WOODTICK AQUATIC HABITAT, ERIE TOWNSHIP, MONROE COUNTY, MICHIGAN

CAP SECTION 204: BENEFICIAL

USE OF DREDGE MATERIAL

APPENDIX #ENGINEERING APPENDIX

March 2022

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1. Introduction

1.1 Location

Woodtick Peninsula is located in southeastern Michigan along the western shoreline of Lake Erie, in an area referred to as North Maumee Bay. It is located approximately 45 miles southwest of Detroit, Michigan and, at its most southern point, 5 miles north of Toledo, Ohio. The project area stretches the entire 3.75 miles of the peninsula, the majority of which is located within the Erie State Game Area **Figure 1**.

1.2 Purpose and Study Area

The purpose of the project is to enhance coastal resiliency through beneficial use of dredged material on Woodtick Peninsula in a manner that addresses fluctuating Lake Erie water levels, varying wave energy, and climate change. Due to historical habitat loss, there is a need to restore and enhance the existing coastal, emergent, and submergent wetlands in order to restore fish and wildlife habitat. Only 5% of the originally 307,000 acres of Lake Erie wetlands remain – approximately 10% of those wetlands are located within or adjacent to Woodtick Peninsula.

The Woodtick Peninsula is part of the North Maumee Bay Archeological District and is open to the public for activities including hiking and fishing. The peninsula also serves to shelter the nearby coastal wetlands and preserve the benefits they provide. Lake Erie borders the east side of the peninsula, while a small channel flows down the western bank and into the North Maumee Bay. The peninsula is connected to the mainland at the northern end, while the southern tip extends into Maumee Bay. The peninsula is accessible from adjacent land owned by Consumers Energy. This project study will focus on potential strategies to reduce erosion and bolster habitat on the peninsula. **Figure 2** shows an image of erosion occurring which is exemplary of the erosion the on the peninsula. This Engineering Appendix discusses the preliminary engineering research and evaluation conducted of the project area(s), evaluation of existing information and data, channels, dredge material, and other engineering considerations that meet the objectives and goals for this study. This Engineering Appendix will also discuss the proposed array of alternatives and if further analysis is needed on the selected plan during the preconstruction engineering and design (PED) phase. This project seeks to beneficially use dredged material from the Federal Navigation Channel in Toledo Harbor to restore Woodtick peninsula and ensure that its function as a coastal barrier is maintained. The need for continued maintenance dredging of the Toledo Harbor federal navigation channel combined with the past loss of wetland habitat provides the opportunity to beneficially use future Toledo Harbor sediments for ecosystem restoration purposes at Woodtick Peninsula. Economic benefits include the benefit to the Nation of beneficially using dredged material and avoiding the use of USACE approved dredged material disposal sites. Beneficially using dredged material allows USACE to maintain capacity in approved dredged material disposal sites and therefore allows for a longer life of the site. Considering avoiding disposal in a USACE approved disposal site as a benefit

1.3 Authority

Section 204 of the Water Resources Development Act of 1992, Public Law 102-580, provides the authority to carry out projects to reduce storm damage to property, to protect, restore and create aquatic and ecologically related habitats, including wetlands, and to transport and place suitable sediment, in connection with dredging for construction, operation, or maintenance by the Secretary of an authorized Federal water resources project. It is a Continuing Authorities Program (CAP) which focuses on water resource related projects of relatively smaller scope, cost and complexity. Traditional USACE civil works projects are of wider scope and complexity and are specifically authorized by Congress. The CAP is a delegated authority to plan, design, and construct certain types of water resource and environmental restoration projects without specific Congressional authorization.

Figure 2. Woodtick Peninsula Experiencing Erosion

2.Alternatives

2.1 Alternatives Design Data

Table 1: Alternatives Design Data

Low Water Datum for Lake Erie	569.2 ft.
Existing Lake Side Shoreline Elevation	Varies-An Average of 574 ft
Existing Lee Side Shoreline Elevation	Varies -An Average of 574 ft
Long-Term Average Water Elevation (LTA)	571.42 ft.
Lee Side Dredged Material Slope	1V:20 H
Lee Side Top of Dredged Material Elevation	570.75 ft. (6 in. below LTA)
Lee Side Bottom of Dredged Material Elevation	562 ft (lake bottom Average Elevation)
Design Boat Channel Width	3 ft.

NOTE: All elevations referenced within this document are relative to the International Great Lakes Datum of 1985.

2.2 Focused Alternatives Array

Engineering team members assisted Planning team members during the Plan Formulation process. This included the Planning Objectives, Preliminary Plan Formulation, including the No-Action Alternative and Alternatives consisting of different elements. The formulation reviewed placing the dredge material from Toledo Harbor (Federal Harbor) and placing that material in four different site locations. In addition to a "no action" alternative, four other alternatives were evaluated. One of the alternatives consisted of using dredged material to rebuild the eroded areas of the peninsula. The other four alternatives consisted of using dredged material to rebuild the peninsula while also constructing reef habitat using geosynthetic containers (GSCs) filled with dredged material. The feasibility of each of these measures would be studied further and a decision on which measure to use would be based on cost, acceptability, and practicability.

2.3 Alternative 1 – No Action Alternative/Future Without Project Condition

The Future Without Project condition, analyzed for comparison with the action alternatives assumes no Federal Action to beneficially use dredged material at Woodtick Peninsula. For purposes of NEPA it represents the no action alternative (NAA) for the proposed project. Alternative 1 (**Figure 3**) would consist of continuation of the current dredged material disposal practice during dredging of Toledo Harbor, OH that consists of open water disposal in the approved location. No placement of dredged material would occur near or on Woodtick Peninsula. Erosion is expected to continue along Woodtick Peninsula, especially near the southern end where exposed land is present. Phragmites would continue to colonize the peninsula. An old commercial channel exists along the leeside of Woodtick peninsula that was once maintained and used by a power plant company. Ships bringing coal to the power plant would use the channel and the power plant company maintained the channel. The power plant has since closed, and the channel is no longer maintained but still has depths of between 12 ft and 15 ft. In the no action alternative, it is assumed that dredging of the channel will not occur and the channel will continue to slowly fill in.

Figure 3. No Action Alternative for Woodtick Peninsula

2.4 Alternative 2a and 2b – Rebuild Peninsula

Alternative 2a and 2b includes placing dredged material from Toledo Harbor, OH on the lee side of Woodtick Peninsula (west of the Peninsula). Dredged material would be hydraulically placed to an elevation of 570.75 ft approximately six inches below the long-term average water elevation of Lake Erie (LTA=571.42 ft), **(Figure 4 and Figure 5)**. At this placement elevation, it is assumed that dredged material would be under water for at least 50% of the year. The low water datum for Lake Erie is 569.2 ft, keeping the dredged material submerged for 50% or more of the year will discourage phragmites colonization.

Dredged material would be placed at a 1V:20H slope to lakebed elevation of 562 ft, the 1V:20H slope is the slope typically used to create Great Lakes Marsh habitat. A key constraint for Alternative 2a and 2b is ensuring access around the peninsula for recreational boaters. This is achieved by sloping dredged material starting at the peninsula down to lakebed elevation of 562 ft. Alternative 2a would have a placement footprint of 129 acres and require approximately 245,500 CY of dredged material. Alternative 2b would have a placement footprint of 142 acres and require approximately 388,000 CY of dredged material. Straight channel was designed to meet the required elevations and slope for habitat, reuse of dredged material to also leave an access channel for the boaters. Curved channel designed similarly to the straight channel and curved to increase the area for dredged material placement, and this will increase the volumes placed and to keep the required slope at 1V:20H and avoid going into the small island in the middle of the lower side off the channel.

Figure 4. Alternative 2a- Rebuild Peninsula -Straight Boat Channel

Figure 5. Alternative 2 b- Rebuild Peninsula -Curved Boat Channel

2.5 Alternative 3 – Rebuild Peninsula & Lakeside Reef

Alternative 3 includes placing dredged material from Toledo Harbor, OH on the leeside and lake side of Woodtick Peninsula **(Figure 6)**. In the lee side dredged material would be hydraulically placed to an elevation of 570.75 ft, which is 6 inches below LTA elevation of 571.42 ft. At this placement elevation, it is assumed that dredged material would be under water for at least 50% of the year. The low water datum for Lake Erie is 569.2 ft, keeping the dredged material submerged for 50% or more of the year will discourage phragmites colonization. In the lake side placement would be to the average shoreline elevation of 574 ft in the lake side. In the lee side dredged material would be placed at a 1V:20H slope to

lakebed elevation of 562 ft and doesn't extend beyond the old leeside channel, the 1V:20H slope is the slope typically used to create Great Lakes Marsh habitat. The lake side material would be placed to an elevation of the average shoreline elevation of 574 ft within a 40-acre footprint. Offshore, from the lakeside placement area, an offshore reef **(Figure 12)** would be created with 17 ft x8 ft x3 ft geosynthetic containers (GSCs) filled with dredged material and a layer of stone on top of the containers. These containers would be placed in roughly a rectangle shape to an elevation of approximately 566.2-566.5 ft at approximately 800 ft from shoreline. Stone rip-rap would be placed on top of the GSCs to create fish and wildlife habitat, stone size ranges between 3 ft armor stone and 6-8 inch gravel/cobble stone. For GSCs placed on the lakeside of Woodtick Peninsula, it is likely the rip-rap would be above water for a majority of the year. The offshore reef would have a footprint of approximately 11.5 acres and require approximately 13,500 CY of dredged material. The lakeside placement area would require 10,500 CY of dredged material and the leeside placement would require 245,500 CY of dredged material, total dredged material reuse for this alternative is around 270,000 CY.

Figure 6. Alternative 3- Rebuild Peninsula & Lakeside Reef

2.6 Alternative 4a and 4b- Dredged Material Placement on the Leeside near the Southern End of Peninsula and Offshore Reef

Alternative 4a and 4b includes placing dredged material from Toledo Harbor, OH on the leeside of Woodtick Peninsula. Dredged material would be hydraulically placed to an elevation of 570.75 ft six inches below the LTA elevation of 571.42 ft. At this placement elevation, it is assumed that dredged material would be under water for at least 50% of the year. Keeping the dredged material submerged for 50% or more of the year will discourage phragmites colonization. Dredged material would be placed at 1V:20H slope to lakebed elevation of 562 ft. The 1V:20H slope is the slope typically used to create Great Lakes Marsh habitat. Alternative 4a **(Figure 7)** would not extend placement past the old channel, while alternative 4b **(Figure 8)** would extend the dredge placement footprint to include the entire old channel. Alternatives 4a and 4b include the creation of an offshore reef **(Figure 12)** made with 17 ft x8 ft x3 ft GSCs filled with dredged material and rip rap at the southern end of Woodtick Peninsula. These GSCs would be placed in roughly a curved line on lakebed elevation of approximately 566.2 – 566.5 ft. Stone rip-rap would be placed on top of the GSCs to create fish and wildlife habitat stone size ranges between 3 ft armor stone and 6-8 inch gravel/cobble stone. For the reef placed at the southern end of Woodtick Peninsula, it is likely that part of the rip-rap would be above water for a majority of the year. The reef would be approximately 1,200 ft in length, have a footprint of approximately 1/3 of an acre, and require approximately 1,200 CY of dredged material. Alternative 4a would have a placement footprint of 115.3 acres and require approximately 156,000 CY of dredged material. Alternative 4b would have a placement footprint of 116.3 acres and require approximately 329,000 CY of dredged material.

Figure 7. Alternative 4a

Figure 8. Alternative 4b

2.7 Alternative 5- Dredged Material Placement on the Leeside near the Southern End of Peninsula and Two Offshore Reefs

Alternative 5 (Figure 9) includes all features from Alternative 4a, plus the lakeside placement area and offshore reef from Alternative 3. Alternative 5 would have a dredged material placement footprint of approximately 167 acres and require 353,000 CY of dredged material for the four features (leeside placement, lakeside placement, lakeside reef, and reef at southern end).

Figure 9. Alternative 5

2.8 Dredge Material Placement Sequences

Dredged material will be placed in a 1V:20H slope in the lee side of the peninsula, this slope is very flat and will not require any shoring. To keep the material from moving and shifting during placement we recommend that the contractor start placing material at the toe of the slope and moving up to the proposed top elevation. We also recommend that the contractor place material in segments and potentially use turbidity curtains for each segment due to the fine particle size of the dredge material and proximity to wetlands and high-quality ecological habitat.

During the Preconstruction, Engineering & Design Phase, the Project Delivery Team (PDT) will need to put some thought into how equipment and materials will be staged and will need to ensure that adequate depths are available to get anticipated equipment into the site. Additionally, the PDT will need to assess the pros and cons of mechanical versus hydraulic placement and whether restricting the methodology will be warranted. The PDT should also consider implementation of best management practices developed from previously constructed projects in the Duluth-Superior Harbor (e.g. Interstate Island and 40th Ave Placement efforts) and other succesful beneficial reuse dredged material placement projects around the Great Lakes.

2.9 Quantity Takeoffs and Cost Estimate

Quantities and costs were developed for each alternative (shown in ATTACHMENT 1-Quantity Takeoffs and Cost Estimate). Calculations were developed using available existing LIDAR data, hydrographic survey data, historical dredging data, and engineering assumptions. Dredged material volume calculations were calculated using Auto Desk's Civil 3D software.

2.10 Alternatives Evaluation, Comparison, and Selection Description of the Tentatively Selected Plan (TSP)

Based on the evaluation of the costs, benefits, completeness, effectiveness, and efficiency of each alternative and an analysis of the four accounts (NED, RED, EQ, OSE) Alternative 4a was designated as the TSP. To learn more about the specifics on this decision, reference to the Integrated Feasibility Report. Figure 10 and Figure 11 show the plan view and cross section of the TSP.

Figure 10-Tentatively Selected Plan (TSP) Plan View

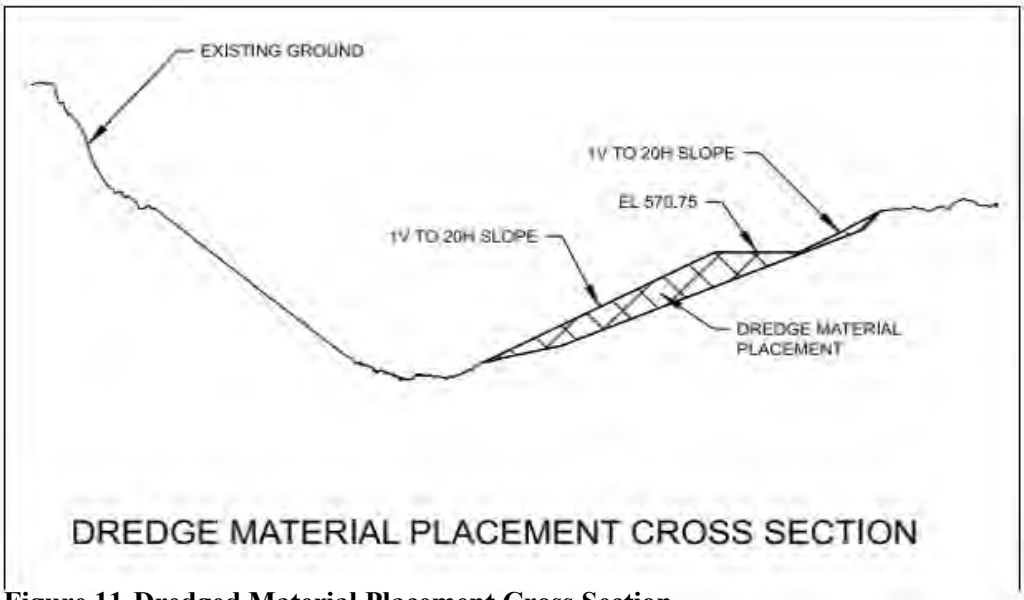


Figure 11-Dredged Material Placement Cross Section

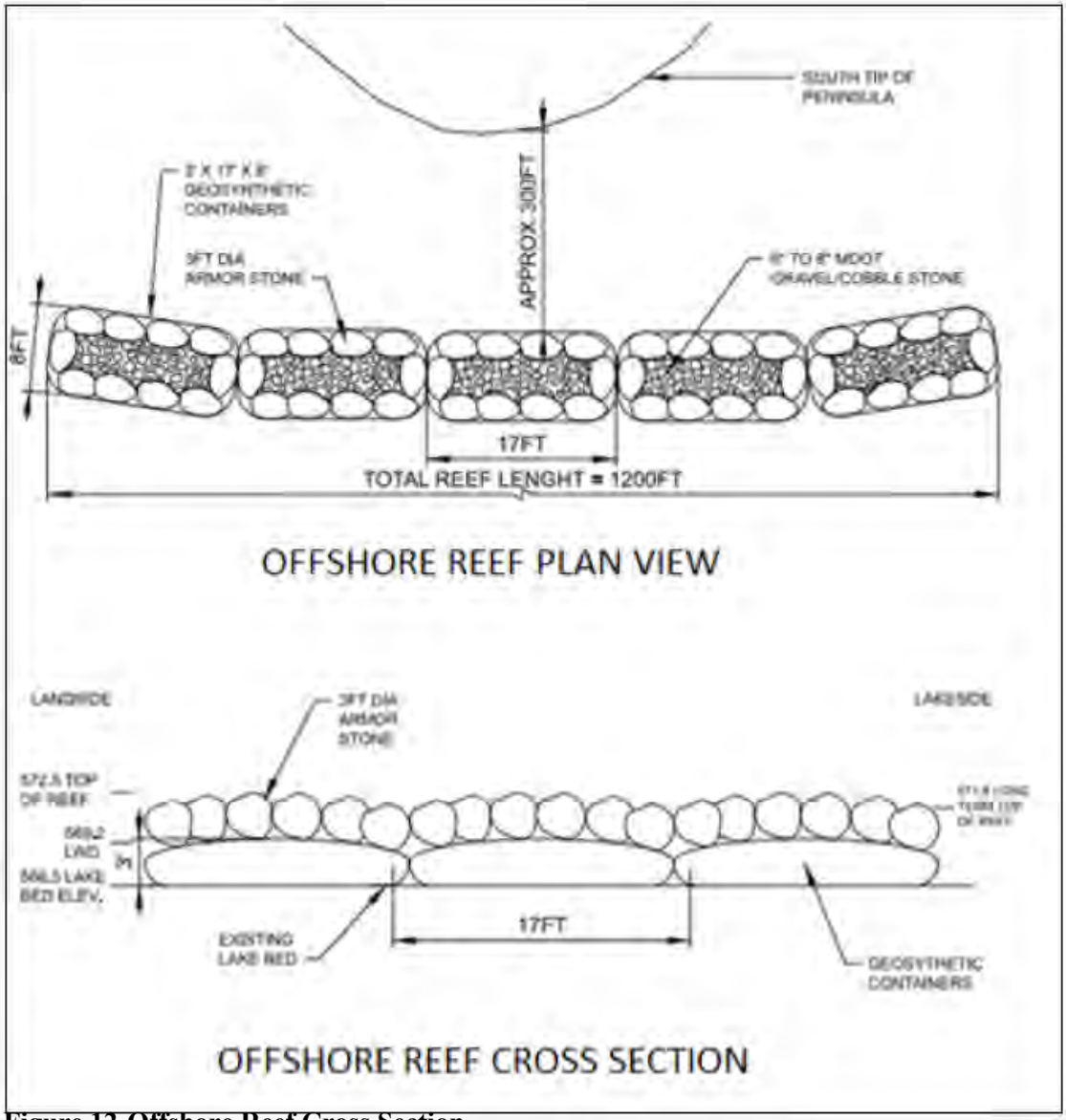


Figure 12-Offshore Reef Cross Section

3. Mapping, Geospatial Data & Utility Investigation

3.1 Surveys & Mapping

Topographic and Hydro survey were obtained by Detroit District Survey team in June 2021. Some areas were not fully surveyed due to thick phragmite growth. Areas between the shore and surveyed locations are either thick vegetation/phragmites or depths below 2-3 ft which would require hand surveying. Surveying these areas could be done if required but would be time intensive. Areas between the topo and hydro surveys were interpolated and combined with the use of LiDAR data to get an accurate understanding of the terrain.

3.2 Horizontal and Vertical Datums

The horizontal control is based on the North American Datum of 1983 (NAD83) and coordinates listed are in the Michigan State Plane Coordinate System, South Zone 2113 in US Survey Feet. Vertical control is based on the North American Vertical Datum of 1988 (NAVD88). Vertical information utilized in all design documents is referenced to Low Water Datum for Lake Erie (+0.0 LWD = 569.2 FT. IGLD85).

3.3 Utility Investigation

During the Preconstruction, Engineering & Design Phase, a planning level utility investigation will be required to ensure that no utilities will be impacted by the proposed work from this project. NOAA charts (https://www.charts.noaa.gov/InteractiveCatalog/nrnc.shtml), Miss Dig (https://www.missdig811.org/) and previously USACE regulatory permit requests are all good resources to assist with utility investigations.

4. Woodtick Geotechnical Investigation

Geotechnical investigation includes review of the nearest available geotechnical borings to understand the general material in the project vicinity. The investigation also evaluates the use of Geosynthetic Containers (GSC) as an offshore reef at the proposed location for the Tentatively Selected Plan (TSP).

4.1 Subsurface Exploration

There are currently no geotechnical borings available at the Woodtick Peninsula site. This investigation considers two available boring reports that are roughly 3 miles from Woodtick Peninsula. **Figure 13** shows their boundary of borings available along 1-75 and Island 18 Confined Disposal Facility (CDF).

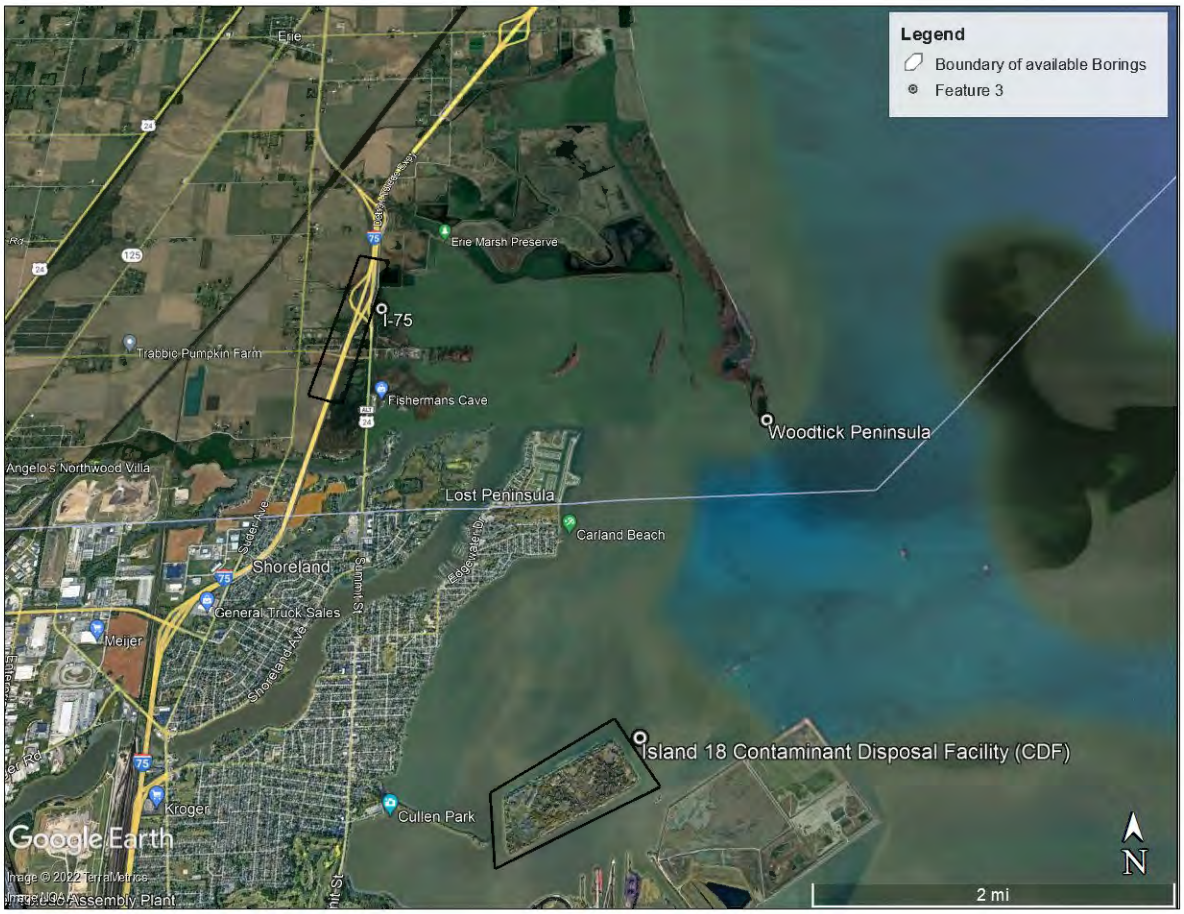


Figure 13. Subsurface Investigations near Woodtick Peninsula

Figure 14 shows geotechnical boring locations available along I-75. These borings indicate the presence of silty clay with varying color and stiffness (medium to very stiff) attributes below the Woodtick channel elevation, approximately 561 feet to 562 feet. This silty clay has traces of sand and gravel.

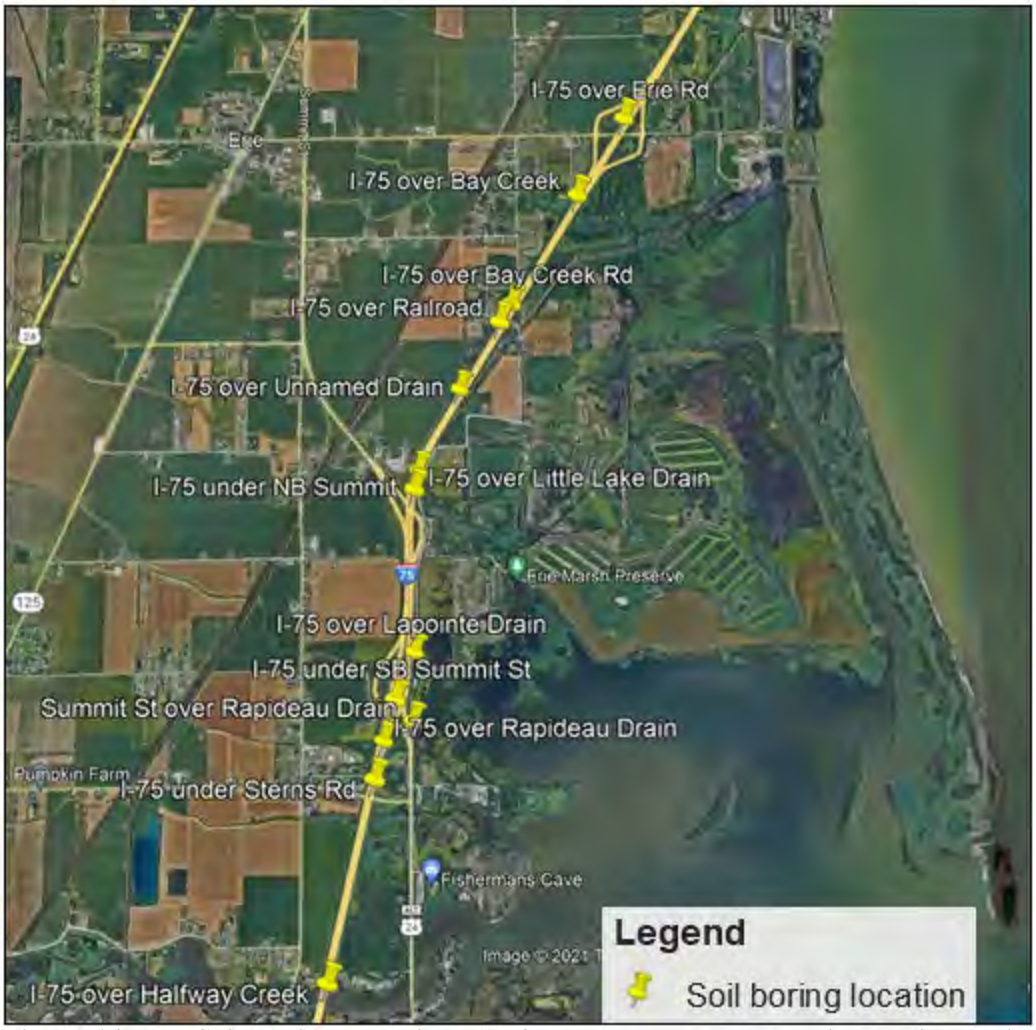


Figure 14. I-75 Soil Boring Locations (Reference: I-75 reconstruction project, Michigan Department of Transportation)

Figure 15 shows geotechnical boring locations at Island 18 CDF, Toledo Ohio. The report shows at approximate elevations ranging from 573 feet to 539 feet, Stratum-1 granular soils consisted of poorly graded sand (SP), clayey sand (SC), poorly graded sand with silt (SP/SM), silty sand (SM), or well graded sand with silt (SW/SM). Trace gravel and/or shells were noted in occasional samples. (See **Figure 16**).

Figure 15. Island 18 CDF Soil Boring Locations

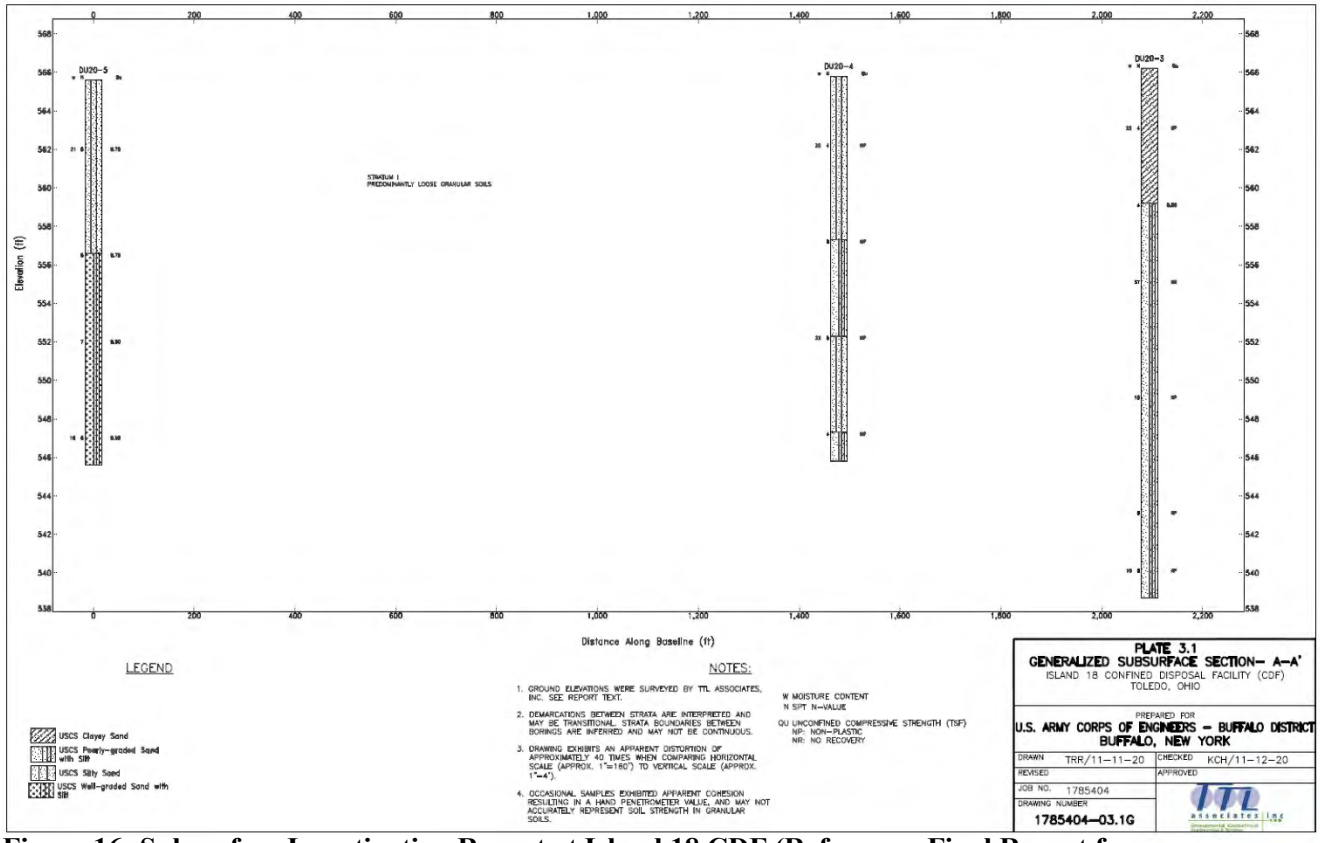


Figure 16: Subsurface Investigation Report at Island 18 CDF (Reference: Final Report for Geotechnical Drilling and Laboratory Testing Services, Island 18 CDF, Toledo, Ohio)

4.2 Generalized Soil Profile

Sediment transport at the project location was studied to understand the deposition of material due to long shore currents. The wave energies on the lakeside are relatively higher than the leeside at the project location. We know that higher wave energies tend to transport heavier materials. Thus, we can expect coarser material deposition due to littoral transport on the lakeside of the Woodtick Peninsula and finer material at the leeside of the Peninsula.

The Woodtick channel has a minimum elevation of approximately 561 feet to 562 feet. Tests of the habitat, including fish communities were conducted using the Lake Erie/Lacustury Qualitative Habitat Evaluation Index (LQHEI). These tests included collecting Ponar grab samples at a depth of 3 – 6 inches around Woodtick peninsula as shown in **Figure 17**.

Figure 17. Ponar Sample Locations

Figure 18 shows the location of the offshore reef on the leeside of the Woodtick Peninsula. Ponar grab samples LQHEI-12 and LQHEI-23 correspond to the offshore reef placement location. The surface of the lakebed on the leeside of Woodtick peninsula is more consistent with a mixture of coarse grain and fine grain material.

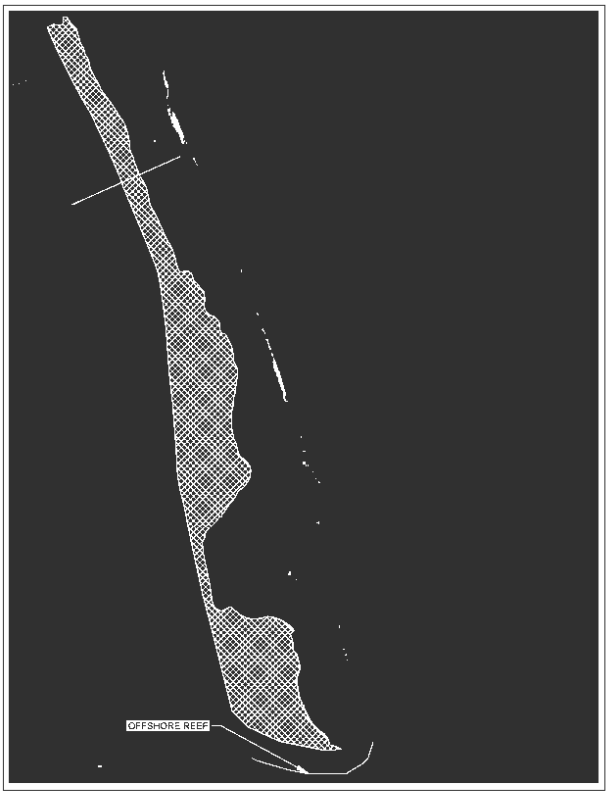


Figure 18. Offshore Reef Placement Location

Table 2. Ponar Sample test results at Offshore Reef placement location

Location	Sample ID	%Gravel	%Sand	%Silt	%Clay	Organic Content (%)	Specific Gravity
Leeside	LQHEI-12	0.9	73.0	26.1	0.0	1.2	2.70
Leeside	LQHEI-23	0.0	41.0	56.3	2.7	2.6	2.64

Based on the nearby borings and Ponar grab samples, it is not definitive of what surficial material is present at Woodtick Peninsula. Hence, additional geotechnical borings should be taken during the Preconstruction, Engineering & Design (PED) Phase of the Woodtick project.

4.3 Borrow Site Material

According to the Toledo Harbor 2020 Section 404(b)(1) Evaluation, the dredged material from the Toledo Harbor Federal Navigation Project is predominantly fine grain in nature. Overall, the sediment samples were comprised of between 35% and 98% clays and silts, with the remainder coarse grain (mainly sands with some gravels). Additional samples of dredged material should be collected and subjected to applicable geotechnical laboratory testing prior to final design. Testing to include visual classification in accordance with the Unified Soil Classification System (ASTM D 2487 and D 2488), moisture content determinations (ASTM D 2216), grain size/hydrometer analysis (ASTM D 7928 and ASTM D 6913), Atterberg limits (ASTM D 4318), and organic content determinations by the Loss on Ignitions test (ASTM D 2974). The final project contract documents will include these test results for GSC design.

4.4 Geosynthetic Containers (GSCs)

Geosynthetic Containers are specially engineered textiles that enable the passage of water while at the same time retaining the solids component of the container fill. GSCs were proposed as an offshore reef based on a successful design from USACE- Buffalo district. Offshore reef design using stones was not considered as an alternative due to higher cost of material. GSC is a simple, cost-effective method that is highly adaptable to a variety of conditions. This Geosynthetic Container will beneficially use the dredged

material from Toledo Harbor as a fill material and will provide a surface for placement of 6-8 inches of gravel/cobble stone that meets the fish habitat requirement, while protecting the leeside material placement.

GSCs will be hydraulically filled with a slurry mix of dredged material and water. Water dissipates through the permeable engineered fabric, while the dredged material will settle out within the container by gravity. This monolithic structure with compacted fill will be used as an offshore reef at Woodtick Peninsula.

GSCs can be tubular shaped, bag shaped, mattress shaped, or more general container shaped. A GSC is constructed with pervious high-strength woven geotextile. If required for solids retention, a nonwoven geotextile inner liner may be added. A GSC is prefabricated at the factory to fit and deploy from a known A-frame vessel. Tensile stresses in a GSC are typically highest during deployment when exiting the vessel and impacting the lakebed. GSC seams are the weakest component and are designed and constructed to provide sufficient tensile strength. Suitable geotextile that provides the required tensile strength will be used towards the GSC design.

Figure 19: TenCate Geotube used for dewatering (Reference: TenCate Geosynthetics)

TenCate Geosynthetics manufactures Geosynthetic Containers called as TenCate Geotube®. **Figure 19** shows these containers being used for a dewatering project. TenCate Geosynthetics, headquartered in Pendergrass, Georgia, United States is the only known manufacturer of GSCs in North America. As such, there will likely be no competition for GSC fabrication services and therefore a Justification and Approval document will be required to sole source to this manufacturer.

4.5 Geotechnical Recommendation

Subsurface investigation is required to understand surficial material at the project location. These additional geotechnical borings will provide engineering parameters for geotechnical analysis during PED phase. This analysis will include stability analysis and settlement analysis at the proposed TSP location. Stability analysis will evaluate the overall stability of the offshore reef. This will include overturning, bearing capacity, sliding and slope stability analysis. Bearing capacity analysis will evaluate the capacity of soil to support GSCs.

5. References

1. U.S. Army Corps of Engineers, Buffalo District; 2021; CAP 204 Fairport Harbor Appendix C – Geotechnical Evaluation
2. Toledo Harbor 2020 Section 404(b)(1) Evaluation
3. Soil Boring data from I-75 Reconstruction Project, Erie Township, Monroe County, Michigan (Michigan Department of Transportation project)
4. Final Report prepared by TTL associates for Geotechnical Drilling and Laboratory Testing Services, Island 18 CDF, Toledo, Ohio (USACE-Buffalo district project)
5. TenCate Geosynthetics: Environmental Dredging and Remediation TenCate Geotube® Case Studies
6. Buffalo District projects- Lorain Section 204 and Huron Section 204 project

ATTACHMENT 1: QUANTITY TAKEOFFS AND COST ESTIMATE

US Army Corps of Engineers ® Detroit District	PROJECT TITLE:	COMPUTED BY	DATE:
	Woodtick Section 204	**Alaa Jafar**	**11/15/2021**
		CHECKED BY:	DATE:
	Alternative 2– QTO's	**Julie Udell**	**11/15/2021**

Alternative 2 – Rebuild Peninsula

Alternative 2 – A- Rebuild Peninsula-Leeside Straight Channel

Narrative: Alternative 2 proposes to rebuild the west/bayside of the peninsula with dredged material from Toledo Harbor from an elevation of 570.75 ft sloping (1:20) to a 562 ft. leaving at least part of the channel accessible to small boat traffic. Approximately 245,000 cubic yards of material would be required for building the peninsula with straight channel side and 388,000 cubic yards for building the peninsula with curved channel side . Figure 2 illustrates a potential channel configuration.

Item 1- Cut & Fill

Alternative	Fill Quantity (CYD)	Cut Quantity (CYD)	Leeside	Dredge Material Needed (CYD) = fill-cut	Leeside Area	Lakeside Area	Area (Acres)	
2-A Straight Channel	309,584.15	64,072.12	245,512.03	245,512	129.047		129.047	Cut material will be only moving material around to create proposed surface no excavation Required

Alternative 2 – B- Rebuild Peninsula-Leeside Curved Channel

Item 1- Cut & Fill

Alternative	Fill Quantity (CYD)	(CYD)	Leeside	(CYD) = fill-cut	Leeside Area	Area (Acres)
2-B Curved Channel	465,101.11	76,716.65	388,384.46	388,384	141.525	141.525

Notes:
Please develop costs for Alternative 2 A and Separate cost for Alternative 2- B
2- A will include the lee side straight channel
2- B will include the lee side curved channel ,

Item-2 temporary SSP

Add a cost of temporary SSP to hold dredged material in place

SSP length=	1300	ft	
SSP width=	20	ft	this includes 10 ft embedment depth
SSP Area=	26000	SF	
SSP Size=	Please use any size used in temporary shoring applications PZ-22 ?		

Figure 3. Footprint of Alternative 2 - Channel Restoration

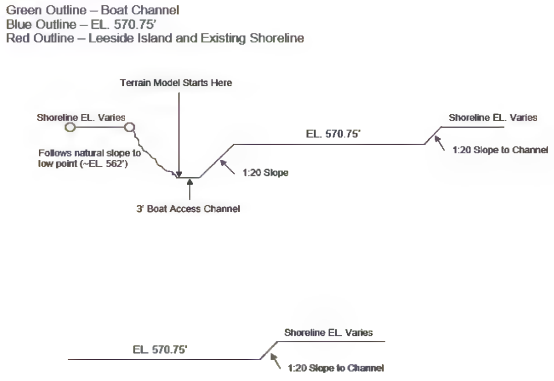


Figure 2. Conceptual cross section of Alternative 2

US Army Corps of Engineers ® Detroit District	PROJECT TITLE:	COMPUTED BY:	DATE:
	Woodtick Section 204	**Alaa Jafar**	**11/15/2021**
		CHECKED BY:	DATE:
	Alternative 3 –QTOs	**Julie udell**	**11/15/2021**

Alternative 3-Rebuild Peninsula + Lakeside Reef

Narrative: Alternative 3 proposes to rebuild the west/bayside of the peninsula with dredged material from Toledo Harbor from an elevation of 570.75 ft sloping (1:20) to a 562 ft. leaving at least part of the channel accessible to small boat traffic. Approximately 245,000 cubic yards of material would be required for building the peninsula with straight channel side and 388,000 cubic yards for building the peninsula with curved channel side. This alterative will also includes Lake side material placement of an approximately 10,500 CY and the placement of approximately 720 (17'x8'x3') Geosynthetic Containers to contain 11,000 Cubic yards of dredged material ad build an offshore reef . Figure 3 illustrates a potential channel configuration.

Item 1- Cut & Fill

	Fill Quantity (CYD)	Cut Quantity (CYD)	Leeside	Dredge Material Needed (CYD) = fill-cut	Leeside Area	Area (Acres)	
3-A Straight Channel	309,584.15	64,072.12	245,512.03	245,512	129.047	129.047	Cut material will be only moving material around to create proposed surface no excavation Required

	Fill Quantity (CYD)	Cut Quantity (CYD)	Leeside	Dredge Material Needed (CYD) = fill-cut	Leeside Area	Area (Acres)	
3-B Curved Channel	465,101.11	76,716.65	388,384.46	388,384	141.525	141.525	Cut material will be only moving material around to create proposed surface no excavation Required

	Fill Quantity (CYD)	Cut Quantity (CYD)	Dredge Material Needed (CYD) = fill-cut	Area (Acres)	
Lake Side Placement	17,662.22	7,242.66	10,420	39.372	Cut material will be only moving material around to create proposed surface no excavation Required

Item-2-Offshore Reef

- Offshore reef constructed with geosynthetic container methodology. Lay these containers on a barge mechanically fill close and lift in place (we can also design the harness)
- Geosynthetic containers on lake bottom are topped with 12-18" of gravel/cobble substrate to create artificial reef habitat that can support walleye spawning and other fish species

17' long x 8' wide x 3' high bags	15					
Capacity of each Container=	15	CY	16.6	Tons		
Number of Container Required=	720					
Total Capacity =	10879	say	11,000	CY		
Price per Container=	$ 901		$ 59.65			cy
Total price=	$ 648,950		$ 59.00			

item 3- Stone Required to hold Containers in place:

Assume 1 ft layer of MDOT 12" gravel/cobble stone

Stone Required for each Container	5	CY	assume 15% void space			
total stone required to build the ree	3,627	CY	3,083	cy	4,624	ton

Item-4 temporary SSP

Add a cost of temporary SSP to hold dredged material in place

SSP length=	1800	ft	
SSP width=	20	ft	this includes 10 ft embedment depth
SSP Area=	36000	SF	
SSP Size=	Please use any size used in temporary shoring applications PZ-22 ?		

Item 6 Plantings 20 ac

Notes:

Please develop costs for Alternative 3 A and Separate cost for Alternative 3- B
3- A will include the lee side straight channel , lake side placement and reef

3- B will include the lee side curved channel , lake side placement and reef

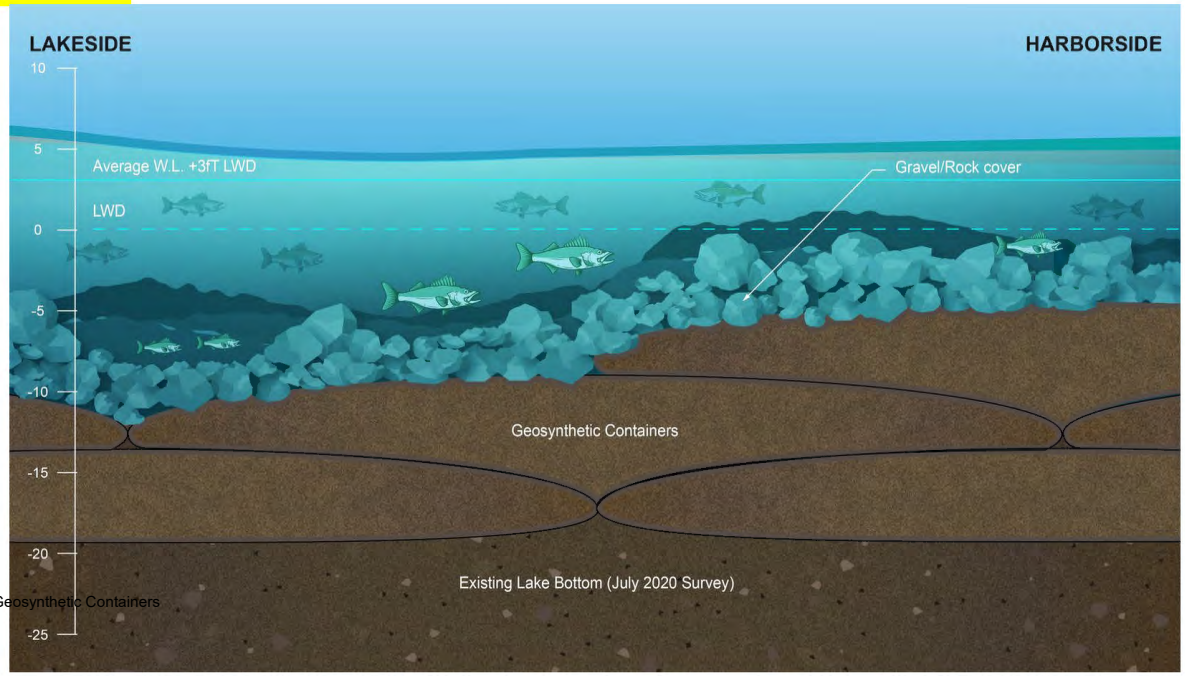


Figure 3. Alternative 3 – Rebuild Peninsula Lee & Lake Side and Geosynthetic Containers

	A	B	C	D	E	F	G	H
1	Woodtick Geobag Dimensions, Volumes, and Weights							
2	11/5/2021							
3								
4	GT1000M Geobag Units	Length (ft)	Width (ft)	Height (ft)	Volume (ft)	Volume (yd3)	Fill Material Density	Weight (US tons)
5	17' x 8' x 5'	17	8	5	680	25.19	1.40	27.695
6	17' x 12' x 5'	17	12	5	1020	37.78	1.40	41.542
7	17' x 17' x 5'	17	17	5	1445	53.52	1.40	58.851
8	17' x 8' x 3'	17	8	3	408	15.11	1.40	16.617
9	17' x 12' x 3'	17	12	3	612	22.67	1.40	24.925
10	17' x 17' x 3'	17	17	3	867	32.11	1.40	35.311

US Army Corps of Engineers, Detroit District	PROJECT TITLE: Woodtick Section 204	COMPUTED BY: Alaa Jafar	DATE: 11/15/2021
		CHECKED BY: Julie Udell	DATE: 11/15/2021
	Alternative 4- QTO's		

Alternative 4 – Southern Peninsula Rebuild (leeside) and Offshore Reef.

Narrative: Alternative 4 proposes to rebuild the west/bayside with dredged material from Toledo Harbor from an elevation of 570.75 ft sloping (1:20) to a 562 ft. leaving at least part of the channel accessible to small boat traffic. Approximately 155,000 cubic yards of material would be required for building the peninsula with straight channel side and 328,000 cubic yards for building the peninsula with curved channel side. This alternative will also includes the placement of approximately 720 (17'x8'x3') Geosynthetic Containers to contain 1200 Cubic yards of dredged material to build an offshore reef and rock placement of 450 ft span to protect teh south tip of the peninsila. Figure 4 illustrates a potential channel configuration.

Item 1- Cut & Fill

	Fill Quantity (CYD)	Cut Quantity (CYD)	Leeside	Dredge Material Needed (CYD) = fill-cut	Leeside Area	Area (Acres)	
4-A Straight Channel	245,537.83	90,863.10	154,674.73	154,675	115.342	115.342	Cut material will be only moving material around to create proposed surface no excavation Required

	Fill Quantity (CYD)	Cut Quantity (CYD)	Leeside	Dredge Material Needed (CYD) = fill-cut	Leeside Area	Area (Acres)	
4-B Curved Channel	412,120.00	84,325.79	327,794.21	327,794	116.218	116.218	Cut material will be only moving material around to create proposed surface no excavation Required

Item-2-Offshore Reef

- Offshore reef constructed with geosynthetic container methodology. Lay these containers on a barge mechanically fill close and lift in place (we can also design the harness)
- Geosynthetic containers on lake bottom are topped with 12-18" of gravel/cobble substrate to create artificial reef habitat that can support walleye spawning and other fish species

17' long x 8' wide x 3' high bags

Capacity of each Container=	15.11	CY	16.6	Tons
Number of Container Required=	80			
Total Capacity =	1209	say	1,200	CY
Price per Container=	901.32			
Total price=	72,105.60	Dollars	$	

item 3-Stone Required to hold Containers in place:

Assume I ft layer of MDOT 12" gravel/cobble stone

Stone Required for each Container=	5	CY	assume 15% void space		
total stone required to build the reef=	403	CY	343	cy	514 ton

Stone Required to closeup the south tip

Assume 3 ft layer X 450 ft legnth of MDOT 12" gravel/cobble	stone	8 ft wide =	150	cy	
			128	cy	191 ton

Item-4 temporary SSP

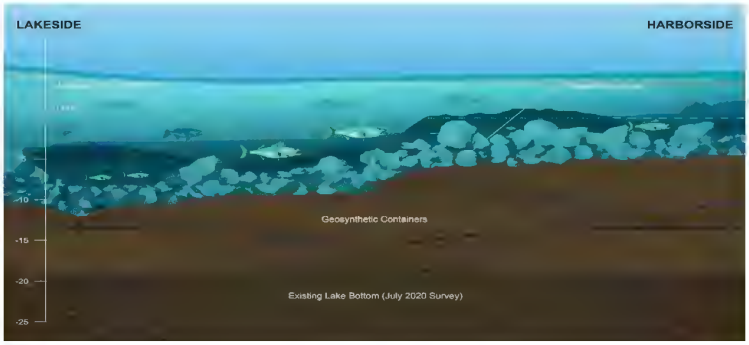
Add a cost of temporary SSP to hold dredged material in place

SSP length=	1300	ft	
SSP width=	20	ft	this includes 10 ft embedment depth
SSP Area=	26000	SF	
SSP Size=	Please use any size used in temporary shoring applications PZ-22 ?		

Notes:
Please develop costs for Alternative 3 A and Separate cost for Alternative 3- B
4- A will include the lee side straight channel and south reefs
4- B will include the lee side curved channel and south reefs

Figure 4. Alternative 4 – Rebuild Peninsila Leeside & Southern Tip Offshore Reef

	A	B	C	D	E	F	G	H
1	Woodtick Geobag Dimensions, Volumes, and Weights							
2	11/5/2021							
3								
4	GT1000M Geobag Units	Length (ft)	Width (ft)	Height (ft)	Volume (ft)	Volume (yd3)	Fill Material Density	Weight (US tons)
5	17' x 8' x 5'	17	8	5	680	25.19	1.40	27.695
6	17' x 12' x 5'	17	12	5	1020	37.78	1.40	41.542
7	17' x 17' x 5'	17	17	5	1445	53.52	1.40	58.851
8	17' x 8' x 3'	17	8	3	408	15.11	1.40	16.617
9	17' x 12' x 3'	17	12	3	612	22.67	1.40	24.925
10	17' x 17' x 3'	17	17	3	867	32.11	1.40	35.311



US Army Corps of Engineers ® Detroit District	PROJECT TITLE:	COMPUTED BY:	DATE:
	Woodtick Section 204	**Alaa Jafar**	**11/15/2021**
		CHECKED BY:	DATE:
	Alternative 5- QTO's	**Julie Udell**	**11/15/2021**

Alternative 5 –Southern Peninsula Rebuild (leeside and Lakeside) + Offshore Reef

Narrative: Alternative 5 proposes to rebuild the west/bayside with dredged material from Toledo Harbor from an elevation of 570.75 ft sloping (1:20) to a 562 ft. leaving at least part of the channel accessible to small boat traffic. Approximately 155,000 cubic yards of material would be required for building the peninsula with straight channel side and 328,000 cubic yards for building the peninsula with curved channel side. This alternative will also includes placement of 10,500 CY of dredged material in the lake side and the placement of approximately 720 (17'x8'x3') Geosynthetic Containers in the lake side and southern tip to contain 12,200 Cubic yards of dredged material to build an offshore reef and rock placement of 450 ft span to protect the south tip of the peninsula. Figure 5 illustrates a potential channel configuration.

Item 1- Cut & Fill

	Fill Quantity (CYD)	Cut Quantity (CYD)	Leeside	Dredge Material Needed (CYD) = fill-cut	Leeside Area	Area (Acres)	
5-A Straight Channel	245,537.83	90,863.10	154,674.73	154,675	115.342	115.342	Cut material will be only moving material around to create proposed surface no excavation Required

	Fill Quantity (CYD)	Cut Quantity (CYD)	Leeside	Dredge Material Needed (CYD) = fill-cut	Leeside Area	Area (Acres)	
5-B Curved Channel	412,120.00	84,325.79	327,794.21	327,794	116.218	116.218	Cut material will be only moving material around to create proposed surface no excavation Required

Item-2-lake side Offshore Reef

- Offshore reef constructed with geosynthetic container methodology. Lay these containers on a barge mechanically fill close and lift in place (we can also design the harness)
- Geosynthetic containers on lake bottom are topped with 12-18" of gravel/cobble substrate to create artificial reef habitat that can support walleye spawning and other fish species

17' long x 8' wide x 3' high bags

Capacity of each Container=	15.11	CY	16.6	Tons	
Number of Container Required=	720				
Total Capacity =	10879	say	11,000	CY	
Price per Container=	901.32				
Total price=	$ 648,950	Dollar	$ 59.00		

Item-3-South Tip Offshore Reef

17' long x 8' wide x 3' high bags

Capacity of each Container=	15.11	CY	16.6	Tons	
Number of Container Required=	80				
Total Capacity =	1209	say	1,200	CY	
Price per Container=	$ 901				
Total price=	$ 72,106	Dollar	$ 60.09		

Item 4 -Stone Required to hold Containers in place:

Assume 1 ft layer of MDOT 12" gravel/ cobble stone

Stone Required for each Container=	5	CY	assume 15% void space			
total stone required to build the reef=	4,030	CY	3,425	cy	5,138	ton

Item 5-Stone Required to closeup the south tip

assume 15% void space

Assume 3 ft layer X 450 ft legnth of MDOT 12" gravel/cobble	stone	8 ft wide =	150	cy	
			128	cy	191 ton

Item-4 temporary SSP

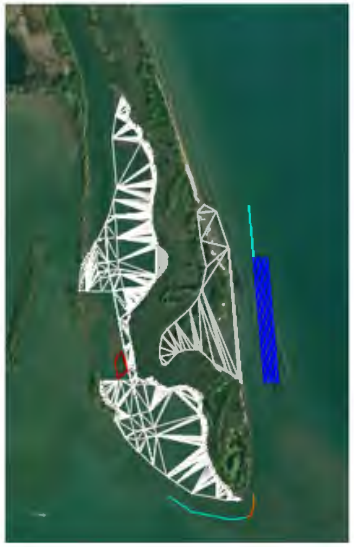
Add a cost of temporary SSP to hold dredged material in place

SSP length=	1800	ft	
SSP width=	20	ft	this includes 10 ft embedment depth
SSP Area=	36000	SF	
SSP Size=	Please use any size used in temporary shoring applications PZ-22 ?		

Item 6 Plantings 20 ac

Notes:

Please develop costs for Alternative 5 A and Separate cost for Alternative 5- B
5- A will include the lee side straight channel , lake side placement and reefs
3- B will include the lee side curved channel , lake side placement and reefs



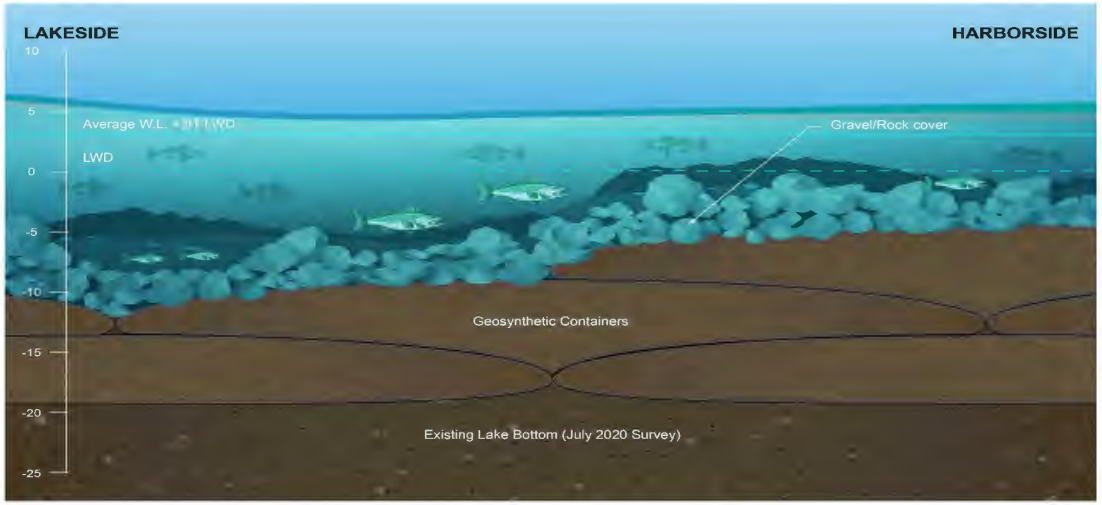


Figure 5. Alternative 5 – Rebuild Peninsila in the Leeside & Lake Side and the Placement of Offshore Reef In the Lake Side and South Tip

	A	B	C	D	E	F	G	H
1	Woodtick Geobag Dimensions, Volumes, and Weights							
2	11/5/2021							
3								
4	GT1000M Geobag Units	Length (ft)	Width (ft)	Height (ft)	Volume (ft)	Volume (yd3)	Fill Material Density	Weight (US tons)
5	17' x 8' x 5'	17	8	5	680	25.19	1.40	27.695
6	17' x 12' x 5'	17	12	5	1020	37.78	1.40	41.542
7	17' x 17' x 5'	17	17	5	1445	53.52	1.40	58.851
8	17' x 8' x 3'	17	8	3	408	15.11	1.40	16.617
9	17' x 12' x 3'	17	12	3	612	22.67	1.40	24.925
10	17' x 17' x 3'	17	17	3	867	32.11	1.40	35.311

WOODTICK PENINSULA CHANNEL RESTORATION

	Contruction Cost	TPCS
ALTERNATIVE 2 A	$ 4,278,192	$ 8,423,000
ALTERNATIVE 2 B	$ 6,564,144	$ 12,913,000
ALTERNATIVE 3 A	$ 7,304,907	$ 14,371,000
ALTERNATIVE 3 B	$ 9,590,859	$ 18,864,000
ALTERNATIVE 4 A	$ 3,033,315	$ 5,793,000
ALTERNATIVE 4 B	$ 5,803,219	$ 11,416,000
ALTERNATIVE 5 A	$ 5,851,630	$ 11,516,000
ALTERNATIVE 5 B	$ 8,621,534	$ 16,956,000

Construction Cost = construction cost + k markups (profit, overheads & bond)
TPCS = construction cost + non-construction cost (S&A, design, PM, etc) + contingency + escalation to midpoint of construction.
Contingency on construction cost = 30%
midpoint construction for alts 1-6 is assumed 2024 Q4 because cy of fill is ~600k or less
midpoint construction for alts 7-8 is assumed 2025 Q2 because cy of fill is ~1M or more (2 construction seasons potentially)

Woodtick peninsula channel restoration feasibility study
with SSP

Alternative 2 A straight channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	245,512	CY	$ 20.00	$ 4,910,240.00
Temporary SSP	1,300	LF	$ 5,000.00	$ 6,500,000.00
LRB share of dredging cost (typical harbor cost)	245,512	CY	$ (4.00)	$ (982,048.00)
			total	**$ 10,778,192.00**

Alternative 2 B curved channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	388,384	CY	$ 20.00	$ 7,767,680.00
Temporary SSP	1,300	LF	$ 5,000.00	$ 6,500,000.00
LRB share of dredging cost (typical harbor cost)	388,384	CY	$ (4.00)	$ (1,553,536.00)
			total	**$ 13,064,144.00**

Alternative 3 A straight channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	245,512	CY	$ 20.00	$ 4,910,240.00
Lakeside fill material and grading	10,420	CY	$ 20.00	$ 208,400.00
Offshore reef	10,879	CY	$ 85.00	$ 924,715.00
Reef stone	4,624	TON	$ 150.00	$ 693,600.00
Temporary SSP	1,800	LF	$ 5,000.00	$ 9,000,000.00
Plantings - seed/plugs	20	Acres	$ 30,000.00	$ 600,000.00
Maintenance - 5 yrs	5	Years	$ 120,000.00	$ 600,000.00
LRB share of dredging cost (typical harbor cost)	245,512	CY	$ (4.00)	$ (982,048.00)
			total	**$ 16,304,907.00**

Alternative 3 B curved channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	388,384	CY	$ 20.00	$ 7,767,680.00
Lakeside fill material and grading	10,420	CY	$ 20.00	$ 208,400.00
Offshore reef	10,879	CY	$ 85.00	$ 924,715.00
Reef stone	4,624	TON	$ 150.00	$ 693,600.00
Temporary SSP	1,800	LF	$ 5,000.00	$ 9,000,000.00
Plantings - seed/plugs	20	Acres	$ 30,000.00	$ 600,000.00
Maintenance - 5 yrs	5	Years	$ 120,000.00	$ 600,000.00
LRB share of dredging cost (typical harbor cost)	388,384	CY	$ (4.00)	$ (1,553,536.00)
			total	**$ 18,590,859.00**

Alternative 4 A straight channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	154,675	CY	$ 20.00	$ 3,093,500.00
Offshore reef	1,209	CY	$ 85.00	$ 102,765.00
Reef stone	514	TON	$ 150.00	$ 77,100.00
South tip stone	191	TON	$ 150.00	$ 28,650.00
Temporary SSP	1,300	LF	$ 5,000.00	$ 6,500,000.00
LRB share of dredging cost (typical harbor cost)	154,675	CY	$ (4.00)	$ (618,700.00)
			total	**$ 9,533,315.00**

Alternative 4 B curved channel

Item	Total Quantity	Unit	unit cost $	total cost

Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	327,794	CY	$ 20.00	$ 6,555,880.00
Offshore reef	1,209	CY	$ 85.00	$ 102,765.00
Reef stone	514	TON	$ 150.00	$ 77,100.00
South tip stone	191	TON	$ 150.00	$ 28,650.00
Temporary SSP	1,300	LF	$ 5,000.00	$ 6,500,000.00
LRB share of dredging cost (typical harbor cost)	327,794	CY	$ (4.00)	$ (1,311,176.00)
			total	**$ 12,303,219.00**

Alternative 5 A straight channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	154,675	CY	$ 20.00	$ 3,093,500.00
Offshore reef lakeside	10,879	CY	$ 85.00	$ 924,715.00
Offshore reef south tip	1,209	CY	$ 85.00	$ 102,765.00
Reef stone	5,138	TON	$ 150.00	$ 770,700.00
South tip stone	191	TON	$ 150.00	$ 28,650.00
Temporary SSP	1,800	LF	$ 5,000.00	$ 9,000,000.00
Plantings - seed/plugs	20	Acres	$ 30,000.00	$ 600,000.00
Maintenance - 5 yrs	5	Years	$ 120,000.00	$ 600,000.00
LRB share of dredging cost (typical harbor cost)	154,675	CY	$ (4.00)	$ (618,700.00)
			total	**$ 14,851,630.00**

Alternative 5 B curved channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	327,794	CY	$ 20.00	$ 6,555,880.00
Offshore reef lakeside	10,879	CY	$ 85.00	$ 924,715.00
Offshore reef south tip	1,209	CY	$ 85.00	$ 102,765.00
Reef stone	5,138	TON	$ 150.00	$ 770,700.00
South tip stone	191	TON	$ 150.00	$ 28,650.00
Temporary SSP	1,800	LF	$ 5,000.00	$ 9,000,000.00
Plantings - seed/plugs	20	Acres	$ 30,000.00	$ 600,000.00
Maintenance - 5 yrs	5	Years	$ 120,000.00	$ 600,000.00
LRB share of dredging cost (typical harbor cost)	327,794	CY	$ (4.00)	$ (1,311,176.00)
			total	**$ 17,621,534.00**

Woodtick peninsula channel restoration feasibility study
with SSP

Alternative 2 A straight channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	245,512	CY	$ 20.00	$ 4,910,240.00
Temporary SSP	0	LF	$ 5,000.00	$ -
LRB share of dredging cost (typical harbor cost)	245,512	CY	$ (4.00)	$ (982,048.00)
			total	**$ 4,278,192.00**

Alternative 2 B curved channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	388,384	CY	$ 20.00	$ 7,767,680.00
Temporary SSP	0	LF	$ 5,000.00	$ -
LRB share of dredging cost (typical harbor cost)	388,384	CY	$ (4.00)	$ (1,553,536.00)
			total	**$ 6,564,144.00**

Alternative 3 A straight channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	245,512	CY	$ 20.00	$ 4,910,240.00
Lakeside fill material and grading	10,420	CY	$ 20.00	$ 208,400.00
Offshore reef	10,879	CY	$ 85.00	$ 924,715.00
Reef stone	4,624	TON	$ 150.00	$ 693,600.00
Temporary SSP	0	LF	$ 5,000.00	$ -
Plantings - seed/plugs	20	Acres	$ 30,000.00	$ 600,000.00
Maintenance - 5 yrs	5	Years	$ 120,000.00	$ 600,000.00
LRB share of dredging cost (typical harbor cost)	245,512	CY	$ (4.00)	$ (982,048.00)
			total	**$ 7,304,907.00**

Alternative 3 B curved channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	388,384	CY	$ 20.00	$ 7,767,680.00
Lakeside fill material and grading	10,420	CY	$ 20.00	$ 208,400.00
Offshore reef	10,879	CY	$ 85.00	$ 924,715.00
Reef stone	4,624	TON	$ 150.00	$ 693,600.00
Temporary SSP	0	LF	$ 5,000.00	$ -
Plantings - seed/plugs	20	Acres	$ 30,000.00	$ 600,000.00
Maintenance - 5 yrs	5	Years	$ 120,000.00	$ 600,000.00
LRB share of dredging cost (typical harbor cost)	388,384	CY	$ (4.00)	$ (1,553,536.00)
			total	**$ 9,590,859.00**

Alternative 4 A straight channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	154,675	CY	$ 20.00	$ 3,093,500.00
Offshore reef	1,209	CY	$ 85.00	$ 102,765.00
Reef stone	514	TON	$ 150.00	$ 77,100.00
South tip stone	191	TON	$ 150.00	$ 28,650.00
Temporary SSP	0	LF	$ 5,000.00	$ -
LRB share of dredging cost (typical harbor cost)	154,675	CY	$ (4.00)	$ (618,700.00)
			total	**$ 3,033,315.00**

Alternative 4 B curved channel

Item	Total Quantity	Unit	unit cost $	total cost

Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	327,794	CY	$ 20.00	$ 6,555,880.00
Offshore reef	1,209	CY	$ 85.00	$ 102,765.00
Reef stone	514	TON	$ 150.00	$ 77,100.00
South tip stone	191	TON	$ 150.00	$ 28,650.00
Temporary SSP	0	LF	$ 5,000.00	$ -
LRB share of dredging cost (typical harbor cost)	327,794	CY	$ (4.00)	$ (1,311,176.00)
			total	**$ 5,803,219.00**

Alternative 5 A straight channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	154,675	CY	$ 20.00	$ 3,093,500.00
Offshore reef lakeside	10,879	CY	$ 85.00	$ 924,715.00
Offshore reef south tip	1,209	CY	$ 85.00	$ 102,765.00
Reef stone	5,138	TON	$ 150.00	$ 770,700.00
South tip stone	191	TON	$ 150.00	$ 28,650.00
Temporary SSP	0	LF	$ 5,000.00	$ -
Plantings - seed/plugs	20	Acres	$ 30,000.00	$ 600,000.00
Maintenance - 5 yrs	5	Years	$ 120,000.00	$ 600,000.00
LRB share of dredging cost (typical harbor cost)	154,675	CY	$ (4.00)	$ (618,700.00)
			total	**$ 5,851,630.00**

Alternative 5 B curved channel

Item	Total Quantity	Unit	unit cost $	total cost
Mob/demob marine plant	1	LS	$ 350,000.00	$ 350,000.00
Channel fill material and grading	327,794	CY	$ 20.00	$ 6,555,880.00
Offshore reef lakeside	10,879	CY	$ 85.00	$ 924,715.00
Offshore reef south tip	1,209	CY	$ 85.00	$ 102,765.00
Reef stone	5,138	TON	$ 150.00	$ 770,700.00
South tip stone	191	TON	$ 150.00	$ 28,650.00
Temporary SSP	0	LF	$ 5,000.00	$ -
Plantings - seed/plugs	20	Acres	$ 30,000.00	$ 600,000.00
Maintenance - 5 yrs	5	Years	$ 120,000.00	$ 600,000.00
LRB share of dredging cost (typical harbor cost)	327,794	CY	$ (4.00)	$ (1,311,176.00)
			total	**$ 8,621,534.00**