



maximum surface velocities observed in Nauset Estuary are approaching or exceeding the safe operating thresholds of the Ellicott 370 and to a lesser degree, the Ellicott 670 dredge.

Based on conversations with dredge manufacturers, it may be possible to increase the safe operating threshold of either dredge by 1.0 knot by adding side tanks and more robust spuds and winches to the dredge. This scenario would require custom fabrication, an evaluation by a naval architect, and would incur an added cost of \$100,000 or more to the initial purchase price. It may also be possible to limit the use of dredging equipment during the highest velocity tides to avoid currents that exceed the safe operating thresholds of the dredging equipment, which would ultimately decrease the production rates of the equipment.

Regarding the Sale of Sand and Lease of Dredging Equipment to Neighboring Municipalities

- Woods Hole Group provided a basic estimate of the volume of sandy material that may be suitable for beach nourishment and dune enhancement based on the best available information. Once municipal beach nourishment requirements are met in the Town of Orleans, it may be possible to sell off some of the remaining sand volume to interested parties at or below market rates. The cost of upland and dredged sand varies considerably and estimating the potential value of the commodity to private parties is often challenging. Based on the EDAC sale of sand in recent years, the sale of dredged material “out of the pipe”, excluding trucking, placement, and grading has ranged from \$10-\$20 per CY.
- The establishment of ongoing public-private partnerships may help to facilitate the sale of sand. To accept sand sold from the municipality, individual waterfront homeowners, municipalities, and/or other end users would need to furnish all necessary permits to beneficially reuse the material within the coastal resource areas.
- Woods Hole Group also estimated the volumes of material that may not be suitable for beneficial reuse. This fine-grained, silty material that is unsuitable for beneficial reuse as beach nourishment or dune enhancement would need to be stockpiled and/or disposed of in the upland or at offshore disposal site, which may add to the cost of future projects.
- In addition to the sale of sand, if the Town of Orleans proceeds with a municipal dredge purchase, certain years may generate a greater demand for dredging services than others. During years when municipal equipment is not occupied for the entirety of the dredge season, it may be possible for the Town to lease the equipment to adjacent municipalities. Securing permits for each dredging site in the Town of Orleans will help to determine the number of days that the dredge might be available for work in other Towns, relative to site-specific time-of-year restrictions, etc. However, reviewing regional demand for dredging services and the potential cost savings to the Town of Orleans was beyond the scope of this initial assessment.

Regarding Permitting

Prior to the construction of any dredging project, the project proponent must secure all necessary local, State, and Federal permits. Based on ongoing efforts to permit new improvement dredging



in Nauset Estuary and maintenance dredging in Pleasant Bay, the required permits may include but not be limited to:

- Massachusetts Environmental Policy Act (MEPA) Review (State)
- National Environmental Policy Act (NEPA) Review (Federal)
- Notice of Intent (NOI) Application (local)
- Chapter 91 License (State)
- Water Quality Certificate (State)
- Massachusetts Coastal Zone Management Federal Consistency (State)
- Army Corps of Engineers General Permit (Federal)
- NPS Special Use Permit (Federal)

Dredging projects are also subject to review and imposed time-of-yea-restrictions (TOYs) by, at a minimum, the State of Massachusetts Natural Heritage and Endangered Species Program (NHESP), Massachusetts Division of Marine Fisheries (DMF), and National Marine Fisheries (NMFS).

Pros and Cons of a Municipal Dredge Purchase

Purchasing and operating municipal dredging equipment presents a significant opportunity for municipalities to take responsibility for the management of their own waterways. However, owning and operating hydraulic dredging equipment is not without risk.

Pros

- Purchasing a dredge reduces uncertainty and prevents scheduled projects from being delayed due to a lack of State, Federal, or private dredging resources.
- Purchasing a dredge allows individual municipalities to exercise a high degree of autonomy in managing waterways, prioritizing projects, and responding to sudden shoaling.
- Purchasing a dredge allows projects to be implemented at a rate that is generally well below private dredging rates, often saving taxpayers money in the long-term.
- Purchasing a dredge allows municipalities, if approved, to beneficially reuse dredged material as beach nourishment, reducing beach management costs while increasing coastal resilience.
- Depending on regional demand and occupancy time of the equipment, opportunities may exist to lease equipment to neighboring municipalities, offsetting operating costs.

Cons

- Purchasing and operating municipal dredging equipment is a significant long-term investment.
- Purchasing and operating municipal dredging equipment in a cost-effective manner is contingent on identifying, permitting, and dredging a sufficient volume of material annually to cover expenses, debts, and to establish a reserve fund. This level of production would be required annually for the lifetime of the dredging equipment.



- Purchasing and operating a municipal dredge would expose the owners to significant liability and risk.
- Disposal and/or beneficial reuse sites in Orleans will generally require the use of one or more booster pumps, adding to the cost of dredging operations while decreasing overall productivity.
- Dredging in Nauset Estuary would expose municipal dredging equipment to current speeds that would regularly approach and often exceed the safe operating thresholds of the equipment.
- Use of an inexperienced municipal dredge crew in Nauset Estuary would expose the crew to challenging and dangerous conditions.
- Identifying and recruiting a qualified dredge superintendent and skilled laborers with industry experience into a municipal role may prove challenging and prohibitively expensive for the Town.
- The Town would need to negotiate storage of up to 2 miles of dredge pipe, the dredge superstructure, and all ancillary equipment through the summer season.

Pros and Cons of Contracting with the Barnstable County Dredge

Contracting with the Barnstable County Dredge presents an opportunity to mitigate liability and risk associated with municipal dredge ownership while still completing dredge projects at a subsidized rate. However, the BCD must ensure equitable access to dredging equipment throughout the region, so the Town would not have exclusive access to BCD dredging services.

Pros

- Contracting with the BCD would allow the Town, if approved, to beneficially reuse dredged material as beach nourishment, reduce beach management costs, and increase coastal resilience.
- Contracting with the BCD would allow the Town to utilize a larger dredge (Ellicott 670 or 870) than the municipality might be able to afford to purchase on its own.
- Working with the BCD would allow the Town to reduce liability and risk of owning and operating dredging equipment.
- Contracting with the BCD would allow the Town to avoid the need to recruit, train, and retain a skilled dredge crew.
- Contracting with the BCD would allow the Town to leverage the experience of a skilled dredge crew to complete challenging dredge projects in Nauset Estuary.
- Because BCD rates are fixed, no minimum dredge volume would be required to achieve a cost-effective pumping rate.
- No minimum annual dredge volume would be required to offset the expenses of owning and operating municipal dredging equipment. In years when the BCD does not complete projects for the Town of Orleans, the Town's financial obligation to the BCD would drop to zero.



Cons

- The BCD is a regional government entity that must ensure equitable access to dredging services. Therefore, the Town of Orleans will not have exclusive access to BCD dredging equipment.
- It is unlikely that the BCD will be available to the Town of Orleans on an annual basis, preventing the Town from responding quickly to sudden shoaling.
- The BCD will not schedule dredging projects until all permits have been secured, which may delay the completion of projects in the Town of Orleans.
- Collaborating with the BCD would not allow the Town to retain fully depreciated assets (at the end of the 30-year project lifecycle), which may have residual value.
- Historically, some BCD dredge projects have been delayed due to unforeseen mechanical breakdowns and project backlog.

Pros and Cons of Soliciting a Private Dredge Contractor

Soliciting and retaining a private dredge contractor presents an opportunity to complete municipal dredging projects in an efficient and professional manner using the best available equipment and most experienced dredge crews. However, utilizing a private contractor is the most expensive alternative.

Pros

- Soliciting a dredge contractor would allow the Town to exercise a high degree of autonomy in managing waterways and prioritizing projects.
- Soliciting a dredge contractor would allow the Town, if approved, to beneficially reuse dredged material as beach nourishment, reduce beach management costs, and increase coastal resilience.
- Soliciting a dredge contractor would allow the Town to utilize the best available dredging technology, equipment, and personnel for the project at hand.
- Soliciting a dredge contractor would allow the Town to reduce liability and risk of owning and operating dredging equipment.
- Soliciting a dredge contractor would allow the Town to avoid the need to recruit, train, and retain a skilled dredge crew.
- Sufficient dredge volumes (to ensure a cost-effective dredge rate) would only be required during the project period, not for the 30-year lifetime of municipally owned dredging equipment.
- No minimum annual dredge volume would be required to offset the expenses of owning and operating municipal dredging equipment. In years when a private contractor does not complete projects for the Town of Orleans, the Town's financial obligation to the contractor would drop to zero.

Cons

- Soliciting a dredge contractor would not allow the Town to retain fully depreciated assets (at the end of the 30-year project lifecycle), which may have residual value.



- Soliciting a dredge contractor is contingent on identifying, permitting, and dredging a sufficient volume of material to ensure a cost-effective dredge rate.
- Contracted dredge rates are not subsidized or fixed and may fluctuate considerably based on available volume of material to be dredged and preferred alternative(s) for beneficial reuse.

Recommendations and Next Steps

If the Town of Orleans decides to continue evaluating the purchase of hydraulic cutter suction dredging equipment, the following recommendations, at a minimum, should be considered prior to moving forward with procurement:

Recommendations and Next Steps

If the Town of Orleans decides to continue evaluating the feasibility of a municipal dredge program, the following recommendations, at a minimum, should be considered prior to moving forward with procurement:

- Provide opportunities for open collaboration between the Orleans DAC, Town officials, and public stakeholders to evaluate alternatives, solicit feedback, and facilitate next steps.
- Consider the need for administrative support staff to manage bookkeeping tasks, dredge records, active permits, contracts, etc.
- File for and secure consolidated, comprehensive dredging and disposal permits for each waterway, to allow for better adaptive management of waterways from year to year, based on need. The permits will contain critical information on the waterways permitted for dredging, the allowable volumes, disposal locations, and allowable dredge frequencies. Because the feasibility of the Town’s dredging program hinges on these fundamental components of the work, it is critical that the permits be issued before a decision is made on the purchase of a municipal dredge.
- The BCD and/or private dredge contractors will not schedule dredging projects until all permits have been secured by the Town. Once permits have been secured, the project will be scheduled by the BCD Advisory Committee (which ensures equitable, but not immediate, access to dredging services) or by the contractor. Given the acute need for dredging, The Town of Orleans should begin the process of collaborating with the BCD and/or private contractors to ensure that Town projects are recognized as a high priority when permitting is complete and scheduling can occur.
- Contract with the BCD for initial dredging in Nauset Estuary behind the barrier beach. Performance of the BCD in this highly dynamic waterway, using the same type of dredging equipment the Town is considering purchasing, with an experienced crew, will provide invaluable information on the challenges the Town will face with a municipal dredging program. Performance of the BCD in Nauset Estuary should be a factor in the Town’s decision to pursue a municipal dredging program.



- Update the financial model once the permits have been issued and performance of the BCD in Nauset Estuary has been evaluated. The financial model should be updated to reflect the permitted dredge volumes for each waterway and costs associated with getting the material to the permitted disposal/beneficial reuse locations. The model could also be updated at this time to reflect current equipment and labor costs.
- Continue to identify suitable dewatering and disposal/beneficial reuse sites for sandy and fine-grained material that could be used once the capacity of preferred areas have been filled.

Response to Comments

The Woods Hole Group received numerous questions and comments from the Town of Orleans Dredge Advisory Committee regarding the Draft Dredge Purchase Feasibility Study. A comprehensive Response to Comments Letter is included in Appendix K.



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APPENDIX A. PROPOSAL

December 3, 2019

Mr. John Kelly
Town of Orleans
19 School Street
Orleans, MA 02653

Re: Proposal for Town of Orleans Dredge Purchase Feasibility Study

Dear Mr. Kelly:

The following is a proposal to assess the feasibility of purchasing and operating a dredge and associated equipment within the Town of Orleans, MA. We understand the importance of maintaining safe and navigable entrance and internal navigation channels to support a vibrant commercial fishing and recreational boating community. Additionally, public and private mooring fields and marinas depend on dredging to maintain safe depths at their docks and moorings. The Town of Orleans also has a need for clean, beach compatible material for ongoing beach and dune nourishment projects. We understand that the Town is interested in learning more about alternatives for beneficial reuse of dredged material and options for disposal within Town to offset the cost of importing upland sand.

The Woods Hole Group has experience working with communities in Southern Maine and on the North Shore of Massachusetts interested in pursuing a similar dredge purchase. Through our work in Maine and on the North Shore, we developed expertise researching historic dredging events, evaluating sediment characteristics within historic dredge channels, and synthesizing the available data to analyze the costs and benefits of a regional dredge purchase. We also learned the importance of evaluating alternatives for cost-effective, beneficial reuse of dredged material (beach nourishment, dewatering and stockpiling, thin layer deposition, etc.), as a critical component of any dredge purchase feasibility study. Both of these projects also included the development of comprehensive recommendations and next steps for municipal project partners.

Woods Hole Group Coastal Scientists and Coastal Geologists also have extensive experience working with the Barnstable County Regional Dredge Program and the Edgartown Municipal Dredge Program on the Cape and Islands, designing municipal dredging projects, identifying locations for the beneficial reuse of dredged material, and developing resilient designs for large-scale beach nourishment and dune enhancement projects using dredged material.



A summary of relevant projects includes:

- Merrimack Valley Planning Commission: North Shore Dredge Purchase Feasibility Study (Essex, MA).
- Southern Maine Planning and Development Commission: Examining the Feasibility of Purchasing and Operating Hydraulic Dredging Equipment in Southern Maine (Saco, ME).
- Nauset Estuary and Pleasant Bay Dredging Projects (Orleans, MA).
- Cow Bay Beach Nourishment and Dune Enhancement Project (Edgartown, MA).
- Popponesset Spit Beach Nourishment and Dune Enhancement Project (Mashpee, MA).
- Thin Layer Deposition Pilot Project (Ninigret Marsh, RI).
- Dewatering and Upland Disposal of Fine-Grained Sediment from Centerville River (Centerville, MA).
- Long Island Dredge Material Management and Disposal Study (Long Island, NY).

It is our understanding that the Town of Orleans is interested in pursuing this feasibility study because many of the shallow-draft boat harbors and navigation channels within Town have not been maintained, posing a significant risk to public safety and navigability, prompting the Town to investigate opportunities to manage their own waterways specifically, **Nauset Estuary** (extent of proposed dredging project), **Pleasant Bay** (narrows and approach channels to terminal ponds), and **Rock Harbor** (approach channel and inner harbor). To address this question, Woods Hole Group proposes the following Tasks:

Task 1. Meetings and Stakeholder Engagement

This Task includes a kick-off meeting with Town of Orleans Dredge Advisory Committee (DAC), Town officials, and regional stakeholders to review the revised scope of work, answer any clarifying questions about the project Tasks and timeline, and discuss the various, site-specific goals and objectives of stakeholder groups (commercial fishermen, recreational boaters, private homeowners, contractors, municipal beach managers, etc.) that may benefit from municipal dredging operations. It is anticipated that this meeting will take place at Orleans Town Hall.

Following the kick-off meeting, the Woods Hole Group will meet with the DAC an additional three (3) times over the course of the project. Meeting objectives are defined below:

- Meeting 1 – Once initial data collection Tasks are complete, update the DAC on project deliverables (historic dredging events, sediment quantity and quality, possible disposal sites, etc.). Based on projected sediment quantity and quality data, discuss appropriately sized dredging equipment to be included in financial analysis. Work with the DAC to limit alternatives to 2-3 appropriately sized pieces of equipment for consideration.



- Meeting 2 – The second meeting the DAC will occur in two (2) phases, to educate members of the DAC on general dredging finances and operations. First, Woods Hole Group will facilitate a site visit on Martha’s Vineyard for members of the DAC to meet with members of the Edgartown Dredge Advisory Board and view active dredging and dewatering operations (weather permitting). Second, the Woods Hole Group will facilitate a site visit with the Barnstable County Regional Dredge Program to meet with County officials and visit an active dredging and dewatering site in Barnstable County (weather permitting).¹
- Meeting 3 – Once suitable dredging equipment has been identified and the financial model and operational cost forecast have been generated, Woods Hole Group will meet with the DAC to review findings, recommendations, possible funding mechanisms, and next steps.

Task 2. Compile Information on Dredging Projects

Based on previous work in the Town of Orleans, Woods Hole Group has a wealth of information on past dredging projects, sediment characteristics, and historical permits for many of the waterways. However, it is anticipated that local stakeholders may provide additional information from their records regarding: historic permits obtained, existing permits, historic quantities dredged, historic dredging location(s), historic dredged sediment types, historic disposal locations, etc. Once received, the data will be compiled. Impediments to dredging within designated Areas of Critical Environmental Concern (ACEC), National Park Service boundaries, Time of Year (TOY) Restrictions, historically permitted channel dimensions, etc. will also be identified.

Woods Hole Group will compile and amend data received from local stakeholders. From these data, the Woods Hole Group will identify and characterize grain size, type of material, potential future dredge volume(s), and expected maintenance dredge frequency for specified locations in Nauset Estuary, Pleasant Bay, and Rock Harbor. Given concerns over shoaling in Nauset Estuary with the current design for a 50-foot wide channel, Woods Hole Group will also evaluate expected dredge volumes and frequencies for a 100 foot wide channel. These data will be used to forecast the quantity of material that a municipal dredge may be expected to dredge in a given year. In conjunction with members of the DAC, the Woods Hole Group will research and identify suitable disposal sites (offshore, nearshore, beach nourishment, TLD, private property, upland, etc.) based on the characteristics of the material to be dredged. This Task also includes the development of GIS imagery to accompany these data. GIS imagery will be incorporated into the Final Report (Task 6).

¹ Costs for stakeholder participation in this meeting (i.e. transportation to/from and on Martha’s Vineyard, Barnstable County dredging sites), should they be required, have not been included in this proposal.



Task 3. Identification of Suitable Equipment

Once the sediment characteristics and historic dredging events have been analyzed, Woods Hole Group will research and identify the most suitable dredging equipment (2-3 alternatives, total) for maintaining navigation channels within the specified region, and beneficially reusing and/or disposing of dredged material. The data collected for this Task will include, but not be limited to, initial costs for the purchase of recommended equipment (dredge superstructure (hydraulic dredge, hopper, etc.), support boats, pipe, booster pump, etc.) labor costs, fuel costs, pumping rates, maintenance costs, etc. Woods Hole Group will consider the November 26, 2018 dredge purchase study by Paul Amman and Stephen Smith (DAC) and the March 15, 2019 memorandum from Ted Keon to Jill Goldsmith (Town of Chatham) in developing these data. Although an analysis of freshwater dredging sites (kettle ponds) is beyond the scope of this assessment, Woods Hole Group will determine whether the specified equipment could be transported and adapted for use in freshwater.

Task 4. Operational Cost Forecast

Task 4 includes the development of comprehensive cost estimates associated with:

- Municipal dredge ownership and operations;
- Utilization of the Barnstable County Dredge to complete municipal dredging projects in the Town of Orleans and;
- Utilization and retention of a private dredge contractor to complete municipal dredging projects in the Town of Orleans.

For municipal dredge ownership and operations scenarios, cost forecasts to include all operational costs, labor costs, ancillary, overhead, maintenance, insurance, and fuel costs. Deprecation expenses to include the dredge superstructure and all ancillary marine and land-based support equipment including but not limited to the primary push boat, support skiff, booster pump, dredge pipe, trucking, trailering, and excavation equipment.

Task 5. Feasibility Assessment – Financial Model

The data obtained in Tasks 1 through 4 will be used to develop a regional sediment budget for dredge material (the amount of material that could be expected to be dredged on an annual basis) for waterways in the specified region. The sediment budget will be factored against the operational cost forecast for owning and operating regional dredging equipment within the specified region, generating a cost per cubic yard of material dredged. This unit cost will help to determine the capital outlay that will be required to obtain the dredge and how quickly the initial investment can be recovered. The financial model will include a detailed summary of all operational costs and depreciation expenses for each dredge purchase scenario.



Task 6. Final Report

Within 8 months of receiving a contract from the Town of Orleans, a report will be generated that documents the data obtained in Tasks 1 through 5. The final report will provide an outline of the assumptions that were made in generating the data and will provide a comprehensive list of recommendations and next steps for future work. The final report will also include a summary of possible State and/or Federal funding mechanisms to assist with an initial dredge purchase and/or dredging costs incurred by the Town of Orleans. As the Barnstable County Dredge is currently in the process of reevaluating its dredging program and resources, this Task also allows time for the Woods Hole Group to review the findings and recommendations of the audit, to be included as a supplement to the Final Report.

Task 7. Project Management

This Task provides time for the Woods Hole Group project team to communicate with the DAC and project stakeholders. This task will help the Woods Hole Group keep the project team up-to-date on the project and to complete administrative tasks.

Estimated Costs

The following are the estimated costs to complete this project:

Task	Estimated Cost
Task 1: Meetings and Stakeholder Engagement	\$8,400
Task 2: Compile Information on Dredging Projects	\$6,270
Task 3: Identification of Suitable Equipment	\$2,000
Task 4: Operational Cost Forecast	\$2,200
Task 5: Feasibility Assessment - Financial Model	\$3,200
Task 6: Final Report	\$7,500
Task 7: Project Management	\$1,300
Total:	\$30,870



Acceptance and Authorization to Proceed

This proposal was assembled under the guidelines for a “fixed-fee” contract. Materials and other direct costs will be invoiced at cost plus our standard markup. Prior to the work being started, Woods Hole Group requires receipt of the signed and dated “Acceptance and Authorization to Proceed” form at the end of this proposal. Invoices for services rendered will be submitted monthly based upon percent complete. Unless otherwise agreed to in writing, payment is due within 30 days following the date of our invoice. In the event of payments that are significantly or routinely late, Woods Hole Group retains the right to stop work until payment issues are redressed. In case of refusal to address payment issues, Woods Hole Group retains the right to use legal measures to obtain rightful payment.

Respectfully Submitted,

Adam Finkle, M.S.; PWS; CERP
Coastal Scientist

Acceptance and Authorization to Proceed:

“I authorize Woods Hole Group, Inc. to proceed with the above scope of work and budget of **\$30,870** for Tasks 1-7.”

Client Name

Date

Woods Hole Group Representative

Date



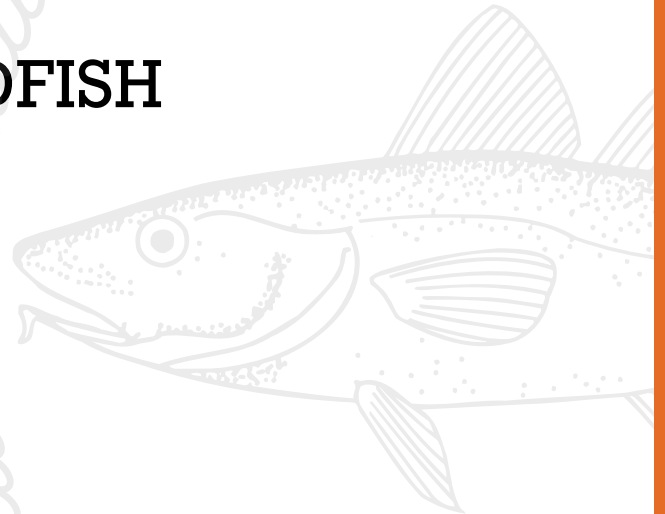
APPENDIX B. BCD ANNUAL REPORT



Report of the Barnstable County

DREDGE

THE CODFISH





Barnstable County Dredge *The Codfish*

**Superior Court House
P.O. Box 427
Barnstable, MA 02630**



M/V "J.W. Doane" with dredge "Cod Fish" passing through the Cape Cod Canal.

Administration

Wayne Jaedtke, Superintendent
508-375-6634 | wjaedtke@barnstablecounty.org

Staff

Stephen Bradbury, Captain
Christopher E. Armstrong, Leverman
Jason Bevis, Deckhand
Cory Fleming, Deckhand

INTRODUCTION

In 1993 Barnstable County conducted a needs assessment and cost benefit analysis of operating a municipal dredge program on behalf of the towns. This report documented that a County operated maintenance-dredging program would be both beneficial to the towns and cost effective to operate.

The County and its legislative delegation approached the Massachusetts Department

of Environmental Management (DEM) and requested financial assistance in the form of a \$1 million capital grant for the purchase of a dredge and ancillary equipment. Prior to this grant, the state was responsible for funding 75% of the cost of municipal dredge projects and the town was responsible for the remaining 25%. However, funding constraints at the state level meant that much of the dredge work was not completed on a timely basis or was never accomplished. As stipulated in the grant Agreement, the provision of a capital grant replaces the state funding for municipal dredge projects here on the Cape.

The Barnstable County Dredge Advisory Committee was established in October of 1994. The Committee has representation from all of the Cape towns, except Brewster, which has no navigable harbors, DEM and County staff. The Advisory Committee is responsible for developing the dredge schedule and recommending the dredge rate each fiscal year.

ADMINISTRATION

COMPLETED DREDGE PROJECTS:

To date the County has dredged 1,856,254 cubic yards of material from the waterways in 16 Cape and Island towns over 21 years. Barnstable County dredged these waterways at a rate approximately 65% below the market rate. The cost per cubic yard to dredge this material ranged between \$3.33 and \$13.00 per cubic yard. The average market rate for dredge services is over \$18.00 per cubic yard.

If there were no Barnstable County dredge program, it would have cost the tax payers an additional \$530,602 to complete the dredge projects that the County has completed on behalf of the towns on the Cape and Islands in FY 2017. This amount is based on the state paying 75% of the cost of town dredge projects at \$18.00 per cubic yard.

The following projects were completed this fiscal year totaling 77,658 cubic yards of material to

nourish the beaches:

- Allen Harbor Approach Channel
- Chatham, Aunt Lydia's Cove
- Dennis, Bass River
- Falmouth Green & Great Pond Inlets
- Harwich, Allen Harbor Inlet
- Mashpee, Popponeset Bay Channels
- Yarmouth, Parkers River Channel

In addition to a reduced rate for dredging services, the County conducts before and after dredge surveys at a savings of approximately \$6,000 per project to the towns. These surveys are invaluable records in the event of a major hurricane for submission to the Federal Emergency Management Agency as documentation of storm damage.

FISCAL STATUS

The operating revenue for FY 2017 was \$867,242.

Chatham's south coast shoreline dredging project at Mill Creek Mill Creek.





APPENDIX C. BCD SITE VISIT MINUTES

Town of Orleans Dredge Purchase Feasibility Study Update Meeting #1 – Meeting Minutes 13 February 2020

Attendees:

Town of Orleans Dredge Advisory Committee

Charlie Carlson
Steve Smith
Virginia Farber
Betsey Furtney
William Amaru

Town of Orleans

Tom Daly
Nate Sears

Barnstable County

Jack Yunits
Steve Tebo

Woods Hole Group

Adam Finkle
Katie Lavallee

Public

Suzanne Phillips
Rick Frankalini

*Others arrived after roll was called.

Housekeeping Items

- Next meeting: Edgartown Municipal Dredge Perspectives, Monday Feb. 24th on the Vineyard
 - 8:15am boat
 - 2-3 vehicles needed – want to make reservations by next week
 - Brief agenda for Edgartown meeting:
 - Roundtable Discussion:
 - Ed Handy – Dredge Board Chair
 - Julie – Procurement



- Jane Varkonda – Conservation agent, permits
- Matt – Keene Excavation
- Multiple disposal sites and how they came to be
- Site Visit(s)
- Stakeholder Engagement Survey
 - Short questionnaire
 - Adam to connect with Charlie offline to review

Overview of Barnstable County Dredge Program

- ***The County Dredge Program is in the process of re-evaluating operations as part of a 5-year plan***
 - Goal: run dredge like an enterprise system
 - County has never established a work plan, has led to issues
 - Needed to account for dredge maintenance and push boat maintenance
 - Hired Foth Engineering to help manage program; work with employees to ‘triate’ inefficiencies
 - Have since purchased two new dredges, upgraded push boat, new skiffs, ordered new push boat
 - At present, approximately \$1.8 million annual operation costs
 - \$1.2 million superstructure, \$250K for 6000’ HPDE pipe, anchors, fusion machine (welding pipes together), push boats
 - Annual labor costs ~\$700k
 - County owns ~12,000’ of pipe
 - Dredge program only has hydraulic dredges at present
 - Rock Harbor needs mechanical and hydraulic, Nauset all hydraulic, Pleasant Bay likely hydraulic (County could likely do that)
 - With a mechanical dredge, nearly all disposal sites are nearby beaches
 - County may consider purchasing mechanical dredge if met with sufficient demand
 - A forthcoming survey will be distributed by the County to all towns to assess needs to create 5-year plan inclusive of all dredge projects Cape-wide (to assist in development of Mass Dredging Database?)
- ***Difficulties encountered with dredge operations***
 - TOY restrictions major factor in operations, very small work window
 - Big part of permitting – need to factor that into disposal plan, that it fits within work window
 - Cape Cod Bay closes due to TOY restrictions 12/31 (right whales)
 - Weather a major factor
 - County has lost 40 days this year, mostly due to wind
 - Dredge operations cannot stop/start as quickly as say, fishing operations
 - i.e. one day lost to weather may equate to 3 total days lost due to demobilization and remobilization
 - County has been able to get some TOY extensions



- **What County would need from Town:**
 - 5-year timetable, project schedule
 - Equipment needs, what needs to be purchased, etc.
 - Projects that might need mechanical dredge
 - Estimated volumes
 - Wellfleet is a large project, shallow water, may require mechanical dredge

- **County versus private contractor**
 - County will nearly always be less than private company
 - Running to break even, not lose money, but not make profit
 - Private dredge operation, high mobilization costs (\$300-350k)

- **MassWorks Program**
 - State government is recognizing importance of dredging to coastal communities
 - Has a match grant program, can match 50% of municipality's costs
 - Seems to prioritize shovel-ready projects
 - Bass River, Dennis successful; Bourne unsuccessful (applied w/o permits in hand and did not receive grant)
 - Need permit first
 - If work goes to private contractor, RFP first
 - Does the program apply to equipment purchase?
 - County was denied a request 2 years ago
 - Would they help town with purchase/program startup? Remains unclear

- **County Dredge Advisory Board and Orleans-Specific Questions**
 - In the process of reorganizing
 - Barnstable County Coastal Management Committee
 - They will select board member selection process; likely town administration will select one person per town
 - Discussion of who has permits and need, a fluid schedule still necessary given TOY restrictions, weather (wind and waves), mechanical issues
 - **Steve Q:** Would the committee have issues with the demand/frequency of a project? i.e. annual required work in a smaller area versus a larger area/deeper depth over several years?
 - A: It is more up to the regulators, qualms with permit addressed at the time of issue
 - A: Also, one person from each town will be on committee
 - Harbormasters, town managers, should be someone who understands permitting process
 - Long-term plans very useful for dredge program planning
 - **Nate Q:** County survey – are 5-year plans shovel ready projects only?
 - A: No. Helpful for County to get sense of all dredging needs
 - **Steve Q:** Difficulties of Nauset Inlet?
 - Dredge superintendent willing to make project-specific adaptations
 - Chatham Stage Harbor most difficult for dredge to enter, good comparison



- **Bill Q:** Depth requirements of dredge equipment?
 - A: 3.5' of water; push boat draws 3.5' full; 45' width
- Pipe length adds complication
 - 3 miles needed? With that length, 2 boosters needed (booster barge requires 5.5'), can drop the boosters directly on beach
- **Is pipe limiting factor in Nauset?**
 - Nate: if Town purchases pipe and maintains
 - Steve: that would be cost effective for County; have it pre-staged
 - Would be cost-effective for Town over the long run, county wouldn't charge for transporting or purchasing pipe
 - Chatham is looking in to purchasing a booster
 - Jack: What if Chatham and Orleans shared a booster, pipe?
 - County not involved in any permitting
 - **Charlie Q:** Issues with access to County dredge?
 - Jack: hope that 5-year business plan will help with planning
- Some long-term staff, but some difficulty finding people to stay for more than 1 year, mostly the support staff
 - Thinking of starting a program with Cape Cod Tech
 - May expand search for personnel in the process of building the plan
- **Charlie Q:** How does the Town guarantee that the dredge will be available when the town has work that needs to be done?
 - Steve: TOY restrictions for Orleans?
 - County builds in mobilization costs into the rate, a percent of the job
- **Betsey Q:** Summary of Town's variable relationship with the County Dredge, how in the past there have been issues with transparency, fairness and reliability- the County is taking steps to address this with new equipment purchases, establishment of business plan and new advisory committee
- **Nate Q:** Permit to bury pipe?
 - Steve A: Has been permitted before, never on Cape (FL?)
- **Nate Q:** If Town purchases pipe and booster, confidence the County can get into Nauset estuary?
 - Steve A: Need 3.5'
 - Steve S: Nauset Bar very difficult, how do you approach (Chatham vs PTown), he comes in behind a sea
 - Proponent of County doing one large job in Nauset, Town could then more easily maintain it with smaller equipment
 - Could potentially schedule (it first in the season) to make entrance easier, i.e. go in August
- **Steve Q:** Would adding Nauset increase risk/insurance?

Technical Discussion

- CY per day is variable (large projects more efficient, versus chasing smaller volumes)
 - Attempting to plan for varied, project-specific costs



- Total annual costs divided by projected CY → rate?
 - BUT lots of other variables involved
 - i.e. big jobs lead to high cy/day rates, small jobs done in pieces (tide, moving location, chasing material, waiting for disposal site to be ready)
 - could then ultimately limit the number of projects completed in one year
- Part of business plan is looking at the days worked on job, weather factors, mechanical issues, all to hone in on a rate/better estimate of actual time/effort required to do jobs
- State working on a dredge database
- Potentially charge smaller jobs more
 - i.e. the small volume does not represent the total effort required for the job
 - Each job has to break even – more equitable for each town
 - County still 75% less than private contractor
 - County still estimate rates of \$13-15/cy
- County established a reserve fund to cover unexpected costs
 - County never did a business plan, depreciated equipment etc. This year, set aside \$400k for reserve
- **County Equipment**
 - Ellicott 670 “New Codfish”
 - 1550’ of pipeline to complete Sesuit Harbor project
 - 2.3’ face – more water than sand in pipe at present in Sesuit, 900 cy/day
 - Other side of inlet 12’ face (more sand than water), 3000 cy/day
 - Boosters usually max out at 1000 cy/day
 - Booster manufactured by GW? Ellicott booster capacity not large enough for Nauset
 - Per dredge operation with booster
 - 3 skiffs, 28’ push boat, barge
 - Front loader, skid
 - Booster job in Nauset would require minimum of 4 operators (dredge and one for each booster pump)
 - Staff
 - Moving forward: supervisor, foreman for each project, support staff, land-based support, booster operator(s)
 - **Nate Q:** how long does it take to get a rookie up to speed?
 - A: ~ 1 year; biggest mistake jamming the pipe, clogging the pipe with too much material was 5-day mistake
 - Last year County spoke with private contractors, found that from foreman down rates were relatively comparable, superintendent was way off
 - At present with 5-person crew, no layoffs over the summer, repair work
 - Equipment companies only provided water curves (for pipe transport rates)



- **Maintenance Program**

- In past, County did not do a good job with preventative maintenance i.e. booster pump was supposed to be taken apart and repaired every 7 years and it never was
- Mechanical issues will always happen in an ocean environment
- County has developed a better preventative maintenance program
 - Some can be done on the dock during a bad weather day
 - That has been built into the schedule now
- County has now built up spares/backup collection
 - If breakdowns happen, no longer waiting days for replacement materials to arrive; building inventory; have spares on vessel
- Larger maintenance (booster pump) goes back to manufacturer for service
 - Engines etc. can be done in house; have Caterpillar-certified technician come in to do work
 - Can take 3 total weeks to replace pump

- **Operations Questions**

- Larger push boat would mean easier transport in difficult conditions, faster transport times, but larger draft
- County has contracted larger transport out before (i.e. Fairhaven to Truro)
 - May do more of that
- Feasibility of entering Nauset Inlet
 - Potentially having an operator check out Nauset?
 - Four years ago: WHG showed Wayne the conditions in Nauset in winter
- County scouts projects before committing to determine feasibility with given equipment
- County looking at new equipment options
 - smaller dredge potentially, Ellicott 370?
 - Issues with currents
 - SandShifter spun around on its spuds in Stage Harbor

- **Permitting**

- Nauset: considering alternatives, once final alternative decided it will move forward
 - Requires federal NEPA
 - 3-year timeline
- Pleasant Bay
 - Historic dredge channels exist, never permitted
 - Looking to secure permits for historic channels, then also beyond
 - Two stages (maintenance then improvement)
- Rock Harbor
 - Mechanical dredge, got extension into Right Whale season
 - Additional project: feasibility of looking at Skaket/First Encounter as options?



- Never dredged the approach
 - Bar at present holds water in harbor at low tide

General Wrap-up Comments

- County dredge needs survey coming out in a few weeks
 - Nate: wants input from committee, WHG
- CCC and CCS have done work in Pleasant Bay
- Shellfish?
 - Mostly a Q on the permitting level
 - A broader picture could help permitting (economics, other habitat, supporting beds etc.)

Site Visit - Sesuit Harbor, Dennis, MA

Meet at Cold Storage Beach

Ellicott 670 active

Jason Bevis, County Dredge Superintendent 12+ years' experience and Steve Tebo

- **Overview of dredging operations**
 - Dredge plants one spud, anchors handled by support skiffs help maneuver dredge, pump arcs/sweeps across bed, dredge moves gradually picking up the 'digging' spud and swinging backwards with second spud down before replanting digging spud
 - Pump runs to the dewatering site, excavator at site moves material as water flows out and material settles
 - Fine grained material can runoff back to ocean or a pit can be dug as a catchment basin
 - Pumping rate dependent upon ratio of water/sediment in pipe
- **Considerations of fuel usage, expense, transport**
 - ~4000 gallons of diesel fuel per week for hydraulic dredge operations with multiple boosters
 - ~800 gallons of fuel required per booster over 8-day period
 - Dredge +/- 300 gallons diesel per day
- **Shallow water issues**
 - Draft of boats and dredge, but also maneuvering of anchors
 - Anchors can be pre-positioned on beach, accessed by personnel in waders
- **Pipe storage, limits of on-road transport, time involved with re-fusing the pipe**
- **Need to consider all operational difficulties with long length of pipe at Nauset**
 - Previous elimination of closer dewatering sites by Seashore
 - Equipment needed on site at dewatering (excavator needed in parking lot), additional staff at each booster
 - Boosters located on shore or off shore?
 - Issues associated with refueling equipment in dunes / on beach
- **Intricacies of private beneficial reuse of material**
 - Strolling easements?
- **Logistics**
 - Can dredge be taken apart and transported to Nauset in ways other than pushed through Inlet?



Figure 1 – Committee members, municipal and county officials, and Woods Hole Group staff conduct a site visit to view Barnstable County Dredging operations at Cold Storage Beach, Dennis, MA.



Figure 2 – Active dewatering site on Cold Storage Beach. County dredge visible in background between jetties.

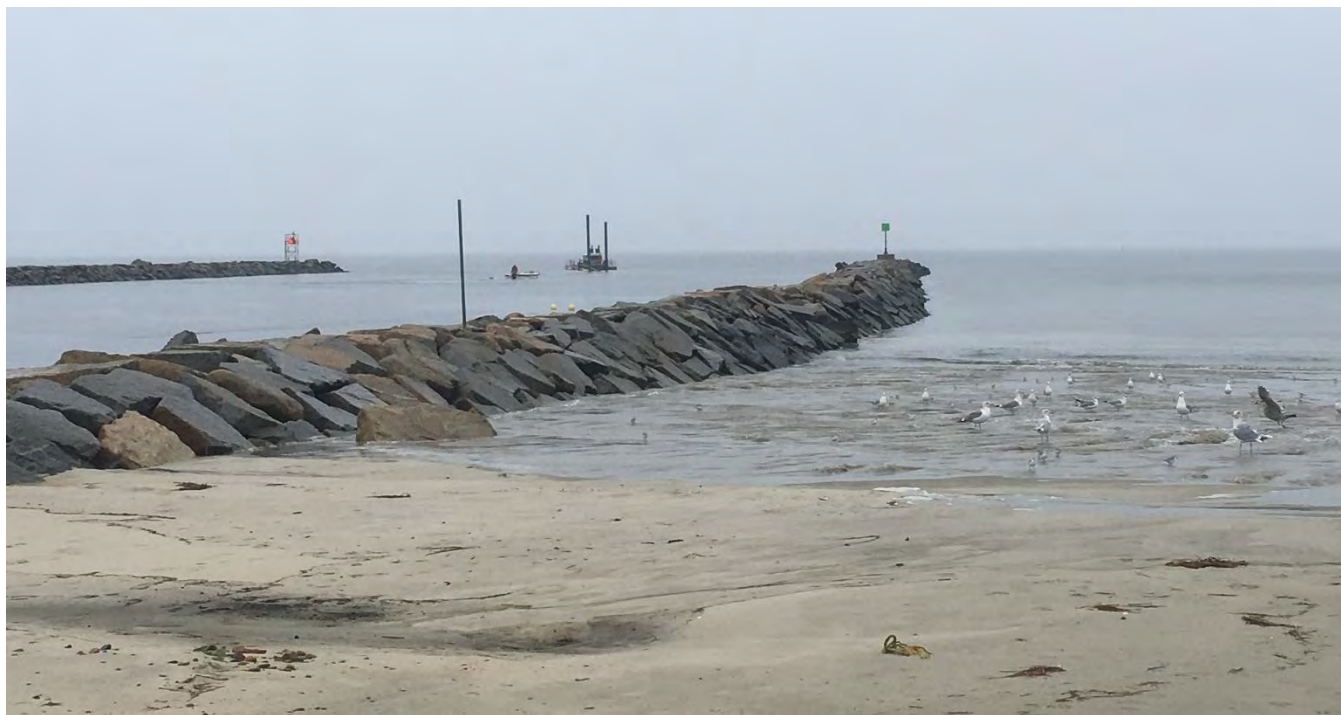


Figure 3 – Barnstable county dredge clears entrance channel to Sesuit Harbor, Dennis MA.



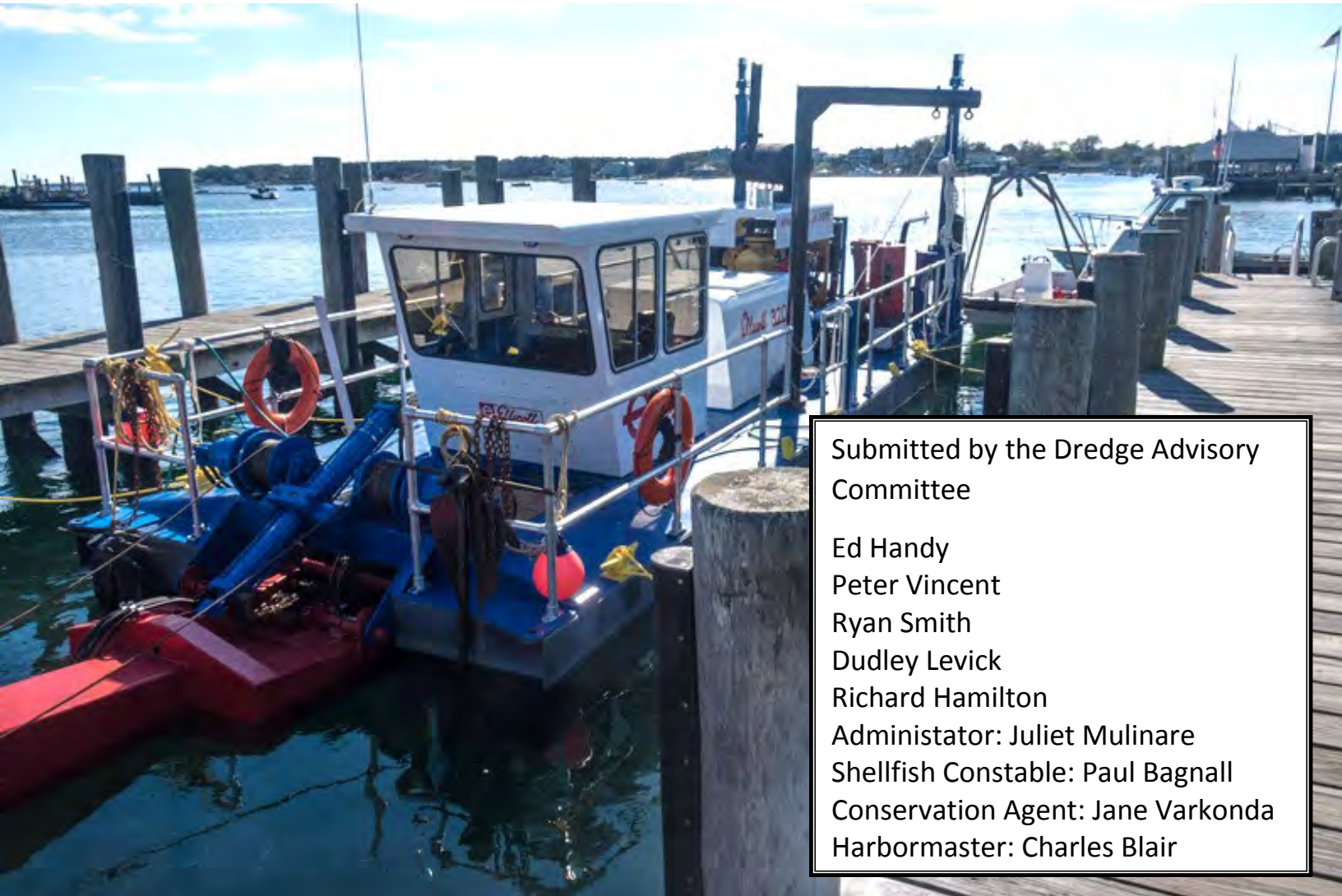
Figure 4 – Dredge pipe comes ashore, Cold Storage Beach, Dennis, MA.



APPENDIX D. EDGARTOWN DREDGE MASTER PLAN



TOWN OF EDGARTOWN DREDGING MASTER PLAN UPDATE 2018



Submitted by the Dredge Advisory
Committee

Ed Handy

Peter Vincent

Ryan Smith

Dudley Levick

Richard Hamilton

Administator: Juliet Mulinare

Shellfish Constable: Paul Bagnall

Conservation Agent: Jane Varkonda

Harbormaster: Charles Blair

EDGARTOWN DREDGE ADVISORY COMMITTEE

The goal of the Dredging Management Plan Committee, now the Edgartown Dredge Advisory Committee, has been to implement and develop a long range master plan for dredging and dredging management which qualifies for State and local funding. The Master Plan was first completed and adopted in March 27, 1996 and was updated in 2007 and again with this update in 2018. The Dredge Advisory Committee's function is to make recommendations to the Board of Selectmen, for their approval, on all matters concerning the sites, operation, and personnel associated with the dredge.

The Edgartown Dredge Advisory Committee, founded in 1995 under the authority of the Board of Selectmen, has experienced many transformations in the years since the most recent 2008 Dredge Master Plan Update. Significant progresses and changes have occurred both in the Edgartown Dredge Committee operation, and in the environment of dredging in Edgartown, which has incorporated cooperation with private sectors and other towns.

One of the most extensive projects the Edgartown Dredge Committee has completed in the past 10 years was the dredging of approximately 100,000 cubic yards of sand from Sengekontacket Pond throughout 2008 to 2010. There was unprecedented cooperation with, and funding from, the private Cow Bay Association to nourish the entire stretch of the western town beach through Bend in the Road Beach to Cow Bay Beach. Edgartown and Oak Bluffs mutually benefitted from the dredging of the Sengekontacket channel on the Oak Bluffs side. Inkwell and Pay Beaches received nourishment, and the pond as a whole experienced an increased flushing ability.

Following the events of 2012, the Dredge Advisory Committee was reselected and reformatted to consist of five Selectmen-appointed members: one from the Marine Advisory Board, one from the Shellfish Committee, one from the Conservation Commission, and two other at-large members. The current members of the Dredge Advisory Committee are: Ed Handy, Chair and Representative from the Marine Advisory Committee; Peter Vincent, Representative from the Conservation Commission; Ryan Smith, Representative from the Shellfish Committee; and Dudley Levick and Richard Hamilton, members at-large. Paul Bagnall, Shellfish Constable; Charles Blair, Harbormaster; and Jane Varkonda, Conservation Agent serve as non-voting advisory members. The primary projects the new committee undertook were the dredging of the Cape Pogue Narrows, assistance to the Great Pond Foundation with the Edgartown Great Pond delta, and the Fuller Street Beach nourishment with dredged sand from Eel Pond.

In addition to the success at Fuller Street Beach and the dredging of the Katama boat ramp and channel, the Committee purchased a new dredge in 2017. The accumulation of dredge repair and replacement costs for the old dredge, in its 21st season, began to exceed the service value of dredging. Ed Handy and Donald Benefit heard bidding presentations and conducted site visits to meet the vendors and see the dredges in person. An Elicott Dredge, Model 370 was ultimately chosen for purchase.

The extensive transformations and improvement the Edgartown Dredge Program has seen over the past 10 years has refocused the Committee on its essential mission statement, "improving waterways and navigation, maintaining shorelines, and protecting habitats."

The inception of the Dredge Program shows the Town's commitment to fishermen, to improving the storm damage and flood control functions of beaches, while also restoring recreational values and endangered species habitat (piping plover). This multiple benefit approach improves the economy by providing

opportunities, protecting the resources that are the basis of the existing economy, and restoring and enhancing natural heritage. This multiple benefit approach is typical of all the projects of the Dredge Program.

Miles of beach have been nourished. Navigation and mooring areas have been restored and need to be maintained. In addition, public access has been restored at three public boat ramps with one more scheduled for dredging. All of this is being done as the Town saves money (estimated to be a 71% savings over contractor costs) by using its own dredge and pursuing project grants.

The Committee has sought to carry out dredging in the most cost effective and efficient manner. To that end, the Committee has been successful in obtaining grants from the Massachusetts Department of Environmental Management Office of Waterways and some private funding for many projects. Additionally, the Town has provided dredging services to other Island Towns, funded by intergovernmental agreements to maintain regional and local resources, such as Tashmoo Pond in Tisbury. The Committee makes Edgartown dredge projects the top priority, and outside projects are only done secondarily when the dredge is available. The Town will continue to seek these types of partnerships in developing and implementing the Dredge Program.

The most conservative approach is taken in developing projects to protect natural habitats and the resources they produce, which are so valuable to the Town. It is believed that this conservative approach continues to be the most effective in restoring the navigable waterways, nourishing the barrier beaches and protecting habitat. The information contained in this plan will be a guide for the Town’s continuing efforts to maintain navigable waterways and the natural marine resources that are so important to the seasonal and year-round economies.

BUDGET HISTORY 2006-2018

Year	Operating and Maintenance Costs	Warrant Articles for Permitting Costs
2006	\$223,646.00	\$30,000.00
2007	\$221,488.00	\$15,000.00
2008	\$221,000.00	\$15,000.00
2009	\$236,000.00	--
2010	\$236,000.00	--
2011	\$236,000.00	--
2012	\$136,000.00	--
2013	\$236,000.00	--
2014	\$244,000.00	--
2015	\$244,000.00	--
2016	\$260,161.00	--
2017	\$259,766.20	\$50,000.00 from CPC funds
2018	\$260,847.40	--

In 2011, the Dredge Budget shifted to an “Unclassified” line item for department budgets.

In 2012, the Dredge was classified as a Town department, and the budget was voted as a line item in the Town Budget.

The Dredge Department will be asking for \$80,000.00 for permitting, and \$120,000.00 for permitting costs at the Katama boat ramp at the Annual Town Meeting of 2019.

MAJOR EVENTS, PROJECTS AND PERMITTING 2006-2018

Year	Major Events	Projects	Permitting
2006	<ul style="list-style-type: none"> • Dredge operating in its 12th year. • Extensive maintenance and repairs needed in early fall due to harsh salt environment. • Grant received from Seaport Advisory Council to examine Lighthouse Point area for build out choking harbor entrance. • Future plans: Inner Harbor maintenance, Lighthouse Pond, Cape Pogue opening. 	<ul style="list-style-type: none"> • Katama: maintenance dredging for boat ramp. • Eel Pond: nourishment of Sheriff’s Meadow, including a small island for rare birds and other species; improved navigation for mooring holders and improved circulation to avoid additional shellfish closures. 	<ul style="list-style-type: none"> • Permit renewals approved to dredge Eel Pond. • Town issued permits for the nourishment of Bend in the Road Beach. • Mattakesset: still waiting on permits. • Permit process becoming difficult and expensive, generally requiring 2-3 years.
2007	<ul style="list-style-type: none"> • Dredge hauled and stored at Town Barn for the summer. • New engine installed in early fall. 	<ul style="list-style-type: none"> • Cape Pogue narrows: improved circulation and shellfish habitat 	<ul style="list-style-type: none"> • Committee working with State officials to develop a comprehensive permit process to streamline the permitting process, • Sengekontacket: extensive permitting to improve navigation and nourish Bend in the Road and other southern beaches (80-100,000 yards³ of sand)
2008	<ul style="list-style-type: none"> • Cooperative project between Sengekontacket, Bend in the Road Beach, and Cow Bay Association homeowners to nourish popular dune system on Town beach, and prevent extreme storm wash overs onto Beach Road. • 180 ft of beachfront adjacent to eastern edge of Bend in the Road Beach was leased to the town for public enjoyment for \$1 per year. 	<ul style="list-style-type: none"> • The dune barrier system was rebuilt from the western border of Town beach all the way to the Strauch property. 	<ul style="list-style-type: none"> • Cow Bay paid for all of the permitting and dune restoration, including the portion owned by the Town. • Costs for the Bend in the Road Nourishment project covered by Cow Bay Association. • Woods Hole group helped in the permitting of this multi-faceted project.

	<ul style="list-style-type: none"> • \$150,000 donated to Town Dredge Program. • Dredge Committee began to function more as a Town Department. 		
2009	<ul style="list-style-type: none"> • New caterpillar engine and other replacement parts paid from Dredge Gift Account. • Dredge Administrator position eliminated, replaced by Clerk and Dredge Foreman; program runs more efficiently. • Cow Bay Association continues to buy sand for nourishment of the Town's and Cow Bay Beaches at \$11 per cubic yard. 	<ul style="list-style-type: none"> • Bend in the Road Beach: nourishment of 3,500 yards³ of sand using spoils from Sengekontacket borrow area just inside of the Big Bridge. 	<ul style="list-style-type: none"> • Oak Bluffs began to seek permitting for their portion of Sengekontacket: 57,000 yards³.
2010	<ul style="list-style-type: none"> • Dredge window extremely short due to many equipment breakdowns and failures. • Master Plan from Woods Hole Group completed, and funded privately. Project premise: to protect most susceptible beaches by nourishing the system as a whole, rather than individually. • Continued cooperation with Oak Bluffs to assist with Sengekontacket. • End of the three year public and private endeavor to dredge Sengekontacket, 100,000 yards³ total. 	<ul style="list-style-type: none"> • Small channel inside Cape Pogue Gut to increase access and flow to the largest and most productive shellfish habitat. • Cooperation with Oak Bluffs to assist with beach nourishment projects: 28,000 of the 57,000 cubic yard project completed in Sengekontacket. Inkwell and Pay Beaches received nourishment, as well as 9,000 yards³ to Bend in the Road and 8,000 yards³ to the Cow Bay Association. 	<ul style="list-style-type: none"> • Difficulty with and lack of cooperation from Division of Marine Fisheries and US Army Corps of Engineers.
2011	<ul style="list-style-type: none"> • One of the most productive and efficient dredging seasons. • Budget removed from warrant articles, and instead placed as an "Unclassified Line Item" in the Department Budgets. 	<ul style="list-style-type: none"> • Sengekontacket: completed navigational channel to clear area between the bridges (remaining 22,000 yards³). • Little bridge cleaning of delta on dogleg end of channel, westerly 	<ul style="list-style-type: none"> • Still working towards 10 year comprehensive permit for federal agencies; already secured on State level. • Funding costs removed from budget, no additional cost for tax payers.

		<p>groin fields of State Beach easily reached by pipe.</p> <ul style="list-style-type: none"> • 1,500 yards³ placed on easterly groin beaches of State Beach. 	<ul style="list-style-type: none"> • Requirements for the U.S. Army Corps of Engineers continually changing, difficult to complete tasks while minimizing large expenses.
2012	<ul style="list-style-type: none"> • Complete change in operation and management of dredge equipment, • June 2012: Dredge Advisory Committee reformatted and new committee selected by Edgartown Board of Selectmen. • Limitations to dredge activity: “seasonal designation” for dredge employees, Hurricane Sandy delay. 	<ul style="list-style-type: none"> • Edgartown Great Pond delta: EGP Foundation owns a smaller dredge, normally used to open the pond. Due to substantial growth in the delta, Town’s larger equipment was used. 	<ul style="list-style-type: none"> • Completed filing of comprehensive permit with US Army Corps of Engineers, allowing for maintenance dredging and nourishment of 36 sites; and more flexibility and efficient management of dredge operations. Approval pending.
2013	<ul style="list-style-type: none"> • Active and successful year for Town Dredge. • Significant repairs needed on dredge hull: after competitive bids, the entire hull sandblasted, the necessary steel replaced, metal barrier coated. Paid for by maintenance funds. 	<ul style="list-style-type: none"> • Edgartown Great Pond delta maintenance. • Beginning to add sand to Fuller Street Beach to account for damage done from winter storms. 	<ul style="list-style-type: none"> • Comprehensive permit: final application conditionally approved, and posted for public comments, hoping have permit in 2014.
2014	<ul style="list-style-type: none"> • Dredge operating in its 20th year, with equipment of same age. • Necessary repairs, replacement costs, and associated labor are starting to not make economic sense. • Discussion of dredge replacement and Capitol Programs begins. 	<ul style="list-style-type: none"> • Completion of Edgartown Great Pond delta. • 3,000 yards³ from Right Fork, South Beach storage to Fuller Street Beach • Eel pond: improve navigability and access to mooring field. • Lighthouse Point: 1,000 yards³ removed to increase tidal flow and added to Fuller Street Beach. 	<ul style="list-style-type: none"> • Official approval from ACOE for 10 year comprehensive permit for all Town’s dredging and beach nourishment sites, expires December 31, 2024.
2015	<ul style="list-style-type: none"> • \$62,250 grant received from Office of Coastal Zone 	<ul style="list-style-type: none"> • Fuller Street Beach receives the highest 	<ul style="list-style-type: none"> • Input from Shellfish Committee,

	<p>Management for engineering work on Lighthouse Beach and pond dredging. Further grants sought from Community Preservation Fund.</p> <ul style="list-style-type: none"> • Application to Capitol Programs Committee for a new dredge. • Existing dredge surveyed, determined to be usable for two seasons. 	<p>quality sand from Eel Pond.</p> <ul style="list-style-type: none"> • Eel Pond dredged for easier navigability and landing area. 	<p>Conservation Commission, and Marine Advisory Board become basis for sites for dredging and nourishment.</p>
2016	<ul style="list-style-type: none"> • Active and successful dredge season. • Long term goals: acquire State funding for State Beach engineering; CPC funds for improving Katama boat launch; hire coastal engineering firm to address accumulation of sand south of the Lighthouse, threatening the Harbor entrance. 	<ul style="list-style-type: none"> • Multiple Town beaches nourished with high quality sand. • Katama boat ramp and channel, Highway Department assisted with trucking the sand from Katama to State Beach. 	<ul style="list-style-type: none"> • New dredge planning expedited because equipment quickly approaching end of service life.
2017	<ul style="list-style-type: none"> • New dredge purchased. • \$50,000 in revenue was generated from the sale of leftover sand. 	<ul style="list-style-type: none"> • Katama channel approach to landing to clear access for larger vessels. Sand was trucked to Fuller Street, and the leftover 4,100 yards³ were sold. 	<ul style="list-style-type: none"> • CPC request for \$50,000 for engineering and capital improvements for the ongoing contract with the State to reconstruct the Katama boat landing.
2018	<ul style="list-style-type: none"> • Dredge Committee formed cooperative agreement with Tisbury, representing increased efforts to create an interconnected support network between towns. 	<ul style="list-style-type: none"> • Lake Tashmoo in Tisbury: channel had not been fully dredged in four years; shoaling was causing navigational issues. 	<ul style="list-style-type: none"> • Open contracts with FOTH Infrastructure (formerly CLE) for the dredging of Lighthouse Beach.

Existing Conditions

Dredging/Nourishment Locations

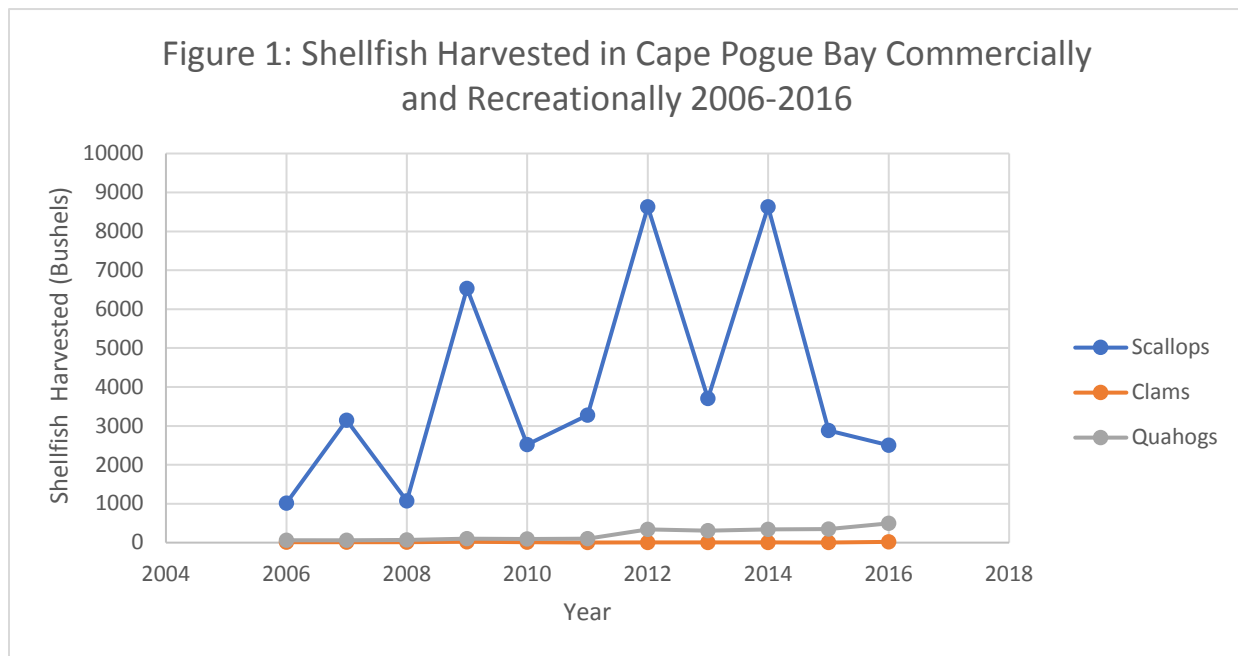
Cape Pogue



The 115-acre Cape Pogue Bay is located in Edgartown on the northeast corner of the island of Chappaquiddick. The northern portion of the bay is bounded by a thin peninsula that has been breached several times, but regularly possesses only one small opening at the end of the Cape Pogue Wildlife Refuge. Additionally, Cape Pogue Bay is connected to Poucha Pond on its southwest corner through the tight inlet of the Narrows and Dike Bridge approach. This bay is categorized by the Martha’s Vineyard Commission as Quality Waters with a substantial amount of eelgrass present.

Cape Pogue is also an essential habitat for shellfish, primarily bay scallop and quahogs. In 2016, the Cape Pogue bay scallop population made up a vast majority of the total \$364,000 worth of commercially caught bay scallops in Edgartown. For this reason, dredging in the pond has taken on a greater economic importance in improving tidal flushing that sustains shellfish habitat. In 2012, a total of 4,900 yd³ of the Cape Pogue Narrows and the Dike bridge approach were dredged, opening up the channel between Poucha Pond and Cape Pogue. The revival of this hydro-connection brought in nutrients from marshy Poucha Pond and increased the circulation throughout the system as a whole. Immediately following the dredging of this connection, the bay scallop population on the Eastern side of Cape Pogue Bay began to flourish.

Figure 1 below displays the commercially caught bushels of shellfish in Cape Pogue from 2006-2016, indicating trends in shellfish population throughout the years. Species in Cape Pogue that primarily serve as water quality indicators are bay scallops and quahogs.



Cape Pogue Shellfish Numbers (Bushels)				
Year	Scallops	Clams	Oysters	Quahogs
2006	1,016	12	0	61
2007	3,145	8	0	63
2008	1,073	13	0	71
2009	6,531	23	0	105
2010	2,516	12	0	91
2011	3,277	7	0	105
2012	8,633	6	0	343
2013	3,701	6	0	307
2014	8,628	6	0	343
2015	2,884	7	0	346
2016	2,505	18	0	495

As seen in Figure 1, the bay scallop population harvest reached peak numbers in the years 2012 and 2014 after dredging of the Narrows and Dike Bridge Approach. From lower yields of 2,512 bushels in 2010 and 3,277 bushels in 2011, the shellfish harvest rose to 8,633 bushels in 2012 and 8,628 bushels in 2014. Shellfish harvests have more than tripled from 2010-2012. Additionally, quahog harvests have flourished averaging approximately 366 bushels throughout 2012-2016, after only reaching peaks of 105 bushels in years previously. Clam harvests, however, have remained consistently low. Shellfish are considered indicators of the stress and ecological productivity of a pond, as seen in the Martha’s Vineyard Indicators Project. The definite increases in bay scallop and quahog harvests following the dredging in 2012 support the idea that dredging boosts circulation of nutrients, tidal flow of salt water, and the overall water quality of the pond.

The total maintenance dredging volume, primarily excavated in 2012 throughout three areas of Cape Pogue, was approximately 16,190 yd³ for navigation and beach nourishment. As seen in the chart below, the greatest volume of dredging, 9,900 yd³, was done in The Gut to ensure safe entrance into the bay from the Nantucket Sound. Dredging volumes for other locations were relatively low due to the fact that the Narrows and Dike Bridge Approach are small channels. In terms of species, there is no eelgrass within the project areas, but only in the vicinity of The Gut. Winter Flounder are not found in the Narrows and Dike Bridge region, nor are they able to spawn in the rapidly flowing water of The Gut. Although shellfish are not currently located within the actual dredging locations, the regions dredged are potential habitat for bay scallops, quahogs, and razor clams. The primary reasons for dredging throughout these sites include maintaining safety for the essential shell fishing economy in the area, increasing tidal pond flushing, and continuing connections within the system of water bodies.

Locations within Cape Pogue	Volume Dredged	Depth Dredged (below MLW)	Area over which Dredged	Reason for Dredging (Navigational Importance)	Species within Dredging Location	Specific Precautions for Dredging
The Gut	9,900 yd ³	2.5 ft	135,000 ft ²	-Shell fishing navigational safety -Tidal pond flushing	-Eelgrass in vicinity of Gut -Unlikely for winter flounder to spawn due to high velocity in entrance channel -Within bay scallop and quahog suitability area	-High velocity in gut monitored -No project areas within eelgrass beds
The Narrows	3,100 yd ³	3 ft	48,500 ft ²	Hydro-connection between Poucha Pond and Cape Pogue	-Initial Permitting: winter flounder not impacted -Within razor clam suitability area	No project areas within eelgrass or shellfish beds

Dike Bridge Approach	1,390 yd ³	3 ft	21,000 ft ²	Hydro-connection between Poucha Pond and Cape Pogue	-Initial permitting: winter flounder not impacted	No project areas within eelgrass or shellfish beds
Outer Channel	1,390 yd ³	6 ft	20,000 ft ²	Shell fishing navigational safety	Within bay scallop suitability area	

The Cape Pogue nourishment area for all three nourishment locations is a total of 147,000 ft². Beach nourishment is only permitted to occur between November 1st and March 15th to minimize adverse effects on piping plovers and other endangered bird species. Deposition of sand in these locations is essential to replenish beach sand washed away by storm erosion, to restore dune habitat for endangered species, and to protect coastal homes and roadways from destruction. Cape Pogue nourishment locations, in particular, were provided with sand in 2012 immediately following severe storm damage from Hurricane Sandy.

Particular species that reside in the nourishment locations have been the piping plover, American oystercatcher, and willets. The Narrows and Dike Bridge Approach are not as commonly known to house piping plovers, but are a transitional area for their movements around Cape Pogue. Additionally, sea-beach knotweed is a special concern, it is an endangered, low-growing vegetation species that inhabits the shores annually in Cape Pogue.

The Trustees of Reservations have declared that, for all Cape Pogue nourishment sites, beach nourishment material should be placed above the mean high water line. Silt barriers, required by the Conservation Commission Order of Conditions, were placed in order to protect salt marsh and removed by April 15th. The vegetation which was minimally disturbed by pipe placement, was replanted in coordination with the Conservation Commission.

Location within Cape Pogue	Area Nourished over which Tide Line	Bird/Vegetation Species within Nesting Area	Time of Year Restrictions for Species	Specific Precautions to Protect Species
Cape Pogue Elbow (NSELB) and North Gut (NSNG)	101,000 ft ² above HTL	-Piping plover and American oystercatchers partially for nesting and foraging habitat ₁	November 1 st to March 15 th	-Nesting sites demarcated for laying of pipe ₁ -No nourishment material within 150 ft of nests, within 100 ft of chicks -Work overseen by Trustees qualified monitor
The Narrows (NSN)	25,000 ft ² above MHTL	-Piping plover area to bring chicks to bayside and back ₁	November 1 st to March 15 th	-No nourishment material within 150 ft of

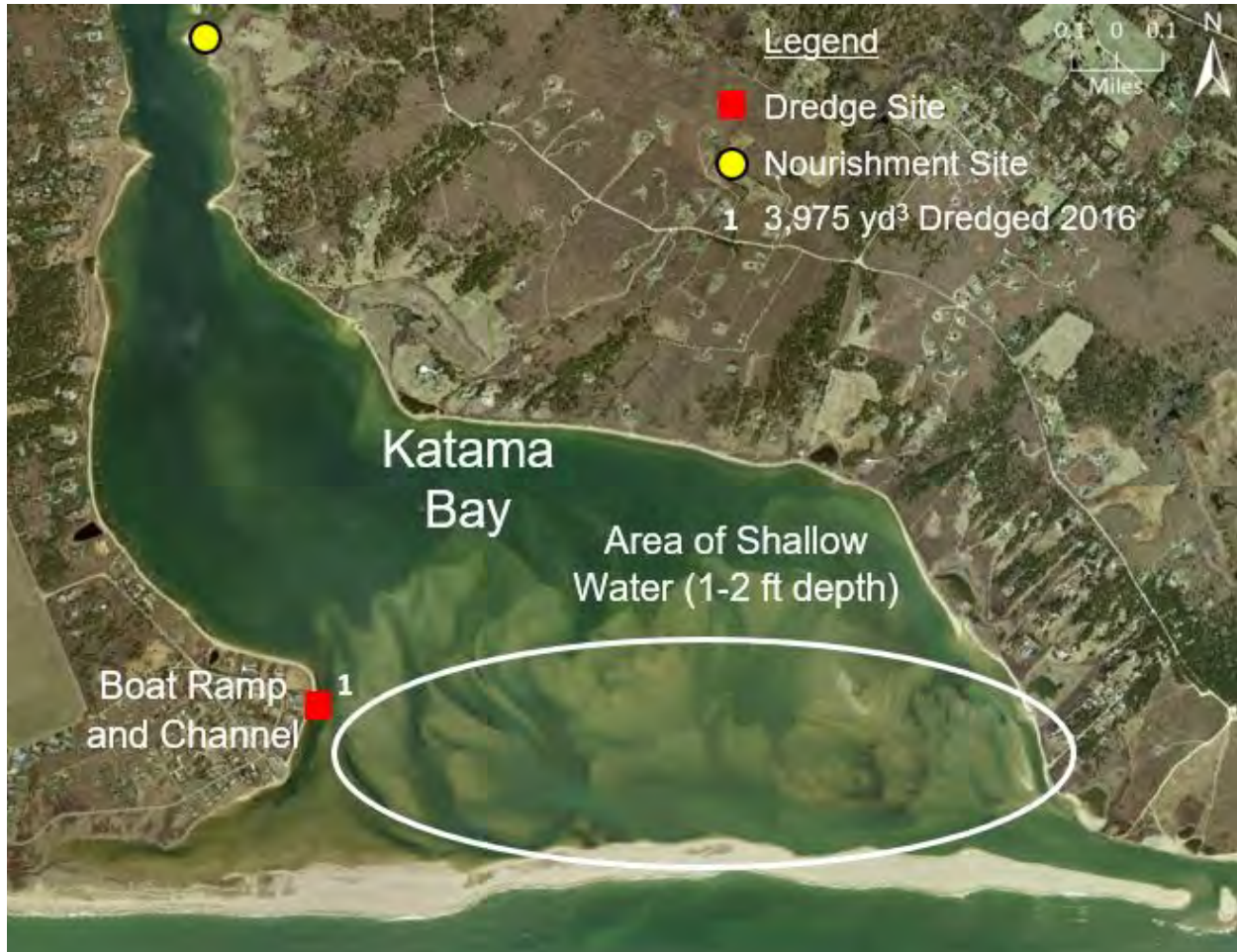
		-American oystercatcher habitat ₁ -Sea beach knotweed in late Summer/early Fall ₁		nests, within 100 ft of chicks -45,000 ft ² of nourishment area at 10:1 slope -Work overseen by qualified Trustees monitor
Dike Bridge (NSDB)	21,000 ft ² above MHTL	-American oystercatcher foraging and chicks ₁ -Willetts chicks -Pair of piping plovers possibly in danger laying of pipe ₁	November 1 st to March 15 th	-No nourishment within 150 ft of nests, within 100 ft of chicks -Efforts not to disturb marsh vegetation

₁Text: Source of Caitlin Borck, Mass Trustees

Edgartown Harbor Region

The Edgartown Harbor region contains three primary water bodies: Katama Bay, Edgartown Harbor and Eel Pond, all of which are contained within the 3,068 acre Katama watershed. These interconnected bodies contain the vast majority of all boat traffic in Edgartown.

Katama Bay



Katama Bay, a 1,695 acre bay, is located on the southern shore of Edgartown bounded to the west by the island of Chappaquiddick and to the south by a barrier beach to the Atlantic Ocean. The northern, well-sheltered region of Katama Bay leads into Edgartown Harbor connecting it to Nantucket sound. Shoaling from tides that run from Edgartown Harbor cause a buildup of sand in the southern region of Katama Bay, a large part of it is now only one to two feet deep. Katama Bay is categorized as Compromised in water quality by the Martha's Vineyard Commission with limited eelgrass, but good circulation and dissolved oxygen levels.

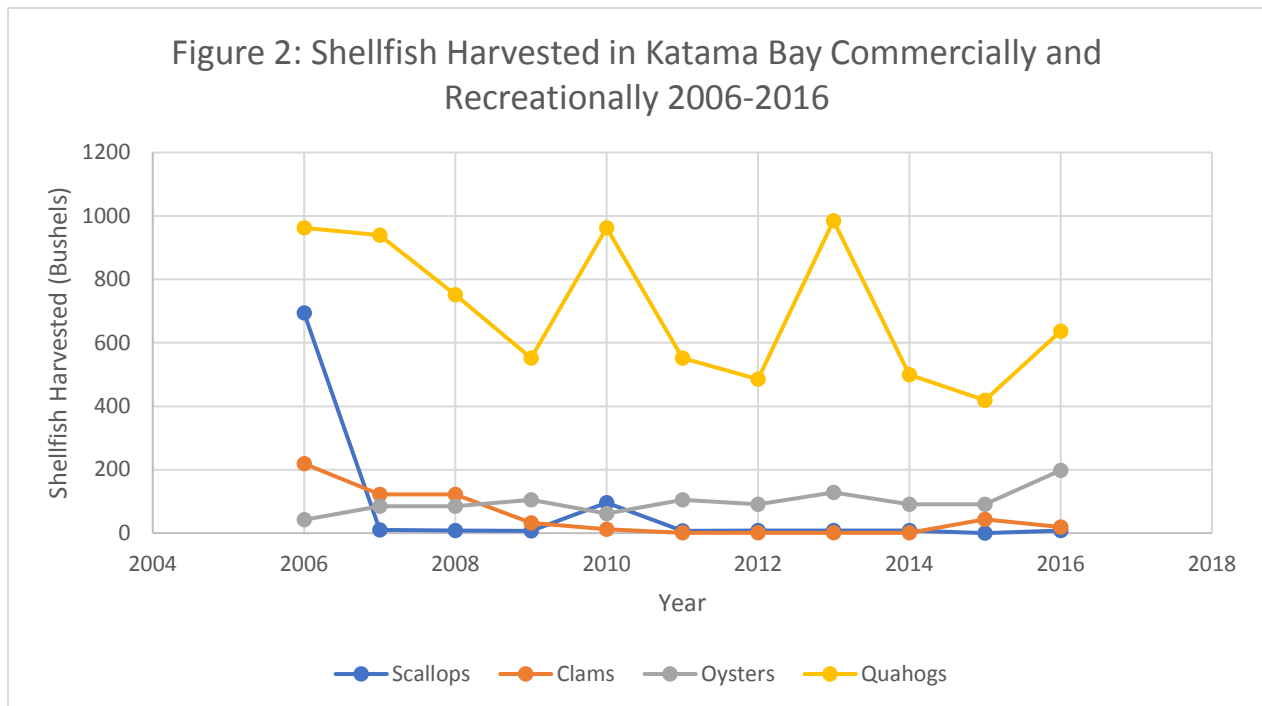
In April of 2007, extreme storm conditions caused a breach in Katama Bay's southern barrier beach, Norton Point, disconnecting Chappaquiddick from the rest of the island. The result was an immediate cleansing of silt and grass buildup, as well as salt water and nutrient circulation for shellfish populations.

The beach was part of a natural cycle and it moved eastward towards Wasque point, ocean water eroding the coast and threatening houses.

The natural breach of Norton Point improved tidal flushing conditions in Katama Bay which are essential to the Bay’s shellfish population. Oyster, Scallops, and Clams experienced a return to water quality equilibrium and harvest numbers flourished. There are over 12 aquaculture farms in Katama, and the worth of Oysters harvested in Katama in 2014 was estimated at \$1.4 million. The shallow waters in the Southern part of the Bay, and the strong tidal flow create a perfect environment for shellfish.

Katama Bay has been dredged around its heavily used town boat ramp and channel in 2006 and again in 2016. Because of the shallow depths in the southern portion of Katama Bay, it has become difficult and dangerous for boats to exit the boat ramp and travel up through Edgartown Harbor or into Katama for shell fishing. Excavating the area around the ramp has improved navigability. Dredging in Katama has also opened up shallower areas, increasing circulation for shellfish.

Figure 2 below displays the commercially and recreationally caught bushels of Katama Bay shellfish from 2006-2016, indicating trends in shellfish population throughout the years. Bay scallops and quahogs are the species in Katama that are of greatest economic importance.



As seen in Figure 2, the Quahog population in Katama Bay has the highest harvests reaching peaks of 900 bushels per year, followed by Oyster harvests reaching almost 200 bushels per year at points. However, scallop harvests, especially after 2006, and clam harvests have not been as successful within Katama Bay.

After dredging the Katama boat ramp and channel in the winter of 2016, the summer shellfish harvest saw a slight upturn in quahogs and oysters. From approximately 90 bushels of oysters caught from 2014-2015, there was an increase to 198 bushels in 2016. Quahog numbers from approximately 450 bushels in 2014-2015 rose to about 630 bushels in 2016. The rise in shellfish harvest can be associated with water quality and circulation benefits that dredging brings about in a water body.

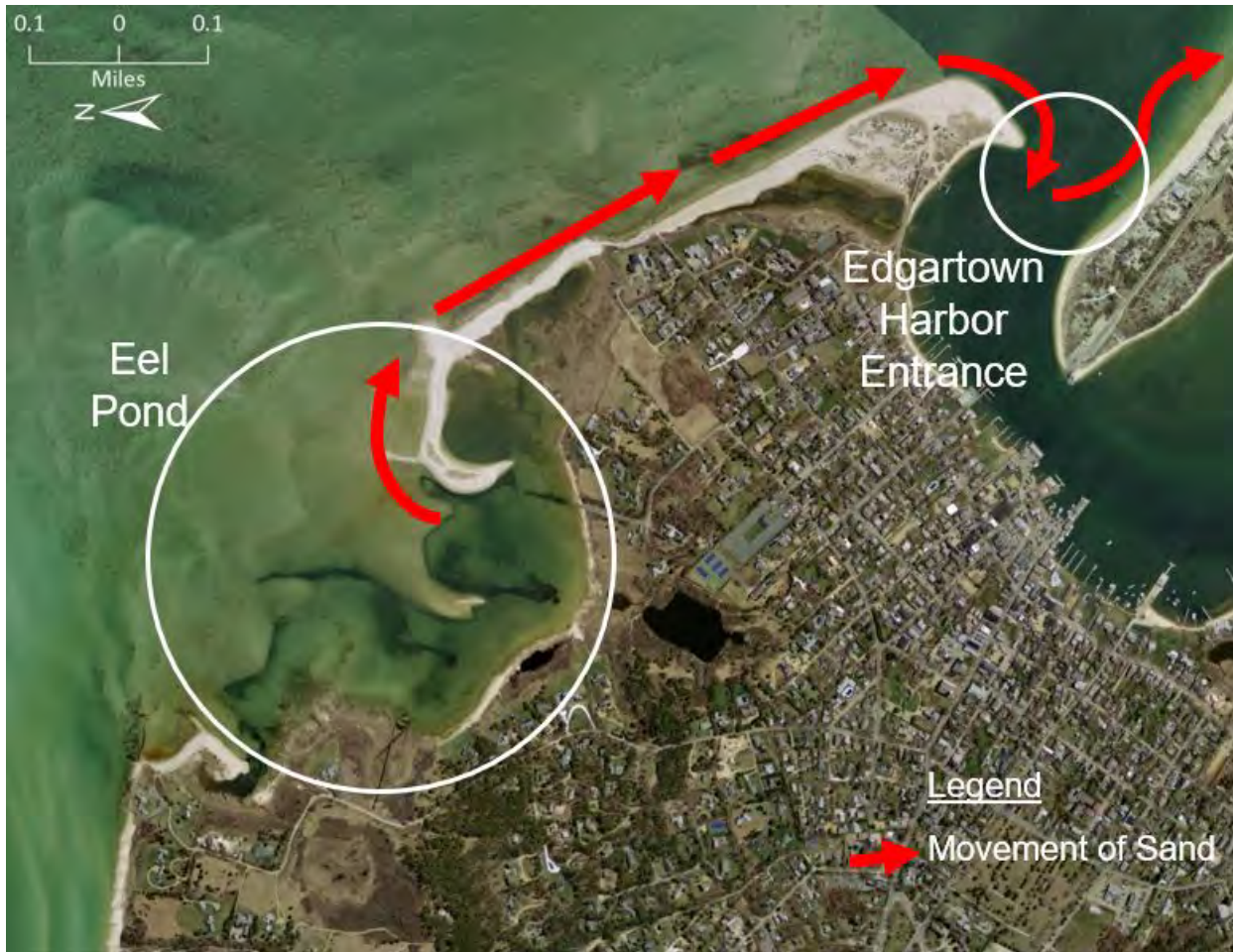
Katama Shellfish Numbers (Bushels)				
Year	Scallops	Clams	Oysters	Quahogs
2006	694	219	42	962
2007	10	122	85	939
2008	8	122	85	752
2009	7	32	105	552
2010	96	12	62	962
2011	7	1	105	552
2012	8	1	91	485
2013	8	1	128	985
2014	8	1	91	499
2015	0	43	91	419
2016	8	19	198	637

Eel Pond/ Edgartown Harbor



Edgartown Harbor is the oldest harbor on the island and experiences the most boat traffic in Edgartown with approximately 1,000 vessels coming in on an average summer day. The Harbormaster manages around 50 transient moorings that handle ships up to 65 feet tall. The Harbor, with its mooring and docking fees, contribute to the economic stability of Edgartown. The scenic and historic nature of the Harbor gives it the name of “village waterfront” within the Edgartown Harbor Plan. Maintaining safe navigability and access to the Harbor is essential to the natural heritage of the Town.

Throughout the past few years, shoaling and the transport of sand around the Edgartown Lighthouse peninsula has caused a depth change from approximately 31 to 17 feet in the entrance channel to Edgartown Harbor, with some areas reaching as low as 15 feet. This has prevented larger boats, including luxury yachts, from entering the harbor. In 2014, the Edgartown dredge excavated 8,400 yd³ from the entrance in an effort to amend the situation. In 2017, the Dredge Advisory Committee began the process of integrating an additional permitted dredging amount for the entrance channel into the 10-year Comprehensive Permit working with CLE Engineering. Surveys and assessment of impact for eelgrass, shellfish, and nesting shorebirds are underway and the Committee anticipates dredging to occur in the next couple of years.

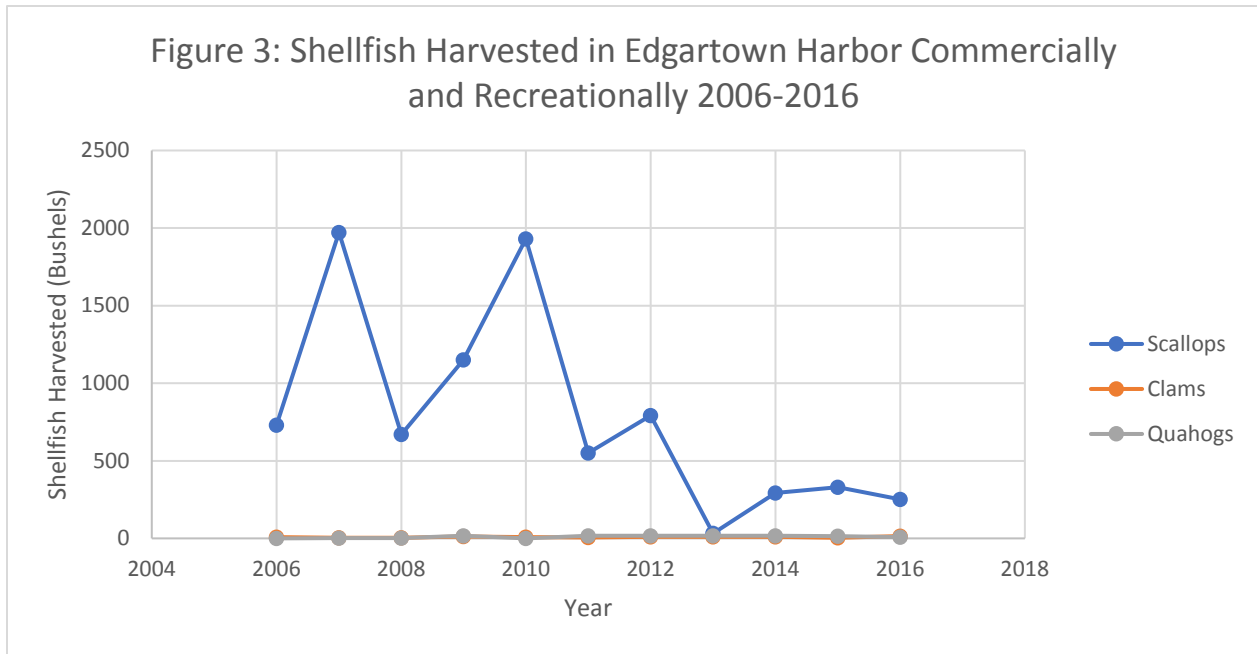


Another embayment within the Edgartown Harbor region is Eel Pond, a small pond with a large opening to the Nantucket Sound, but somewhat sheltered by a thin arm extending from the Edgartown Lighthouse peninsula. This pond has experienced a large buildup of silt, sand, and grasses on the eastern side of the pond, blocking access to many moorings. Sand from the buildup is carried from eastern Eel Pond, around the Edgartown Lighthouse peninsula, and then accumulates in the entrance to Edgartown Harbor. This process of sand movement is illustrated in the map above.

Eel Pond is in close proximity to a location that is in great need of nourishment, Fuller Street Beach. Fuller Street Beach, a target of severe winter storms, is being eroded back to the line between the public and private beach. Failure to restore sand to this beach will result in a priceless loss of Town property and popular public beach. Therefore, approximately 8,400 yd³ were excavated from Lighthouse Point and brought to Fuller Street beach in 2014. In 2016, approximately 4,000 yd³ were pumped through 3,500 feet of pipe to Fuller Street beach. Material has also been brought from Edgartown Great Pond for nourishment, and Fuller Street Beach will continue to erode and require nourishment every couple of years.

Eel Pond has not historically been a location with substantial shellfish populations. However, in 2014, two farming operations set up oyster populations in the middle flats, a quarter of a mile from the interior. The expansion of shellfish operations may be viable in the near future for Eel Pond, especially as a refuge from

Vibrio infections that have occurred in Katama in recent years. Edgartown Harbor, on the other hand, has historically housed large bay scallop populations. Figure 3 below illustrates the trends of the bay scallop harvest in Edgartown Harbor from 2006-2016.



Edgartown Harbor Shellfish Numbers (Bushels)				
Year	Scallops	Clams	Oysters	Quahogs
2006	731	9	0	0
2007	1,972	5	0	2
2008	671	5	0	2
2009	1,150	12	0	17
2010	1,931	9	0	0
2011	550	6	0	17
2012	792	11	0	17
2013	32	11	0	17
2014	292	11	0	17
2015	329	4	0	14
2016	252	15	0	8

As seen in Figure 3, the shellfish in Edgartown Harbor were flourishing in years prior to 2013, averaging harvests at approximately 1,110 bushels and peaking at almost 2,000 bushels. Diminished water quality and decreased salt water flow from the Edgartown Harbor entrance have caused a rapid decline in bay scallop harvests from 2013 to the present.

The total maintenance dredging volume for seven areas of Edgartown Harbor is 44,015 yd³. The primary reason for dredging in these areas is for navigational safety for commercial and recreational boats, especially for shell fishing. The most critical areas that have restrained access are the Katama boat ramp, the Harbor entrance area around Lighthouse Point, and Eel Pond boat ramp. Dredging in these regions

also allows greater access to emergency boats that may often have to respond to a boat fire or injury in this heavily populated area.

Species of shellfish that inhabit or contain potential habitats in these regions are commonly bay scallop, quahogs, and soft-shelled clams. Quahog populations are particularly essential within Katama Bay where peak numbers of approximately 900 bushels have been harvested. Within Edgartown Harbor, profitable bay scallop populations have previously existed in large numbers and populations could potentially rebound. Especially within these locations, precautions are taken not to dredge within shellfish beds and the relocation of beds is a viable option. Eelgrass is present within Eel Pond and sporadically throughout Katama Bay, but no dredging work is done within eelgrass beds.

Locations within Edgartown Harbor	Volume Dredged	Depth Dredged (below MLW)	Area over which Dredged	Reason for dredging (Navigational importance)	Species within Dredging Location	Specific Precautions for Dredging
Eel Pond Channel and Ramp	3,200 yd ³ 800 yd ³	4 feet 2.5 feet	59,000 yd ² 10,000 ft ²	Maintenance	Within quahog and American oyster suitability area	No eelgrass beds in project areas
Lighthouse Point	8,400 yd ³	7 feet	50,990 ft ²	Navigational safety entering Edgartown Harbor	Within bay scallop and quahog suitability areas	No shellfish within project areas
Inner Harbor	8,500 yd ³	6 feet	113,000 ft ²	Navigation in mooring area off Chappaquiddick Point	Within bay scallop and quahog suitability Areas	No shellfish within project areas
Collin's Beach	2,150 yd ³	6 feet		Navigation for commercial and recreational vessels		
Caleb's Pond	8,400 yd ³	4 feet	92,000 ft ²	Navigation for commercial and recreational shellfish	Within bay scallop, quahog, and soft shelled clams suitability areas	No shellfish within project areas
Katama Boat Ramp	9,390 yd ³	5 feet		Maintain area around boat ramp and navigation	Within bay scallop, quahog, and soft shelled clams suitability areas	No shellfish within project areas
Katama Channel	3,975 yd ³	5 feet	50,094 ft ²	Shoaling causes shallow area of 1-2ft depth throughout southern part of Bay	Within bay scallop and quahog suitability areas	No shellfish within projects areas

The total nourishment area for all four nourishment areas in Edgartown Harbor is 320,700 ft². Sand may be placed on beaches for nourishment only between the dates of November 1st and April 1st to maintain compliance with Town of Edgartown restrictions. Deposits of sand from dredging will be used to replenish beaches damaged by storm erosion and will restore habitats for endangered shorebirds.

Endangered avian species most commonly found in these locations are the piping plover, least terns, and common terns as listed species; and the American Oystercatcher as non-listed species. The Eel Pond location and the Norton Point locations have migratory bird species that stop-over for a few months, including the semi-palmated plovers, greater yellow legs, dunlin black-bellied plovers, semi-palmated sandpipers, and various other species. These and the more permanent shorebird species both rely on the undisturbed dune areas for survival.

Various precautionary techniques are utilized in order to ensure that endangered shorebird species are not being negatively impacted. As required by the Conservation Commission Order of Conditions, silt barriers are put up to protect salt marsh habitat from destruction. Specifically on Norton Point beach, Fuller Street beach, and Eel Pond, nourishment material is deposited at a specific 10:1 slope in order to ensure that the dunes are adequate for bird nests. Coordination with the Conservation Commission is also necessary to ensure that pipe placement on the beach does not disturb essential dune vegetation. Dune nourishment, however, in the long-term benefits shorebirds that may otherwise have their nesting areas eroded by storms.

Location within Edgartown Harbor	Volume Nourished	Area Nourished over which Tide Line	Bird/Vegetation Species within Nesting Area	Time of Year Restrictions for Species	Specific Precautions to Protect Species
Eel Pond	1)1,800 yd ³ 2)1,400 yd ³	1) 19,500 ft ² above HTL 2) 9,700 ft ² above HTL	-Sheriff's Meadow within piping plover, least terns, common and roseate terns, black skimmer, and willet habitat ₂ -Migratory birds ₂	November 1 st to April 1 st	-Sheriff's Meadow Beach: 10:1 slope ₂ -Minimize impact of pipes on beach vegetation ₂
Fuller Street (Lighthouse) Beach		1) 74,580 ft ² above MHW 2) 7,420 ft ² below MHW	Within habitat of Piping Plover and American Oystercatcher ₂	November 1 st to April 1 st	-Nourishment above MHW: 10:1 slope
A-D, F (NSA-D,F) (NSE) Within Edgartown Inner Harbor		1) 27,375 ft ² above HTL 2) 8,575 ft ² from MHW-HTL 3) 20,300 ft ² from MLW-MHW	-Sites B-D possible American Oystercatcher ₂ -Sites D, F Osprey ₂	November 1 st to April 1 st	-Nourishment placed landward of MHW of nourishment sites

NSNB Norton Point Beach		153,500 ft ² above HTL	-Piping plovers, least terns, common terns, roseate terns, black skimmers, saltmarsh sparrows ₂ -Migratory species ₂ -Sea-beach knotweed ₂	November 1 st to April 1 st	-Beach slope: 10:1 for shorebird habitat -Minimize impact of pipes on beach vegetation
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Text₂: Information Sourced from MV Biodiversity works Liz Baldwin

Sengekontacket:



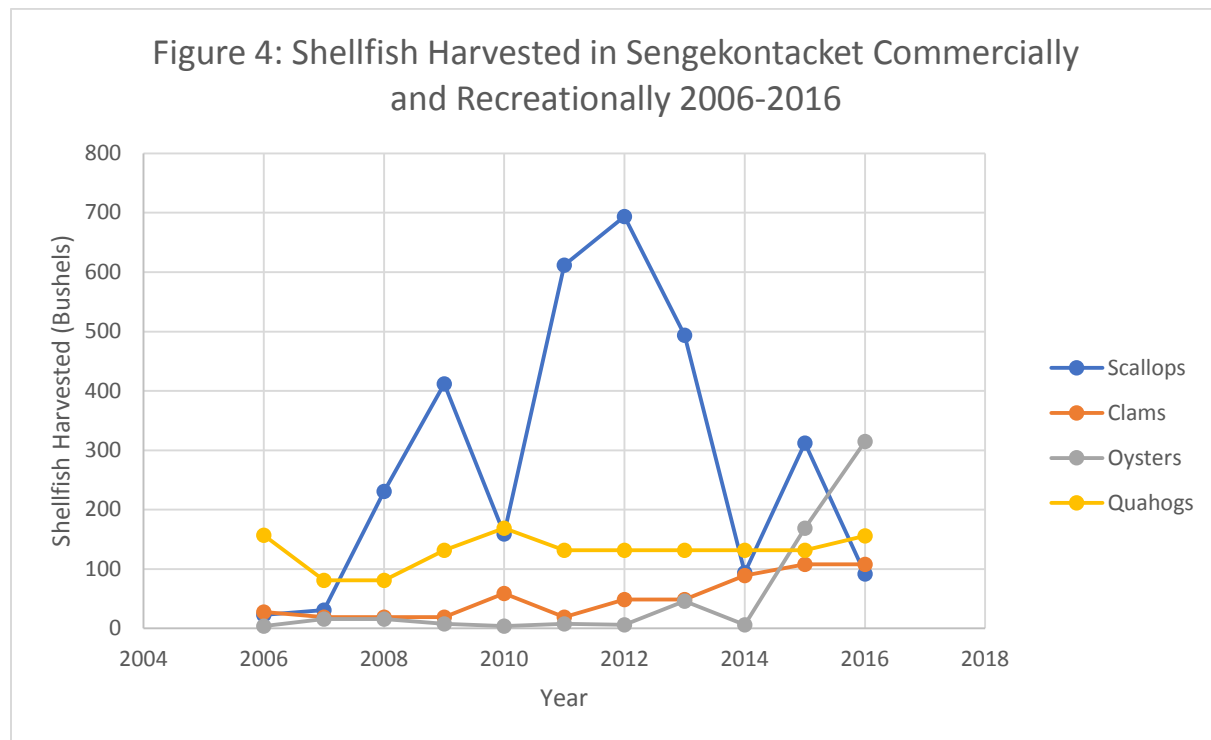
Sengekontacket is a 726-acre pond located directly landward of Joseph Silvia State Beach and Bend in the Road Beach, separated by State Beach Road by an extensive salt marsh and dune system. The eastern side of Sengekontacket belongs to Edgartown while the western side belongs to Oak Bluffs with a small section of its watershed in West Tisbury. The pond contains two inlets to Nantucket Sound, under the first and second bridge, that allow tidal flushing twice per day.

Sengekontacket, with its ideal flats and mean depth of only 3 feet, is ideal for shell fishing and other recreational activities. The Martha’s Vineyard Commission categorizes Sengekontacket Pond as Impaired Water Quality, with declining eelgrass and an expansion of wrack algae. Nitrogen levels are also very high in the inner areas of the pond, primarily in Major’s Cove and Trapp’s Pond.

In 1988, the entirety of Sengekontacket Pond was closed to shell fishing by the Massachusetts Division of Marine Fisheries for high coliform levels within the pond. A multitude of possible reasons for this closure were proposed, but a study in 1989 done by the Woods Hole Oceanographic Institute showed that failed septic systems in coastal homes, fertilizer runoff, and waste from the multitude of birds in the pond together overcame the pond’s ability to flush out contaminants.

Towards the beginning of the Edgartown Dredge Program in 1996, a dredging solution was formulated for Sengekontacket, recognizing that a buildup of sand in Borrow Area 1 and around first bridge (Big Bridge) was inhibiting the flushing ability of the pond. Excavating sand from those areas almost immediately improved circulation in the pond and decreased bacteria counts. To prevent this dangerous accumulation of bacteria and stagnation of the pond from reoccurring, Sengekontacket has become a dredging priority, especially in the project from 2008-2011.

Figure 4 below shows the shellfish caught recreationally and commercially in Sengekontacket from 2006 to 2016. Like Katama Bay, Sengekontacket Pond is one of the only water bodies in Edgartown that is home to bay scallops, soft shelled clams, oysters and quahogs.



As shown in Figure 4, the bay scallop population peaked in 2012, coming in at a whopping 694 bushels, a noteworthy increase from 159 bushels in 2010 and 31 bushels in 2007. This peak was followed by a gradual decline, to 494 bushels in 2013 and 94 bushels in 2014. The oyster harvests are significantly on the rise in recent years, multiplying their numbers nearly seven-fold from 2013 to 2016, from 46 bushels to 315

bushels. Soft shelled clam harvests are also slightly on the rise, but not as sharply as the oyster catches. The average harvest for clams in Sengekontacket averaged about 21 bushels from 2006 to 2009, which increased to an average of about 80 bushels from 2012 to 2016, topping out at 108 bushels in 2015 and 2016. The quahog harvests have maintained steadily, averaging 130 bushels per year for the entire time period.

Sengekontacket Shellfish Numbers (Bushels)				
Year	Scallops	Clams	Oysters	Quahogs
2006	23	28	4	157
2007	31	19	16	81
2008	231	19	16	81
2009	412	19	8	132
2010	159	59	4	169
2011	612	19	8	132
2012	694	49	6	132
2013	494	49	46	132
2014	94	89	6	132
2015	312	108	169	132
2016	92	108	315	156

Throughout the three-year extensive process of dredging Sengekontacket Pond, 67,000 yd³ were dredged from the Borrow Area 1 by second bridge; 57,000 yd³ were dredged from the inside channel on the Oak Bluffs side; and an additional 6,500 yd³ were dredged in the Borrow Area 2 and Little Bridge Outside Channel combined. Oak Bluffs and Edgartown formed their first dredging partnership working towards a goal of improving tidal flow through Sengekontacket’s two openings for the greater health of the pond. Oak Bluffs was singularly responsible for funding the permitting cost for dredging, but received the work itself from the Edgartown dredge pro-bono.

Sand from the dredged areas served a dual purpose of nourishment for the delicate and storm-eroded beaches across from Sengekontacket. Between Silvia State Beach, Cow Bay Beach, and Bend in the Road Beach, a total area of 1.01 million ft² was nourished. Private dunes such as Cow Bay for two reasons, the significant funding of permitting and dredging costs from the Cow Bay Association and the adjacent dune support for Bend in the Road Beach. A shaping idea behind beach nourishment was that the Town beaches could not singularly be nourished and have long term stability without bolstering support from the whole system of beaches.

The total dredging volume of all four areas within Sengekontacket Pond, broken down in the chart below, is 130,500 yd³, the greatest amounts being within Borrow Area #1 and Sengekontacket Channel. Navigational safety for shell fishing access, and the immense number of recreational boaters influence the importance for dredging in Sengekontacket Channel. The dredging of Borrow Area #1 and Little Bridge Outside Channel were the most significant in improving tidal flushing. The high dredging volume in these areas was tied to the great need for nourishment material on the lengthy eroded barrier beaches on the other side of Beach Road.

Location within Sengekontacket	Volume Dredged	Depth Dredged	Area over which Dredged	Reason for Dredging (Navigational Significance)	Species Within Dredging Location	Specific Precautions for Dredging
Borrow Area #1	67,000 yd ³	3 feet	720,000 ft ²	-Nourishment of Cow Bay and Bend in the Road Beach -Horseshoe crab breeding area	-Within bay scallop, quahog, and soft-shelled clam suitability areas	-No dredging within shellfish or eel grass beds -No dredging in horseshoe crab breeding season
Borrow Area #2	2,500 yd ³	3 feet	147,814 ft ²	-Nourishment of Cow Bay and Bend in the Road Beach		
Little Bridge Outside Channel	4,000 yd ³	5 feet	12,000 ft ²	-Increased pond tidal flushing -Beach nourishment	-Within bay scallop and quahog suitability areas	-No dredging within shellfish or eel grass beds, relocation -Silt barrier to protect salt marsh
Sengekontacket Inside Channel	57,000 yd ³	5 feet	832,000 ft ²	-Navigational safety shell fishing -Beach Nourishment -Horseshoe crab breeding area	-Within bay scallop and quahog suitability areas	-No Dredging within shellfish or Eel Grass beds/ Shellfish relocation -No dredging in horseshoe crab breeding season

Potential habitat in many regions of Sengekontacket Pond are primarily well suited to scallops, quahogs, and soft-shelled clams. Horseshoe crabs are also a listed species of concern along the coastline of Sengekontacket Pond, but primarily breed in the months of May and June. The seasonal restriction for Sengekontacket from November 1st-April 1st for endangered shorebirds also avoids disrupting shellfish breeding season.

The total nourishment area for all three locations within the Sengekontacket Pond region, broken down in the chart below, is approximately 728,000 ft². Nourishment slope and design remains consistent throughout all three locations to ensure entire system support. Species within the dune habitats that are nourished include primarily piping plovers, least tern, common tern, and American oystercatchers. Many of these species' habitats have been disrupted by storm surges that wash over the dunes and onto

Beach Road. Therefore, deposition of material in these locations will ensure that species' habitats will remain intact.

Locations within Sengekontacket	Area Nourished over which Tide Line	Bird/Vegetation Species within Nesting Area		Time of Year Restrictions for Species	Specific Precautions to Protect Species
Silvia State Beach (SBNS)	1) 464,749 ft ² above HTL 2) 19,278 ft ² below MTL	-Piping plover, Least tern, common tern, American oystercatcher nesting and foraging areas ₃		November 1 st -April 1 st	-Maintenance of temporary groins placed in 1997 for storm protection -Consistent nourishment design with Bend in the Road beach for longevity -Piping plover nesting sites demarcated
Bend in the Road Beach (BITRNS)	1) 23,957 ft ² above HTL 2) 47,917 ft ² below MHW	-Piping plovers, common tern, least tern nest adjacent to beach ₃ -Potential for future nesting in the area ₃ -American oystercatchers ₃		November 1 st -April 1 st	-Consistent nourishment design with Silvia State for longevity
Cow Bay Dunes (CBNS)	175,113 ft ² above MHW	-Piping plover, least tern, common tern ₃ -Trapp's Pond habitat protected by Cow Bay Dunes ₃	November 1 st -April 1 st	-Consistent nourishment design with Silvia State for longevity -Piping plover nesting sites demarcated	

Text₃: Information sourced from Suzan Belencampi from Felix Neck Reserve

Edgartown Great Pond



Edgartown Great Pond is a 544 to 840-acre embayment on the southern side of the island with a barrier beach separating it from the Atlantic Ocean and many long fingers extending inland. The pond is bordered by many residences, and the Great Pond Foundation was founded in 1998 partnering with the Town of Edgartown to perform water quality monitoring and dredging within the pond. Water quality has fluctuated with the duration of openings in the barrier beach, but the Martha's Vineyard Commission categorizes this pond as impaired water quality with small amounts of eel grass present.

Of Edgartown's major waterways, Edgartown Great Pond is unique in that it is three feet higher than sea level, supplied from an underground reservoir of fresh groundwater. This adds extra considerations for dredging and the opening of the pond. A long pond opening depletes the reservoir of groundwater, which must refill itself before the pond can rise high enough to be opened again. There is a trade-off between the duration of the pond openings and their frequency, there is not enough groundwater to have long pond openings multiple times per year.

Since 2008, the Great Pond Foundation's dredge has done maintenance work within regions like Herring Creek. However, in 2012, after Hurricane Sandy, forceful tides washed over the pond's southern barrier beach and created a tidal delta. The Great Pond Foundation's dredge has a much smaller capacity for dredging volumes, so it was necessary for the Edgartown Town Dredge to remove material built up by the

hurricane. As seen in the map above, a majority of the dredging was done in the Sluiceway approach and the Great Pond Delta and Channel, about 9,800 yd³ in each location, with dredging also in Wilson’s Landing and Herring Creek.

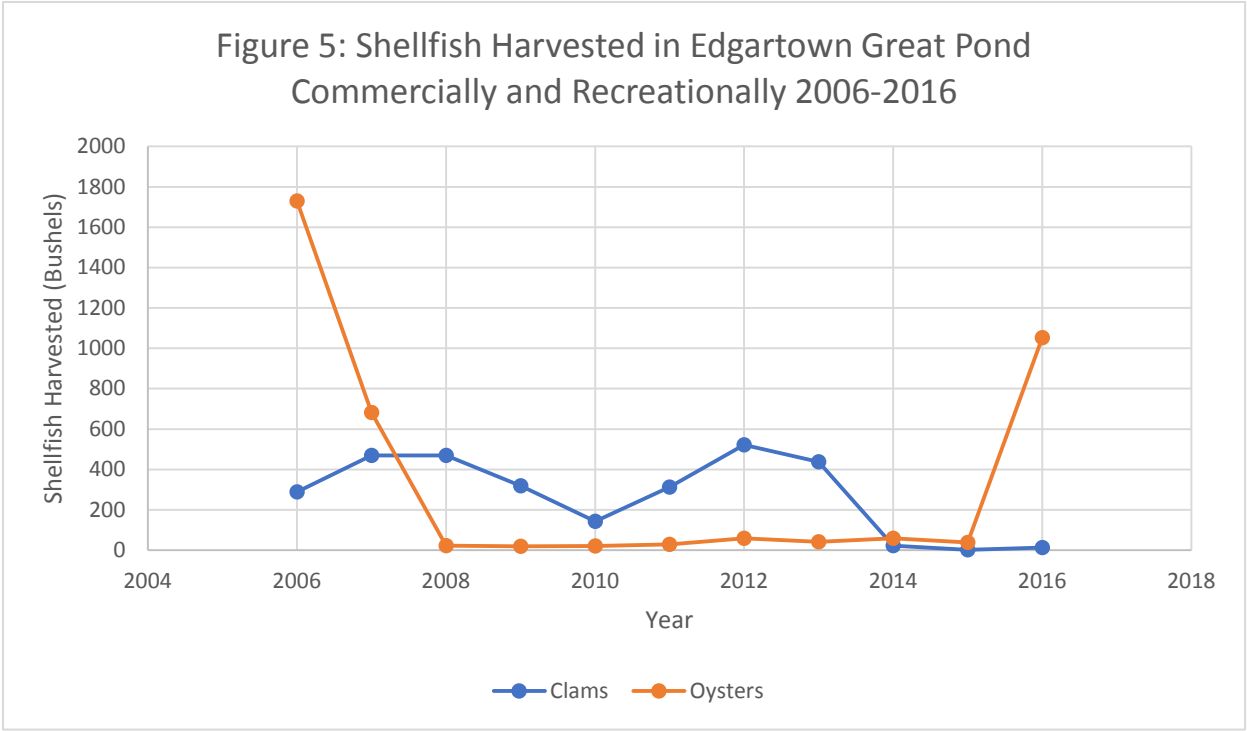
As seen in the chart below, a total volume of 25,900 yd³ of material was excavated from the four areas of Edgartown Great Pond dredged. The dredged material was used for beach nourishment. One of the more essential areas for dredging was the Great Pond Channel, which allowed ocean water to flow into the pond, flushing out silt buildup and increasing the circulation in the pond. The Sluiceway Approach and Herring Creek are fish runs with great historical successes, but have been clogged by vegetation and silt build up throughout past years.

Location Within Edgartown Great Pond	Volume Dredged	Reason for Dredging (Navigational Importance)	Species within Dredging Location	Specific Precautions for Dredging
Great Pond Ramp	500 yd ³	Maintain town owned boat ramp, Wilson’s Landing	Within American oyster and soft shelled clam suitability area	Work done April 1 st -July 31 st with monitoring of shorebirds and consultation with the Conservation Commission
Great Pond Channel	9,800 yd ³	-Create outlet to Atlantic Ocean -Enhance marine fisheries and tidal flushing	Within American oyster and soft shelled clam suitability area	Work done April 1 st -July 31 st with monitoring of shorebirds and consultation with the Conservation Commission
Sluiceway Approach	9,800 yd ³	-Maintain approach to Herring Creek	Within American oyster suitability area	Work done April 1 st -July 31 st with monitoring of shorebirds and consultation with the Conservation Commission
Herring Creek Restoration	5,800 yd ³	-Maintain restored historic anadromous fish way	-Native species: Anadromous fish - Within American oyster and soft shelled clam suitability area	-Nuisance species removed (by hand) -Native species replanted

The total nourishment area for the two locations in Edgartown Great Pond is 223,900 ft². A great majority of nourishment material is placed on South Beach, approximately 212,000 ft². Material placed on South Beach must be compatible with the sand type and can only be taken from certain locations, such as the Sluiceway Approach and Great Pond Channel. Nourishment work can only be done between the months of September 1st and February 28th so as to not disturb endangered shore bird species.

Location within Edgartown Great Pond	Area Nourished over which Tide Line	Bird/Vegetation Species within Nesting Area	Time of Year Restrictions for Species	Specific Precautions to Protect Species
South Beach (SBNS)	1) 85,640 ft ² above HTL 2) 72,143 ft ² from MHW to HTL 3) 55,847 ft ² from MLW to MHW	-Within actual habitat of endangered shorebirds -Nuisance vegetation problematic	September 1 st -February 28 th	-Only permitted compatible material from Sluiceway Approach, Great Pond Channel, and Herring Creek Restoration -Invasive vegetation disposed of upland -Beach slope: 10:1 and no vegetation planting
Great Pond Boat Ramp (Wilson's Landing)	10,270 ft ² above HTL	-Within actual habitat of endangered shorebirds	September 1 st -February 28 th	-Disposal only permitted when pond is low -Beach slope: 10:1

Figure 5 below shows the trends in soft shelled clam and oyster harvests in Edgartown Great Pond from 2006 to 2016. Due to the brackish water, Edgartown Great Pond is not a suitable habitat for saltwater organisms like bay scallops and quahogs.



The oyster population severely declined from 2007 to 2008, with a harvest of 1,729 bushels in 2006 dropping to 681 bushels in 2007 and only 22 in 2008. These numbers remained low from 2009 to 2015, with a slight increase in 2016.

averaging about 37 bushels per year during that time. The oyster harvests in 2016 indicate that the numbers may be reaching their old glory, with a harvest of 1,052 bushels. The clam harvests fluctuated slightly from 2006 to 2013, averaging 370 bushels per year with a significant drop in 2014, of only 22 bushels and an all-time low of two bushels in 2015.

Edgartown Great Pond Shellfish Numbers (Bushels)				
Year	Scallops	Clams	Oysters	Quahogs
2006	0	289	1,729	0
2007	0	470	681	0
2008	0	470	22	0
2009	0	318	19	0
2010	0	143	20	0
2011	0	313	29	0
2012	0	522	59	0
2013	0	438	41	0
2014	0	22	59	0
2015	0	2	38	0
2016	0	12	1,052	0

Permitting

Dredging is one of the most highly regulated activities in Massachusetts. The removal and placement of materials in nearshore and offshore are intensely supervised. There continues to be numerous agencies at all levels of government who have some responsibility for permitting, funding and implementing these projects. Each of the agencies involved have different jurisdictions, both in terms of political boundaries and separate focuses on protecting natural resources that can be impacted by dredging. The permitting process could include the following agencies: Edgartown Conservation Commission, Massachusetts Environmental Policy Act (MEPA), the Massachusetts Department of Environmental Protection (DEP), and its Divisions of Water Pollution Control (WPC), and Wetlands and Waterways (DWW), Massachusetts Coastal Zone Management (MCZM), the U.S. Army Corps of Engineers (COE), the U.S. Environmental Protection Agency (EPA), and a number of other agencies by an advisory role to these agencies. Since the original Dredge Plan was approved by the State, the Martha's Vineyard Commission no longer reviews projects that are part of the accepted municipal plan. Water is subject to a myriad of regulations.

One of the larger issues with the dredge program has been finding permissible dredge sediment disposal areas. This has been a problem particularly from the downtown area out to Katama Bay. Cooperation between Town boards and Commissions is essential to an efficient and effective dredge program.

In general, many of the environmental agencies may be reviewing a project simultaneously. As a general rule, the permitting issuance sequence will start at the local level and proceed through regional, state and federal agencies. Review documents, such as the Notice of Intent, may be submitted simultaneously to several agencies, although the issuance of the permits must be in a specific order (see MCZM Project Review Chart).

A project would require a State permit through the Massachusetts Environmental Policy Act, for instance, if the project would impact ½ acre or more of any wetlands. The Notice of Intent (NOI) would be filed with the local Conservation Commission, who would issue an Order of Conditions. The Martha's Vineyard Commission does not automatically review these projects as a Development of Regional Impact (DRI) because it is a part of the approved Dredge Plan.

No State or local permits or licenses can be issued before the MEPA process is complete. The MEPA process is only an information gathering process that determines the adequacy of information for agencies to evaluate the environmental impacts. When the MEPA certificate declares that the information is complete, then State agencies can begin their review. The Department of Environmental Protection (DEP), Division of Watershed Management Water Quality Certificate (WQC) is the next permit in sequence with the DEP, Wetlands and Waterways Program (WWP). The Ch. 91 Waterways permit follows. It should be noted that the Waterways permit requires notification and response from the local Planning Board, Town Clerk, and Harbormaster. The last approval is the Massachusetts Coastal Zone Management (MCZM) Federal Consistency Review (FCR). This review cannot be completed until all other State approvals have been acquired.

Once the State approvals are in place, the Federal permits can be issued. The United States Army Corps of Engineers (COE), is the primary agency with Section 10, Section 404, and Section 103 permits. The COE regulates projects in Massachusetts under a Programmatic General Permit and an Individual Permit process. The COE reviews projects jointly with the U.S. Environmental Protection Agency (EPA), the U.S.

Fish and Wildlife Service (USFWS), and the National Marine Fisheries Service (NMFS). The EPA has veto power over Section 103 permits.

Timeframes for permitting are subject to changes based on the complexity of the project and conditions discovered during the assessment and review process. With a straight-forward project, the local process is estimated to take 45 days, the State process approximately six to eight months, and the Federal process two months. These periods do not include time for preparing submittals. And while the MCZM estimates six to eight months for a non-controversial project, one to two years is a more realistic period for town planning purposes for any project of magnitude.

LIST OF REQUIRED PERMITS

- A. Local
 - a. Conservation Commission (Includes local Wetlands By-Law)
 - i. Application Form: Notice of Intent
 - ii. Permit: Order of Conditions, valid for 3 years can be extended to 5. If requested for maintenance dredging, can be valid for 10 years.
 - iii. Statute: M.G.L. C.131 S.40
 - iv. Regulation: 310 CMR 10
- B. Regional
 - a. Martha's Vineyard Commission - possible
 - i. Application Form: Notice of Intent
 - ii. Permit: Development of Regional Impact
 - iii. Statute: Enabling Legislation Ch.831
- C. State
 - 1. Massachusetts Department of Environmental Protection
 - a. Division of Water Pollution Control, WQC (maintenance and new)
 - i. Application Form: Standard Application
 - ii. Permit: Water Quality Certificate
 - iii. Statute: M.G.L. Ch.21 S.26-53
 - iv. Regulations: 314 CMR 9.00; 33 United States Codes 1341 S.401
 - b. Waterways Regulation Project, Ch.91 permit (maintenance for 10 years)
 - i. Application Form: Standard Application
 - ii. Permit: Chapter 91 Waterways Permit
 - iii. Statute: M.G.L. Ch.91
 - iv. Regulations: 310 CMR 9.00
 - 2. Mass Environmental Policy Act (MEPA)
 - a. Thresholds: if greater than 10,000 cubic yards of dredged material, requires an Environmental Notification Form (ENF); if greater than 10 acres of resource area impacted, requires an Environmental Impact Statement.
 - i. Application Form: Environmental Notification Form; Environmental Impact Statement
 - ii. Permit: Certificate of the Secretary of the Executive Office of Environmental Affairs
 - iii. Statute: M.G.L. Ch.30 S.61-62H
 - iv. Regulations: 301 CMR 11.00

3. Mass Coastal Zone Management (MCZM), Federal Consistency Review (FCR)
 - a. Regulatory policies impacted; non-regulatory policies
 - i. Application Form: Consistency Certificate and Federal Permit Application
 - ii. Permit: Federal Consistency Concurrence
 - iii. Statute: CZMA, 1972 76, 90; MCZMA, 1978
 - iv. Regulations: 301 CMR 21.00; 301 CMR 20.00; 15 CFR Part 930
4. Natural Heritage and Endangered Species Program (as part of WPA process)
5. Mass Historical Commission (as part of WPA process)

D. Federal

- a. U.S. Army Corps of Engineers (COE)
 - i. Application Form: Notice of Intent (same as Wetlands Protection Act), or standard application
 - ii. Permit: Section 10; Section 404 fill; Section 103 transport; Programmatic General Permit Process (PGP)

Under the PGP, the project is classified as: non-reporting, screening or individual permit. If the project requires an individual permit, a joint review will be conducted by the ACOE, USEPA, NMFS, and USF&W. The Corps considers the other agencies' comments in its decision.

- iii. Statute: Rivers and Harbors Act; Clean Water Act of 1977; Marine Sanctuaries Act
- iv. Regulations: 33 CFR Parts 320-330

Testing (Sampling) Requirements

State

- a. Agency: DEP, Division of Water Pollution Control (Classification of Materials and approvable dredging, handling and disposal options are contained in 314 CMR 9.03. See attachments)
 - i. Grain Size Analysis: A complete grain size analysis of the dredge material is required. A single pooled representative analysis will be analyzed initially. Based on project specifics, further sampling may be required.
 - ii. Chemical Analysis of Sediment: A complete bulk analysis of the dredge material is required. A singled pooled representative sample will be analyzed initially. Based on the specifics of the project, more samples and analysis may be required.
 - iii. Supplemental Information may be required, including additional chemical sampling and clinical analysis.
 - iv. Special Requirements for Dredge Material to be Reused or Disposed at Landfills (see Interim Policy #Comm-94-007)
 1. Sampling analysis and frequency include: 1 core sample for each 1,000 cubic yards; minimum of 2 cores in all cases; up to 3 cores may be composited for analysis, but a minimum of two analytical data sets must be presented representing the sediment volume to be dredged.

2. Sediment analysis for reuse or disposal at landfills: sediment conductivity test for reuse at unlined landfills (ATSM g-57, see attachment).

Federal

Borings and sediment sampling and testing must be consistent with ACOE/EPA February 1991 publication, Evaluation of Dredged Material Proposed for Ocean Disposal, and the ACOE/EPA Regional Protocols for Performing Tests on Dredged Material to be Disposed of in Open Waters, effective May 15, 1989.

3. Three Tier evaluation System
 - a. Tier I is to review historical data and determine if there are likely contaminants of concern.
 - b. Tier II is chemical evaluation. Tier II evaluation is often used to determine the necessity of Tier III evaluations.
 - c. Tier III evaluation is biological evaluation. Many projects are now being required to do a Tier III evaluation, particularly for ocean disposal.

New Dredge Purchased and In Use

The maintenance costs for the old dredge, compounded with the operating and permitting costs, were becoming too exorbitant to be considered the best use of taxpayer money. The old dredge was needing so many repairs that it began to limit the productivity of the already restricted dredge season. The Committee also concluded that a new dredge would be more environmentally friendly and safer for the crew to use.

Specific equipment failures were limiting the use of the old dredge. The sand and water that go through the dredge were corroding the pipe, which generally needs to be replaced every three to five years, based on the volume dredged. The pipe has a 12-inch diameter and costs about \$12 to 15 per foot to replace. The pipe is thousands of feet long, and those costs add up. The replacement costs needed to be staggered year by year to not take on the full cost all at once. There are no year-round employees on island able to perform the necessary maintenance work during the dredging off-season, which forced the Committee to fit the dredging repairs into the end of September. This timing is not ideal, because it lies during the first part of the dredge season, but allowed the Committee to be able to have the dredge ready for the bulk of the work that could be performed later during the narrow dredge window.

In 2007, the engine in the dredge itself was submerged under saltwater, and needed to be replaced. The dredge itself could not stay afloat, which was a huge issue.

In 2010, there were many equipment delays and the required repairs shortened the season significantly. The gear box seized, and caused a back-up of several weeks.

In 2013, significant repairs were needed on the dredge hull. The entire hull was sandblasted, the steel was replaced, and the metal barrier was painted. The work on the hull was approximately a two week delay, but was able to be completed on island by Ralph Packer.

In 2014, when the dredge was operating for its 20th season, the equipment was evaluated and the necessary repairs were beginning to not make economic sense. With a 10-year permit in place, the budget did not need to account for permitting costs, which freed up money to purchase a new dredge. The Dredge Committee began to work with Capital Programs to begin the process of purchasing a new dredge, and completed a preliminary application in 2015.

In 2016, serious planning work began for a new dredge by the 2018-2019 dredging season. It was officially determined that the cost to repair the old dredge were greater in value than purchasing a new one, and the Dredge Committee began to look into sellers.

In April 2017, at the Edgartown Annual Town Meeting, a vote was placed to allocate \$600,000 of the Town budget for the purchase of a new dredge.

The Dredge Committee decided on a process of selecting a bidder and the model of the new dredge. The most important criteria for selecting a new dredge were its approximate size of 12 feet long by 36 feet wide; a dredging depth capacity of 20 feet; a minimum suction inlet diameter of 12-inches, and a minimum discharge diameter of 10-inches. Members of the Dredge Committee heard bidding presentations from each bidder, conducted site visits to see the dredges in person (both before purchase and before delivery). Any variations from the dredging specifications were met with an explanation with specific reasoning.

There were three primary vendors for the bid: Ellicott Dredge with a Model Ellicott 370, DSC Dredge with a refurbished Shark Class Dredge, and Custom Dredgeworks.

After deliberations, it was decided that the Ellicott Series 370 Dredge was the best fit for Edgartown because of the small, portable cutter head; the dredge is easily portable by truck; and the maintenance and training of operations are simple. It was also the most suitable for small navigational projects, like canals and inland waterways. The final specifications are shown below.

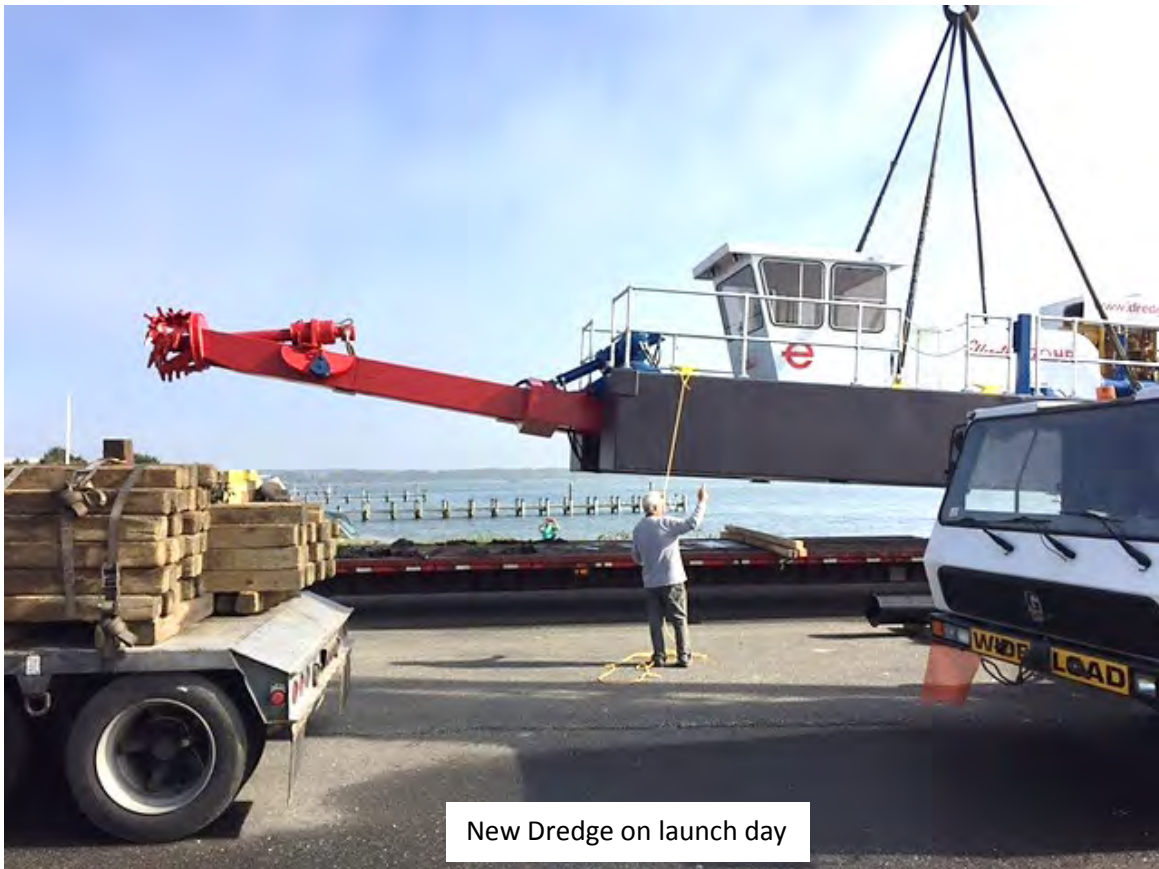
Specifications for Dredge versus Ellicott Series 370 Dredge

Aspect of Dredge	Committee Specification	Ellicott Series 370 Dredge	Approximate Cost
Pumping System Range		-Up to 225 yd ³ /hr. -Rate per 500M of pipeline: 175 m ³ /hr	
Length Overall		57.5'	
Hull Sections	One center tank, Two side tanks	Two side tanks	
Hull Length	36'	36'	
Hull Width	12'	12'	
Maximum Dredge Depth	20'	20' at 60 degree inclination 15' at 40 degree inclination	
Minimum Dredge Depth		3'	
Channel Width with maximum 40 degree swing		Min digging depth: 73' Max digging depth: 60'	
Main Hull end, bottom, sides, deck plates thickness	¼"	¼"	
Hull Material		-One-piece welded steel, ABS River Standards -Built in fuel oil and ballast tanks	Hull Zinc installation: \$1,667
Height Overall		10' 7"	
Dry Weight		28 U.S. tons	
Draft		To spud point: 3.58 ft Molded (max): 2.67 ft	
Fuel Tanks	800 gal. capacity	800 gal. capacity	
Anodes	Zinc with bolt-on connections		
Rope Cleats	16"		
Cab Size	7' X 5' X 6'6"		

Lever Room	Welded with 4 sides/lockable doors, Air conditioned	Removable welded steel room Plexi glass windows and lockable door Control Panel with fingertip levers for operations, Air conditioned	Air condition-er: \$10,000
Water pump	Centrifugal driven off main pump engine		
Main Engine	Caterpillar Marine with -24 volt electric starters -105 amp alternator -220 amp-hr batteries	Caterpillar C-15 440 HP -24 volt D.C. electric starter -60 amp alternator -220 am-hr batteries -Throttle control lever room -Marine Power Display (MPD) engine operating data	
Dredge Pump	Suction 12", Discharge 10"	-Ellicott Series 400 Pump -Suction 12", Discharge 10" -500 BHN Alloy Cast Iron chrome alloy -Steel Side Heads -V-belt driven, anti-friction bearings	10" flap valve assembly: \$7,667 10" discharge hose assembly: \$5,833
Production Equipment	-Flow Meter in lever room monitoring dredged material	Lever room contains dredge pump vacuum and discharge gauge	
Swing Winches	-Two independent, reversible, hydraulically driven -Two 200' X 1/2" swing wires	-Two independent, reversible -8,000 lb line pull, 75 ft/min -Two 200' X 1/2" swing wires -Drum capacity: 200 ft -Gear type hydraulic motor -Enclosed planetary gearing with anti-friction bearings	Outfitting kit swing wires: \$667
Dredge Ladder	-Structural steel -Abrasion resistant pipe	-Structural steel, bolted on suction pipe -Mounted to eliminate dragging -23 ft. long from trunnion pin to cutter end -Heavy duty trunnions with removable pins in hull ladder -Spline connected to planetary reduction gear	
Anchors	Two 150 lb. Danforth type or equal	150 lb. anchors	Anchor: \$500, \$1000 ext.

Cutter Head	-Submerged Hydraulic with variable speed 0-35RPM and 40 HP by engine -Toothed with replaceable teeth	-Hydraulic with variable 0-39 RPM and 40 HP -Diameter 31.5 in and force: 4000lbs -6 blade cast steel plain edge cutter with keyed and tapered shaft connection -Alloy steel, watertight cutter shaft -Sheave blocks for ½ in diameter rope	31.5 Six blade cutters: -plain edge: \$5,833 -Pin tooth: \$4,500
Ladder Hoist	-Double Acting Hydraulic cylinder -Single lever control and independent winch operating system	-Double acting hydraulic cylinder; Ram cylinder for crowding action -Single lever control	
Spuds	-Two, tubular steel capped with lifting eye -Length 10' greater than digging depth: 30'	-Two Tubular steel, mounted in stern, cap with lifting lug on upper end -Length: 29 ft 1 ½ in -12 ¾ in O.D. X 0.562 in minimum -Cross tubes for stowage of cross pins -Stowage saddles on spuds for main deck	
Spud gates and hoist	-Hinged for easy spud removal -Two spud collars for hoist slings	-Spud mounted in spud keepers at stern -Vertical hydraulic cylinder and choker slings for hoisting - ½ in. Wire rope and lubricated sheaves	
Hydraulic System	-Biodegradable hydraulic fluid for running -Functions for cutter head motor, ladder hoist, swing winches, spud carriage, spud hoist: single-lever	-Triple Section Hydraulic Gear Pump -Three independent operating circuits: swing winch, cutter, spud, ladder hoist -Relief valves for protection -230 gal reservoir with level and temperature gauge	
Dredge Piping	-Suction side 14 in ID X 3/8in wall ANSI 150lb flange at discharge -Corrosion resistant: all water piping	-Suction side 12 in ID X 3/16 in wall abrasion resistant suction pipe bolted in ladder -Flanged rubber suction hose for full vacuum service -Flanged suction cleanout trap	
Dredge Lifting Rig			\$5,667
Lighting	-LED Powered lights -Diesel engine batteries (min 1000 lumens)	-24 Volt D.C. internal/electrical lighting -Powered by main engine	

		-Floodlights for forward and aft end, Dome light in lever room	
Safety Equipment	-Deck handrail - 2000 gal bilge pumps for dredge pump room	-Deck handrail -Life vests (3) -Life rings -A.B.C. fire extinguishers -Automatic bilge pump system (24 V.D.C)	Portable bilge and fire pump with hoses: \$2,362
Spare Parts List	-Main pump casing -Main pump impeller -Front head liner -Back head liner -Main pump shaft wearing sleeve -Lantern ring -Service water pump assembly -Spare cutter head work ready	-Pump Alloy Cast iron parts: case, impeller, and head liners -Replaceable 316 stainless steel shaft sleeve for fresh/sea water service	
Auxiliary Equipment	Deck crane for pump parts and assembly Impellor lifting hook		



New Dredge on launch day

Dredging For and In Other Towns

The Dredge Committee also researched other island town Dredge Programs. Chilmark had issues with J-Way Dredging in 2016. They were hired to dredge an 8-foot deep, 80 foot wide channel from the Harbor entrance jetties past the west basin, and Red Nun past Picnic Point to Menemsha Pond. Menemsha Pond was designated a “Harbor Refuge” in 1945 for boats during storms, but was not safe to navigate at the time. In 2016, the \$2.2 million project came to a halt for the second time in two years. J-Way had failed to meet the permitting deadline and the U.S. Army Corps shut down the project. The DMF claimed disruption to the winter flounder species. The contract was terminated in 2016 and renewed for 2017. After two years of dredging, only 16,000 cubic yards were dredged out of the 45,000 cubic yards that were needed for maintenance. There were also other issues with the project. The 1.5-mile pipeline running through Lobsterville Road was obstructing traffic and causing damage to the parking areas, and sand was accumulating in the Bay during the nine-month delay. J-Way received allowances to park heavy machinery on the beach and in the parking lots, but that allowance expired in September of 2016, and the equipment needed to be removed before the project was finished.

In Tisbury, Barnstable Dredge was hired to dredge the entrance to Tashmoo, where sand was pumped from the far end of the jetty up to the Chop to improve pond flushing and resolve circulation issues. The distance needed to transport the dredge and associated equipment was expensive. This year, the Tisbury Board of Selectmen asked to hire Edgartown to perform the dredging work. Over a 10-year span, the proposal includes dredging 25,000 cubic yards of material over 5.1 acres for maintenance. 3,120 cubic yards will be transported to an up-island location for disposal. Tisbury will also need 500 cubic yards of material at the town landing.

In Oak Bluffs, the Edgartown town dredge was selected as the final bidder for dredging Sengekontacket Pond. The other bids were substantially more expensive. There was the same per-cubic yard price, but much higher up-front costs for dredge delivery. There were other benefits for this inter-Town partnership, where Oak Bluffs only had to pay for the permitting of the project. The work to be done was paid for by the Cow Bay Neighborhood Association, which allowed Edgartown to refund the cost to Oak Bluffs; and was able to provide the sand for the Inkwel Beach nourishment project at no cost.

The conclusions determined by the Edgartown Dredge Committee were that off-island companies out to bid are known to have delays in completing the work. Dredging in-house allows for more control over the timeline of work, and awareness of building in weather delays, and less costs for transport. It is also much more cost effective to foster these inter-town partnerships and allows for more continuous long-term dredging.

Which locations were most heavily dredged since the 2007 plan update

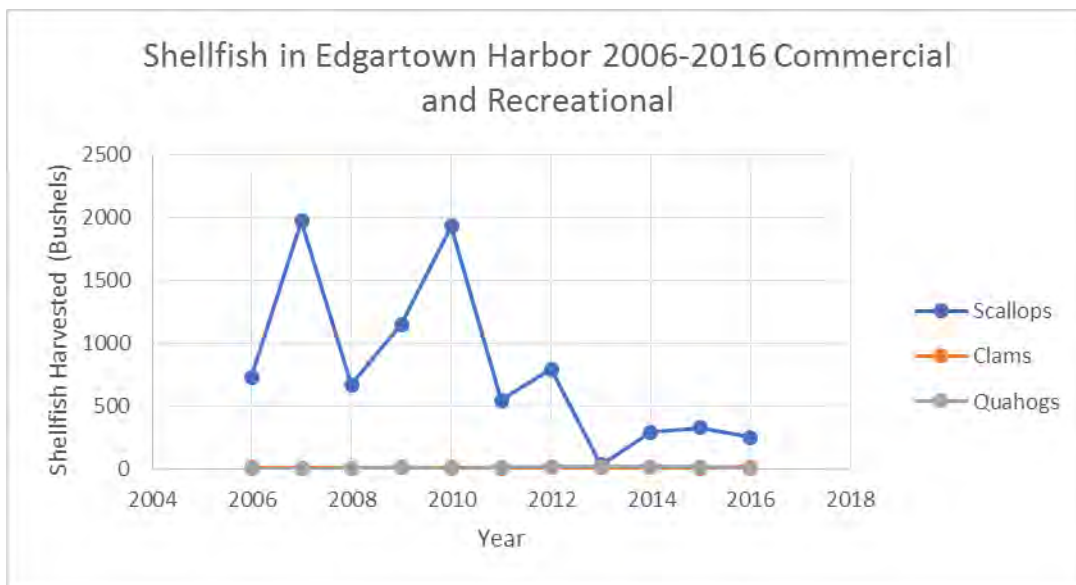
The Dredge Committee ordinarily tries to achieve two locations per year. Eel pond (dredging in 2013, 2014 and 2015) was dredged the most heavily during those three years. Its proximity to Fuller Street beach is helpful because the crew can pump the dredged material

Katama Pond (2016) has seen most of the dredging. Dredged material trucked from there to Bend in the Road beach addresses problems with too much sand buildup in Katama beaches, and the selling of the sand assuaged issue. Sengekontacket Pond has also been heavily dredged in recent years. The dredging in both Katama and Sengekontacket have had real benefits to the shellfish population.

Future Issues

Dredging in Edgartown Harbor

There has been attention given to increased dredging in Edgartown Harbor. The entrance to the Harbor has gone from 31 to 17 feet deep in the past few years. This prevents the entrance of larger boats. In addition, many citizens want their private docks dredged. There is an issue of scale in Edgartown Harbor, with the current dredge viewed as too large to fit in the Harbor, so the smaller dredge owned by the Edgartown Great Pond Foundation would need to be borrowed. The possible dredging of the Harbor entrance has potential to increase circulation in the harbor and increase the bay scallop population. The Edgartown Harbor contained an average bay scallop harvest of 1,291 bushels per year in years 2006 to 2010. In 2011, average bay scallop harvests fell to about a quarter or the previous harvests with averages totaling 374 bushels per year.



There were formally a series of groins that controlled the flow of sand through the harbor entrances. This should be completed again.

Addition of Borrow Areas

There has been discussion of permitting additional areas for the mining of sand for beach nourishment. These may be harder to permit, as the State does not currently permit dredging for the sole reason of beach nourishment, only for navigation. However, there are growing calls for such a nourishment practice. There are locations desired in Katama and Edgartown Great Pond for borrowing.

The Town should Continue to Focus on Nourishment of Silvia State Beach, Bend in the Road Beach, Cow Bay Beach and Fuller Street Beach

The Town should focus on the coastlines. The worst of the winter storm erosion in Edgartown is experienced on State Beach and Lighthouse Beach. Rising sea levels will only exacerbate the problem. The Town should also concentrate of Silvia State Beach, Bend in the Road Beach, and Cow Bay Beach because they are all part of the same system. This is an all-encompassing approach. Support for the beach is only effective on the entire coast, not just one area.

The loss of Fuller Street Beach would be incalculable. Erosion pushes the beach back to the public/private line.

(Map of public/private line to come)

Revise Regulatory Restrictions on Dredging

There has been commentary that the current regulatory time frame for dredging has become outdated. For example, Winter Flounder and Herring no longer nest in Eel Pond because the water has become too warm, yet restrictions remain in place. The regulations are too general, not based on specific species in each pond, but rather based on a cumulative region.

The regulations and dredging time frame should be established by location and not one Town standard. Some locations may be able to be dredged for longer into the season than others.

Develop Regular Procedures and Process for Working with Other Towns

With the purchase and operation of a new dredge, the Town has the ability to complete projects for other towns on the island. Goals and procedures should be developed so that each project proceeds through a defined process. This process should include the development of a policy on the logistics of moving sand, specifically trucking to where it will be stored, as spoil is not allowed to sit on most beaches for extended periods of time. Attention should also be paid to the development of qualified crew members. The need for personnel who are licensed to operate the dredge safely, and who can work when needed is paramount to a successful operation.



APPENDIX E. EDGARTOWN DREDGE SITE VISIT

**Town of Orleans Dredge Purchase Feasibility Study
Update Meeting #2 – Meeting Minutes
Edgartown, Martha’s Vineyard, MA
24 February 2020**

Attendees:

Town of Orleans Dredge Advisory Committee

Charles Carlson
Steve Smith
Virginia Farber
Betsey Furtney
William Amaru

Town of Orleans

Tom Daly – DPW Director
Nate Sears – Harbormaster

Town of Edgartown Dredge Committee

Ed Handy
Juliet Mulinare
Rick Hamilton

Woods Hole Group

Adam Finkle – Coastal Scientist
Katie Lavallee – Coastal Scientist

Public

Rick Frankalini – Town of Orleans Resident

Overview of Edgartown Dredge Program

- Started in 1996, first funded when a Federal grant became available to train displaced fishermen.
- Town decided to maintain its own waterways; first leased the dredge then purchased at end of season.
- Was a town meeting line items were used to fund dredge annually, up to ~10 years ago.
- Dredge is now funded as part of the annual town budget.
- Obtained comprehensive permits for multiple dredge and disposal sites.
- Operating expenses have increased gradually per year; permitting expenses have increased dramatically.
 - Permits cost as much or more than dredge operations
 - Budget is sometimes supplemented through Town meeting to assist with permitting.



- **Scheduling**
 - Inclusive, stakeholders discuss needs (Shellfish Dept., Public Works etc.), try to plan one year in advance.
 - Committee decides and sets schedule.
 - Storms/weather delays require modifications to set schedule.
- **Staffing**
 - Juliet only municipal staff member (15 hrs./wk.)
 - Crew are part-time contractors; hourly contract up to 6 months of the year; contracts typically staggered (in part based on the crew's other employment)
 - Work 3 weeks prior and 1 month post dredging season.
 - \$40-45/hour; no overtime.
 - Town pays workman's comp, no other municipal benefits (paid by the Dredge Department).
 - Took some time to work out this arrangement.
 - Qualified employees make of break the program. Try to offer low stress, high pay.
 - Keeps operating expenses lower
 - Dredge Department
 - Normal operations 3 people (dredge leverman, shore-based loader, deckhand).
 - Hire trucks/excavators as needed.
 - Local, small scale projects can be handled by Edgartown Highway Dept.
 - When they sell sand, typically require purchaser to plan for a dewatering site and transportation costs.
 - Current dredge operator was one of the original trainees.
 - Try to make it worth their time to work for the dredge.
 - Very important to find people who are interested and want to stay.
 - Ellicott has a strong training program for those purchasing dredging equipment.
 - Masterplan required at the initiation of the program (Juliet to send scanned copy); last updated in 2018 – Town to provide a copy.
- **Dredging and Support Equipment**
 - Dredge superstructure – Ellicott 370 (original dredge replaced ~2015, overhaul next year).
 - \$628K with expanded maintenance pack.
 - \$1M+ operation inclusive of supporting equipment.
 - Pipe (\$15/ft), Dredge Dept. owns approx. 4 miles.
 - Fusion machine required.
 - Deere 544 Loader (Dredge Dept. has own loader)
 - Purchased used (\$34k versus \$200k).
 - Dredge Dept. not adverse to purchasing used equipment.
 - Concerted effort to maintain equipment exposed to saltwater.
 - Loader Attachments.
 - 3 support craft
 - Steel push boat, Carolina skiffs.



- Facilities (storage space, garage)
- **Operations**
 - Typically charge \$10-20 per cy, including mobilization/demobilization costs
 - Contract out pre- and post- surveys.
 - Volumes on average 30-40k cy annually, although volumes vary considerably year-to-year.
 - Dredge capacity exceeds needs.
 - Typically, de-water as close to pumping site as possible; transport material after; minimizes pipe length and need for booster pumps.
 - Longest operation approximately 2 miles.
 - Required booster pump.
 - Ran into significant production issues, now moved away from this method.
 - Pay a local landowner to store pipe on their beach through the off-season; can keep pipe lengths at 300 ft, reduces refusing efforts.
 - Fusion seals actually fairly strong.
 - Typically avoid areas with fine-grained sediments.
 - Only two areas in town fit in that category.
 - Currents
 - Effort made in planning work, timing; careful; haven't run into issues.
 - Weather
 - If dredge needs to move to safe harbor to avoid a storm, 4-5 hours to break down operations, move dredge to protected area, put spuds down and anchors to leave overnight.
 - Fuel
 - Program has one double walled 400-gallon tank (shore based), one 100-gallon transfer tank (boat based).
 - Standard fueling procedure (notify Fire Dept.).
- **Great Pond**
 - Channel opened by excavator not the municipal dredge.
 - Promotes flushing.
 - Shellfish Constable makes that decision.

Dredge Advisory Board

- All committee members able to stop by active sites. Ed Handy (Committee Chair) gets call if anything goes wrong on-site.
- Day to day operations supervised by crew foreman.
- Dredge Committee oversees all operations.
 - Schedule, budget, permits, major capital expenses.
 - Meets every 2 weeks year-round; sometimes more frequently.
 - Good working relationships with Harbormaster, Highway Dept. etc.
 - All volunteer positions (except Juliet).
 - Marine Advisory Board, Shellfish, Conservation Commission, two at large.



Comprehensive Permit

- 10-year permit; has been renewed once.
 - Permits written for maintenance dredging, easier to renew.
- Applied for permits under the guise of improving public safety and navigation; easiest path to permit.
- Environmental dredging (to improve water quality of fisheries) is a non-starter. Difficult to prove that dredging will lead to marked improvement.
- Can now use beach nourishment as a permissible reason; state now becoming more receptive to borrow sites / nourishment for improved resilience.
 - Will likely edit existing permit to include borrow sites, beach nourishment.
- Did not include shellfish/habitat improvement due to additional work needed to prove that conditions would improve to secure.
- Looked in to including upland storage of sand for later use, dismissed due to expense in proving viability of storage site.

Dredge Manufacturers

- Q: Did Edgartown look at other manufacturers besides Ellicott?
 - Did look into others, DSC (Louisiana).
 - Edgartown wanted something that could be transported on a tractor trailer.
 - Wanted a simple dredge without electronics etc.
 - Difficult finding other supplier with a dredge that size (smaller than most).
- Ellicott 370
 - Draws about 3 ft of water.
 - 34 ft long; 24 ft ladder in front; 12" pipe.
 - \$628k for dredge.
 - With support boats and pipe up to \$1mil.
 - Increased fuel capacity in new model.
 - Added weight and changed distribution of weight.

Public-Private Relationships

- In the beginning, no one wanted dredged sand now, with increased erosion, demand has increased.
- In last 10-12 years with increasing erosion, increased waterfront development, demand for sand has increased.
 - Transitioned from byproduct to commodity.
- Have sold sand to private homeowners (since 2009), HOAs, contracted with other towns (Oak Bluffs, Tisbury).
 - Partnerships help fund dredge program. Target permitting above MHW to avoid need for extensive permitting at the State and Federal level.
 - The program isn't fully covered every year, but partnerships have contributed to the town's general fund.
 - Operations have paid for investment in dredging equipment in ~3 years (~500k revenues in 19'-20').



- Towns must already have their own permits before purchasing dredge.
- Private homeowner wanted new site dredged; made donation to program to pay for permitting included in adding this site; program supervised operations.
- Program has received donations to pay for engineering studies to expand permitted dredging areas.

Summary

- Townspeople continue to vote to fund Dredge program.
- Many people involved in operations, site selection (Shellfish, Harbormaster); Conservation Commission; questions/concerns typically raised before reaching the point of work.
- People involved in decisions have seen firsthand what dredging can do.
- Conservation Agent very experienced.
- Program has not made many mistakes over the years.
- Very cooperative, would be very difficult without everyone on board with the Program.

Site Visits:

Town Barn

- Met with dredge operator.
- Ellicott 370 out of water for end of season maintenance.
- Dredge model very similar to the original model which lasted 25 years, invested in new equipment ~3 years ago.
- Town specifically purchased a model without electronics.
- Steel push boat.
- Carolina skiff support boat.
- Loader with support beam/spreader bar and bucket.
- Fusion machine.
- Garage, trailer, storage space.

Katama Landing

- Town received State-matched funds to replace ramp, doubled in width to allow dredge to be launched via trailer, rather than crane.
- Channel is dredged from landing to harbor every 5-10 years.

Fuller Street Beach Nourishment Area

- Town has nourished Fuller Street Beach multiple times.
 - Prioritized maintaining public beachfront, which would become private if eroded to property line.

Beach Road/Edgartown Beach/Cow Bay Nourishment and Storage Site

- Sand stored for use at Cow Bay/Bend-in-the-Road

Bend in the Road Beach/Jaws Bridge Dewatering Site

- Can hold 30-40k cy of material, large nourishment projects every 2-3 years.
- Sand pumped directly from borrow site in Senge Pond, under bridge to site.



Figure 1 – Orleans Dredge Committee tour dry-docked municipal dredging equipment in Edgartown, MA.



Figure 2 – Cutterhead on Ellicott 370 Dredge, Edgartown, MA.



Figure 3 - Ellicott 370 Dredge superstructure, Edgartown, MA.



Figure 4 – Municipal dredge support craft, Edgartown, MA.



Figure 5 – Fuller Street Beach nourishment site, Edgartown, MA.



Figure 6 – Dewatering site adjacent Big Bridge, Edgartown, MA.



APPENDIX F. SEDIMENT BUDGET

Location	Width Alternative	Type	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30	Total	
Behind Barrier	100 ft	Year-Over-Year	109,575	54,787	0	54,787	54,787	0	54,787	54,787	54,787	54,787	54,787	54,787	54,787	54,787	0	54,787	54,787	54,787	54,787	54,787	54,787	54,787	54,787	54,787	54,787	0	54,787	54,787	54,787	54,787	1,479,260	
Behind Barrier	100 ft	Annualized	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	49,309	1,479,260	
Behind Barrier	50 ft	Year-Over-Year	60,734	30,367	0	30,367	30,367	0	30,367	30,367	30,367	30,367	30,367	30,367	30,367	30,367	0	30,367	30,367	30,367	30,367	30,367	30,367	30,367	30,367	30,367	30,367	0	30,367	30,367	30,367	30,367	819,913	
Behind Barrier	50 ft	Annualized	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	27,330	819,913	
Priscilla Spur	50 ft	Year-Over-Year	9,146	0	0	0	0	0	0	0	0	9,146	0	0	0	0	0	0	9,146	0	0	0	0	0	0	0	0	9,146	0	0	0	0	0	36,584
Priscilla Spur	50 ft	Annualized	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	1,219	36,584	
Eastern Main Channel	100 ft	Year-Over-Year	18,505	0	0	0	0	0	0	0	0	18,505	0	0	0	0	0	0	18,505	0	0	0	0	0	0	0	0	18,505	0	0	0	0	74,018	
Eastern Main Channel	100 ft	Annualized	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	2,467	74,018	
Eastern Main Channel	50 ft	Year-Over-Year	10,249	0	0	0	0	0	0	0	0	10,249	0	0	0	0	0	0	10,249	0	0	0	0	0	0	0	0	10,249	0	0	0	0	40,996	
Eastern Main Channel	50 ft	Annualized	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	1,367	40,996	
Central Main Channel	100 ft	Year-Over-Year	7,248	0	0	0	0	0	0	0	0	7,248	0	0	0	0	0	0	7,248	0	0	0	0	0	0	0	0	7,248	0	0	0	0	21,745	
Central Main Channel	100 ft	Annualized	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	725	21,745	
Central Main Channel	50 ft	Year-Over-Year	3,395	0	0	0	0	0	0	0	0	3,395	0	0	0	0	0	0	3,395	0	0	0	0	0	0	0	0	3,395	0	0	0	0	10,186	
Central Main Channel	50 ft	Annualized	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	340	10,186	
Town Cove	100 ft	Year-Over-Year	14,123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28,246
Town Cove	100 ft	Annualized	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	942	28,246	
Town Cove	50 ft	Year-Over-Year	6,260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,520
Town Cove	50 ft	Annualized	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	12,520	
Inner Harbor	50 ft	Year-Over-Year	0	0	0	0	0	25,232	0	0	0	0	0	0	0	0	0	25,232	0	0	0	0	0	0	0	0	0	0	25,232	0	0	0	0	75,696
Inner Harbor	50 ft	Annualized	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	2,523	75,696	
Quanset	50 ft	Year-Over-Year	0	0	1,635	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,635	
Quanset	50 ft	Annualized	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	1,635	
Narrows*	50 ft	Year-Over-Year	0	0	3,500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,500	
Narrows*	50 ft	Annualized	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	3,500	
Paw Wah	50 ft	Year-Over-Year	0	0	2,848	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,848	
Paw Wah	50 ft	Annualized	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	95	2,848	
Arey's	50 ft	Year-Over-Year	0	0	3,033	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,033	
Arey's	50 ft	Annualized	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	101	3,033	
Lonnie's	50 ft	Year-Over-Year	0	0	3,804	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,804	
Lonnie's	50 ft	Annualized	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	127	3,804	
Meetinghouse Pond**	50 ft	Year-Over-Year	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Meetinghouse Pond**	50 ft	Annualized	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

*Assumes a max dredge volume of 3,500 CY from The Narrows, regardless of channel width.

**Dredge channel not yet established. Additional data required to calculate volume estimate.



APPENDIX G. DREDGE SPECIFICATION SHEETS



12" x 10" (300 mm x 250 mm) Hydraulic Cutter Suction Dredge

The Series 370 HP **DRAGON**[®] is one of the most popular and successful small-size range cutter suction dredges in the industry. Customers range from new, first-time operators in remote areas of the world, to general marine contractors, private owners, and government agencies in the USA. Some key features include:

- Lower start-up investment for a powerful and dependable dredge.
- Easily transported by truck— lower costs for mobilization.
- Control system, engine and mechanical components specifically selected for use in marine environments.
- Simple design makes it an ideal dredge for first-time owners.
- Versatile—used for sand mining, dredging of small waterways, canals and marinas.
- Highly rugged and reliable cutter suction dredge with minimal down time for routine maintenance.

The Series 370HP Dragon® Dredge is Available in the Following Sizes

		370-20'	370-6M	370-33'	370-10M	370-42' / 50'	370-13M / 15M
		English	Metric	English	Metric	English	Metric
GENERAL	Suction Pipe x Discharge Pipe	12" x 10"	300 mm x 250 mm	12" x 10"	300 mm x 250 mm	12" x 10"	300 mm x 250 mm
	Dredging Depth, Maximum	20'	6 m	33'	10 m	42'-0" / 50'-0"	12.8m / 15.2 m
	Length, Overall (with Ladder Raised)	57'-5"	17.53 m	74'-9"	22.7 m	81'-9" / 91'-3"	24.9 m / 27.8 m
	Length, Hull	36'	11 m	42'	12.8 m	62'	18.9 m
	Width, Hull	12'	3.66 m	20'	6 m	12'	3.66 m
	Depth, Hull	4'	1.22 m	4'	1.22 m	4'	1.22 m
	Number of pontoons (Tanks)	1		3		1	
	Plate Thickness	1/4"	6 mm	1/4"	6 mm	1/4"	6 mm
	Dry Weight	56,000 lbs	25,396 kg	63,000 lbs.	28,756 kg	70,000 / 72,000 lbs.	31,751 kg / 32,659 kg
	Hull Draft (not Including Spuds)	2'-8"	0.8 m	2'-2"	0.63	2'-8"	0.8 m
Fuel Capacity	800 gallons	3,028 litres	800 gallons	3,028 litres	800 / 700 gallons	3,028 / 2,649 liters	
ENGINE AND INSTALLED POWER	Swing Width @ Minimum Dredging Depth	73'	22.5 m	90'	27.3 m	No restriction	
	Swing Width @ Maximum Dredging Depth	60'	18.29 m	67'	20.3 m	No restriction	
	Main Engine (Caterpillar)	C 9.3		C 9.3		C 9.3	
	Power	416 HP	310 kW	416 HP	310 kW	416 HP	310 kW
Rating	Marine Tier 3		Marine Tier 3		Marine Tier 3		
Cooling	Onboard heat exchangers		Onboard heat exchangers		Onboard heat exchangers		
CUTTER DRIVE	Power at Shaft	40 HP	30 kW	40 HP	30 kW	40 HP	30 kW
	Cutter Speed	0-39 RPM		0-39 RPM		0-39 RPM	
	Cutter Diameter	31.5"	800 mm	31.5"	800 mm	31.5"	800 mm
	Cutting Force	4,000 lbs	1,815 kg	4,000 lbs	1,815 kg	4,000 lbs	1,815 kg
SPUDS	Diameter	12.75"	325 mm	12.75"	325 mm	None	
	Length	29' 1.5"	8.88 m	44' 7"	13.6 m	Stern Wire	
Specifications Are Subject to Change Without Notice							

Rev. 12/4/2019



Series 670 Dragon® Dredge



14" x 14" (350 mm x 350 mm) Hydraulic Cutter Suction Dredges

The Series 670 **Dragon**® cutterhead dredge is typically used to complete medium-sized navigational projects in locations such as small ports, rivers, and inland waterways. Features include:

- Inherent stability that allows for use in semi-protected waters.
- Well suited for first-time owners and operators—easy to train on and operate.
- Relatively low initial investment with dependability for long-term use.
- Easily transported over road by trucks.
- Powerful pumping capacity: 715 HP (533 kW) and 100 HP (74 kW) cutter drive.
- Ideal dredge for marine and general contractors, small ports and harbors, and self-managed government dredging programs.



Series 670 Dragon® Dredge

The Series 670 Dragon® Dredge is Available in the Following Sizes

		670-33'	670-10M	670-42'	670-12.8M
		English	Metric	English	Metric
GENERAL	Suction Pipe x Discharge Pipe	14" x 14"	350 mm x 350 mm	14" x 14"	350 mm x 350 mm
	Dredging Depth, Maximum	33'	10 m	42'	12.8 m
	Length, Overall (with Ladder Raised)	77'-6"	23.62 m	85'-8"	26.11 m
	Length Hull	50'	15.3 m	54'	16.5 m
	Width, Hull (Including Side Pontoons)	20'	6 m	20'	6 m
	Depth Hull	4'	1.22 m	4'	1.22 m
	Number of Pontoons (Tanks)	3		3	
	Plate Thickness of Center Pontoon	1/4"	6 mm	1/4"	6 mm
	Dry Weight	135,000 lbs	61,235 kg	138,600 lbs.	62,857 kg
	Hull Draft (Not Including Spuds)	2'-10"	0.9 m	2'-4"	0.7 m
Fuel Capacity	2,700 gallons	10,221 liters	2,700 gallons	10,221 liters	
GENERAL	Swing Width @ Minimum Dredging Depth	97'	29.6 m	103'	33.2 m
	Swing Width @ Maximum Dredging Depth	72'	21.9 m	81'	24.7 m
ENGINE AND INSTALLED POWER	Main Engine (Caterpillar)	C-18		C-18	
	Power	715 HP		533 kW	
	Rating	Marine Tier 3		Marine Tier 3	
CUTTER DRIVE	Power At Cutter Shaft	100 HP	75 kW	100 HP	75 kW
	Cutter Speed	0-36 RPM		0-36 RPM	
	Cutter Diameter	43"	1,092 mm	43"	1,092 mm
	Cutting Force	7,405 lbs	3,358 kg	7,405 lbs	3,358 kg
SPUDS	Diameter	16"	400 mm	16"	400 mm
	Length	43'-6"	13.3 m	51'-0"	15.5 m

Specifications Are Subject to Change Without Notice

Rev. 7/29/2019

POSEIDON® P2-5 PORTABLE SECTIONAL BARGES



	P2-5-20 Section		P2-5-40 Section	
Length, Overall	20'-4"	6.20 m	40'-4"	12.29 m
Width, Overall	10'-4"	3.15 m	10'-4"	3.15 m
Height, Overall	5'-0"	1.52 m	5'-0"	1.52 m
Shipping Weight, Approx.	12,900 lbs	5,851 kg	23,800 lbs	10,796 kg
Draft, Unloaded	13"	0.33 m	12"	0.30 m
Draft, Full Load	30"	0.76 m	30"	0.76 m
Payload at Full Load	8.9 tons	8.1 mT	18.9 tons	17.1 mT



Standard Features:

- Baril DCC Paint System including Zinc Rich Primer Coat & Premium Abrasion-Resistant Topcoat
- Flush Mounted, Sacrificial Zinc Anodes provide added Corrosion Protection
- Internal void spaces coated with Biofloat environmentally friendly Corrosion Inhibitor
- Patented Heavy Duty Roll Form, HSLA Steel Deck Construction with 20,000 psf Concentrated Load Capacity
- The high strength to weight ratio allows two 40ft barges to be shipped per truck, saving freight costs!

Available Poseidon Accessories:

- Spud Pockets
- Spuds, 18" diameter x 1/2" wall thickness, in a wide range of lengths from 20ft to 80ft
- Double Drum Hydraulic Winch Systems
- Deck Cleats, Handrail, Safety Ladder
- Sea Bee Thruster System

Poseidon® P2-5 40ft and 20ft Barge sections are built using drawings approved by the American Bureau of Shipping, in accordance with the ABS Rules for Building and Classing Steel Vessels for Service on Rivers and Intercoastal Waterways.



POSEIDON® BARGE, LTD
 725 East Parr Road, Berne, IN 46711
 PH: 866-99-BARGE; FAX: 260-589-2088
 WEBSITE: www.poseidonbarge.com

STOCK LOCATIONS: Berne, IN • Plain, WI • Leland, NC
 Cocoa, FL • Coeymans, NY • St. Louis, MO • New Orleans, LA

POSEIDON® P2-5 SECTIONAL BARGE ACCESSORIES



Hinge Assemblies for Ramps

Minimize excess loading on the connections as the equipment walks the barge. Wood mats must be used to maintain the steel surfaces from denting and damage.



Deck Cleat



Rake

Male & Female Spud Pockets



ISOMETRIC VIEW
MALE SPUD POCKET
WEIGHT = 2692 lbmass
SCALE 1 : 20

ISOMETRIC VIEW
FEMALE SPUD POCKET
WEIGHT = 2738 lbmass
SCALE 1 : 20

Rub Rail Castings

- One casting to mount on either the male or female casting on the P2-5'
- Wood rub rails can easily be replaced by removing the bolts and replacing with new timbers.
- Rub rail size can be determined by you!



POSEIDON® BARGE, LTD
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APPENDIX H. FINANCIAL MODEL

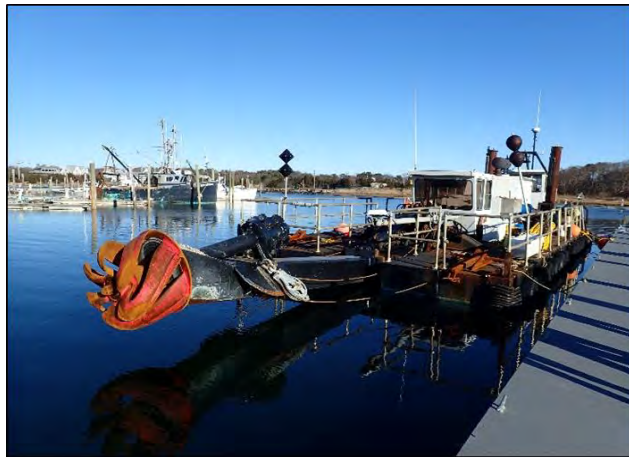


APPENDIX I. COSTING ANALYSIS



Orleans Dredge Purchase Feasibility Study

Costing Analysis



Adam Finkle
Coastal Scientist
afinkle@woodsholegroup.com
Direct: 508-495-6272

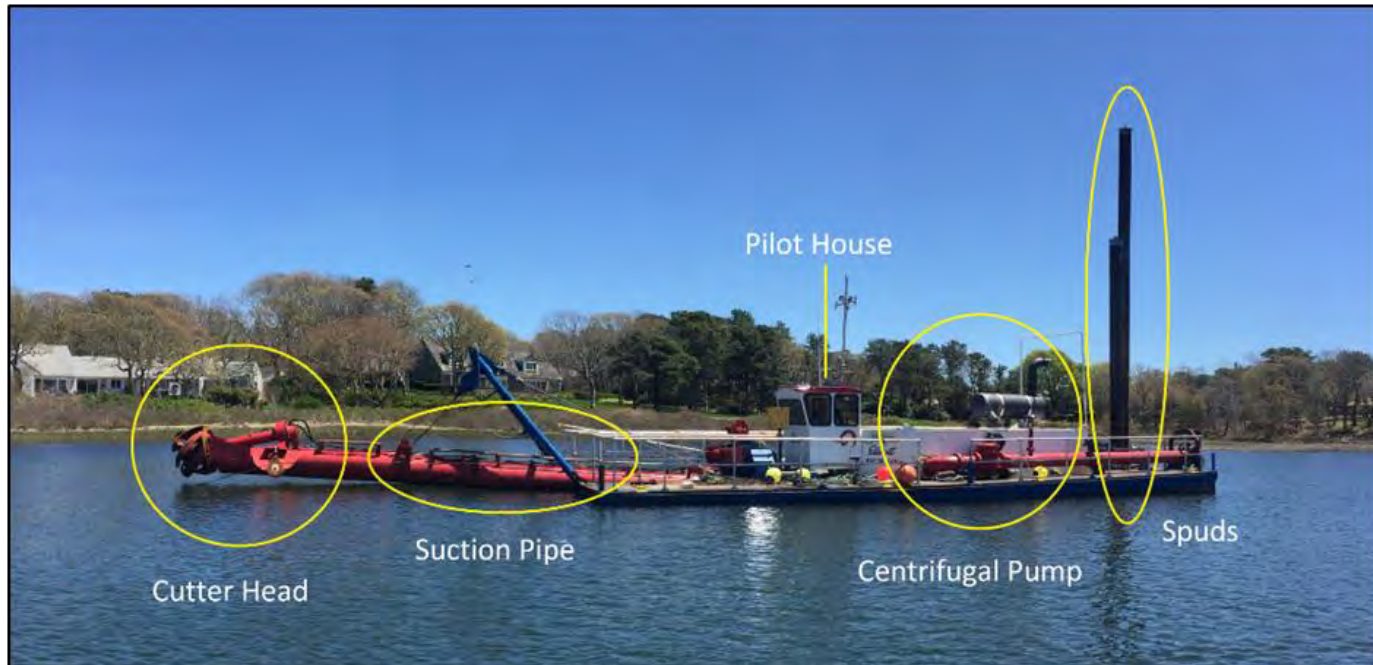
Leslie Fields
Senior Coastal Geologist
lfields@woodsholegroup.com
Direct: 508-495-6225

Katherine Lavalley
Coastal Scientist
klavalley@woodsholegroup.com
Direct: 508-495-6224

Dredge Costing Analysis

- *The purpose of the presentation is to help interpret the financial analysis.*
- The attached tables summarize the 30-year lifecycle costs associated with (3) types of dredging equipment being considered:
 - **Ellicott 370** – Hydraulic Dredge w/ (2) in-line booster pumps
 - **Ellicott 670** – Hydraulic Dredge w/ (2) in-line booster pumps
 - **Poseidon P2 Barge System** – Mechanical Dredging w/ CAT3-series excavator
- Costs were developed for all dredging and associated ancillary equipment:
 - Dredge Superstructure
 - Dredge Pipe (if required)
 - Marine-Based Support
 - Land-Based Support
 - Disposal Costs (if required)
 - Personnel Costs (assuming full-time, year-round staff)
 - Overhead Costs (maintenance, insurance, fuel, etc.)
- As a refresher, a photographs of hydraulic and mechanical dredging equipment are included on the following slides.

Hydraulic Dredging Equipment – Ellicott 370-670



Mechanical Dredging Equipment – Poseidon P2 Barge System



Sediment Budget

Annual Volumes and Assumptions

- The ***Sediment Budget*** tab outlines the volumes of material currently available to be dredged and the expected annual dredge volumes for the full, 30-year lifecycle of the dredging equipment.
- Factoring the annual estimated dredge volume against the annual operating costs of the dredge generates a cost per cubic yard – the dredge rate, which serves as an important means of comparison between dredging alternatives.

Assumptions

- Nauset Estuary includes volume estimates for a 50' ***or*** a 100' wide channel, which have recently been updated to follow the deepest portion of the natural channel and stay 300' from the back side of the barrier beach.
- After the first round of dredging behind the barrier beach, it is assumed that 50% of the original estimated volume in that area will need to be dredged annually, for the lifetime of the equipment.
- Given the short length of the dredge season and time needed to mobilize and demobilize equipment, it is assumed that dredging will only occur in (1) waterway per year.
- The required dredge frequency within each waterway is based on Woods Hole Group's best engineering estimate but may vary based on local conditions.

Scenario Costs

Equipment Costs and Assumptions

- The **Equipment Costs** tab includes a breakdown of the estimated costs associated with acquiring, owning, and operating dredging equipment.
- Costs are included for (2) hydraulic dredges: the Ellicott 370 and the larger Ellicott 670. Costs for (1) mechanical dredge, the Poseidon Barge System are also included.
- Costs were developed through direct correspondence with dredge manufacturers. Personnel and ancillary costs were developed based on costs incurred by regional and municipal dredge outfits in Massachusetts.

Assumptions

- It is assumed either hydraulic dredge would be capable of completing projects in any Town waterway, while the mechanical dredge would be not be able to operate in areas behind the Nauset barrier beach to avoid swift currents and maximize productivity.
- It is assumed the dredge would be purchased using capital grant funding at 0% interest. If desired, an interest rate may be applied to the figures.
- Personnel costs are based on a full-time, year-round dredge crew operating the dredge and up to (2) booster pumps.
- Maintenance, insurance, and diesel fuel costs are included for the full fleet of equipment, based on an assumed 63 days of operation, annually (5 days/wk. in season – 20% weather delays and maintenance).

Dredge Purchase Scenarios 1-3

Financial Data and Assumptions

- The **Scenario 1-3** tabs summarize the 30-year lifecycle costs of the equipment.
- **Staff, Labor, and Ancillary/Overhead** rows assume a 2% annual markup (MU).
- **Depreciation Expenses** or, the amount owed annually on the equipment were calculated using the **useful life – straight line** (UL/SL) method – dividing expenses over the expected useful life of the equipment (5, 10, 15, 25 years, etc.).
- **Total Annual Costs** were calculated by combining depreciation and ancillary costs.
- **Cumulative, year-over-year** costs are also provided.

Non-Financial Data and Assumptions

- The **CY Available for Extraction** summarizes the estimated annual Sediment Budget on a year-over-year and annualized (average) basis, assuming either a 50' or a 100' wide channel in Nauset Estuary. Because the feasibility of dredging behind the barrier beach is still in question and because of the possibility of a breach that would eliminate the need for dredging behind the barrier beach, a separate table **excluding** volumes behind the barrier is included as a reference.
- The **CY needed to break even** at subsidized, Barnstable County Dredge rates, and the operating days required to do so are included as a reference.
- The **Subsidized Removal Rate** assumes a standard, Barnstable County rate of \$13/cy + \$2/hr for each booster pump (2 total) + 10% mobilization fee, with costs increasing ~10% every decade.
- The **Cost per CY** for municipal dredge ownership varies year-to-year based on the sediment budget. Years where the cost of owning and operating Town equipment exceeds the cost of utilizing the Barnstable County Dredge are shown in **RED**.
- **N/A** was used as a placeholder during years when the estimated dredge volume is zero.

Dredge Purchase Scenarios 1-3

Private Dredge Contractor Rates

- A range of private dredge contracting rates are included for Nauset Estuary, Pleasant Bay, and Rock Harbor. Rates were developed in consultation with private dredge contractors and reflect best estimates based on the limited available information.
- Many unknowns still exist (permits, duration, time of year restrictions, approved work areas, change orders, contract modifications, etc.). Once resolved, estimated rates can be further refined.

Considerations and Assumptions

- It is assumed that the forthcoming feasibility study will be thoroughly vetted by Town officials, Town council, and citizen stakeholders.
- The purchase of a dredge and boosters is a significant acquisition for any municipality and any return on investment will take years.
- Owning and operating dredging equipment opens the Town to significant risk of liability that must be addressed prior to any purchase.
- The feasibility assessment assumes that the Town will be able to recruit, train, and retain a skilled dredge crew. The need for an experienced crew in Nauset Estuary cannot be understated – for the safety of the crew, equipment, and success of the project.
- The current costing analysis assumes velocities in Nauset Estuary will not exceed the safe operating thresholds of standard, non-custom dredging equipment.
- It will be important to have all local, state, and federal permits in hand, detailing time of year restrictions, options for dewatering and placement of dredged material north of Nauset Beach, etc., which will inform the selection of the most appropriate dredging equipment.
- Updates to the cost model and feasibility analysis may be required based on conditions detailed in the permits.
- If dredging behind the barrier beach proves infeasible for any reason (permitting, depths, currents, wind and weather conditions, future breach, etc.), the remaining sediment volumes cannot support a dredge purchase.
- If dredging equipment has been purchased and a breach occurs in the barrier beach, the need for dredging will be significantly reduced.





APPENDIX J. BCD WAGE SHEETS

FY18 SALARY SCHEDULE - DREDGE - 2% COLA

		MINIMUM	MID-POINT	MAXIMUM	
D-1	ANNUAL	40,034.59	44,021.89	52,201.55	deckhand
	80 HRS	1,539.79	1,693.15	2,007.75	
	DAILY	153.9792	169.3150	200.7752	
	HOURLY	19.2474	21.1644	25.0969	
D-2	ANNUAL	44,665.71	55,515.20	64,955.07	Leverman
	80 HRS	1,717.91	2,135.20	2,498.27	
	DAILY	171.7912	213.5200	249.8272	
	HOURLY	21.4739	26.6900	31.2284	
D-3	ANNUAL	44,665.71	55,515.20	64,955.07	Maintenance Engineer
	80 HRS	1,717.91	2,135.20	2,498.27	
	DAILY	171.7912	213.5200	249.8272	
	HOURLY	21.4739	26.6900	31.2284	
D-4	ANNUAL	48,501.44	60,499.09	71,476.08	Captain
	80 HRS	1,865.44	2,326.89	2,749.08	
	DAILY	186.5440	232.6888	274.9080	
	HOURLY	23.3180	29.0861	34.3635	
D-5	ANNUAL	79,308.18	86,662.10	97,539.10	Superintendent
	DAILY	305.0315	333.3152	375.1504	
	HOURLY	42.3131	46.2354	52.0408	



APPENDIX K. RESPONSE TO COMMENTS

December 4, 2020

Job No. 2019-0054

Dredge Advisory Committee
19 School Road
Orleans, MA 02653

cc. John Kelly, Town Administrator
Tom Daley, DPW Director
Nate Sears, Harbormaster

Re: Dredge Purchase Feasibility Study Response to Comments

Members of the Dredge Advisory Committee,

This letter provides a formal response to comments received by Woods Hole Group from the Dredge Advisory Committee (DAC) in emails sent by DAC Chair, Charlie Carlson on October 22nd, November 4th, and November 25th, 2020. We are happy to answer any additional questions that you may have during the DAC meeting scheduled for December 14, 2020.

October 22, 2020 email:

I'm grateful for the responses you have already provided to various comments and questions on WHG's draft report. The Dredge Advisory Committee (DAC) will provide you with a final and more thorough set of comments on the draft report after its next meeting, now scheduled for November 2. That said, the DAC agreed on Monday that the best course of action is to slow down completion of the dredge purchase feasibility study. Mark Mathison (the DAC's Select Board liaison) and Nate Sears agreed with this conclusion. There is no need to rush to complete the study and the following considerations argue in favor of a slower process:

1. It will take some time for Barnstable County to provide confirmation of feasibility and new cost data relevant to dredging Nauset Estuary and that information will affect the financial model.

Agreed. Data from BCD will help further refine the model.

2. WHG's recommendations on dredging methods for the Pleasant Bay channels and the Town's decisions in response to those recommendations will affect the financial model.

Agreed. Modifying the methods and volumes will affect the model results.

3. The Town should decide the method of dredging Rock Harbor and that decision will affect the financial model.

Agreed. We understand that the DAC and Town officials are working with the Town's consultant to evaluate appropriate methods for dredging Rock Harbor. Once a consensus has been reached, we can incorporate it into the report with additional funding.



4. A rough estimate of the dredge volume associated with the potential dredging of Mill Pond Channel should be included in the financial model.

To address this question, a contract would be necessary to conduct a bathymetric survey and sediment coring (currently executed and underway). It is important to note that any additional volume from Mill Pond is likely to have a negligible effect on the overall dredge volume and costs over a 30-year planning horizon.

5. The DAC has concluded the Barnstable County dredge should be used for the initial dredging of Nauset Estuary so that work should be excluded from the financial model.

Additional funding will be required to modify the model, but it can be done.

6. The final report should address the DAC's comments on the draft report. I expect these comments will be extensive.

A response to comments is provided in the following sections. Additional funds will be required to make revisions, draft additional sections, and update the draft report.

The DAC recognizes that revision of the financial model as described above and addressing the DAC's comments will take time and some work by WHG that was not contemplated at the time of WHG's proposal. Further, we now know that the Town does not have an immediate source of additional funding to pay for this additional work and we will have to seek that funding at the May 2021 Town Meeting. Therefore, we have developed a process for completing the dredge purchase study in the following manner and we have informed John Kelly and Kevin Galligan of this process.

1. The DAC will meet with WHG to discuss the DAC's comments on the draft report. I hope this meeting can take place on a mutually agreeable date in November or December. I understand WHG has funds for that meeting since the meeting is specified in your contract.

Woods Hole Group is scheduled to appear at the December 14th, 2020 DAC Meeting (rescheduled to January 11, 2021). The only remaining funds in the original Dredge Purchase Feasibility Study budget cover this meeting.

2. After that meeting, I will ask WHG for a proposal for additional funding to complete the report with revisions that address all the Committee's comments and revisions to the financial model. I will plan to talk with you and Leslie about the work elements before you prepare this proposal.

Once the DAC and the Town have finalized a list of requested revisions, Woods Hole Group will prepare a budget outlining the expanded scope.

3. During the next few months, the DAC will gather more information that is relevant to WHG's report and we will provide that information to WHG. Without intending to provide a complete list, this information will include the new data on Barnstable County dredging costs, decisions on dredging methods in Pleasant Bay and Rock Harbor and (probably) some alternative inputs for WHG to consider for various costs in the financial model. I expect it will not be necessary for WHG to incur costs for more research during this period.



When developing these data, the DAC should consider the various inputs and outputs (line items) of the model and try to provide the additional data in the format(s) of the inputs used by the model. This will limit the need for costly revisions to the overall structure of the model.

4. The DAC will ask the Select Board to put WHG's request for additional funds on the May 2021 Town Meeting warrant.

Understood.

5. If the additional funding is approved in May, WHG can then do the required work and write a revised report. I believe it will make sense for WHG to meet first with the DAC and then with the Select Board to discuss the final report. If the additional funding is not approved, it would then be appropriate for WHG to finalize its report with whatever funds you have left and we will have to jointly figure out how to deal with the new information that comes in during the next few months.

If funding is approved, Woods Hole Group will work with the DAC and BOS to update and finalize the draft report.

6. Finally, I want to let you know that in light of all these developments, the DAC voted on Monday to ask the Select Board to postpone indefinitely the October 31 Town Meeting article that sought \$30,000 for dredge purchase design assistance. It is clear the Town will not be making a dredge purchase decision in the near term so I expect the Select Board will recommend indefinite postponement to the voters. This article may be reactivated at some later date.

A sound decision at this stage.

November 4, 2020 email:

1. Focus the financial model on the narrower scope of hydraulic dredging work that we now believe should drive the Town's choice between using the Barnstable County Dredge (BCD) and purchasing a dredge. Although we originally agreed WHG should incorporate all possible hydraulic dredging work in the financial model, this narrower scope now makes sense in light of recent Town decisions.

Modifications to the financial model will require additional funding. We can revise the financial model to focus on the narrower scope of hydraulic dredging work identified by the DAC and Town Officials. To expedite the process, it would be helpful if the DAC and Town officials reviewed Tables 5-7 in the report, making note of any volumes that should be excluded from the aforementioned "narrower scope".

2. Revise the financial model and the report to incorporate new information that will be provided shortly.

Modifying the financial model and report will require additional funding.

3. Consider DAC suggestions of some alternative inputs to the financial model and work with the DAC to achieve consensus on the best inputs.

Modifications to the financial model will require additional funding. The DAC and Town officials should work together to reach a consensus regarding the alternative inputs and forward requested



modifications to WHG. Prior to drafting a scope of work for revising the model, Woods Hole Group will review the alternative inputs to ensure seamless incorporation into the existing model. When evaluating alternative inputs, consider them within the construct of the existing model, to help expedite revisions.

4. Add information on several topics.

Writing additional sections/covering additional topics will require additional funds, but it can be done.

5. The DAC would like to meet with WHG to discuss these comments. This meeting should occur before you prepare a final report and after you receive the new information that will be provided soon. This new information will include (a) new dredging cost guidance from the BCD, and (b) data that will be gathered by DAC members for your use, and (c) guidance from the Town as to whether Rock Harbor and certain channels in Pleasant Bay should be included in the hydraulic dredging program.

Woods Hole Group is scheduled to participate in the December 14, 2020 DAC meeting (rescheduled to January 11, 2021) to review the results of the report and discuss the initial round of comments. The DAC should prepare brief memos summarizing (a)-(c) to share with Woods Hole Group. Additional meetings to review new information prior to drafting a final report will require additional funds.

6. Introduction and Pages 33-48- Clarify that WHG's analysis and Town guidance have resulted in certain conclusions, i.e.:

- a) Mechanical dredging is appropriate for some areas and hydraulic dredging is appropriate for other areas.

Correct. Given the variable sediment quality, quantity, channel characteristics, currents, and disposal alternatives, there is not a one size fits all solution.

- b) Based on WHG's research, it is only the hydraulic dredging program that involves a choice between using the BCD, a Town owned dredge or a private contractor. Explain why this is so.

Woods Hole Group considered (3) hydraulic dredging alternatives. Costs for a Town purchase of a mechanical dredge are included in the financial model. Costs for a private dredge contractor to complete the work mechanically is included in Table 21 of the draft report. Barnstable County does not own a mechanical dredge, so a subsidized, BCD mechanical dredge rate was not included in the analysis.

- c) The hydraulic dredging program will include maintenance dredging of Nauset Estuary, selected Pleasant Bay channels, Rock Harbor (if that is the Town's conclusion), and the potential dredging of the Mill Pond channel. In Nauset Estuary, the Town has concluded that the initial dredging should be done by the BCD.

Woods Hole Group agrees with the DAC and Town officials that this is a sound decision.

- d) The mechanical dredging program will include [list elements]. The report probably should state that this program will be too small to justify consideration of a mechanical dredge purchase and the costs of this program are beyond the scope of the study and will be developed at a later date.



We are unsure of what the DAC is asking here. Please provide additional clarification.

7. Pages 12 and 50-52- DAC members have recently advised that (a) diesel booster pumps much larger than those used by the BCD are available and could be leased (thereby saving purchase costs) and such pumps could address any pumping limitations identified so far, and (b) electric drive booster pumps are now becoming available. This advice will be discussed during the meeting with WHG. If this information is confirmed, it should be considered in your revision of the financial model.

Woods Hole Group determined that it was not cost effective to lease booster pumps. Ellicott Dredge quoted \$10-20k+ monthly lease rate, plus freight, therefore the alternative was excluded. As specified by Ellicott and by the BCD during the most recent site visit, the dredge and all associated boosters have the same head pressure. To our knowledge, is not possible to “step up” the pressure using a large booster to extend the maximum pumping distance. Further, utilizing a larger or electric (custom configured) booster would add additional cost to the project. Last, none of the private dredge contractors that we spoke to are currently utilizing electric pumps. Ellicott indicates that electric pumps are only available as custom units.

Per Steve Miller, (Ellicott Dredge), Ellicott dredging equipment is available for lease at rates of \$45k/month for the Ellicott 370 and \$75k/month for the Ellicott 670, plus freight. Woods Hole Group would be happy to include this information in the revised report once we have a contract to incorporate additional information.

8. Page 18-22- So that uninformed readers have some context, mention past problems with BCD performance, including equipment problems and lack of availability of dredge when needed. Add that new BCD equipment, additional staff and pending 5-year plan may fix problems but this remains to be determined.

Woods Hole Group is not privy to past problems with the BCD beyond delays and mechanical breakdowns associated with the recently purchased Ellicott 670 fly-by-wire dredge. Additional data provided to Woods Hole Group by the DAC (see question 5), may help to better answer, and inform this question. We will amend this section of the report to describe the process the Town has to go through to get on the BCD schedule. Prior to buying the new dredge and hiring a consultant to help coordinate the dredge schedule, there was a waiting period. Now that they have additional equipment and a more structured program, it is hoped that BCD will be accessible to all Towns that want it in a timely manner.

9. Pages 31-50- Add a section on Mill Pond Channel and the possibility that future studies will conclude dredging of Mill Pond Channel is feasible and recommended. Consequently, for completeness, the estimated dredge volume from this channel and an assumption that the dredged material will be 90% sand are included in the analysis. For dredge volume, use results of bathymetry (if complete) or Carlson depth readings with highlighting that volume is only a rough estimate.

Adding a section describing the Mill Pond Channel will require additional funding. Woods Hole Group has yet to estimate the quantity or quality of sediment that might be dredged from the Mill Pond channel and therefore, cannot include the assumptions stated above in the final report. To address this question, a contract will be necessary to conduct a bathymetric survey and sediment coring.



10. Page 39- Make improvement dredging text in the first paragraph consistent with text on page 55 and text of 2/10 memo from WHG to DAC, i.e., improvement dredging in an ACEC is quite difficult and can only be permitted if consistent with a management plan and based on fisheries and wildlife enhancement, etc.

This update has been made. Text from p. 55 has been carried on p. 39.

11. Pages 39-55- Incorporate Town decisions stemming from recommendations in WHG's 11/2 memo on Pleasant Bay dredging. Include the likely disposal site for Rock Harbor material based on guidance from the Town.

We will incorporate information from the 11/2 memo on Pleasant Bay. Town officials have recently indicated that there is limited interest in beneficially reusing dredged material from Rock Harbor on Town beaches. Material from Rock Harbor was historically placed on Skaket Beach, which resulted in an undesirable reaction from Town residents. Therefore, material from future Rock Harbor dredging projects is likely to be disposed of offshore or used for coastal resilience projects in less heavily trafficked areas.

12. Pages 49-50- Reference the recommendation that the BCD will be used for the initial dredging of Nauset Estuary because of the large dredge volume and BCD's larger dredge and that therefore the financial model excludes that initial volume. If the average dredge volumes in Table 10 include the initial dredge volume, remove that initial volume from the average.

Additional funds will be required to modify the model and associated dredge volume tables. Utilizing the BCD to dredge the initial volume of material will require modifications to the financial model (i.e. costs for the BCD to complete the initial volume will be carried for the first 1-2 years, followed by a transition to Town-owned equipment).

13. Pages 50-52- Figure 33 shows dredging will occur all the way to Nauset Inlet, i.e., potentially beyond the reach of a two-booster system. However, DAC member information indicates that in most of this area, there is no need for dredging because depths are sufficient so the diagram may indicate a problem where none exists. See also comment #2 regarding the possibility of extending the pumping distance with a different pump.

The channel shown extends to the inlet so that the Town is prepared to address any future shoaling in this area. The bathymetry associated with the northernmost portion of the channel is shown in 23 and illustrates that this area is less of a problem than other sections.

14. Page 56- Add text here (and/or somewhere else) regarding possible sidecast dredging behind barrier beach

Adding an additional section on the sidecast dredging alternative will require additional funding. It will be important to solicit feedback from the regulators during the permitting process to help inform this section of the report.

15. Pages 57-65- Consider adding language recommending a particular size of dredge for purchase by the Town, given the hydraulic dredging program that is envisioned by the Town. This language would also be useful in the Conclusions (referenced below).



Woods Hole Group cannot speak on behalf of the Town regarding long-term finances or capital purchases. The Town and the DAC should consider the data presented in the draft report to help inform municipal decision making.

16. Pages 60-62- DAC members have asked that WHG provide the data sources for the costs set forth in Tables 11 and 12, so please provide same to me and I will circulate this information. Once this information is reviewed, DAC members may have suggestions of alternative data sources. In addition, they may suggest ways of reducing the estimated costs (e.g., for booster pumps, trucks). This topic will be discussed in the meeting with WHG.

Costs were developed through direct consultation with equipment manufacturers and suppliers. Wherever possible, the specific manufacturer has been provided. Information and costs regarding hydraulic dredging and support equipment (Tables 11-12), were obtained from Steve Miller, Ellicott Dredge, Domestic Sales Manager. Information and costs regarding mechanical dredging and support equipment (Table 13), were obtained from Carl Piedmont, Poseidon Barge, Northeast Sales Manager. It is important to note that the DAC or the Town may be able to secure a lower cost for specific line items if/when the project goes to bid, or alternatively, through the procurement of used equipment. The numbers provided in Tables 11-13 are meant as a placeholder and may change over time or through the procurement process. As previously noted, changing a single line item in the financial model will have a nominal impact over the 30-year time horizon, which translates into pennies on the dollar when it comes to the annual dredge rate for a given piece of equipment.

<i>Ellicott 370/ 670 Superstructure</i>	<i>Ellicott – Steve Miller</i>
<i>Hypack GPS Package</i>	<i>Ellicott – Steve Miller</i>
<i>Comprehensive On-Site Training</i>	<i>Ellicott – Steve Miller</i>
<i>Delivery</i>	<i>Ellicott – Steve Miller</i>

<i>Primary Push Boat</i>	<i>Ellicott – Steve Miller</i>
<i>Support Boat (to haul pipe)</i>	<i>Workboat Brokers – Used Inventory</i>
<i>Support Skiff (to haul personnel)*</i>	<i>Carolina Skiff – New Inventory</i>
<i>Booster Pump (2X)</i>	<i>Ellicott – Steve Miller</i>

<i>Dredge Pipe (11,000 linear feet (12-14"))</i>	<i>ISCO Industries (costs fluctuate with oil prices)</i>
<i>Attachments, Fittings, & Floats</i>	<i>Neptune Flotation</i>
<i>Pipe Fusion Machine</i>	<i>Ellicott – Steve Miller</i>

<i>3x GMC Sierra 2500HD Duramax Pickups</i>	<i>Battles GMC – New Inventory</i>
<i>2x Heavy-Duty Equipment Trailers</i>	<i>Loadtrail HD Deckover Equipment Trailers - New</i>
<i>CAT Wheeled Loader</i>	<i>Machinery Trader – Newer, Used Inventory</i>
<i>Loader Attachments</i>	<i>Iron Planet – New Inventory</i>

17. Pages 65 and 71- The DAC understands that WHG used BCD full-time labor costs in the financial model and WHG also considered (per page 71) the alternative of part-time employees (the “Edgartown model”). Tom Daley has advised that it is not reasonable to assume the Town would hire 5 new full-time employees to operate a partial year municipal dredge program and we cannot assume existing DPW staff would be available to be assigned to a municipal dredge program, so planning for part-time employees seems appropriate. In addition, it is worth discussing potential costs for the part-time



employees based on data to be gathered by DAC members. This topic and the hypothesis at the end of this email will be discussed in the meeting with WHG.

Substituting a TBD labor-cost model for the current study will require additional funding. The DAC and Town officials should work together to agree upon on the labor costs that they would like included in the model prior to Woods Hole Group updating the model. It is important to note that the Orleans model assumes up to (2) booster pumps operating at a significant distance away from the dredge site, which will require significantly more labor than the Edgartown model.

18. DAC members have requested that WHG consider data that will be provided by the DAC (for examples, see comments #11 and 12) to either (a) revise the existing financial model or (b) generate an “alternative scenario” for the financial model. This topic will be discussed in the meeting with WHG.

While alternative scenarios may present themselves in the future, it is not possible for Woods Hole Group to foresee and incorporate all possible financial alternatives in the existing model. Woods Hole Group developed the costs in Tables 11-14 based on the most recent costs available from manufacturers and our best, independent engineering assessment. WHG has worked hard to develop a financial model based on industry standard data. The report provides an objective analysis of costs associated with a municipal dredge purchase by the Town of Orleans and compares this with alternative methods for dredging municipal waterways.

19. Add to the report a RANGE estimate of the number of days a municipal dredge might be available for work in other towns based on the dredge volumes and assumptions for # dredging days, mob/demob time to move dredge, etc. The goal will be to determine whether contracting out a Town owned dredge might generate revenue for the Town or whether it might be wise for Orleans to consider purchasing a dredge in concert with another town.

Woods Hole Group could estimate the number of working days each calendar year that the dredge would likely be occupied in Orleans to determine how many days might be available to complete projects in other municipalities. This would require an amendment to the contract for the revised report. It is important to note, that depending on the project, weeks of mobilization/demobilization and transit time may be required to prepare the dredge for projects in other municipalities. Further, it will be important to account for unforeseen weather delays, mechanical breakdowns, injuries, and pumping rates that are below the maximum daily output of the dredging equipment. Consequently, the estimated number of available days could vary considerably year to year.

20. Page 78- Reconsider statements regarding feasibility based on BCD input that will be provided later this year.

Woods Hole Group will revisit this question once supplemental information is provided by the DAC.

21. Page 80- DAC members will provide input on the current cost of sand/cubic yard from nearby sources. There is interest in including a range of possible revenue from sales of Nauset Estuary sand if the sand is not used by the Town or, conversely, the potential reduction in Town costs for purchasing sand to rebuild dunes, nourish beaches, etc. Nauset Estuary sand that will be dredged from locations in Eastham should be excluded from this calculation. Of course, the text should highlight that future changes in demand, prices, etc. will affect the guidance provided.



Including a discussion of the variable cost of sand will require additional funding. More important than the prevailing cost of sand is identifying potential buyers and sites that are willing to accept large volumes of material. Like the dewatering discussion, it is not cost effective or efficient to place 100 CY at one site and 300 CY at another – the DAC and the Town will need to identify sites that can accept thousands or tens of thousands of cubic yards annually for the duration of the 30-year planning horizon.

22. Page 81-82- Consider adding more “Pros” for a municipal dredge purchase, including (a) the ability of the Town to quickly respond to sudden shoaling problems and thereby enhance navigation and public safety, as well as the annual availability of a dredge to the Town (b) there may be opportunities for the Town to reduce its dredging costs (assuming it appears a municipal dredge would have enough downtime that it would be available for contracting with other towns or could be purchased jointly with another town) (c) a municipal dredge might be used for dredging fresh water ponds (assuming WHG determines the Ellicott 370 has been and could be used for this purpose). Conversely, consider adding more “Cons” for use of the BCD, including (a) uncertainty regarding BCD performance, given past problems with BCD performance, (b) the Town will be unable to respond quickly to sudden shoaling problems, so risks to navigation and safety may be greater and (c) (revising the second BCD “Con” bullet) it’s unlikely the BCD would be available to Orleans annually for maintenance dredging work due to the ongoing queue for its services.

Pros

- a) Have been added to the draft report.*
- b) Have been added to the draft report.*
- c) Analyzing the demand for and potential impacts of dredging freshwater ponds is not included in the scope of this assessment – therefore, (c) was not included as a Pro of a dredge purchase. It is likely the Ellicott 370 could be used to dredge freshwater systems, the 670 would be too large to access the ponds.*

Cons

- a) Have been added to the draft report.*
- b) Have been added to the draft report.*
- c) Have been added to the draft report.*

23. Page 81 Last bullet on page- Adjust text to reflect that Tom Daley has indicated the Town has storage space for all equipment and the dredge itself. Possible storage locations for pipe (including possible in-water storage) should be discussed with Daley, perhaps during the DAC meeting with WHG, and discussed in the report.

Town officials have not indicated to Woods Hole Group that they have the capacity to manage and store all dredging and ancillary equipment (including pipe). The DAC should work with Town officials to determine the most appropriate storage locations and communicate findings/preferences to Woods Hole Group. The bullet was left in the draft report because any in-water storage would create a navigational hazard (even if marked) to recreational and/or commercial boaters, especially at low tide. Further, any in-water storage in the estuary risks burying and permanently losing or damaging long sections of the pipeline. As a reference, the EDP has lost much shorter sections of pipe left over short periods of time in dynamic inlets.

24. Conclusions- Consider adding text that recommends the size of dredge that would be best if the Town elects to pursue a dredge purchase. In addition, (a) Highlight the need to balance cost and dredge



availability concerns in choosing between the BCD and a municipal dredge. (b) Quantify the cost difference with a municipal dredge versus the BCD (c) Highlight that Nauset Estuary dredging costs (except for Mill Pond Channel) should be shared with Eastham regardless of whether a municipal dredge or the BCD is used.

Woods Hole Group cannot speak on behalf of the Town regarding long-term finances or capital purchases. The Town and the DAC should consider the data presented in the draft report to help inform municipal decision making regarding whether to purchase a dredge and the most appropriate equipment to fulfill municipal dredging needs.

- a) *Woods Hole Group has acknowledged the associated costs and availability of equipment in the Pros and Cons section of the draft report.*
- b) *The cost differences between the BCD, a municipal dredge, and a private contractor are provided in Tables 17-19.*
- c) *Woods Hole Group cannot speak on behalf of the Town of Eastham and will not speculate on how any future dredging projects with neighboring municipalities will be negotiated. The DAC, Town officials, BOS, and the Nauset Estuary Working Group should continue to collaborate on the most amenable solution for all parties.*

25. Additional Information Needed- WHG's study proposal indicates that the following information will be provided but this information is not included or is covered only briefly in the draft report. Each information issue is followed by a suggestion.

- Proposal pages 2-4- Previous dredging permits for Nauset Estuary- Not included. Assuming WHG already has this information, it would be helpful to include this history for future reference.

These data will be added to the draft report.

- Proposal pages 3,5- Possible funding sources for dredging costs. Not included except for a passing funding reference on page 77. Would be helpful to add this information.

A section regarding possible funding sources will be included in Chapter 6.

- Proposal page 4- Suitability of equipment for use in freshwater ponds. Not included. Should be added based on input from Ellicott, Steve Smith, and others.

The Ellicott 370 could likely be used in ponds that have suitable boat ramps and/or crane access. The Ellicott 670 would be too large to transport for such purposes. A reference to this possibility will be included in the draft report. However, a more thorough analysis regarding the demand for and possible impacts associated with dredging freshwater ponds is not included in the scope of this assessment. It should also be noted that a standard Ellicott 370 can only dredge to a maximum depth of 20', which may be insufficient to reach the bottom of larger freshwater ponds where nutrients tend to accumulate. Modified Ellicott 370 dredges are available with longer (33'-42') arms, at an additional cost.

TECHNICAL/MINOR COMMENTS



1. Page 2- Mention that in recent years there have been a number of Town Meeting votes in support of dredging Nauset Estuary and Pleasant Bay and major expenditures for studies. Note that dredging of Mill Pond Channel was included in these votes.

Included as a bullet item on p.3 Municipal Action to Address Dredging Need. Awkward to reference Mill Pond Channel and not all other channels/sections of channel being considered.

2. Page 49- Is the first sentence on the page consistent with Table 8?

Updated to reflect the revisions included in Table 8.

Based on this assessment of sediment quantity and quality, a total estimated 87k – 150k CY of sand and 43k – 48k CY of fine-grained material are currently available to be removed from Town of Orleans waterbodies. Total expected volumes from individual waterbodies are summarized in Table 8. Nauset Estuary accounts for approximately 70 – 80% of all potential dredge material; with the section behind the barrier beach accounting for approximately 67 – 68% of that total.

Table 8. Summary of Dredge Volume Calculations for Town of Orleans Waterways.

Waterway	Sand Volume (CY)	Fines Volume (CY)
Nauset Estuary 50' Channel	76,490	13,295
Nauset Estuary 100' Channel	139,972	18,625
Pleasant Bay	10,694	4,126
Rock Harbor	0	25,233
Total Assuming 50' Nauset Channel	87,184	42,654
Total Assuming 100' Nauset Channel	150,666	47,984

3. Throughout report- Replace references to a “regional” dredge purchase with references to a “municipal” dredge purchase.

Updated throughout the draft report.

4. Page 73- First paragraph- Replace reference to “Town council” with reference to DAC and Select Board.

Update has been made on p. 73. Board of Selectmen updated to Select Board throughout the draft report.

5. Page 74- Nauset Estuary Dredge Volume- Second bullet- The numbers in lines 3 and 4 should be reversed.

Update has been made in the draft report.

6. Page 80- Regarding the sale of sand- third bullet- last line is garbled



Updated in the draft report to read: This fine-grained, silty material that is unsuitable for beneficial reuse as beach nourishment or dune enhancement would need to be stockpiled and/or disposed of in the upland or at offshore disposal site, which may add to the cost of future projects.

HYPOTHESIS FOR LABOR COSTS IF “EDGARTOWN MODEL” IS USED

Assumptions-

1. Year-round employment for Superintendent- 15 hours/week at \$X/hour x 50 weeks plus workmen’s comp
2. Six months employment for three persons- captain, leverman, 1 deckhand (40 hours/week plus workmen’s comp; need estimates of hourly rates)
3. XXX months employment for one or two deckhands when Nauset Estuary is dredged- deckhands will man booster pumps (40 hours/week plus workmen’s comp)
4. Use of staff listed in #2 for maintenance and mobilization/demobilization
5. Hourly rates will be researched by DAC members

Revising the model to reflect the EDP model will require additional funding. The DAC and Town officials should consult with the BCD and EDP regarding prevailing wage rates, and with the Town of Orleans Human Resources Office regarding workman’s comp rates. For reference, the EDP has recently indicated that they are planning to increase hourly rates from the historic \$40/hr. to \$45/hr. for their crew. The Town of Orleans needs to consider that nearly all dredging projects in Town will require at least one booster pump and that each pump will need to be manned. Further, there will need to be at least one additional crewman (or subcontractors) present at the end of the pipe to manage the dewatering pit and stockpile and/or load the spoils into trucks. In short, any future Orleans Dredge Program will not be synonymous with the established EDP model. Woods Hole Group feels that the BCD model provides a much more realistic picture of the expected scale and associated costs of operating a dredge program in Orleans.

November 25, 2020 email:

1. Pg. 1. 2nd paragraph Little water, not litter

Update has been made in draft report.

2. Pg. 2. error, there are 5 historical sites, not 6.

Update has been made in draft report.

3. Pg. 2. under Nauset Estuary: Should specify portions of project within Eastham borders for transparency, just like is done in subsequent section on Rock Harbor.

Update has been made in draft report.

Nauset Estuary is a dynamic barrier estuarine and salt marsh system, where strong tidal currents and wind and wave exposure result in a continuously evolving shoreline and channel within the Towns of Orleans and Eastham.



4. RH section should specifically state that in 2015 expense split was 46% Eastham and 54% Orleans based on dredged volumes.

Update has been made in draft report.

The harbor and access channel have required dredging every 10 years, most recently in 2015, to maintain safe navigability and full functionality, a coordinated effort between the Towns of Orleans and Eastham, who funded 54% and 46% of the project, respectively, based on the total dredged volumes within each Town.

5. Pg. 6. paragraph any contaminants, not and

Update has been made in draft report.

6. Pg. 18. Clarify last paragraph statement (.... State paying 75% of the cost of private municipal dredging projects at market rates). What does this mean?

The cost savings is calculated based on the historic practice of the State paying 75% of municipal dredging projects using a private dredge contractor to complete the work at prevailing market rates per CY.

7. Pg. 38. For transparency, all volumes should show portion in Eastham, portion in Orleans, then a total.

Breaking down the dredge volume by Town in a separate Table would require additional funds.

8. Pg. 38. What is the proposed dewatering site if we exceed 80k, or are we just assuming all work would be limited to 80k to stay with the only dewatering site we have??

Through its work on the Nauset Estuary Dredging project, the Woods Hole Group is working to determine how to manage the dewatering site and sand stockpile (i.e., length of time required for dewatering and red tide cyst mortality; needs for sediment reworking at the dewatering site;). While the proposed 7-acre dewatering site is sufficient to manage the initial 80k CY of material, the DAC and Town will need to develop a process for identifying how the material will be moved off site to accommodate any future maintenance dredging volume.

9. Pg. 49. Add a line showing vol excluding behind the barrier beach.

p. 38 includes an overview of how the dredge volumes would change if areas behind the barrier beach were excluded.

10. Pg. 50. first paragraph typo exclude the word when.

Update has been made in the draft report.

11. Pg. 50. last paragraph, to be consistent, the text should discuss 2 booster pumps since this is reflected on the following diagram.

Updated in the draft report.



Woods Hole Group looks forward to meeting with the DAC on December 14th to review the response to comments and to discuss next steps. Please let me know if you have any additional questions.

Sincerely,

A handwritten signature in black ink, which appears to read 'Adam Finkle', is positioned below the word 'Sincerely,'.

Adam Finkle
Coastal Scientist, PWS, CERP