Appendix E – Dredged Material Management Plan

Matagorda Ship Channel Improvement, Port Lavaca, Texas

Validation Report and Supplemental Environmental Impact Statement,

Calhoun and Matagorda Counties, Texas

May 2026

Note: The Section 508 amendment of the Rehabilitation Act of 1973 requires that the information in federal documents be accessible to individuals with disabilities. The Agency has made every effort to ensure that the information in Appendix E: Dredged Material Management Plan is accessible. However, if readers have any issues accessing the information in this appendix, please contact the U.S. Army Corps of Engineers at MSC_SEIS@usace.army.mil so additional accommodations may be provided.

US Army Corps of Engineers

Galveston District

(NOTE: This page intentionally left blank.)

Contents

1 Project Description and Background ... 1
1.1 Study Area ... 1
1.2 DMMP Scope ... 2
1.2.1 DMMP Requirements ... 2
1.3 Post-Authorization Changes ... 3
1.4 Assumptions and Uncertainties ... 3
1.4.1 Hydraulic ... 4
1.4.2 Geotechnical ... 4
1.4.3 Civil ... 5
1.4.4 Cost ... 5
1.5 Key Risks ... 5
1.6 MSC Channel Segments ... 5
1.6.1 Sea Bar to Jetty Channel ... 8
1.6.2 Matagorda Peninsula to Light 48 ... 9
1.6.3 Light 48 to Alcoa Channel ... 10
1.6.4 Alcoa Channel to Turning Basin ... 12
1.6.5 Point Comfort Turning Basin ... 13
1.7 Datum Control ... 14
2 Problems and Objectives ... 14
2.1 Problems ... 14
2.1.1 Existing Placement Area Capacity ... 14
2.1.2 Lack of Beneficial Use ... 17
2.1.3 Recycled Dredged Material ... 17
2.2 Overview of FWP DMMP ... 19
2.3 Objectives ... 20
2.3.1 Appropriately Size Placement Areas ... 20
2.3.2 Maximize Beneficial Use ... 26
2.3.3 Minimize Quantity of Recycled Dredged Material ... 26
3 Existing Conditions ... 27
3.1 Dredging History ... 27
3.2 Shoaling Rates ... 31

3.3 Dredged Material Composition ... 33
3.4 Advance Maintenance ... 34
3.5 Placement Areas ... 34
3.5.1 Existing Capacity ... 36
4 Future Without Project Conditions ... 41
4.1 Shoaling Rates ... 41
4.2 Maintenance Volumes ... 42
4.3 Advance Maintenance ... 43
4.4 Placement Areas ... 43
4.4.1 Placement Area Capacity ... 46
4.4.2 Key Capacity Considerations ... 46
4.5 FWOP DMMP ... 47
5 Placement Area Scenarios ... 47
5.1 Considerations for DMMP Development ... 47
5.1.1 Opportunity to Avoid and Minimize Environmental Impacts ... 48
5.1.2 Minimize Costs to Federal Government ... 48
5.2 Overview of Placement Area Measures ... 48
5.2.1 ODMDS ... 49
5.2.2 Upland Confined Placement ... 49
5.2.3 Open Water Placement ... 50
5.2.4 Beneficial Use ... 50
6 Evaluation and Comparison of DMMPs ... 51
6.1 Base Plan Development ... 51
6.2 Feasibility DMMP (2019) ... 52
6.3 Modified DMMP (2023) ... 53
6.4 Modified DMMP (2024) ... 54
6.5 Proposed DMMP (2025) ... 55
6.5.1 Pump Distance ... 58
7 Future With-Project Conditions ... 59
7.1 New Work Quantities ... 59
7.1.1 New Work Template ... 60
7.2 Shoaling Rates ... 61

7.3 Maintenance Volumes 62
7.4 Advance Maintenance 63
7.5 Placement Areas 64
7.5.1 Sand Engine 66
7.5.2 NP1 66
7.5.3 NP2 66
7.5.4 NP3 66
7.5.5 NP4/5 66
7.5.6 NP6 67
7.5.7 Beneficial-Use Bird Island 67
7.6 NW Placement Area Capacity 68
7.7 Environmental Mitigation Cost 70
7.8 Pumping Cost 72
7.9 Cultural Resource Sites 72
7.10 PA Placement over Pipeline 73
8 Plan Selection 73
8.1 Costs 73
8.2 Adaptive Management Plan 74
8.2.1 Core Philosophy and Objectives 74
8.2.2 Foundational Components of the Adaptive Management Strategy 74
8.2.3 The Adaptive Management Process: Cycle of Assessment and Action 75
8.2.4 Key Adaptive Management Strategies 80
8.3 Future BU Opportunities 80
8.3.1 OP9 for Shallow Water Habitat 81
8.3.2 Tiered Habitat System at Chester Island 82
8.3.3 Beachside and Bayside Erosion Mitigation for Matagorda Peninsula 83
8.3.4 Allow Partner Acceptance of Maintenance Materials for Restoration 84
9 2019 vs 2025 84
10 Introduction to Dredge Plant 84
10.1 Hydraulic Cutter Suction Dredge 85
10.2 Hydraulic Hopper Dredge 85
10.3 Mechanical (Clamshell) Dredge 86

11 References 87

1 Project Description and Background

The Dredged Material Management Plan (DMMP) defines the dredging and placement requirements for the construction and maintenance of the Matagorda Ship Channel Improvement Project (MSCIP). The DMMP is designed for a 50-yr project life to allow for operation and maintenance of the MSC from the Gulf of America to the Port of Calhoun. The contents of this document should serve as reference for any changes to the existing placement areas (PAs), creation of new PAs, and offshore disposal of dredged material.

1.1 Study Area

The Matagorda Ship Channel is a federally maintained navigation channel in Matagorda Bay, TX (Figure 1-1). The channel is nearly 26.3 miles long, starting in the Gulf of America and ending at Point Comfort. Originally constructed in 1962, the MSC crosses both Calhoun and Matagorda Counties, and features several connecting waterways, including the Gulf Intracoastal Waterway (GIWW), Channel to Palacios, Port Lavaca Channel, and Approach Channel.

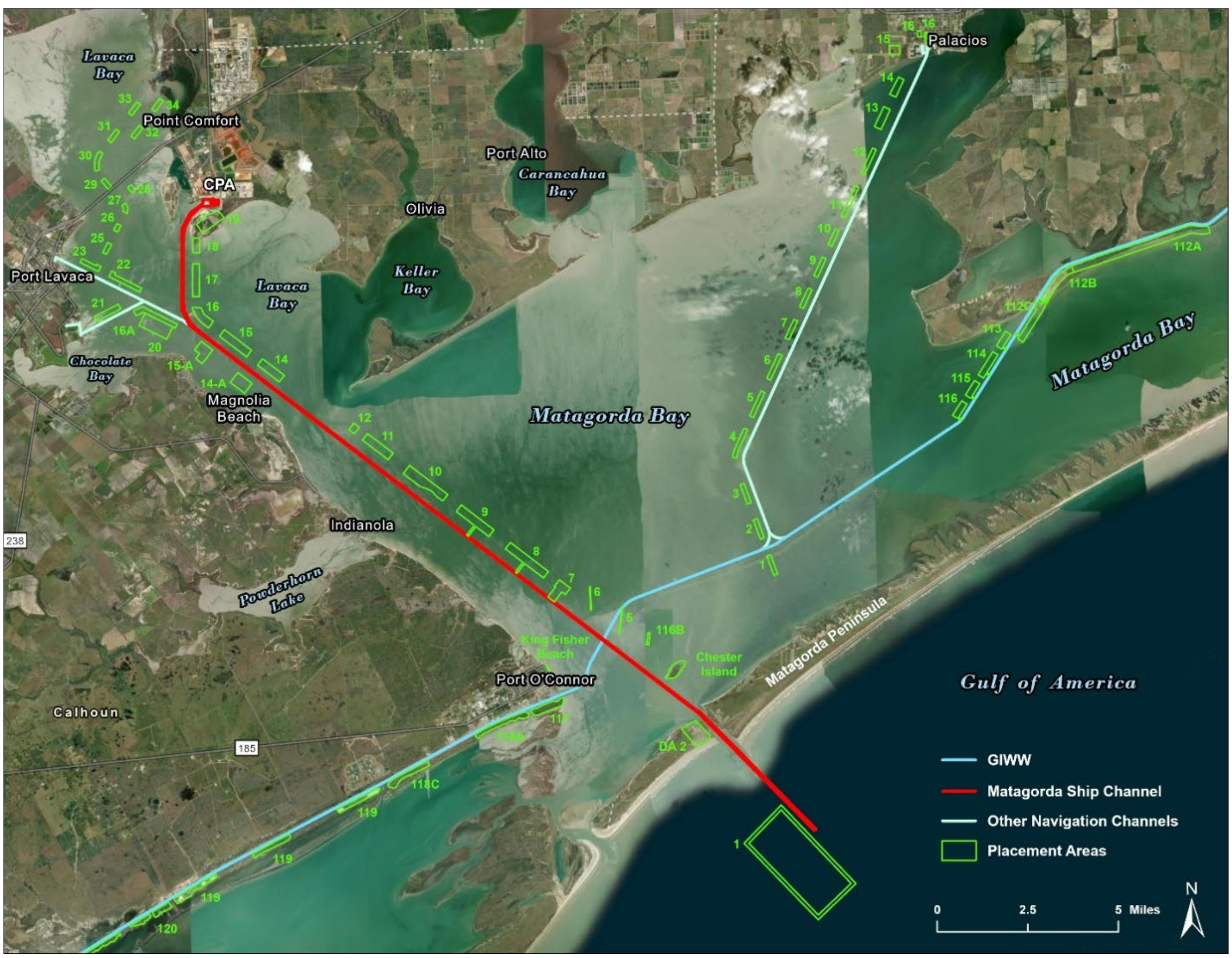


Figure 1-1: Project Study Area for the DMMP

The authorized depth and width of the MSC are listed in Table 1-1.

Table 1-1: Authorized Depth and Width of the MSC

Station	Authorized Depth MLLW (ft)	Width (ft)
-20+246 to 0+000	38	300
0+000 to 118+502	40	200

1.2 DMMP Scope

The Matagorda Ship Channel Improvement Project (MSCIP) DMMP combines the 2019 Final Integrated Feasibility Report and Environmental Impact Statement (IFR-EIS) new work and maintenance dredging requirements with updated information following post-authorization changes to the federally authorized project. The MSCIP DMMP considers placement options for the 2019 Recommended Plan (RP) pertaining to both New Work (NW) and maintenance (O&M) dredged materials. The Future Without Project (FWOP) and Future With Project (FWP) placement requirements are assessed based on updated information regarding NW and O&M material quantities. Features of the DMMP were appropriately screened by the planning process outlined in ER-1105-2-100:

- Identify problems and objectives (Section 2)
- Inventory and forecast conditions (Section 3, 4, and 7)
- Formulate alternative plans (Section 5.1)
- Evaluate alternative plans (Section 6)
- Compare alternative plans (Section 6)
- Select a plan (Section 8)

The DMMP was developed to satisfy engineering requirements, avoid environmental and cultural resources, reduce costs, and provide the largest net benefit for the project.

1.2.1 DMMP Requirements

The DMMP has been established on the following principles for successful construction and maintenance of the MSCIP:

- FWOP conditions utilize the best information available upon the writing of this report.
- FWOP conditions reflect changes to the incremental maintenance in the channel.
- FWP conditions reflect the incremental maintenance due to MSCIP improvements.
- Future (FWOP and FWP) conditions account for other planned projects in the study area.
- Management of dredged material is projected for a 50-yr period.
- The DMMP is designed to adapt to the needs of maintenance dredging over the next 50-yrs.

- Beneficial use (BU) must reflect the enterprise vision highlighted in the Water Resources Development Act (WRDA) 2024 Section 1130. See Section 2.3.2.

1.3 Post-Authorization Changes

Following the authorization of the 2019 IFR-EIS, the quantity of NW dredged material was found to be erroneous, thereby mispresenting the total project cost. In light of the change in NW material quantity, the USACE Galveston District (SWG) Engineering and Construction (E&C) team revisited the DMMP. The newly recommended DMMP represents several key changes to the 2019 authorized DMMP, based on the RP, namely:

- Material will not be placed on the west side of the channel between the inlet (0+000) and Keller Bay Peninsula (84+500).
- A bird island will be constructed in Lavaca Bay in place of the 2019 open water sites (NP7/OP10).
- Existing PAs 18/19 (semi-confined sites) near the Port of Calhoun will be expanded.
- Placement Area 1 (2019 recommended terrestrial upland site) will not be included.
- An option for Beneficial Use (BU) at Keller Bay Peninsula will be included.
- Existing open-water PA (OWPA) O&M sites, not included in 2019, will be included in the new plan.
- An offshore sediment trap from the previous plan is discarded.

1.4 Assumptions and Uncertainties

The main engineering assumption is that no changes are expected to the 2019 recommended channel design (RP – Alternative A). The features of this plan are detailed below in Table 1-2.

Table 1-2: Recommended Plan for DMMP Development

Alternative	Depth Main/Entrance (MLLW)	Width Main/Entrance	Turning Basin
A	47’/49’	300’/550’	1200’

The focus of DMMP development is to optimize the material distribution associated with the RP, avoiding direct impacts and saving costs. Since the most cost-effective channel design was not yet identified at the onset of revaluating the project, it was assumed that the DMMP should be designed to accommodate materials from construction of the RP (Alternative A). Since the Non-Federal Sponsor (NFS) was in agreement with the RP, a deeper/wider channel was not considered for the DMMP as it would incur additional construction costs. Adjustments to the DMMP are reserved for Preliminary Engineering Design (PED) as long as they incur no additional costs to the project, respect identified placement limits and are justified by the adaptive management plan.

1.4.1 Hydraulic

Several hydraulic assumptions and uncertainties are made in formulation of the proposed DMMP and are listed herein:

- Future meteorology will be similar to present-day conditions.
- Vessels (tanker, cargo, etc.) are not a factor considered for channel sedimentation.
- Sediment transport is modeled for “normal” meteorological and hydrodynamic conditions, which best informs a 50-yr plan.
- Advance maintenance is optimized for the RP.
- OWPAs are highly dispersive; they do not retain much material in the short term, though they slowly accrete in the long term with dredged material supply.

1.4.2 Geotechnical

Geotechnical assumptions and uncertainties include the following:

- The bulking factor and material loss rate during underwater placement were combined into a single “retention factor” for this study. Reasonable, study-level retention rates were assumed to evaluate the placement area (PA) capacities. These assumptions will be monitored and verified during the PED phase using survey data.
- For the underwater PA capacity assessment, a retention rate of 0.70 was assumed for new work material and 0.5 for operations and maintenance (O&M) material.
- Potential placement limitations due to existing pipelines were included in the study-level PA capacity estimates.
- The adoption of an imaginary 50-foot-wide no-placement or limited fill height (3-foot) corridor along existing utility lines is not expected to significantly impact PA capacity. The proposed dredged material placement method within PAs containing utility lines is as follows:
- Dredged materials are primarily classified into two categories: sand/silt and clays.
- The diameter and embedment depth of the existing pipelines are currently unknown. As a precaution, a 50-foot-wide corridor has been assumed to minimize surcharge loading on the pipelines and to allow space for potential repair activities.
- Pipeline embedment depths are assumed to be approximately 3 feet.
- Based on geotechnical data, the channel segments assigned to the NW (NP) areas are expected to produce approximately 50% sand/silt, making the proposed placement method feasible without compromising pipeline integrity.
- Due to limited soil data, the foundation soil conditions within some PA areas remain unknown. These soils may be very soft, and existing pipelines could be susceptible to deformation even under a 3-ft fill. However, sand/silt placement is expected to enhance the underlying soft or submerged loose soils through self-compaction during underwater placement. This assumption supports the recommendation of either:
    - Case 1: A 50-foot-wide limited fill corridor (up to 3 feet), or

  - Case 2: A 50-foot-wide no-placement corridor along the centerline of utility lines.
- The appropriate case will be selected during the PED phase based on additional foundation soil data.
- If Case 1 is adopted, only selective dredged material (sand/silt) will be placed within the 50-foot-wide corridor along the pipe centerline, limited to a maximum fill height of 3 feet.

1.4.3 Civil

- Since the DMMP is based on the -47'/-49' scale, advance maintenance quantity is calculated for this scale and applied to the other scales (i.e. -45'/-47') as a percentage (%) of the dredged volume.
- Capacity analysis based on outlined assumptions will be verified in PED by use of new surveys.

1.4.4 Cost

- Cost estimates reflect the best data available at the writing of this report.
- The Bird Island feature is costed by reference of an existing design constructed during the Houston Ship Channel (HSC) CIP during the late 1990s; this carries a high contingency as design refinement will be required in PED.

1.5 Key Risks

The movement of sediments after placement will primarily depend on the dredged sediment composition and local interactions between the seabed and ambient currents and waves.

PAs are sized from material quantity estimates and use of historical open-water PA (OWPA) surveys. Seasonal variations in meteorology, tropical storms, or a mischaracterization of sediment composition, could significantly alter how dredged material is mobilized in the bay. To best contain materials within OWPA boundaries, while also preventing PAs from becoming emergent, the following steps should be taken for every dredging contract:

1. Define acceptable discharge locations within PAs based on before-dredging (BD) survey.
2. Monitor OWPA sites to identify capacity concerns before they arise.
3. Re-route materials to nearby and available PAs if capacity becomes a concern (see Section 8.2).

1.6 MSC Channel Segments

Per the National Channel Framework (NCF), the MSC can be divided into 5 main segments (Figure 1-2). The offshore reach of the MSC, the Sea Bar and Jetty Channel (SJC), is where the authorized channel begins and then transitions into the jettied inlet. Matagorda Peninsula to Light 48 (MPL) is the longest stretch of the MSC, starting at the inlet and ending close to mid-bay, south of Magnolia Beach, TX.

Light 48 to Alcoa Channel (LAC) begins south of Magnolia Beach and turns towards Point Comfort, TX, before approaching Alcoa Channel. Alcoa Channel to Point Comfort Turning Basin (ATB) is named for the old Alcoa Channel that jogs north and west of the Calhoun Port Authority (CPA). And lastly, the Point Comfort Turning Basin (PCT) is directly adjacent to CPA.

Figure 1-2: Matagorda Ship Channel Overview (NCF)

The ATB reach terminates at the Point Comfort Turning Basin (PCT) and CPA docking basins (Figure 1-3 and Figure 1-4). The CPA primarily services liquid bulk cargo, with additional docks for dry bulk, general cargo, and barges. Two basins (North and South Basin) are maintained around the liquid bulk terminal at the same depth as the PCT.

Figure 1-3: View of CPA Docks at Point Comfort Turning Basin (1)

Figure 1-4: View of CPA Docks at Point Comfort Turning Basin (2)

1.6.1 Sea Bar to Jetty Channel

The SJC reach (Figure 1-5) is also referred to as the entrance channel. The entrance channel has been extensively studied due to navigational issues experienced by MSC pilots. Strong cross-currents make piloting the entrance channel especially difficult. While the DMMP is not intended to address these navigational challenges, the plan does aim to combat channel sedimentation. As part of the planning process, a sand engine (SE) was studied to assess the benefit of bypassing the channel and providing long-term nourishment to the southwestern shoreline at Matagorda Peninsula.

Since the channel intercepts and retains much of the longshore sediment transport, a nearshore berm on the leeside of the south jetty is considered to supply the beach with sand that is lost to the channel. By allowing material to be transported by cross-shore wave action and littoral drift, sand is inhibited from returning to the channel while also nourishing downdrift beaches. Nearshore placement would be classified as BU for its role in stabilizing the south jetty while providing recreational and environmental benefit.

Figure 1-5: Sea Bar to Jetty Channel (SJC) Station -20+246 to 0+000

1.6.2 Matagorda Peninsula to Light 48

The MPL reach (Figure 1-6) features a transition of extreme depths at the inlet (greater than 120 ft) to a straight and narrow authorized channel (-38 ft MLLW). At station 21+500, the GIWW intersects the reach and then turns south to Port O'Connor. Along MPL, there is one semi-confined PA site in Chester Island and several OWPAs. Chester Island is located just south of the GIWW, near the old intersection of the GIWW at station 10+500. Historically, Chester Island has been preserved to attract both native and migratory birds, providing nesting habitat. Placement at Chester Island is considered BU; recently, agency partners have made design efforts to protect the site from erosion. Chester Island is one of several BU options that was considered in the DMMP. Moving north of the GIWW, OWPAs 6-10 are closely situated along MPL. These PAs are used frequently for maintenance contracts and are considered highly dispersive.

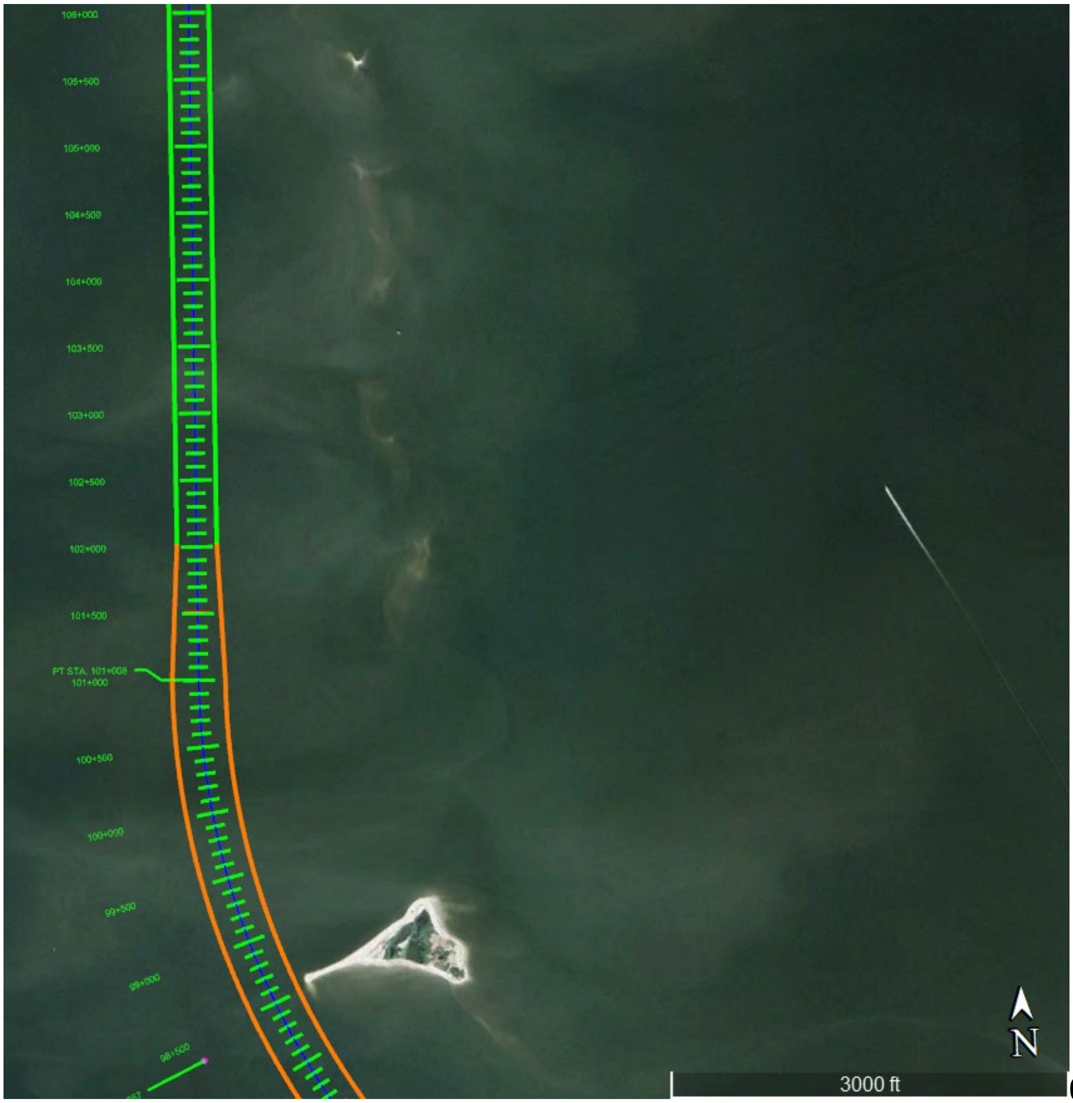
Figure 1-6: Matagorda Peninsula to Light 48 (MPL) Station 0+000 to 65+150

1.6.3 Light 48 to Alcoa Channel

The LAC reach (Figure 1-7) is comprised of the straight and narrow section from MPL to Port Lavaca Channel, as well as the turn towards Point Comfort. Between PA12 and PA14, there are no OWPAs in current operations. Predictably, the adjacent channel between 73+000 to 79+000 has experienced a relief in shoaling. The bend in the channel is the focal point of very high shoaling. Small dredged-islands are present from the original construction and maintenance of the MSC. These small island features change in shape and location over time depending on the supply of dredged material (Figure 1-8). The current MSC maintenance plan utilizes several OWPAs in Lavaca Bay. Over many years, maintenance material has been pumped on the leeside of emergent dredged-islands. However, these placement techniques have proved rather ineffective and much of the maintenance material is returning to the channel.

Figure 1-7: Light 48 to Alcoa Channel (LAC) Station 65+150 to 110+000

Figure 1-8 illustrates the current condition from satellite imagery (08/01/2024), where emergent spoils have eroded away due to the recent abandonment of PA17 (RP shown). The shallow-water environment and fine sediments in Lavaca Bay encourage elevated shoaling along the LAC reach. The open-water placement of dredged materials along the eastern side of this reach is especially counterproductive for maintenance.



041

Figure 1-8: Evolution of Dredged Material Islands (Satellite Imagery 2024)

The DMMP considers the ongoing channel shoaling problems in the LAC reach. Dredging records, survey, and coastal modeling were utilized to advise the most cost-effective placement options. Options to confine NW material were explored and eastern OWPA sites were avoided. Because of the high shoaling, DMMP sites are intended for optimization over the 50-yr project life as a means to reduce dredging and circumvent operational challenges. Should existing shoaling rates persist or worsen, the structure of the DMMP allows for reduction or removal of footprints based on new data and coordination with the Operations Manager (OM).

1.6.4 Alcoa Channel to Turning Basin

ATB reach (Figure 1-9) is a stretch of the MSC that turns northeast around existing PA19, a semi-confined disposal site south of CPA. Much like the LAC reach, ATB experiences high shoaling. The cause of high shoaling is largely attributed to OWPA sites, such as PA18, just south of the reach. Materials that are deposited south of ATB are likely carried up by the tidal current and settle out due to the change in flow direction, much like the southern turn in LAC. The DMMP focuses on placement measures that utilize the existing operational framework. The practice of allowing dredge slurry to overflow into open water (PA19) may be ineffective. Removing dredged material from the system, and confining the spoils, would place erosion primarily at the shoreline interface. Without including a sediment interception structure, an expansion of PA 18/19 requires further deliberation on placement strategy to minimize the material loss.

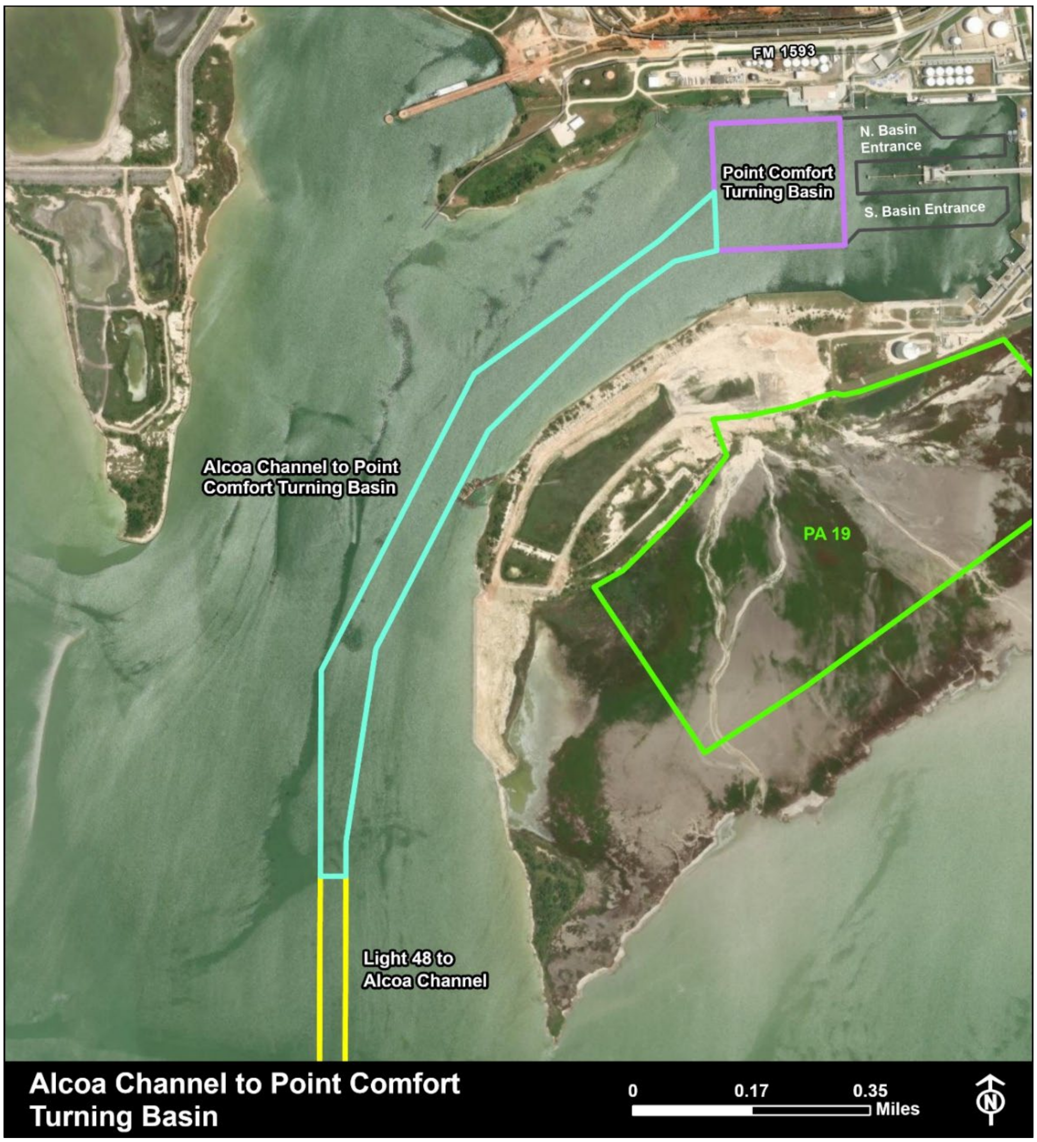


Figure 1-9: Alcoa Channel to Turning Basin (ATB) Station 110+000 to 116+223

1.6.5 Point Comfort Turning Basin

The PCT area (Figure 1-10) is a relatively small section of the MSC (1000 ft x 1000 ft) that connects to the North and South Basins at CPA. PCT experiences relatively low shoaling due to the sheltered nature of the basin. Commercial vessels and tugs may contribute to the suspension of bed sediments by way of drawdown and prop wash, though these are fairly small-scale effects. The primary contribution to sedimentation is originates from downstream of the basin. The PCT reach is rather stable, exhibiting only small variations in shoaling over the years. The DMMP is intended to maintain, or perhaps alleviate, the shoaling in this area. The RP calls for modifications to the existing channel template at ATB and PCT, featuring a turning basin at 1200 ft wide. The RP turning basin transitions back to 1000 ft until it meets the PCT reach (Figure 1-11). The required cut of material is expected to be mostly fine, cohesive clays. The DMMP explored options to both beneficially use and confine this material, so as not to worsen the existing shoaling conditions.

Figure 1-10: Point Comfort Turning Basin (PCT) Station 116+223 to 117+223

The RP channel template features a new turning basin as pictured in Figure 1-11.

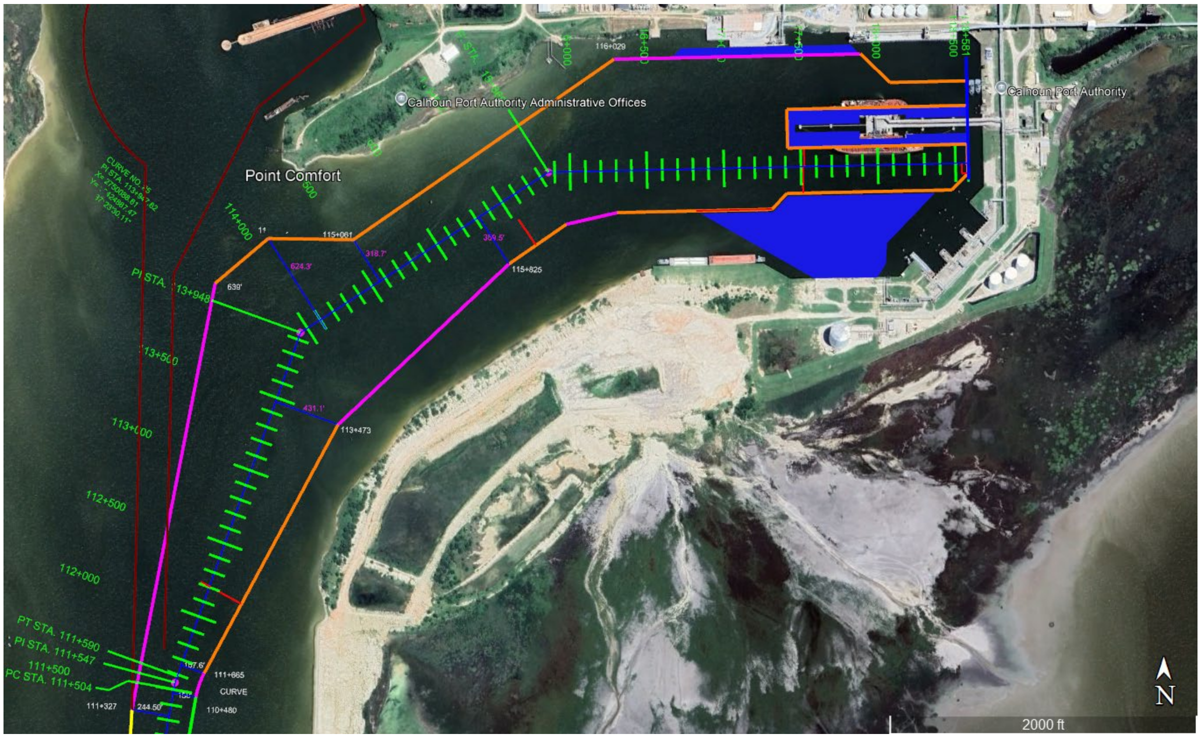


Figure 1-11: New Turning Basin and Transition to PCT under the RP

1.7 Datum Control

The horizontal datum is referenced to the North American Datum of 1983 (NAD 83), Texas State Plane Coordinate System, Texas South Central Zone. Vertical datums are referenced to the Mean Lower Low Water (MLLW). Based on the NOAA gauge 8773701, Port O'Connor, TX, the conversion of Mean Sea Level (MSL) to MLLW is taken as -0.4 ft.

2 Problems and Objectives

2.1 Problems

In the FWP scenario, the DMMP will not have adequate capacity for 50 years; the existing DMMP will have enough capacity for FWOP. Furthermore, the current DMMP does not provide adequate opportunities for Beneficial Use (BU). The DMMP layout also promotes the recycling of dredged material; that is to say, dredged material is placed adjacent to the MSC and often returns to the channel shortly thereafter.

2.1.1 Existing Placement Area Capacity

In the absence of a new management plan, there is little to no capacity for dredged material. Available OWPA survey (see Figure 2-1 example) illustrates that many sites are already approaching capacity. Contract hydrographic survey from 2021-2024 indicates that, based on average depths, FWP dredging quantities would violate minimum depth requirements for recreational (boating) safety.

While the current DMMP may be sufficient for the dredging needs of the existing channel, NW material and increased O&M quantity will require additional capacity. Section 2.3.1 reviews the data, methodology, and findings from the capacity analysis.

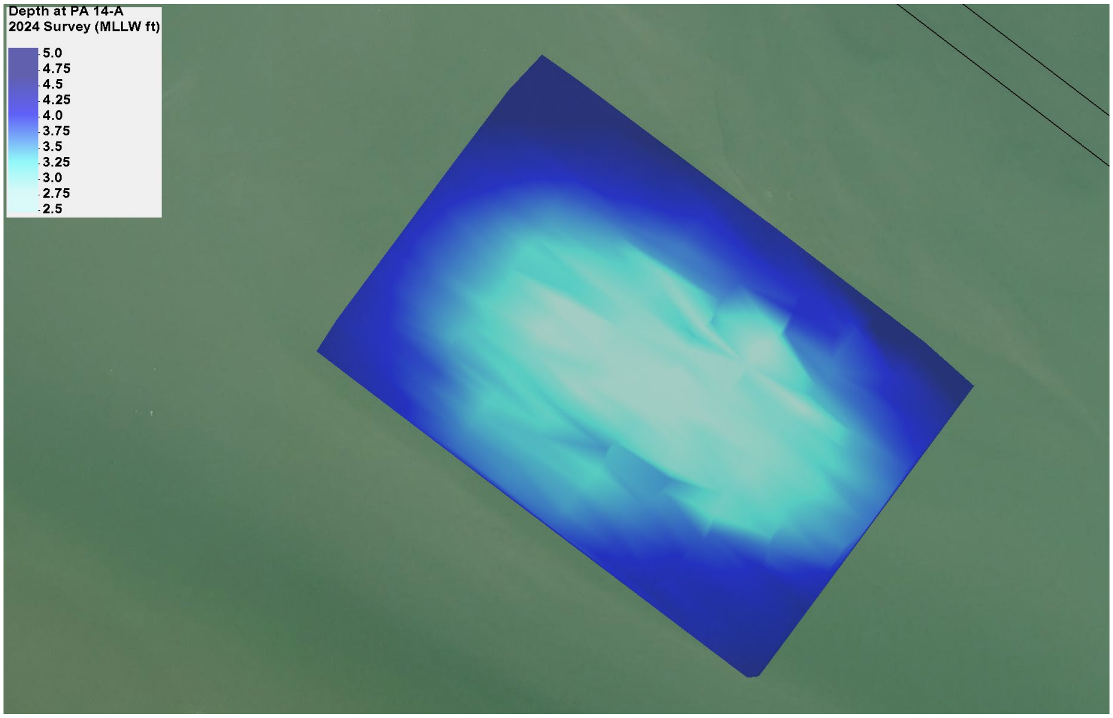


Figure 2-1: OWPA 14-A After-Dredging Survey (2024)

The minimum depth requirement to satisfy recreational safety is chosen as -3 ft MLLW; this freeboard accommodates average fishing boat drafts. By use of existing surveys, such as that depicted in Figure 2-1 for PA14-A, it was found that numerous PA sites are already exceeding this limiting condition after-dredging (AD).

A summary is provided in Table 2-1 for existing PA sites with average depths estimated from NOAA's Continuously Updated Digital Elevation Model (CUDEM). PA 7 – 14 sites (mid-bay) largely represent AD survey depths. AD bathymetry is more clearly shown in Figure 2-2 where depths are 1-1.5m (3-5 ft) MSL in mid-bay.

Table 2-1: Estimated (Average) Existing PA Site Depths

Existing Site	MSL Depth (ft)	Available Depth (-3 ft MLLW Condition)
PA6	8.957	5.557
PA7	4.921	1.521
PA8	4.692	1.292
P 9	3.609	0.209
PA10	3.281	-0.119

Existing Site	MSL Depth (ft)	Available Depth (-3 ft MLLW Condition)
PA11	3.117	-0.283
PA12	3.028	-0.372
PA14	4.134	0.734
PA14-A	6.890	3.490
PA15-A	7.218	3.818
PA15	6.430	3.030
PA16	4.429	1.029

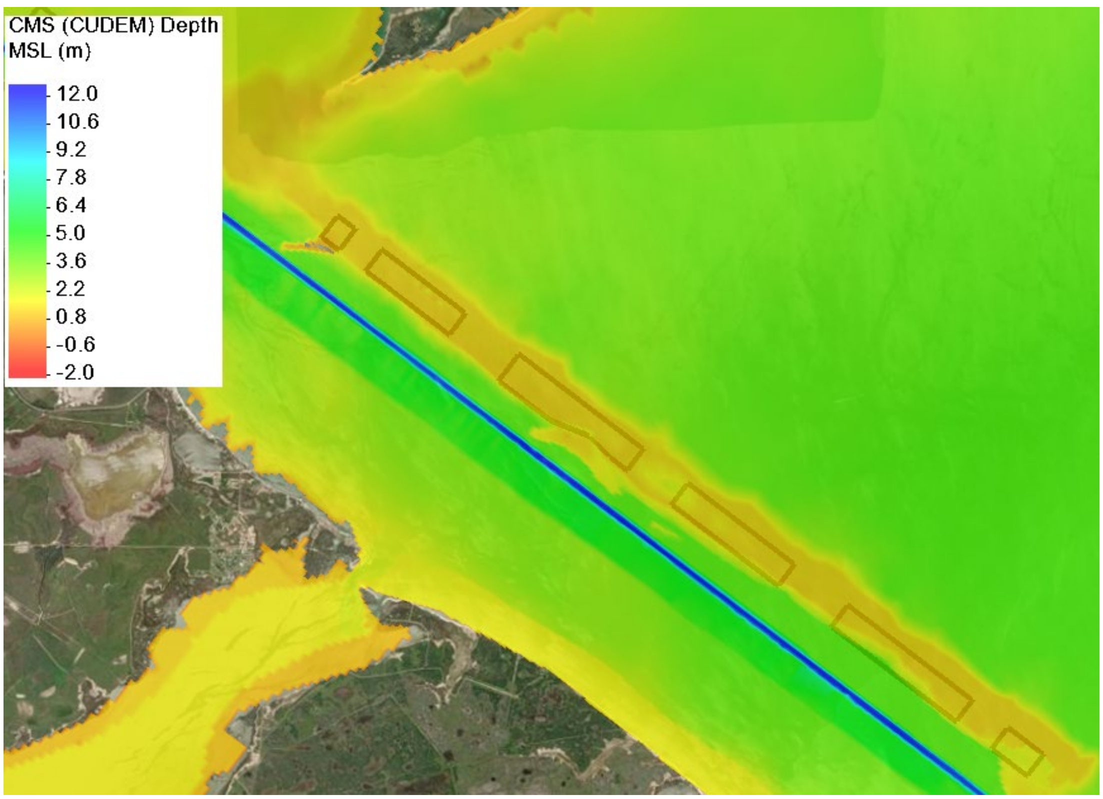


Figure 2-2: MSL Depth from Coastal Modeling System (CUDEM)

CUDEM depths provide insight into planning dredged material placement. Using these depths, the capacity for PAs listed in Table 2-1 would be just under 3 MCY. The last O&M contract (2023) called for the dredging of 5.5 MCY from the MSC (Section 3.1).

To maintain the current DMMP, it is presumed that open-water materials are lost at a rate of 50% between dredging contracts; this is based on survey data and experience in other District channels.

While the current DMMP is manageable under existing conditions, FWP will increase channel shoaling volumes (Section 7.3), thereby requiring additional capacity in certain reaches of the MSC. An assessment of existing OWPA capacities is provided in Section 3.5.1, which employs recent before-dredging (BD) surveys and average depths where survey data is unavailable.

Based on the analysis described in Section 2.3.1, the total FWP O&M capacity requirement without ODMDS is nearly 27.8 MCY. Seeing as how existing OWPA sites are already approaching capacity, the FWP DMMP aims to utilize new PA sites.

2.1.2 Lack of Beneficial Use

The existing placement plan does not provide for adequate beneficial use (BU) opportunity. Under the current plan, BU efforts are concentrated on Chester Island (Figure 2-3) near the GIWW. Chester Island has been the focus of ongoing restoration work between the USACE, non-federal agencies, and industry partners. The FWP plan pursues additional sites to implement the USACE's BU initiative.

Figure 2-3: Sole Beneficial Use Site in Matagorda Bay (Chester Island)

2.1.3 Recycled Dredged Material

The existing placement plan is recycling dredged material between OWPA sites and the federal channel. Since the predominant direction of sediment transport in the Matagorda

Bay is east to west, material that is disposed into eastern OWPA sites ultimately returns to the channel. Slowing the return of sediment to the MSC allows for a more manageable placement plan.

As originally proposed in the 2019 IFR/EIS, western sites would allow for channel bypassing, thereby restoring the natural sediment supply to west Matagorda Bay shoreline. Because of substantial mitigation costs uncovered as a consequence of these sites, western OWPAs were mostly abandoned.

ERDC TR-13-10 first identified the high channel shoaling area in Lavaca Bay. The 2013 Regional Sediment Management (RSM) study focused on design alternatives to reduce this shoaling. The effort considered a geotube, artificial island (AI), and new PA sites as potential solutions in the alternatives modeling (Figure 2-4).

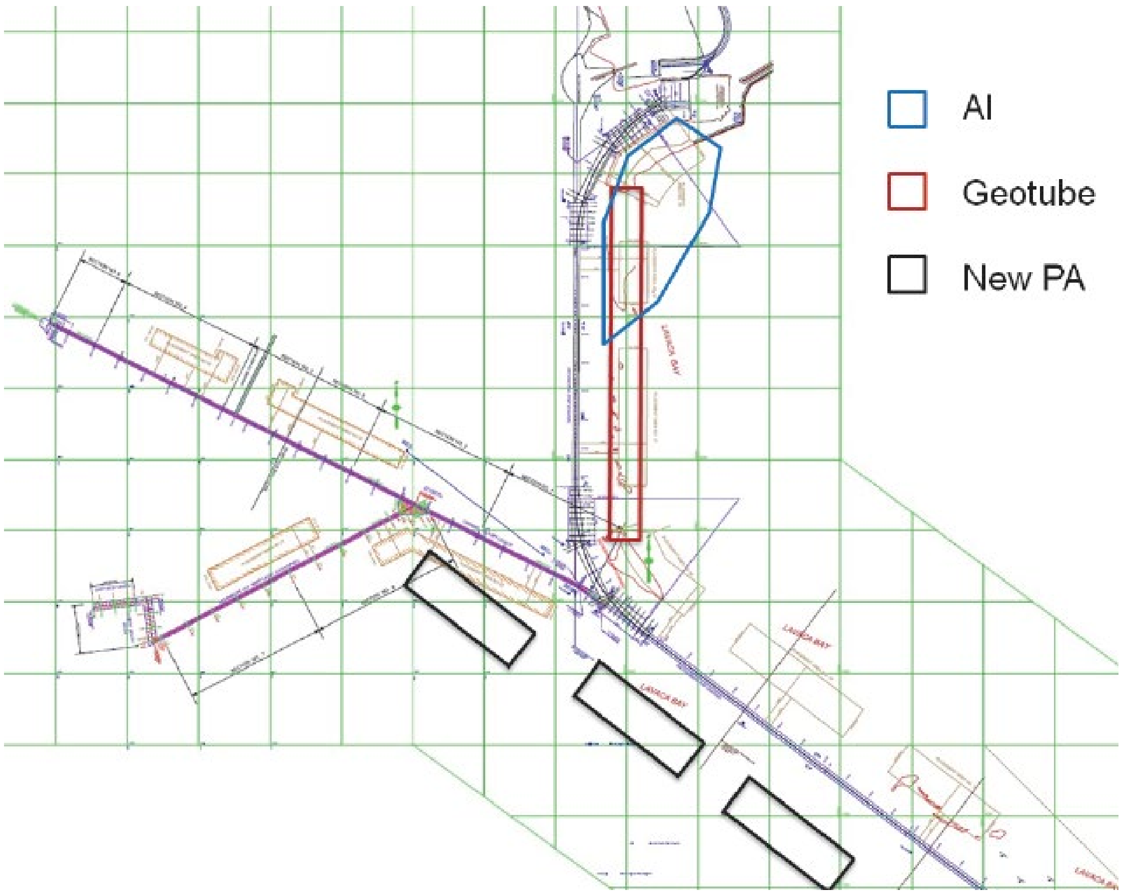


Figure 2-4: Model Alternatives from 2013 RSM Study to Reduce MSC Shoaling in Lavaca Bay

Findings from this study demonstrated that the geotube (sediment interception feature) and PA relocation were most effective at decreasing channel shoaling. Similar shoaling challenges exist in the lower reaches of the MSC where “hotspots” arise from material immediately returning to the MSC during and after placement. The offset of existing OWPA sites from the proposed channel toe would range from 1000-2000 ft. The new DMMP considers the recommendations made in the 2013 RSM study, providing larger offsets in an effort to alleviate material recycling. Specific measures taken to reduce immediate material recycling are discussed in Section 2.3.3.

2.2 Overview of FWP DMMP

The proposed DMMP features a total of 19 PAs for regular usage, including the Offshore Dredged Material Disposal Site (ODMDS). 4 PAs are utilized for both NW and O&M material, namely the ODMDS, SE, NP1/OP1, and NP6/OP8. While the proposed PAs shown in Figure 2-5 are intended for all NW materials and the majority of O&M, the full plan, detailed in Section 6.5, provides maximum flexibility for Operations. Table 2-2 provides the list of placement areas that take precedence for O&M materials and planned NW sites.

Table 2-2: Overview of FWP DMMP

Stationing	O&M Priority Site	NW Site?	O&M Acreage	NW PA Site	NW Acreage
-26+000 to -14+000	ODMDS	Yes	2,768	ODMDS	2,768
-14+000 to 0+000	Sand Engine	Yes	165	Sand Engine	165
	MP1	No	71		
0+000 to 20+000	Chester Island	No	202	–	–
	MP2	No	1		
20+000 to 25+000	OP1	Yes	238	NP1	238
25+000 to 35+000	OP2	No	410	NP2	788
35+000 to 50+000	OP3	No	495	NP3	517
50+000 to 73+500	OP4	No	714	NP4/5	689
73+500 to 85+500	OP5	No	454	–	–
85+500 to 90+500	OP6	No	215	–	–
90+500 to 97+000	PA15-A	No	102	–	–
97+000 to 102+000	OP8	Yes	459	NP6	459
102+000 to 108+000	OP9	No	708	Bird Island	346
108+000 to 118+581	PA 18/19 Exp.	No	606	–	–

Figure 2-5: Overview of FWP DMMP

2.3 Objectives

2.3.1 Appropriately Size Placement Areas

PAs are sized under the new plan (Table 2-3) by use of recent OWPA survey data and average depths at proposed sites. The capacity analysis considers immediate material retention, long-term environmental losses, and overflow capacity. With uncertainty regarding the future maintenance needs, it is best engineering practice to design the DMMP with safety factors. The OWPA surveys listed in Table 2-4 were used to estimate immediate dredged material loss and long-term environmental losses. The survey data, combined with Resident Management System (RMS) dredging data, allows for an estimate of annual volumetric loss.

Table 2-3: Available OWPA Surveys (BD and AD)

–	OWPA SURVEYS		DREDGING DATES	
OWPA	Survey Before Date	Survey After Date	Pump Start date	Pump End Date
8	2/2/2021	6/1/2021	2/22/2021	3/29/2021
10	3/12/2021	5/20/2021	4/8/2021	5/20/2021
14A	3/12/2021	8/9/2021	6/11/2021	6/28/2021
16A	3/12/2021	8/9/2021	6/29/2021	7/20/2021

–	OWPA SURVEYS		DREDGING DATES	
OWPA	Survey Before Date	Survey After Date	Pump Start date	Pump End Date
7	12/18/2023	4/16/2024	12/22/2024	4/1/2024
8	3/12/2024	5/21/2024	4/2/2024	5/15/2024
10	7/2/2024	9/11/2023	7/14/2024	8/31/2024
14A	10/8/2024	11/26/2024	10/10/2024	11/22/2024
16A	9/15/2023	11/4/2023	9/17/2023	10/24/2023

From a desktop analysis, the estimated losses were determined by the following relationships:

$$Immediate\ Loss\ = \left(1 - \left(\frac{BD\ survey\ Volume - AD\ survey\ Volume}{RMS\ Gross\ Volume\ Placed\ in\ OWPA}\right)\right)$$

$$Environmental\ Loss\ = \left(1 - \left(\frac{BD\ Survey\ Volume\ (1) - BD\ Survey\ Volume(2)}{RMS\ Gross\ Volume\ Placed\ in\ OWPA}\right)\right)$$

The loss estimates are summarized below in Table 2-4 based on a basic desktop analysis.

Table 2-4: Estimates of Dredged Material Loss

Type	Lower Bay	Mid Bay	Upper Bay
Immediate Loss	65%	69%	55%
Loss/yr on Total Volume	28%	28%	19%
Selected Loss/yr on Volume	10%	10%	20%

While immediate losses are significant throughout Matagorda Bay, lower long-term losses are used to provide contingency for Operations. Lower long-term losses in deeper areas of the bay provide a more accurate physical representation of the system. Shallow areas (upper-bay) experience greater bed shear stress from wave action.

The DMMP is conservatively designed to have sufficient capacity for 50 years; the values in Table 2-5 were used to determine the capacity requirement of each site.

Table 2-5: Loss Assumptions for O&M PA Sizing

DMMP Stationing	PA Site	Immediate Loss (%)	Environmental Loss (%/yr)
-26+000 to -14+000	ODMDS	25%	10%
-14+000 to 0+000	SE	25%	10%
0+000 to 20+000	Chester	65%	5%
20+000 to 25+000	OP1	65%	10%
25+000 to 35+000	OP2	65%	10%
35+000 to 50+000	OP3	70%	10%
50+000 to 73+500	OP4	70%	10%
73+500 to 85+500	OP5	70%	10%
85+500 to 90+500	OP6	70%	10%
90+500 to 97+000	PA 15-A	55%	10%
97+000 to 102+000	OP8	55%	20%
102+000 to 108+000	OP9	55%	20%
108+000 to 118+581	PA 18/19	55%	5%

The sizing of PA sites assumes lower long-term losses than those calculated. On average, the total acreage of proposed sites is conservative. However, sediment retention will vary from year to year between PAs.

FWP shoaling rates in the upper-bay are expected to be considerably worse than present-day. Because of increased shoaling, proposed sites could approach the limiting condition (-3 ft MLLW) within the 50-yr project life, thought the expectation of relative sea level change (RSLC) may add available water depth. RSLC is not a design factor in capacity analysis. To mitigate the risk of the limiting condition being exceeded, several O&M PAs have extra capacity in the proposed DMMP.

Capacity estimates for the proposed DMMP O&M sites are provided in Table 2-6.

Table 2-6: FWP Capacity Requirement vs Available in Proposed DMMP for O&M

Stationing	PA Site	Capacity Required (CY)	Plan Capacity (CY)
-26+000 to -14+000	ODMDS*	3,532,302	N/A
-14+000 to 0+000	SE*	2,955,380	3,966,317
0+000 to 20+000	Chester	2,735,733	2,528,674
20+000 to 25+000	OP1*	2,724,671	3,449,793
25+000 to 35+000	OP2	857,240	3,479,208
35+000 to 50+000	OP3	1,373,167	3,676,312
50+000 to 73+500	OP4	1,884,791	4,508,628
73+500 to 85+500	OP5	588,619	2,386,296
85+500 to 90+500	OP6	532,195	1,129,168
90+500 to 97+000	PA15-A	1,078,568	627,797
97+000 to 102+000	OP8*	3,791,357	2,326,568
102+000 to 108+000	OP9	1,714,065	3,496,614
108+000 to 118+581	PA 18/19	7,525,196	7,113,348
* Indicates dual-purpose site that includes NW quantity in capacity requirement.			

The adaptive management plan (Section 8.2) will allow for zero-cost adjustments to the placement scheme over the project life. Future capacity concerns are addressed under the proposed DMMP with alternative sites at similar pumping distance (such as OP9 and OP6).

It will be the responsibility of the MSC OM to assess PA capacity prior to contract execution by comparing before-dredging (BD) survey with contract quantities. In the example shown below (Figure 2-6), the proposed site at NP6/OP8 may hit capacity in just a few years. However, there is additional capacity at OP9 within the same pumping distance to relieve this concern.

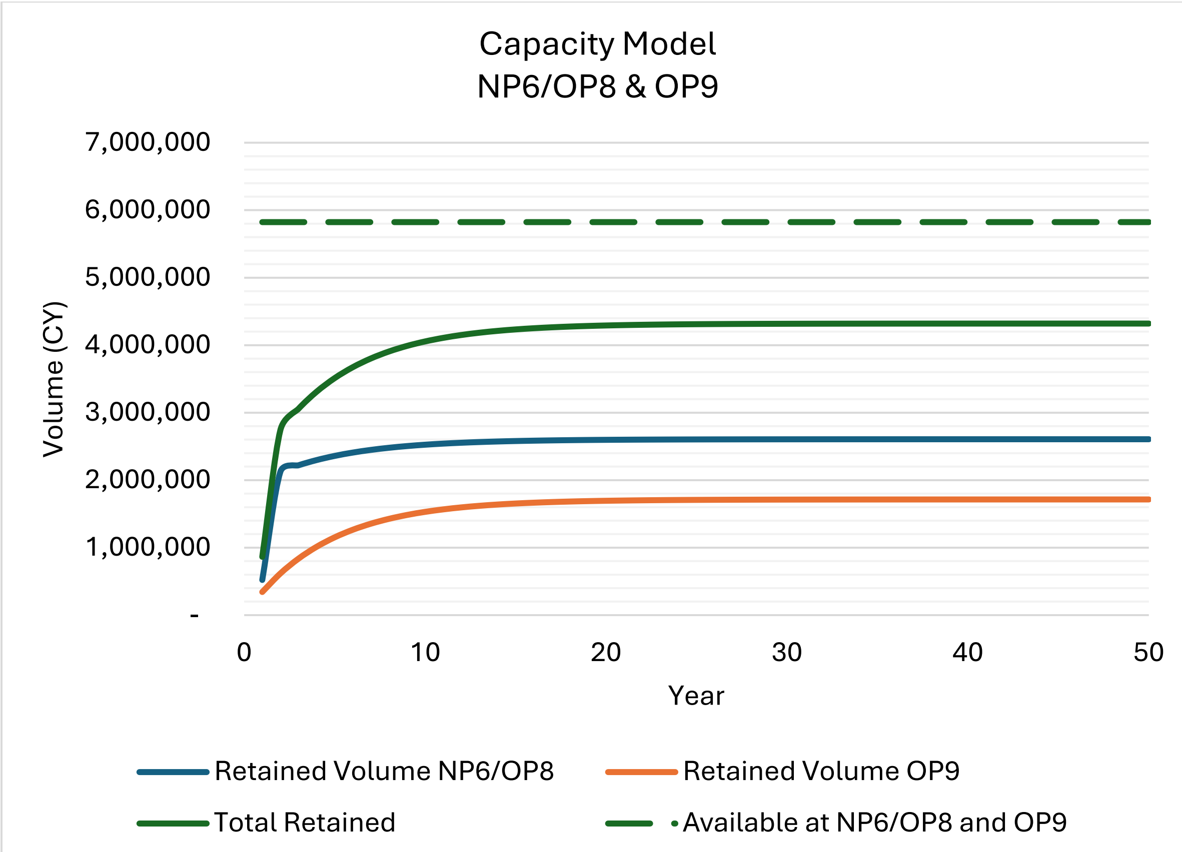


Figure 2-6: Volumetric Retention Model at NP6/OP8

Capacity estimates for emergent O&M sites, namely Chester Island and PA 18/19, assume a practical construction elevation of 1-4 ft MSL. In reality, these sites will be allowed to expand as needed to meet the maintenance demand. Following outlined assumptions, the total capacity for proposed O&M sites is 38.7 MCY without counting ODMDS. The O&M DMMP capacity need, not including ODMDS, is nearly 27.8 MCY and includes NW materials at dual-purpose sites. The corresponding volumetric safety factor is calculated as 1.4.

While the O&M PA sites incur more risk due to the uncertainty of FWP conditions, the sizing of NW sites is rather straightforward. In determining the capacity requirements for NW materials, the expected retention is taken as 70%, an experience-based retention rate taken from Corpus Christi Ship Channel (CCSC) CIP. The NW sites are detailed in Table 2-7 with plan capacities and corresponding requirements.

Table 2-7: FWP Capacity Requirement vs Available in Proposed DMMP for NW

Stationing	PA Site	Capacity Required (CY)	Plan Capacity (CY)
-26+000 to -14+000	ODMDS	2,204,030	N/A
-14+000 to 0+000	SE	1,415,697	3,966,317
0+000 to 20+000	NP1	2,025,240	3,449,793
20+000 to 47+000	NP2	4,850,468	11,070,767
47+000 to 72+000	NP3	4,557,925	5,264,974
72+000 to 97+000	NP4/5	4,499,008	5,229,632
97+000 to 101+000	NP6	1,185,289	2,319,272
101+000 to 118+581	Bird Island	6,795,498	7,544,590

Discounting the ODMDS, the total volumetric safety factor for NW material is estimated as almost 1.6. The additional safety (mainly at NP2) is desired due to the unique geotechnical properties of the virgin material. Higher clay content and less sandy, silty sediment fractions results in higher retention and post-placement bulking. More discussion regarding material retention is found in the Geotechnical section of the Engineering Appendix.

The construction elevations for emergent PA sites are provided in Table 2-8.

Table 2-8: Construction Elevations Used for Emergent Features

Site	Construction Elevation (ft)
Chester Island	1 ft MSL
PA 18/19	4 ft MSL
Bird Island	6.2 ft MSL

Due to the semi-confined nature of Chester Island and PA 18/19, the capacity estimates assume long-term losses are small (< 5%). However, the immediate loss of dredged material is estimated to be fairly high (> 55%).

If efforts are made to confine semi-confined sites in the future, then the presumed losses will be largely inaccurate. The engineering assumption regarding Chester Island and PA 18/19 is that capacity is effectively unlimited; these PA sites will be allowed to expand as needed, with training and shaping of material to accommodate maintenance material supply.

Nearly 1.2 MCY of material is expected to be placed at Chester Island from the bottleneck removal project. Designing Chester Island for MSCIP NW materials would be considered a duplicate effort that does not accurately capture future changes in island topography. Because of this, and uncertainty regarding protection efforts at the BU site, Chester Island is proposed only for MSC O&M materials.

2.3.2 Maximize Beneficial Use

The proposed plan allows for nearly 1385 acres of potential BU, which includes the existing footprint of Chester Island. BU sites comprise of the Sand Engine (SE), MP1/MP2, Chester Island expansion, Keller Bay Peninsula nourishment, and Bird Island (BI). The BI and SE sites are planned for NW material, while the Chester Island expansion is only intended for maintenance dredging. Keller Bay PA is included in the plan as a long-term option to address erosion at the Keller Bay Peninsula through collaboration with partner agencies. Similar to Keller Bay PA, the intent of the SE is to nourish the beach at Matagorda Peninsula over the project life by cross-shore and littoral transport of the berm sediments.

In the process of formulating the DMMP, BU sites were reviewed and screened with state and federal partners to gauge sediment demand, location interest, and appeal. Sites that were ultimately selected at feasibility may be refined at the design level, though the general location will remain the same. Sites that are recommended in the BU strategy are shown below in Figure 2-7.

Figure 2-7: Incentive to Increase Beneficial Use (Proposed Plan)

2.3.3 Minimize Quantity of Recycled Dredged Material

DMMP sites east of the MSC employ an additional 1000 ft offset from the channel to counter immediate material recycling (Figure 2-8). Furthermore, western OWPA sites are proposed as a means to bypass the channel and nourish eroding shorelines, such as those at Magnolia and Alamo Beach, over time.

Though many western sites were included in the DMMP alternatives screening, several locations proved to be undesirable for the final plan. Western sites are discussed in more detail in Section 6.

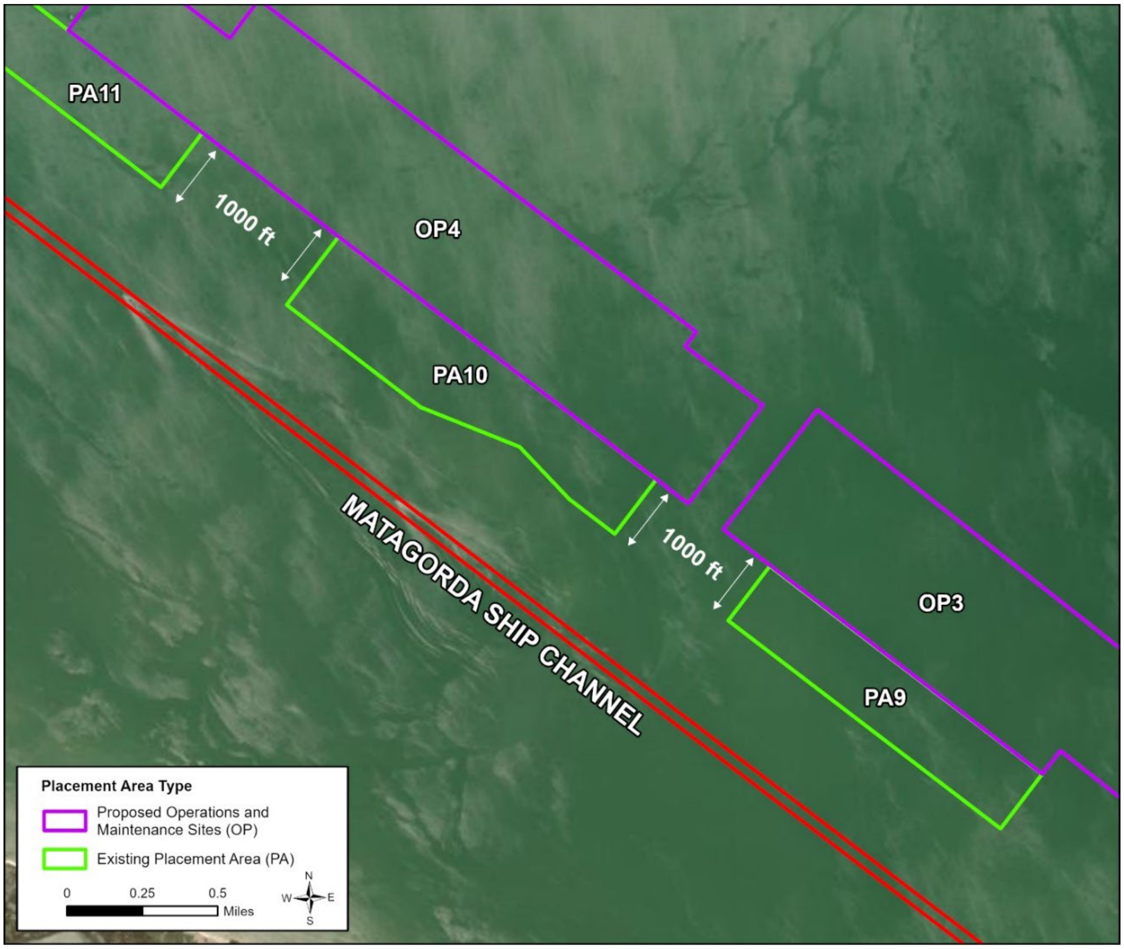


Figure 2-8: Countermeasure for Immediate Material Recycling

Rather than continuing to place in open-water sites at Lavaca Bay, the DMMP allows for confined placement of NW materials (BI) and maintenance sites that are on the west (OP6) or semi-confined placement (PA 18/19) to inhibit sediment from returning to the MSC. Improvements to the proposed plan may explore additional sediment retention features. Retention features are considered PED-level designs that are proven cost-saving solutions to manage sediment.

3 Existing Conditions

3.1 Dredging History

While MSC contract costs are presumably a function of the dredged quantity, costs also depend on the dredging frequency (time between dredging), inflation, and bid competition. Since external variables such as inflation and bid competition are not controllable, it is most practical to reduce MSC maintenance costs by optimizing the quantity to be dredged with the time between dredging contracts.

Available contract data is shown in Table 3-1 for Matagorda Peninsula (MPL)/Gallinipper Point to Point Comfort for years 2001-2023.

Table 3-1: MSC MPL/Gallinipper Point to Point Comfort Dredging Contract History

MPL/Gallinipper Point to Point Comfort Contract History						
FY Award	Start	Complete	Duration (Months)	MCY	Cost ($M)	Time between Dredging (Months)
2001	1/9/2001	2/28/2002	14	4.64	$3.91	NA
2003	1/24/2003	4/11/2003	3	1.60	$1.59	11.0
2005	12/5/2004	3/12/2005	3	1.59	$1.66	20.1
2006	1/26/2006	8/19/2006	7	4.64	$6.45	10.7
2007	4/11/2007	7/2/2007	3	1.83	$3.10	7.8
2008	4/30/2008	6/13/2008	1	1.05	$2.93	10.1
2009	3/5/2009	10/1/2009	7	2.80	$6.10	8.8
2010	3/4/2010	9/10/2010	6	3.61	$6.09	5.1
2011	2/1/2011	10/2/2011	8	3.09	$8.03	4.8
2013	10/26/2012	8/13/2013	10	3.22	$9.07	13.0
2014	9/19/2014	6/15/2015	9	3.20	$10.13	13.4
2016	7/1/16	2/26/2017	8	5.01	$9.05	12.7
2018	11/1/18	5/13/2019	6	5.40	$9.00	20.4
2020	11/30/20	8/15/21	9	5.20	$13.44	18.9
2023	9/16/2023	–	14	5.49	$15.19	25.4

For MPL/Gallinipper Point to Point Comfort, historically, an average of 3,490,755 CY has been dredged per cycle based on contract data from 2001-2023. Recently, contract costs have increased significantly, along with the time between dredging contracts. The above quantities and costs are graphed together in Figure 3-1 for MPL to Point Comfort contracts. Figure 3-2 illustrates correlations between quantity, frequency, and costs for the MPL to Point Comfort contracts (main channel).

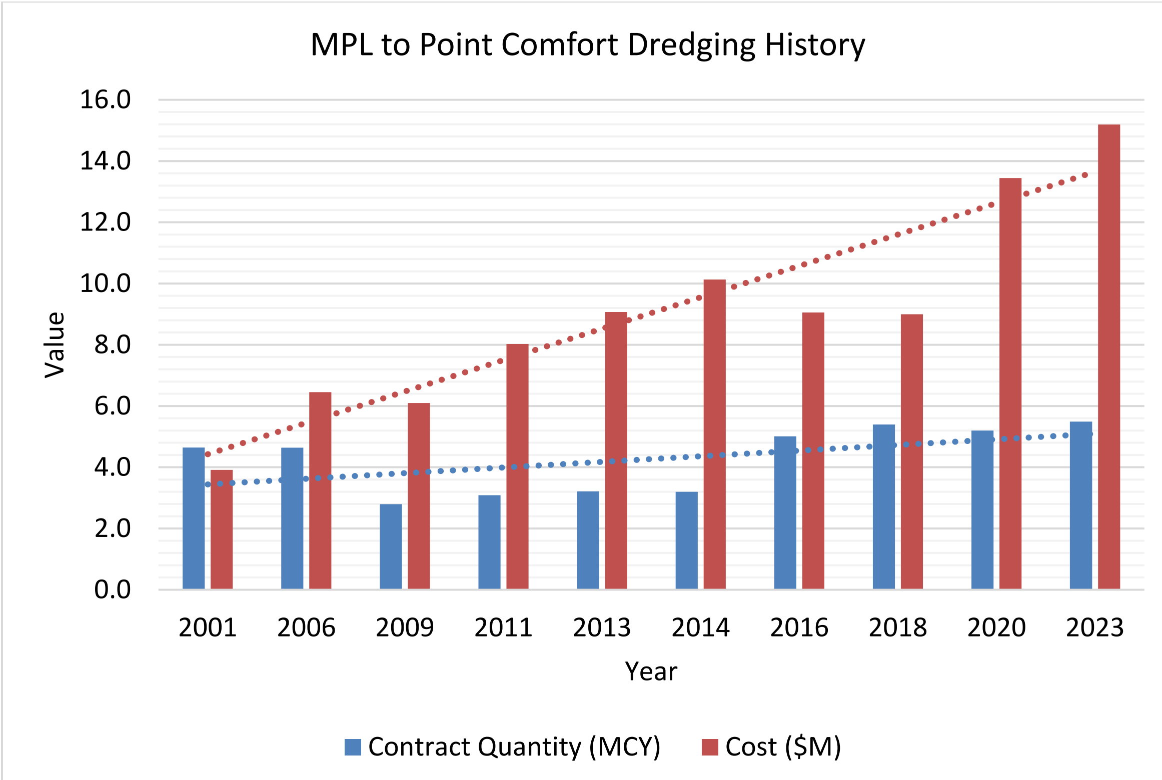


Figure 3-1: Main Channel Cost & Quantity History

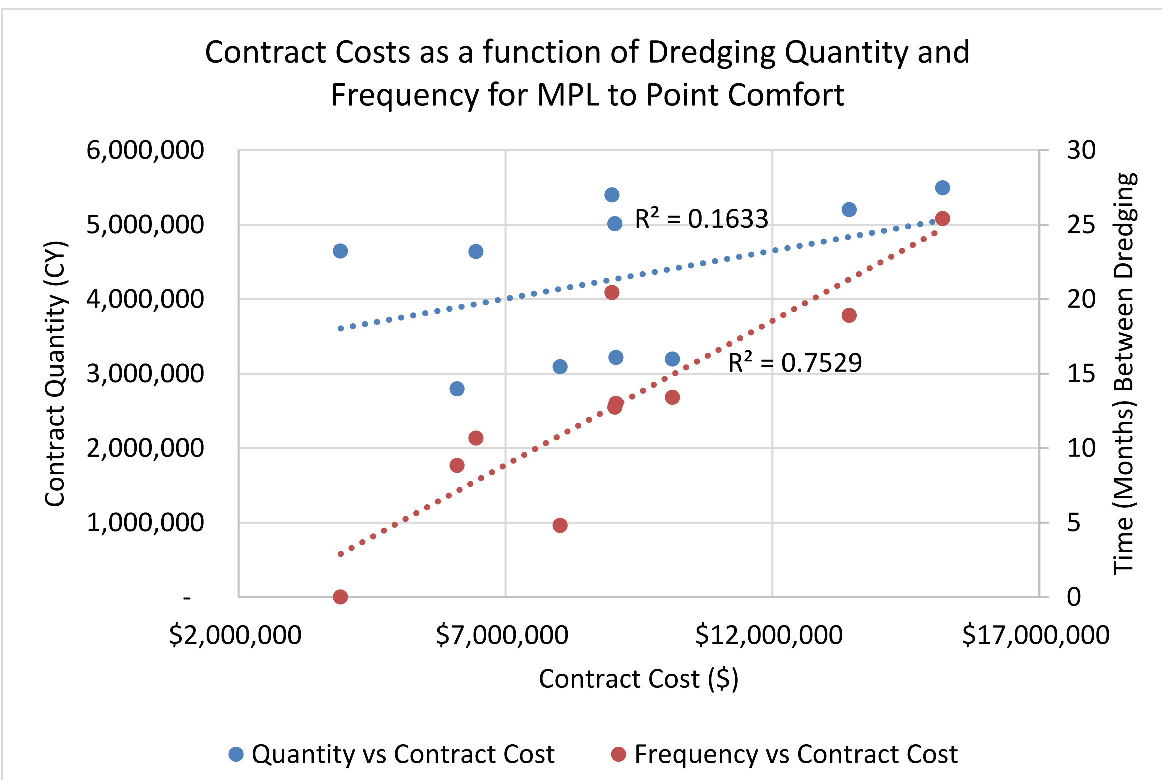


Figure 3-2: Correlation of Frequency and Quantity with Contract Cost

A couple basic observations can be made from the MPL to Point Comfort contract data:

(1) Costs to maintain the main channel are increasing.
(2) Operational inefficiency is affecting the costs; quantity is not well correlated to cost.

The same trends seen for MPL to Point Comfort are not quite as evident at the entrance channel. Table 3-2 below details the available contract data for the entrance channel (2001-2022). As can be seen in Figure 3-3, material quantity is not rising in the entrance channel as it is in the main channel.

Table 3-2: MSC Entrance Dredging Contract History

Entrance Channel Contract History						
FY Award	Start	Complete	Duration (Months)	MCY	Cost ($M)	Time between Dredging (Months)
2001	10/16/2000	1/4/2001	3	0.31	$0.48	NA
2004	1/13/2004	2/18/2004	1	0.37	$0.57	36.8
2012	8/28/2012	12/2/2012	3	0.48	$0.76	103.8
2017	12/20/2016	1/27/2017	1	0.19	$1.09	49.3
2021	2/2/2021	2/17/2021	1	0.35	$1.75	48.9
2022	1/21/2022	1/31/2022	1	0.13	$0.65	11.3

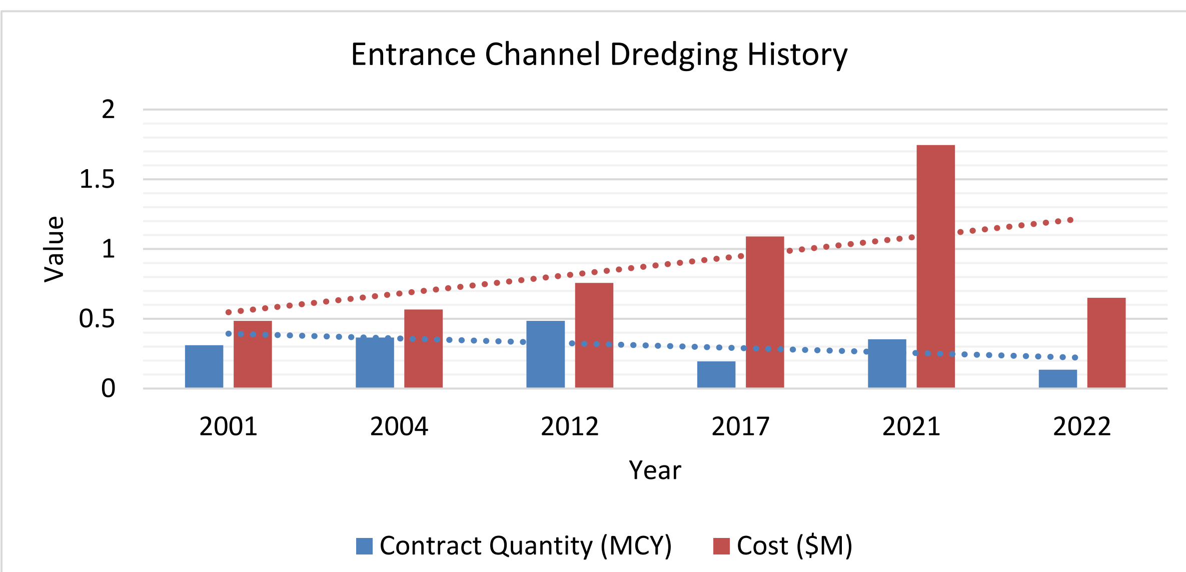


Figure 3-3: Entrance Channel Dredging Cost & Quantity History

While costs are increasing to maintain the entrance channel, dredging quantities are stable if not decreasing over the past 20 years. The inverse relationship between costs and quantity suggests an influence from external factors, such as bid competition. At the entrance channel, the data implies that a modest reduction in dredging volume may have little to no effect on the contract cost.

The MSC dredging history suggests that the MPL to Point Comfort reaches are increasing in contract cost due to operational inefficiency. Based on the timeframe of 2001-2023, the unit cost of O&M material is about $2/CY. Recent expenses have increased, bringing the unit cost closer to $3/CY.

The entrance channel has also seen rising costs since 2001. The data does not suggest that a mild reduction in material quantity will generate large cost savings. Based on the timeframe of 2001-2023, the unit cost of dredging the entrance is slightly higher at $3/CY. The last three contracts averaged almost $5/CY.

3.2 Shoaling Rates

For the 2011-2024 timeframe, the average shoaling rate in the MSC increased. Based on Corps Shoaling Analysis Tool (CSAT), Resident Management System (RMS) dredging data, and contract specifications, the sharpest increases are evident over the past 4 years (2020 – present). To investigate the driving forces behind increased sedimentation, data was obtained from 2 nearby gauges to identify potential trends and anomalies.

USGS gauge 08164000 at Lavaca River, Edna, TX, provides hydraulic data upstream of Matagorda Bay (Figure 3-4). Over the past 15 years, the largest change in streamflow occurred in 2017 (Hurricane Harvey). Based on these data, there is little supporting evidence of above-average riverine sediment load entering Lavaca/Matagorda Bay between 2020-2024 from Lavaca River.

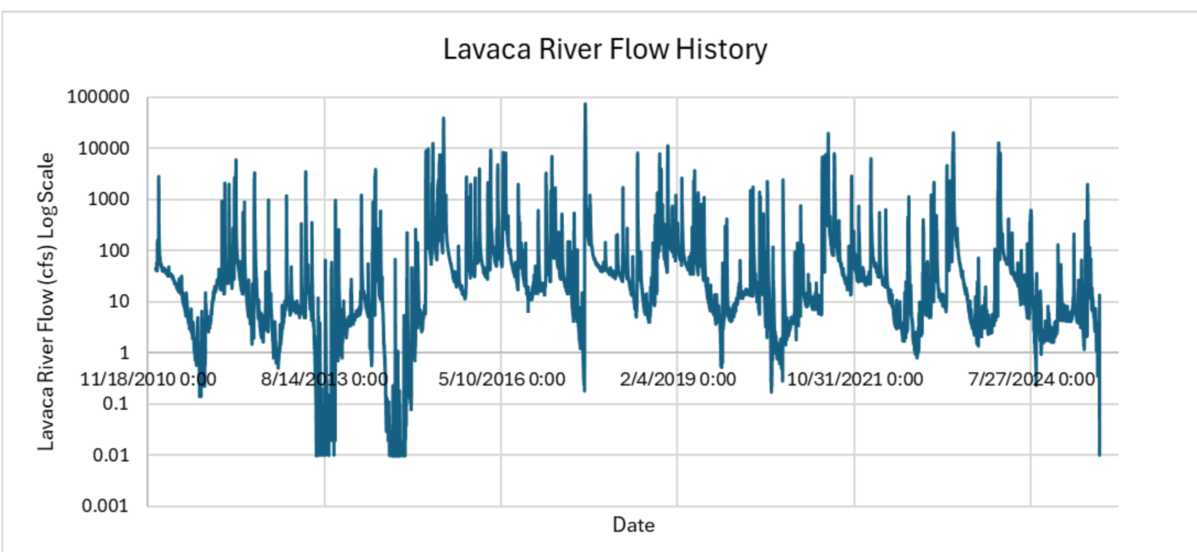


Figure 3-4: Lavaca River Flow at Edna, TX, USGS Gauge 08164000

Much like riverine flow, wind speed provides insight into forcing mechanisms (waves/currents) that may exacerbate sediment transport. The NOAA record (2013-2025) at Port O'Connor, TX, (8773701) illustrates that the average wind speed for 2020-2024 generally conforms to the previous epoch (2015-2019) average (Figure 3-5).

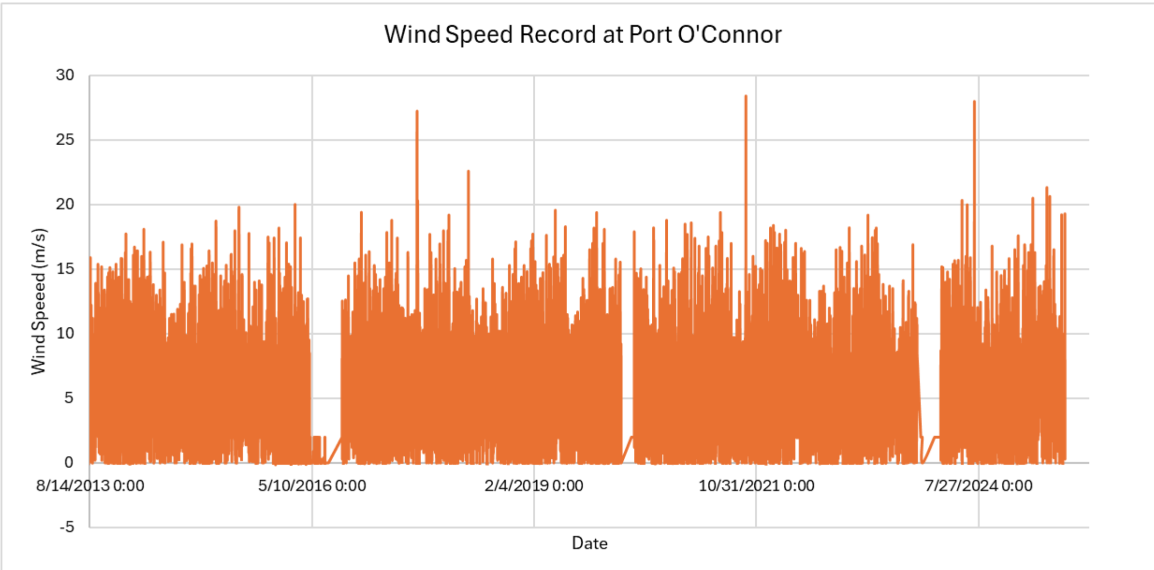


Figure 3-5: Wind Speed at Port O'Connor, TX, NOAA Station 8773701

In Matagorda Bay, episodic events have become more commonplace when compared to the beginning of the century (2000-2010). Between 2020-2024, Hurricane Beryl, Nicholas, and TS Beta made landfall within a 50-mile radius of Matagorda Bay (Figure 3-6). The previous 5 years (2015-2020) also featured 3 high-energy events, namely Imelda, Harvey, and Bill. Prior to 2015, the most recent tropical system within a 50-mile radius was Hurricane Erin in 2007.

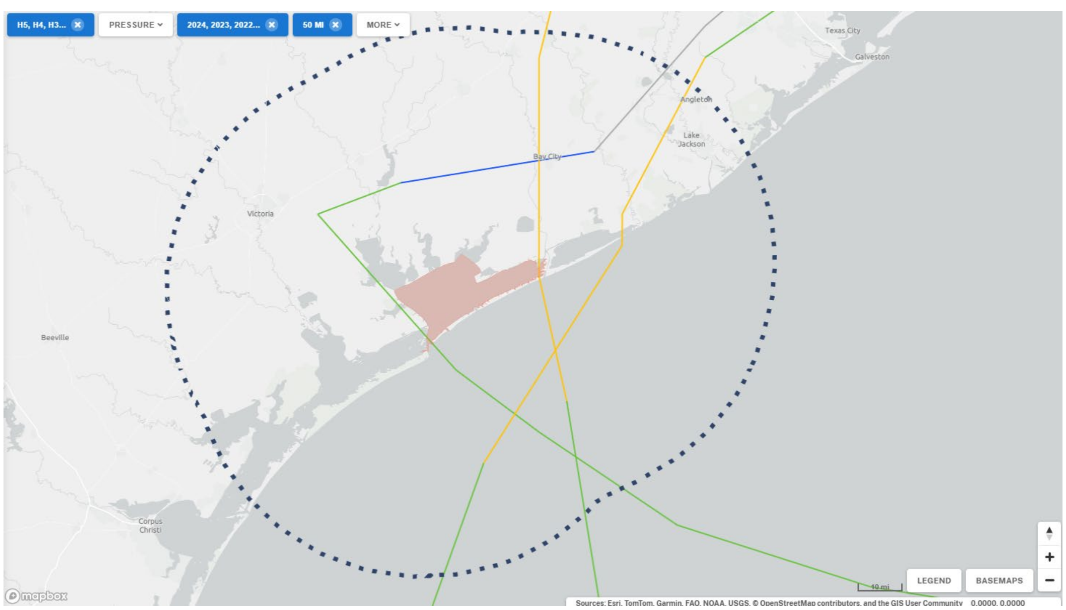


Figure 3-6: Historical Tropical Storms (2020-2024) within 50-mile Radius of Project

Seeing as how tropical systems have steadily impacted the region over the past 10-yrs, the "normal" existing condition should be informed on the most recent data. Informing the existing condition on outdated data, such a 2015 and prior, is less conservative than newer data.

2020-2024 was chosen to quantify the existing shoaling rates. Based on these most recent data, the existing shoaling volume for the MSC is an estimated 2.97 MCY/yr. The corresponding rate is approximately 2.9 ft/yr. The highest shoaling rates are in the Lavaca Bay area, as illustrated in Figure 3-7 by stations 97+000 to 118+502. A more detailed breakdown of the existing shoaling conditions is provided in the Appendix F (Engineering Appendix).

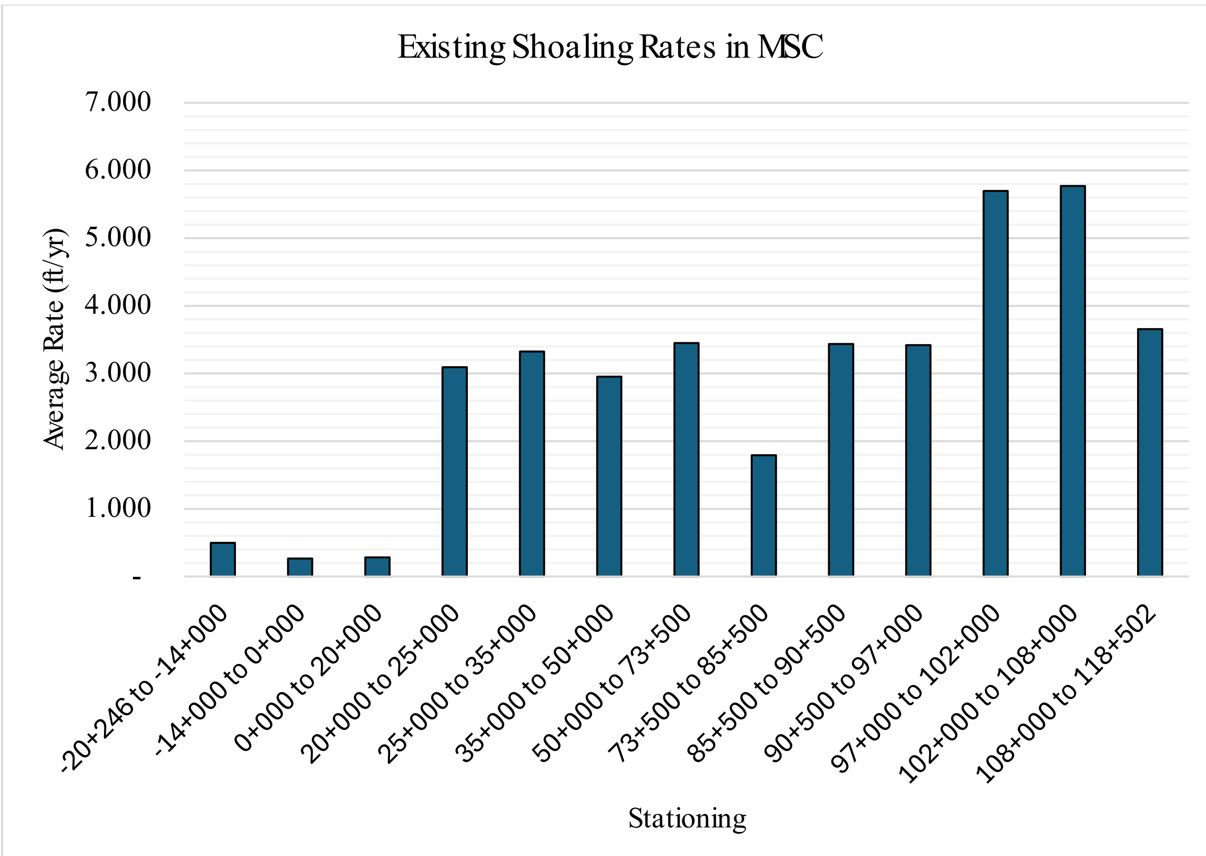


Figure 3-7: Existing Shoaling Rates

3.3 Dredged Material Composition

Dredged material in Matagorda Bay is primarily silts and clays outside of the entrance channel. At the entrance channel and into mid-bay, sandier materials persist. In the offshore and Lavaca Bay area, materials are primarily stiff to hard clay or soft clay/silt. By inspection of Figure 3-8, it is clear that a transition occurs between lower-bay and mid-bay into a softer silt/mud layer. The fluid mud nature of this dredged material corroborates the perceived dispersive nature of nearby OWPAs. These soft mud layers do not generate significant capacity concerns but may lead to immediate shoaling issues and dredging inefficiencies.

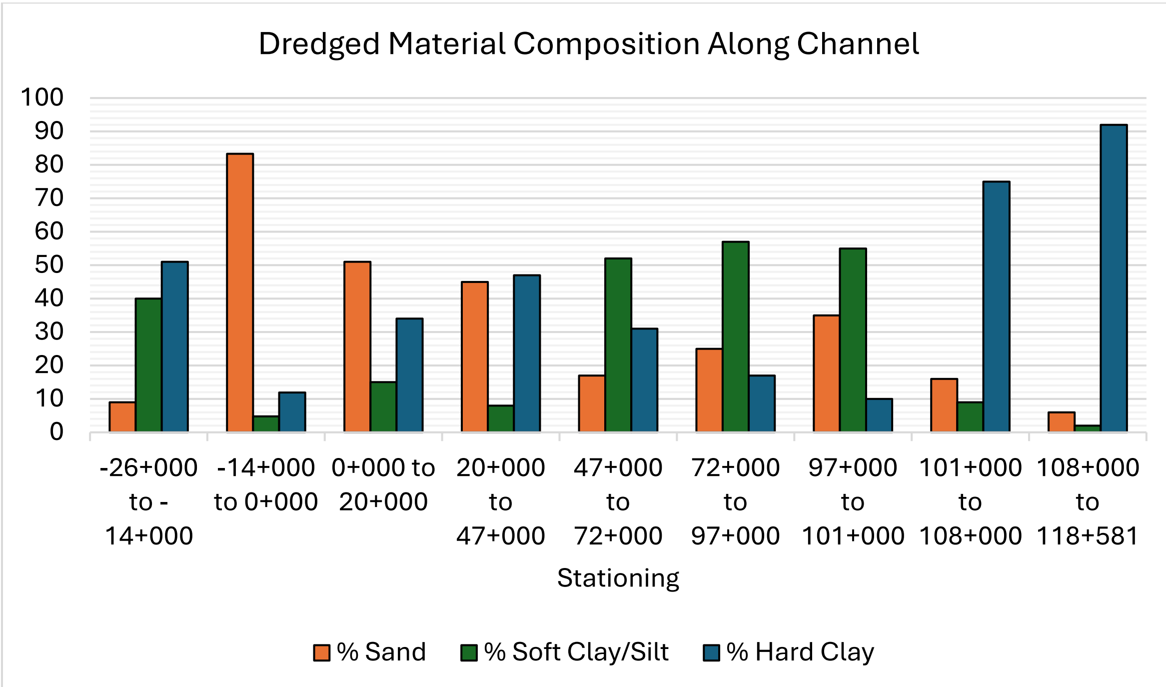


Figure 3-8: Dredged Material Composition in MSC

Notably, a layer of clay/sit is present at the -26+000 to -14+000 stationing; this is believed to be an artifact of little to no dredging and lack of longshore sediments being intercepted by the offshore channel.

3.4 Advance Maintenance

The current advance maintenance (AM) depth in the MSC is 2 ft for the main channel and 3 ft for the entrance. Table 3-3 summarizes AM depth and overdepth (OD).

Table 3-3: Existing Advance Maintenance and Overdepth in MSC

Station	Channel Reach	Advance Maintenance Depth (ft)	Overdepth (ft)
-20+246 to 0+000	Entrance	2	2
0+000 to 118+581	Main	3	2

No changes have been made to AM or OD between 2019 and present day for the MSC.

3.5 Placement Areas

Per the National Sediment Management Framework (NSMF), the MSC has 21 PA sites available for operational use, not including the ODMDS. The use of several sites, such as those at PA17 and PA18, have been avoided recently due to high shoaling concerns.

A full list of available PAs is shown in Table 3-4 with typical stationing, availability for future usage, and site notes.

Table 3-4: Existing Placement Scheme

PA/BU Site	Typical Stationing	Feasible for Future Use (Y/N)	Note
ODMDS	-20+246 to 0+000	Y	Offshore Disposal
DA2	-10+000 to 0+000	Y	Upland Beach – Not used
Chester Island	0+000 to 20+000	Y	BU
PA116B	14+000 to 17+500	Y	OWPA
PA5	17+500 to 22+500	N	OWPA – shoaling concern
PA6	22+500 to 27+500	Y	OWPA
PA7	27+500 to 32+500	Y	OWPA
PA8	32+500 to 42+500	Y	OWPA
PA9	42+500 to 50+000	Y	OWPA
PA10	50+000 to 60+000	Y	OWPA
PA11	60+000 to 67+500	Y	OWPA
PA12	67+500 to 75+000	Y	OWPA
PA14	75+000 to 90+000	Y	OWPA
PA15	85+000 to 95+000	Y	OWPA
PA14-A	75+000 to 90+000	Y	OWPA
PA15-A	90+000 to 95+000	Y	OWPA
PA16	95+000 to 100+000	Y	OWPA
PA16-A	95+000 to 100+000	Y	OWPA
PA17	100+000 to 105+000	N	OWPA – shoaling concern
PA18	105+000 to 111+000	N	Semi-Confined
PA19	111+000 to 118+581	Y	Semi-Confined

In recent years, several of the OWPA sites listed in Table 3-4 have been avoided. This has been taken into consideration for the FWOP DMMP (Section 4.5).

3.5.1 Existing Capacity

Capacity at existing OWPA sites is limited in Matagorda Bay. Available capacities are estimated from BD survey and average depths for current OWPA sites (Table 3-5).

The capacity at Chester Island and PA19 are presumed to meet the current maintenance demand in the channel. Likewise, the ODMDS has effectively unlimited capacity in relatively deep waters.

The historical expansion of emergent sites in the existing DMMP suggests that they will continue to grow if supplied with dredged materials. When considering existing O&M burden, the behavior of most OPWAs is considered highly dispersive and low-risk for current operations.

The existing OWPA capacity in Matagorda Bay is estimated to be roughly 10 MCY, though the exact capacity of existing sites fluctuates with time and depends on many factors. For the purpose of investigating capacity requirements, 10 MCY is an optimistic figure that utilizes every available OWPA site and ignores the complexities of dredged material disposal, settlement, and resuspension. The largest available capacity is shown in mid-bay (PA8-PA11), which validates field experience.

Capacities utilize the fully available area at the PA site. Factors associated with immediate bed changes, such as mounding, slopes to the PA boundary, etc., are not considered for capacity estimates. More complicated considerations such as these are not necessary at the planning level.

Table 3-5: Assessment of Existing Capacity

Existing Sites	Area (sqft) of Survey	Volume (Depth) (cf)	PA Volume of Water (CY)	Full PA Volume of Water @ -3 ft MLLW Trigger (CY)	Estimate of Dredged Material Capacity (CY) in Survey Area	Note	Area Factor	Capacity Estimate (CY)
PA6	518,417	3,114,565	115,354	57,602	57,752	2021 BD	0.90	51,726
PA7	2,614,597	18,994,813	703,512	290,511	413,001	2024 BD	0.92	379,125
PA8	8,462,219	67,479,717	2,499,249	940,247	1,559,002	2024 BD	0.99	1,547,488
PA9	7,812,769	60,261,205	2,231,896	868,085	1,363,811	2024 BD	0.92	1,256,808
PA10	10,971,249	91,206,418	3,378,015	1,219,028	2,158,988	2021 BD	0.84	1,820,235
PA11	6,458,996	45,099,442	1,670,350	717,666	952,683	2021 BD	0.87	831,800
PA14-A	5,219,919	31,376,101	1,162,078	579,991	582,087	2021 BD	0.90	521,868
PA15-A	3,601,326	21,860,836	809,661	400,147	409,513	Reduced Footprint	1.23	504,870

Existing Sites	Area (sqft) of Survey	Volume (Depth) (cf)	PA Volume of Water (CY)	Full PA Volume of Water @ -3 ft MLLW Trigger (CY)	Estimate of Dredged Material Capacity (CY) in Survey Area	Note	Area Factor	Capacity Estimate (CY)
PA16-A	9,138,609	53,460,031	1,980,001	1,015,401	964,600	Erroneous Points Removed	0.98	949,975
–							*SUM PA6 - PA16-A*	**7,863,894**
Existing Sites	**Area (sqft) of Survey**	**Volume (Depth) (cf)**	**PA Volume of Water (CY)**	**Full PA Volume of Water @ -3 ft MLLW Trigger (CY)**	**Estimate of Dredged Material Capacity (CY) in Survey Area**	**Note**	**Area Factor**	**Capacity Estimate (CY)**
PA12	N/A	N/A	N/A	133,378	222,297	Assumes.. -8 ft	N/A	–
PA14	N/A	N/A	N/A	533,265	177,755	Assumes.. -4 ft	N/A	–
PA15	N/A	N/A	N/A	666,662	666,662	Assumes.. -6 ft	N/A	–

Existing Sites	Area (sqft) of Survey	Volume (Depth) (cf)	PA Volume of Water (CY)	Full PA Volume of Water @ -3 ft MLLW Trigger (CY)	Estimate of Dredged Material Capacity (CY) in Survey Area	Note	Area Factor	Capacity Estimate (CY)
PA16	N/A	N/A	N/A	426,335	142,112	Assumes.. -4 ft	N/A	–
PA17*	N/A	N/A	N/A	533,333	444,444	Assumes.. -5.5 ft	N/A	–
PA18*	N/A	N/A	N/A	238,889	199,074	Assumes 0.5 ft of material	N/A	–
*** Denotes existing site not included in FWOP plan due to high shoaling concerns.**							*SUM*	**9,716,236**

Table 3-6: Existing DMMP Capacity under FWP Conditions for O&M

Proposed Stationing	Existing Site	Estimated Total Capacity (CY)	Capacity Need for O&M (CY)	Deficit?
-26+000 to -14+000	ODMDS	NA	1,328,272	None
-14+000 to 0+000	ODMDS	NA	1,539,683	None
0+000 to 20+000	Chester Island	NA	1,595,733	None
20+000 to 25+000	PA6, PA7	430,851	699,431	-268,580
25+000 to 35+000	PA8	1,547,488	857,240	None
35+000 to 50+000	PA9, PA10	3,077,043	1,373,167	None
50+000 to 73+500	PA11, PA12	1,054,096	1,884,791	-830,695
73+500 to 85+500	PA14, PA14-A	699,623	588,619	None
85+500 to 90+500	PA15	666,662	532,195	None
90+500 to 97+000	PA16, PA15-A	646,982	1,078,568	-431,587
97+000 to 102+000	PA 16-A	949,975	2,606,068	-1,656,093
102+000 to 108+000	PA17, PA18	643,518	1,714,065	-1,070,547
108+000 to 118+581	PA19	NA	7,525,196	None
–	–	–	*SUM of Deficit*	-3,426,807

Based on Table 3-6, it is clear that the mid-bay stations do not have serious long-term capacity concerns for O&M materials. However, the upper-bay has significant capacity limitations, illustrated by Figure 3-9. An expanded PA18/19 is expected to relieve most capacity concerns, but not all.

Assuming that existing emergent sites and ODMDS are able to accommodate FWP materials, the projected deficit for FWP capacity is largely attributed to higher shoaling in the Lavaca Bay reaches of the MSC (Station 90+500 to Point Comfort). In total, the current DMMP is projected to be at least 2.5 – 3.5 MCY shy of the 50-yr FWP capacity requirement.

Re-routing dredged material under the existing plan is not sustainable for FWP conditions. Large capacity needs are anticipated for stations 97+000 to 108+000, and the nearest existing PA with extra capacity would be PA10, almost 8.5 miles from PA 16-A. Similarly, the proposed expansion of PA18 and PA19 into PA 18/19 is designed to accommodate materials at a reasonable pumping distance without future confinement. The assessment of existing O&M capacity under FWP conditions does not account for PAs listed for future removal (Section 4.4) or the allocation of NW materials.

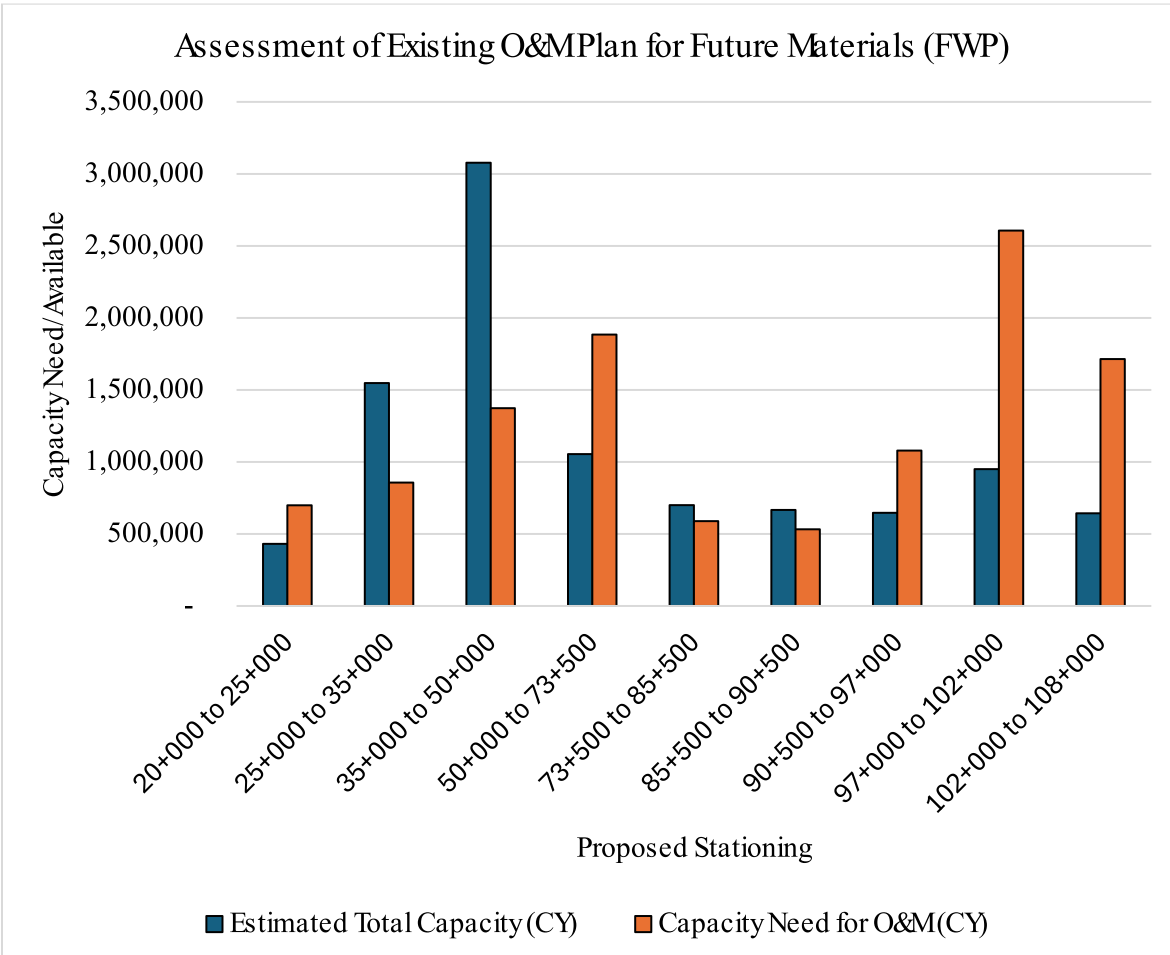


Figure 3-9: Capacity of Existing Sites under FWP Conditions

4 Future Without Project Conditions

Future without Project (FWOP) conditions consider the life of the DMMP absent of heightened shoaling conditions from construction and maintenance of the project.

4.1 Shoaling Rates

Methodology to determine the FWOP shoaling rates is detailed in Appendix F. The total shoaling volume is slightly higher than existing at 3.13 MCY/yr, attributed to the planned bottleneck removal at the MSC entrance. The average rate is similar to existing.

4.2 Maintenance Volumes

Maintenance volumes are projected for the 50-yr period to estimate the total burden on the DMMP. While the annualized shoaling volume will vary from year to year, the 50-yr volume is expected to approach nearly 156 MCY as shown in Table 4-1. The only proposed changes to the FWOP DMMP come by removal of 2 problematic OWPA sites (PA-5, PA-17) and the necessary combined-expansion of PA18 and PA19 (PA 18/19).

Table 4-1: FWOP 50-yr Maintenance Volumes

Stationing	Annual Shoaling Volume (CY/yr)	Average Dredge Frequency (yr)	Total Shoaling Volume per Cycle (CY)	No. of Cycles in 50-yr Plan	Total 50-yr Shoaling Volume
-20+246 to -14+000	34,578	4	138,312	12.5	1,728,900
-14+000 to 0+000	118,996	4	475,985	12.5	5,949,814
0+000 to 20+000	127,357	2	254,713	25	6,367,832
20+000 to 25+000	114,564	2	229,128	25	5,728,199
25+000 to 35+000	246,195	2	492,389	25	12,309,726
35+000 to 50+000	328,207	2	656,413	25	16,410,334
50+000 to 73+500	600,666	2	1,201,332	25	30,033,299
73+500 to 85+500	160,176	2	320,353	25	8,008,815
85+500 to 90+500	127,256	2	254,511	25	6,362,787
90+500 to 97+000	182,216	2	364,432	25	9,110,796
97+000 to 102+000	309,858	2	619,717	25	15,492,915
102+000 to 108+000	256,493	2	512,986	25	12,824,658
108+000 to 118+502	525,702	2	1,051,403	25	26,285,087
Total Federal O&M (CY)					**156,613,160**

4.3 Advance Maintenance

FWOP Advance Maintenance (AM) depth and overdepth are recommended to remain the same as existing for the MSC (Section 3.4). This features 3 ft AM at the entrance channel and 2 ft for the main channel.

4.4 Placement Areas

The Placement Areas (PAs) identified in the FWOP 50-Year DMMP are expected to continue supporting long-term dredged material placement with very minimal capacity concerns, except for PA19, which will require future expansion. The Ocean Dredged Material Disposal Site (ODMDS) will serve the Entrance Channel from Sta. -20+256 to Sta. 0+000, accommodating approximately 7.6 million cubic yards (MCY) of material. Chester Island PA, covering Sta. 0+000 to Sta. 20+000, will receive an estimated 6.4 MCY. Both areas will maintain current operations and are expected to have sufficient capacity for the 50-year period. For Sta. 20+000 to Sta. 108+000, materials will be placed in existing Open-Water Placement Areas (OWPAs), which are projected to handle about 116.3 MCY of federal O&M. These OWPAs are naturally dispersive and therefore are not anticipated to reach capacity limits within the planning horizon. At the upper end of the project, PA19, serving Sta. 108+000 to Sta. 118+502, will handle a combined 26.3 MCY. Historical footprint growth from 35 acres in 1990 to roughly 287 acres in 2022 highlights the semi-confined site's reliance on sediment runoff. To accommodate future placement, approximately 230 additional acres will be required, and it is recommended that this be factored into FWOP environmental impact evaluations.

- ODMDS (Ocean Dredged Material Disposal Site)
    - Station Limits: Sta. -20+256 to Sta. 0+000 (Entrance Channel)
    - Volume: ~7.6 million cubic yards (MCY)
    - Status: Current O&M (Operations & Maintenance) practices will continue.
    - Capacity: No issues anticipated.
- Chester Island PA
    - Station Limits: Sta. 0+000 to Sta. 20+000
    - Volume: ~6.4 MCY
    - Status: Current O&M practices will continue.
    - Capacity: No issues anticipated.
- Existing OWPAs (Open-Water Placement Areas)
    - Station Limits: Sta. 20+000 to Sta. 111+000 (Bay Channel)
    - Volume (Federal OM only): ~116.3 MCY over 50 years
    - Status: Use of the OWPAs listed in Table 4-2 will continue.
    - Capacity: No expected limiting capacity due to dispersive nature of sites.
        - The use of PA5 and PA17 is excluded.
- PA19 (Upland Semi-Confined Placement Area)
    - Station Limits: Sta. 108+000 to Sta. 118+502
    - Combined Volume (Federal + NFS): ~26.3 MCY
    - Footprint Growth (1990–2022):
        - From 35 acres to ~287 acres (see Figure 4-1)
        - Driven by bay-bottom settling and dispersive characteristics

- Remaining Capacity: Estimated 70% usable capacity per visible acre

Table 4-2: FWOP DMMP

FWOP Stationing	Permitted FWOP Placement Area
-20+246 to -14+000	ODMDS
-14+000 to 0+000	ODMDS
0+000 to 20+000	Chester Island
20+000 to 25+000	PA116-B, PA6, PA7
25+000 to 35+000	PA7, PA8
35+000 to 50+000	PA9, PA10
50+000 to 73+500	PA11, PA12
73+500 to 85+500	PA14, PA14-A
85+500 to 90+500	PA15, PA15-A
90+500 to 97+000	PA15-A, PA16
97+000 to 102+000	PA16, PA 16-A
102+000 to 108+000	PA16-A, PA18/19
108+000 to 118+502	PA18/19

Figure 4-1: Expansion of PA19 (Top – 1990, Bottom – 2025)

4.4.1 Placement Area Capacity

The 50-yr FWOP Dredged Material Management Plan (DMMP) outlines the continued use and capacity expectations for several existing Placement Areas (PAs) along the project channel. From Sta. 20+000 to Sta. 108+000, the plan relies on various Open-Water Placement Areas (OWPAs) to manage around 116.3 MCY of federally dredged material. These sites are considered dispersive in nature and therefore are not expected to reach capacity limits during the 50-year period. Continued monitoring should be used in compliance with Section 8.2.

At the upper end of the channel, PA19 will continue to receive both federal and non-federal sediment from Sta. 108+000 to Sta. 118+502, totaling approximately 26.3 MCY. Historical data shows the placement footprint at PA19 expanded from 35 acres in 1990 to about 287 acres by 2022, primarily due to settled material remaining active and easily mobilized. To accommodate the projected 50-year volume, an estimated 230 additional acres will be needed, with capacity calculations assuming 70% usability per acre. While no immediate capacity issues are expected for most PAs, expansion of PA19 (into PA18/19) and consideration of alternative sites will be needed to maintain operational efficiency and minimize environmental impacts.

4.4.2 Key Capacity Considerations

Chester Island PA

- O&M will continue to be placed on Chester Island.
- Surrounding bathymetry is relatively deep and placement practices aim to expand the PA.
- Not expected to reach capacity limits in 50 years.

Open-Water PAs (OWPAs):

- Highly dispersive, helping manage large volumes over time.
- Not expected to reach capacity limits in 50 years.
- Monitoring recommended to adaptively manage O&M burden.

PA19:

- Upland, semi-confined; historically the site expanded from 35 acres (1990) to 287 acres (2022).
- To handle the projected 26.3 MCY, ~230 additional acres will be needed by year 50.
- Assumes ~70% usable volume per acre.
- The expansion of PA19 footprint is inevitable.

4.5 FWOP DMMP

The FWOP plan (Figure 4-2) employs an “avoidance is best” policy to manage dredged material. High shoaling areas are excluded to inform best placement practices. The existing plan utilizes western OWPA sites, namely PA14-A, 15-A, and 16-A. The FWOP instruction is to continue placement at these preferred sites as opposed to the alternative eastern locations. Likewise, for FWOP, PA17 and PA5 are not included because of immediate shoaling effects associated with these OWPAs. PA18 will expand from maintenance materials into the PA18/19 footprint. To prevent mud waves, dredge pipe should be placed within existing PA19 footprint, rather than the historical PA18 bounds.

Figure 4-2: FWOP DMMP

The FWP DMMP represents the most cost-effective continuation of placement for the existing channel. MP1 and MP2 (at Matagorda Peninsula) are identified within existing federal real estate to mitigate ongoing erosion on an as-needed basis.

5 Placement Area Scenarios

5.1 Considerations for DMMP Development

The DMMP was developed to save the federal government costs over a 50-yr project life while minimizing environmental impacts, if and where possible. Aside from ensuring the DMMP is able to accommodate FWP maintenance materials, the plan is also designed to reduce the risk of increased channel sedimentation.

Placement area options are generally constrained by a reasonable pumping distance, available real estate, and resource data (environmental, utilities, etc.). When one of these variables is missing, the placement measure becomes increasingly unfeasible.

5.1.1 Opportunity to Avoid and Minimize Environmental Impacts

Over the course of creating the DMMP, several datasets were acquired to map the seabed and environmentally sensitive areas for the following:

- Seagrass
- Oysters
- Potentially contaminated areas

The DMMP is designed by the following order of priority:

1. Guarantee public safety by providing adequate capacity.
2. Minimize project costs.
3. Avoid environmental impacts/benefit the environment where possible.

From the above procedural list, (2) and (3) naturally work in tandem. By avoiding known environmental resources, the upfront mitigation costs are reduced. Likewise, the creation of a bird island in Lavaca Bay is chosen as a least-cost feature. If it is determined that the bird island is unfeasible to implement, PA 18/19 will serve as the preferential site to accommodate this new work material, contingent upon available capacity and environmental compliance. The engineering refinement of the DMMP resulted in moderate environmental impacts that can be reasonably mitigated.

5.1.2 Minimize Costs to Federal Government

Costs to maintain the MSC are increasing (Section 3.1). The order of reducing FWP costs associated with the DMMP is listed below:

1. Avoid environmental resources and utilities.
2. Design footprints to be further from the channel.
3. Prioritize western sites over eastern sites.
4. Optimize pumping distance with stationing.
5. Provide extra capacity and legacy sites to serve as contingency.

5.2 Overview of Placement Area Measures

The 4 main kinds of dredged material placement measures (Figure 5-1) are listed below:

- Offshore Dredged Material Disposal site (ODMDS)
- Upland confined PA
- Open water placement area (OWPA)
- Beneficial use (BU)

The focus of MSC dredged material management is on OWPA and BU sites. PA 18/19 expansion is unique in its semi-confined state.

Placement Area 1 - Offshore Dredged Material Disposal Site

Upland Confined Placement Area located northeast of Matagorda Ship Channel

Open Water Placement Areas along Matagorda Ship Channel

Chester Island - Beneficial Use Site

Figure 5-1: Different Types of Dredged Material Disposal Options

5.2.1 ODMDS

ODMDS (Offshore Dredged Material Disposal Site) is a placement area permitted by the U.S. Environmental Protection Agency (USEPA). The primary function of the ODMDS is to receive material that otherwise cannot be placed in designated OWPAs due to operational limitations, such as pumping distance or capacity. EPA's proposed ODMDS would be expanded from the existing PA1, allowing the USACE to place maintenance material for 50-yrs.

5.2.2 Upland Confined Placement

Upland confined placement, such as that shown Figure 5-1 near Palacios, is an effective method for long-term dredged material management. The costs to create an upland confined PA are generally concerned with real estate acquisition, engineering design, and construction. The benefit is more effective management, though this comes with a drawback of higher upfront costs and PA upkeep. Semi-confined sites, such as the proposed PA 18/19 in Figure 6-4, are cheaper in the short-term because they require no drainage control structures (drop outlets, culverts, earthen dikes, weirs, etc.).

5.2.3 Open Water Placement

Open water placement is the primary means of managing dredged material in Matagorda Bay. The major benefit to using OWPAs is the increased efficiency of dredging operations and little to no cost for PA upkeep. However, the caveat is that OWPAs are only low cost so long as they remain submerged and do not intensify channel shoaling. In several other District projects, analyses have been conducted to inhibit OWPA materials from returning to federal waterways. Designs typically consider a sediment retention feature, such as a breakwater, or modification to the PA footprint. If OWPA sites become emergent, they create recreational hazards and can require future confinement. The use of open water placement requires close monitoring and operational flexibility (Section 8.2).

5.2.4 Beneficial Use

Beneficial use (BU) of dredged material is an effective measurement when a least-cost solution presents an environmental, social, or economic advantage. The categorization of BU is intricate and requires continued coordination with stakeholders, industry partners, and government agencies that have a vested interest. Per EM 1110-2-5026, the use of BU may range from fish and wildlife habitat development to human recreation and commercial uses. By continued coordination with the NFS and partner agencies, the characterization of BU primarily focused on habitat creation or reintroduction of sediment supply. Though these two goals often result in direct environmental benefits (marine organisms, plants, birds, etc.), they may also provide unrealized benefit to the local community over time.

The introduction of BU features should consider the social benefits to encourage long-term public engagement with the project. Likewise, environmental designs should be closely coupled with engineering requirements based on hydraulic loading, geotechnical analyses, and site planning. The MSCIP recommends several BU features that address environmental, recreational, and economic needs. Further refinement of BU design is required in PED.

6 Evaluation and Comparison of DMMPs

Between 2019 and 2025, several iterations of the DMMP were examined. In 2019, the DMMP was approved by the authorization of the project. Since then, the DMMP has been reassessed for feasibility given significant changes in NW material quantity and updated existing conditions. Sections 6.2 to 6.5 review the screening process, highlighting the shortcomings of each iteration and decisions made to correct the preceding plan. The goal of the refinement process was to identify the base plan and recommended plan. The same DMMP would be adopted for alternate scales because the location of DMMP footprints is intended for operational efficiency and to minimize impacts. Furthermore, due to dredged material dispersion, large footprints are desired in an effort to contain sediments within the placement area boundary.

6.1 Base Plan Development

In accordance with ER 1105-2-100, it is the responsibility of the USACE to establish the base plan, that is, the plan which is associated with the least costly disposal and maintenance of dredged material. The refinement of the recommended plan demonstrated herein is a prioritization of lowest costs to the project; therefore, the recommended plan reflects the elements of the base plan. Deviations from the base plan that may be considered commonplace, such as beneficial use, are not intended to be such in the context of this study. Rather, such features, like beneficial use, are introduced firstly because they are cost-effective; consequently, they provide an advantageous opportunity for habitat creation, erosion mitigation, and recreation.

An example of base plan development would be the confinement of NW dredged materials at the Bird Island (see Section 6.5). The limited real estate in Lavaca Bay presents a challenge for confining such a vast quantity of dredged material (9.7 MCY). The most practical alternative was the expansion of PA 18/19, though it was deemed less attractive for the following reasons:

- Associated mitigation costs for placement of NW material on sensitive habitat.
- Similar construction material costs (rock, fill, shaping).
- Reduced contingency does not offset large uncertainty in associated costs.
- Long-term concerns for capacity.

Similarly, the usage of the Sand Engine (SE) and Chester Island are practical disposal locations for entrance and lower-bay dredged materials. These sites serve as long-term resiliency features while also accommodating significant sediment volume from adjacent channel.

For more discussion on the base plan development, please see the cost appendix C-2 which provides details on placement alternatives.

6.2 Feasibility DMMP (2019)

Figure 6-1: 2019 Feasibility DMMP

The 2019 DMMP (Figure 6-1) featured all OWPA sites on the west side of the MSC, except OP10 and NP7 in Lavaca Bay. In reviewing the 2019 DMMP, several concerns were immediately identified.

- Western sites had not been adequately investigated for environmental impacts (burying of seagrass or oysters).
- OWPAs did not consider the increased maintenance volumes over a 50-yr project life.
- Proposed OP10/NP7 in Lavaca Bay was located in an area where dredged material largely contributes to the worsening shoaling condition (Section 1.6.3).
- The plan was not designed for the correct NW quantity.
- The plan did not provide sufficient BU opportunities.

To address the high shoaling in the upper reaches of the MSC, roughly station 95+000 to Point Comfort, the DMMP footprint was slightly adjusted. PA 19 was proposed for future maintenance, along with an expansion of NP7. The 2019 proposal of upland site P1 was removed from consideration due to high acquisition costs and uncertainty (not pictured).

6.3 Modified DMMP (2023)

Figure 6-2: 2023 DMMP

The 2023 DMMP (Figure 6-2) addressed concerns about upper-bay capacity for dredged material. The main differences between the 2023 DMMP and the 2019 feasibility DMMP are the following:

- NP7 is expanded.
- OP10 is relocated further east.
- PA19 was included in the O&M plan.

The 2023 DMMP made necessary adjustments to address construction concerns for the project based on updated NW quantities. Furthermore, the 2023 plan recognized the need for additional O&M placement options in the Lavaca Bay area.

The 2023 DMMP was largely beneficial for sediment management because it proposed materials, which are naturally intercepted by the channel, to be placed on the west. This plan effectively bypassed the MSC to reintroduce sediment at the western shoreline. Since the plan was designed for long-term nourishment of the western shoreline, the DMMP was likely advantageous in respects that were not identified as BU.

While the 2023 DMMP addressed a number of key concerns, the plan failed to fully correct many of the issues in the 2019 DMMP, namely:

- Environmental impact uncertainty (impacts to oysters, seagrass).
- Capacity uncertainty.
- Dredged material recycling in Lavaca Bay.
- BU opportunities.

6.4 Modified DMMP (2024)

Figure 6-3: 2024 DMMP

The 2024 DMMP (Figure 6-3) addressed many of the issues present in the 2023 DMMP. The following changes were made to improve the 50-yr viability and decrease project first costs:

- OP2-OP5 were removed due to large environmental impacts to seagrasses at an estimated mitigation cost of $400 million.
- OP1 and NP1 were removed due to MSC pilot's concerns regarding draft restrictions in lower bay.
- Existing PA sites were added to the plan to allow for long-term maintenance capacity, alleviating operational concerns. PA17 and PA18 are not included as OWPA sites.
- NP7 was confined to a Bird Island to counteract material recycling in the Lavaca Bay reaches; OP10 was moved to the west side of the MSC with the same intent.
- PA18 and PA19 were planned for a combined expansion (semi-confined site) to allow for additional maintenance capacity in the upper-bay.

The revision to the 2023 plan refined the environmental impact and allowed for a more flexible maintenance plan, featuring numerous placement options. Furthermore, the 2024 DMMP addressed shoaling concerns in Lavaca Bay with the Bird Island feature, which serves as confined placement of NW materials and doubles as BU. The plan also moved the OP10 site to the west under the pretense that less maintenance material would return to the channel.

The 2024 DMMP made substantial improvements from previous versions. However, there was uncertainty regarding the resilience of the 50-yr maintenance plan given the existing capacity of PA sites. Additionally, the 2024 DMMP did not pursue new BU in a way that fully identified existing sediment shortages.

6.5 Proposed DMMP (2025)

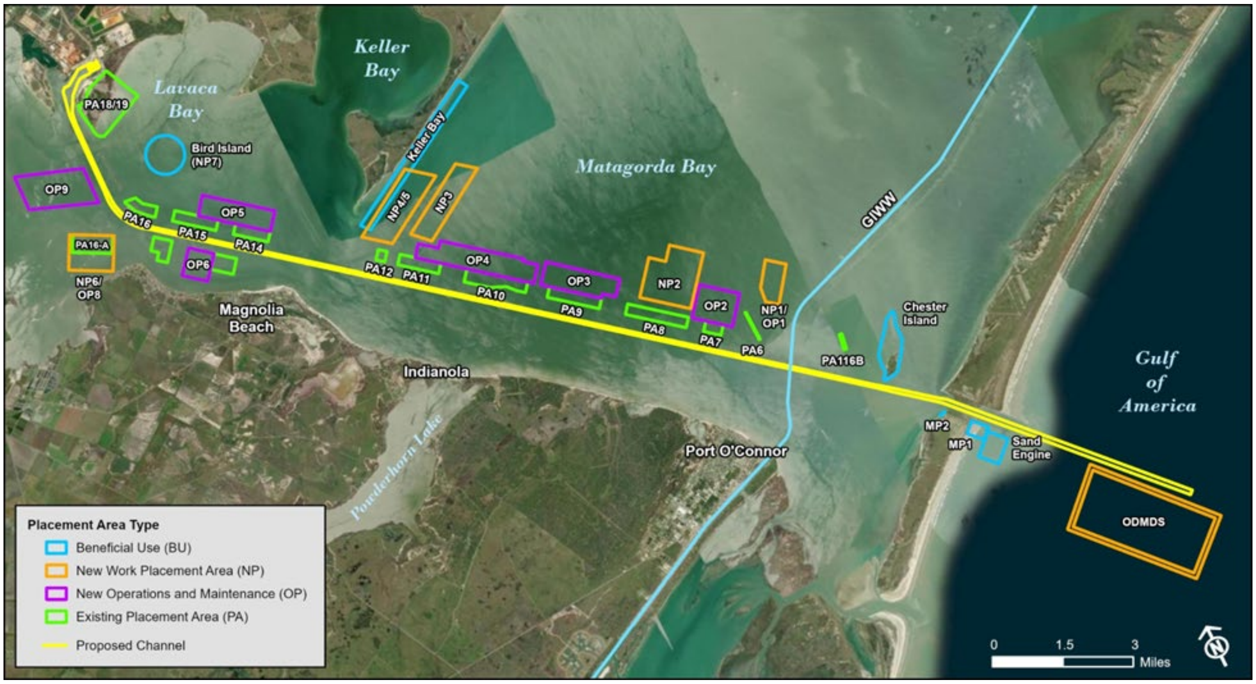


Figure 6-4: 2025 DMMP

The proposed DMMP (Figure 6-4) is the most robust and cost-effective plan, given the constraints identified between 2019-2024 (see attachment C-2 found in Appendix F). A few findings from the 2024 DMMP had to be addressed in the final version of the DMMP:

- Environmental mitigation costs (due to oyster impacts) could still be very high with the presence of NP3 and OP6/7 on the west side of the MSC.
- Existing OWPA sites did not provide adequate capacity for 50-yrs of O&M in the Lavaca Bay area.
- Updated sizing for NW sites was needed as a consequence of relocating former NW sites.
- A BU site that considered sediment-starved areas needed to be identified (Keller Bay, MP1, MP2).

Following the discussion on the 2024 plan deficiencies, the USACE held meetings with the NFS to identify the best path forward. Given the large environmental impact on the western side of the channel, and consequent excessive mitigation costs, the team determined it was most practical to explore eastern OWPA sites. After reviewing this plan with the NFS, an environmental survey plan was developed for the east side of the MSC, stretching from roughly station 22+000 to 73+000. The NFS contracted the survey and delivered it to the USACE as work-in-kind (WIK).

The survey delineated hard-bottom habitat from soft-bottom and classified the viable oyster habitat (VOH) from buried shell. In summary, the survey identified 61 acres of oyster resources and only 27 acres of VOH. VOH represents an estimated 0.2% of the surveyed area (Figure 6-5). The footprints shown in Figure 6-4 were carefully drawn to avoid VOH.

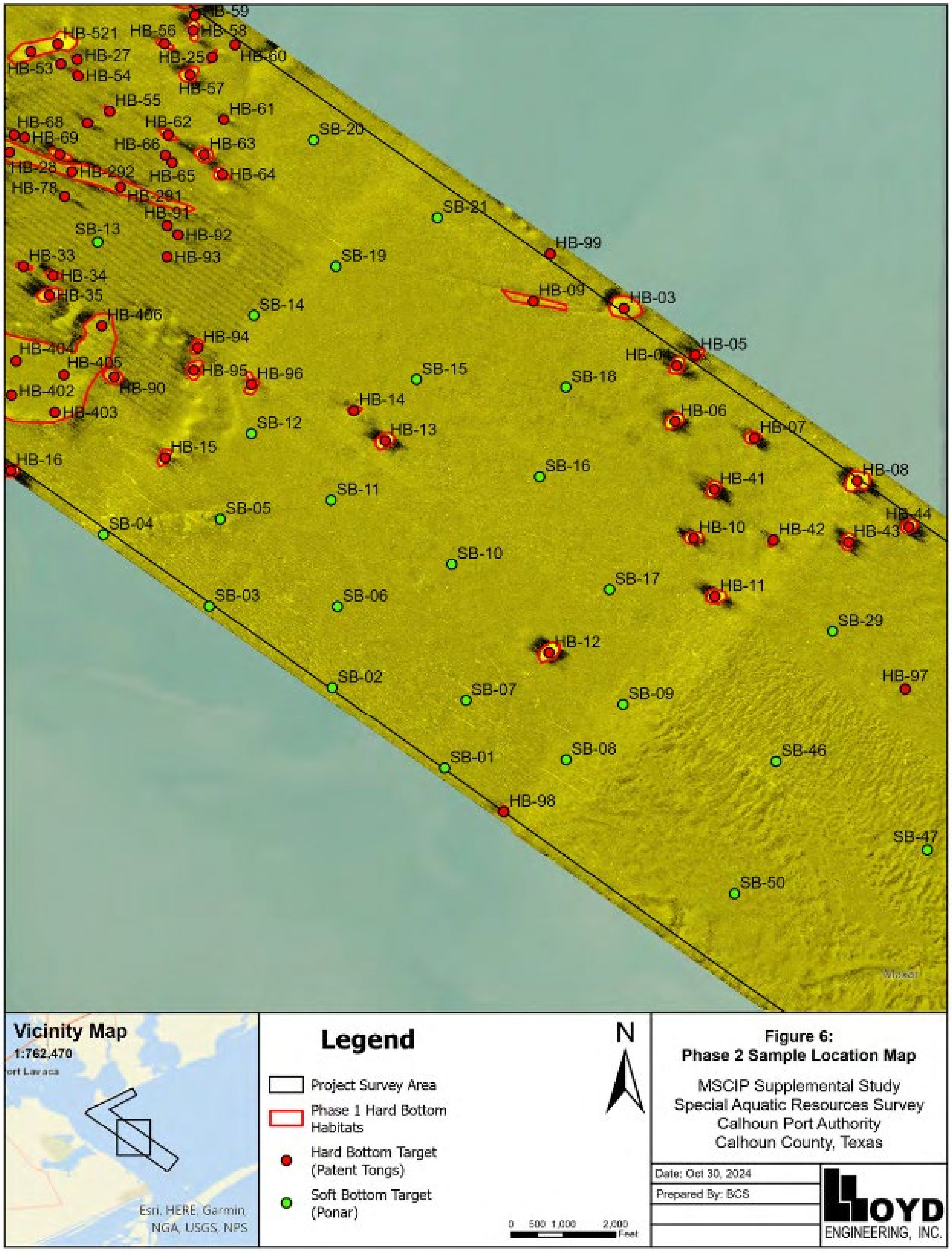


Figure 6-5: Oyster Survey Delivered to USACE as WIK

In planning the 2025 DMMP, the engineering approach was the following:

- Calculate NW material quantity by use of 2023 & 2024 MSC survey; NW material is characterized by 2021 geotechnical investigation.
- Conservatively estimate capacity needs for projected O&M and NW material.
- Avoid VOH and aim to avoid buried shell anomalies.
- Respect practical dredging pump-distance requirements.
- Avoid known pipelines.

6.5.1 Pump Distance

To prevent the use of booster pumps for routine maintenance, the priority O&M PAs employ pumping distances less than 3 miles. Likewise, the NW sites aim to maintain a pumping distance less than 5 miles (Table 6-1). Inner-bay NW sites are proposed in deeper water, further away from the MSC for two main reasons:

- NW material will swell more than O&M materials; deeper water depths provide more capacity.
- Placing NW sites closer to the channel could result in mud waves that prolong construction by worsening immediate shoaling conditions.
- The original construction of the MSC placed most materials next to the channel; consequently, material is currently recycling between PA sites and the bay.
    - The 1961 design memorandum states, “Under normal conditions, the annual total volume of sediment entering the bay would be approximately 1,240 acre-feet or about 2,000,000 cubic yards.”
    - With a significant sediment load originating outside the bay, it is illogical to create another significant sediment supply directly adjacent to the channel.

Table 6-1: DMMP Approximate Pumping Distances

O&M Sites	Distance from Far Station to PA Boundary (miles)	NW Sites	Distance from Far Station to PA Boundary (miles)
ODMDS	1.0	ODMDS	1.0
SE	1.9	SE	1.9
Chester Island	1.9	NP1	1.3
OP1	1.3		
OP2	1.3	NP2	1.8
OP3	2.3	NP3	3.3

O&M Sites	Distance from Far Station to PA Boundary (miles)	NW Sites	Distance from Far Station to PA Boundary (miles)
OP4	3.0	NP4/5	4.9
OP5	2.4		
OP6	0.7		
OP7	1.0		
OP8	1.0	NP6	0.8
OP9	0.9	Bird Island	2.2
PA 18/19 Exp.	1.1		

7 Future With-Project Conditions

7.1 New Work Quantities

Hydrographic survey conducted by the Southern Area Office in August 2023 (using multibeam sonar) and a 2021 bathymetric survey completed by the NFS were used to calculate FWP new work dredging volumes (Table 7-1). New Work Material Quantities. These volumes account for advance maintenance (AM) and allowable overdepth (AO) and represent new material identified within the project template (Section 7.1.1).

Table 7-1: New Work Material Quantities

Stationing	NW Volume (CY)
-26+000 to -14+000	3,149,800
-14+000 to 0+000	2,022,400
0+000 to 20+000	2,893,200
20+000 to 47+000	6,929,300
47+000 to 72+000	6,511,450
72+000 to 97+000	6,427,200
97+000 to 101+000	1,693,300
101+000 to 118+581	9,707,900

Dredging scales were analyzed, each based on different channel depths. For the purpose of designing the DMMP, the -47'/-49' (RP) scale volume was used in site planning (Table 7-2). The footprint of the DMMP is the same for alternate scales.

Table 7-2: New Work Volume at -47'/-49' Scale Channel Depth

Depth + AM + AO	Reach		Length (ft)	Volume (cy)
	Sta.	Sta.		
49′ + 3′ + 2′	-26+000	-14+000	12,000	3,149,800
49′ + 3′ + 2′	-14+000	0+000	14,000	2,022,400
47′ + 2′ + 2′	0+000	20+000	20,000	2,893,200
47′ + 2′ + 2′	20+000	47+000	27,000	6,929,300
47′ + 2′ + 2′	47+000	72+000	25,000	6,511,400
47′ + 2′ + 2′	72+000	97+000	25,000	6,427,200
47′ + 6′ + 2′	97+000	101+000	4,000	1,693,300
47′ + 6′ + 2′	101+000	108+000	7,000	2,893,400
47′ + 2′ + 2′	108+000	118+581	17,581	6,814,500
–				
Total			151,581	**39,334,500**

7.1.1 New Work Template

The new work dredge template follows USACE Galveston District (SWG) guidance dated 08 April 2019 regarding dredging template development for studies, new work construction, and channel maintenance projects (Figure 7-1).

New work (NW) volumes are calculated by comparing the new work dredge template to the latest available survey surface. NW material is defined as material located outside the existing Operations & Maintenance (O&M) template and below the lowest elevation of the allowable overdepth template. Material within the existing O&M template, including allowable overdepth, is not considered part of the NW volume.

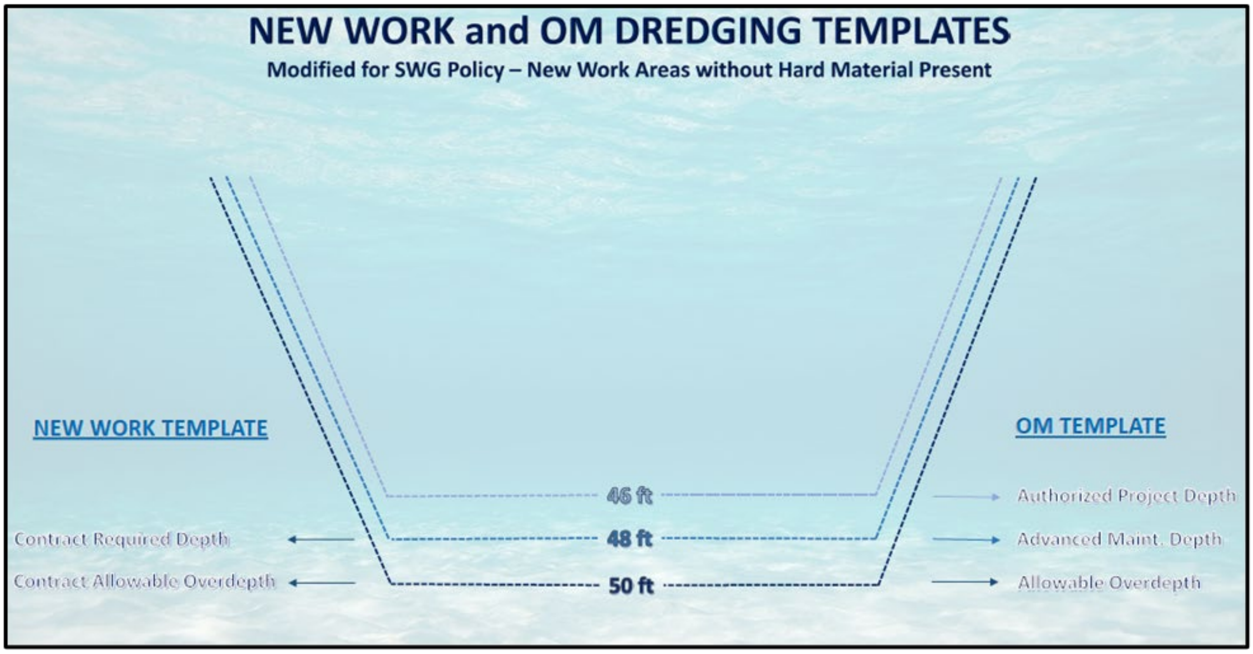


Figure 7-1: Modified for SWG Policy - New Work Areas without Hard Material Present

Advance Maintenance (AM) and Allowable Overdepth (AO) areas are included as NW. Non-pay material is excluded from NW volume calculations.

7.2 Shoaling Rates

The FWP shoaling volume is projected to be nearly 5.6 MCY/yr, a 90% increase from the existing condition. The distribution of this volume is anticipated to be highly localized to the bend-easing and Lavaca Bay area past FWP station 97+000.

The reported shoaling rate in the upper-reaches of the MSC may be unrealistic due to the added effects of vessel passage and material consolidation. However, the quantity of maintenance material is expected to be dramatically higher from station 97+000 to 118+581 when compared to the rest of the channel. Because of this expectation, adaptive management strategies and PED efforts to retain placement materials is advised. The adaptive management strategy is outlined in Section 8.2.

The shoaling rates for FWP are shown below in Figure 7-2. The reported rates are not fully representative of the physical processes; therefore, a 16 ft/yr shoaling rate may be more realistically encountered as 10-12 ft/yr. This is a documented shortfall of the analysis; it is recommended that consolidation and vessel effects be better investigated for the project. More discussion regarding this uncertainty is provided in Appendix F (Engineering Appendix).

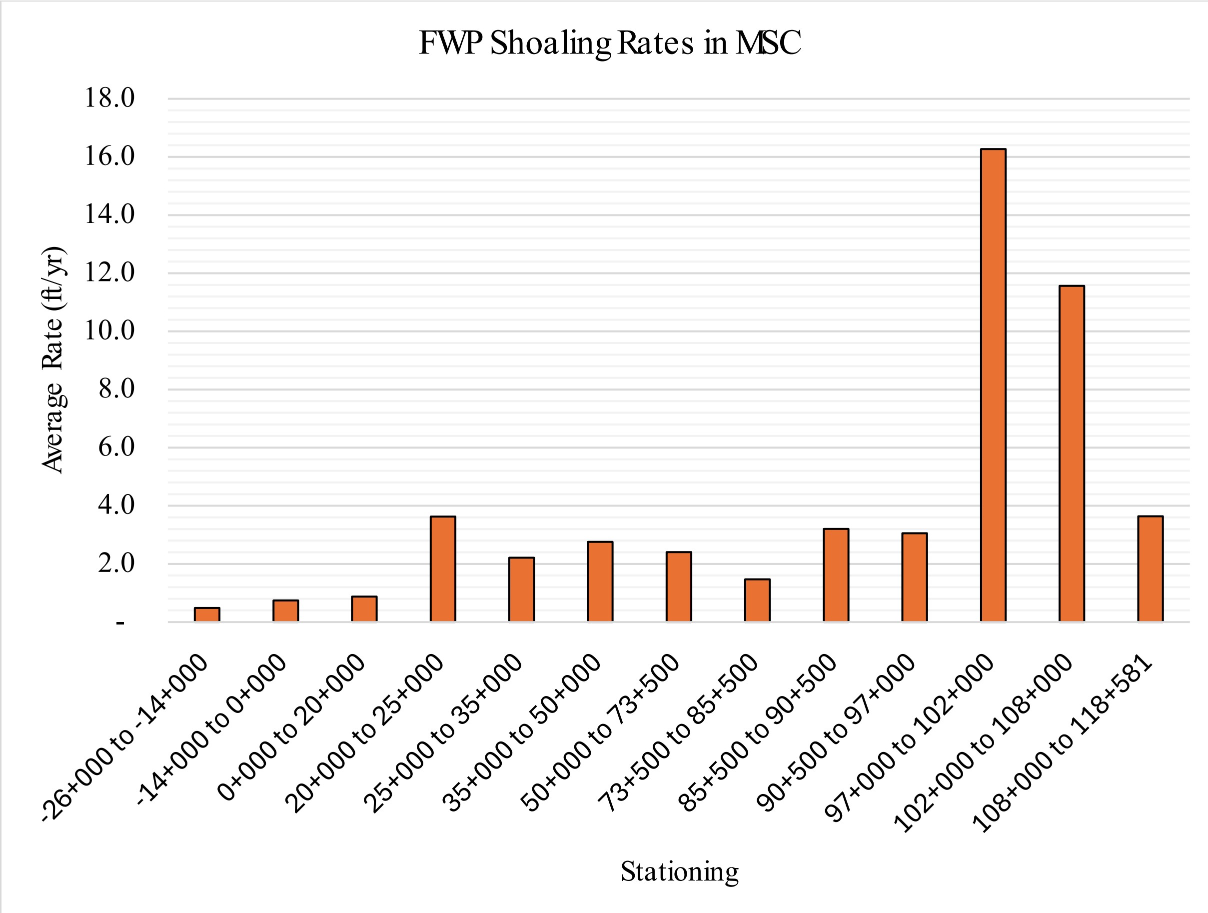


Figure 7-2: FWP Shoaling Rates

7.3 Maintenance Volumes

Maintenance material in Matagorda Bay is generally fine-grained, consisting primarily of clay and silt. Offshore maintenance materials also predominantly consist of clay and silt, (CH) and (ML) respectively.

The maintenance material within the existing channel will be dredged together with the new work material and both will be placed into their respective placement areas. This material is broken out within the QST, such that O&M volume is separated from the new work volume. With time, the O&M shoaling is expected to increase during and post-construction.

Estimated maintenance dredging volumes are calculated by contract using HYPACK® modeling software, which supports various survey types including shallow-water single beam surveys, side scan search and recovery, sub-bottom sediment profiling, advanced multibeam navigation surveys, and dredging surveys. Apart from the contract-specific volumes, anticipated FWP maintenance volumes are provided over a 50-yr timeframe by use of the shoaling analysis (Table 7-3).

Table 7-3: FWP 50-yr Maintenance Volumes

Stationing	Annual Shoaling Volume (CY/yr)	Average Dredge Frequency (yr)	Total Shoaling Volume per Cycle (CY)	No. of Cycles in 50-yr Plan	Total 50-yr Shoaling Volume
-26+000 to -14+000	177,833	4	711,332	12.5	8,891,651
-14+000 to 0+000	211,656	4	846,623	12.5	10,582,791
0+000 to 20+000	253,071	2	506,142	25	12,653,556
20+000 to 25+000	201,578	2	403,156	25	10,078,891
25+000 to 35+000	246,195	2	492,389	25	12,309,726
35+000 to 50+000	459,624	2	919,248	25	22,981,190
50+000 to 73+500	628,589	2	1,257,179	25	31,429,470
73+500 to 85+500	196,108	2	392,216	25	9,805,412
85+500 to 90+500	177,918	2	355,837	25	8,895,925
90+500 to 97+000	240,120	2	480,240	25	12,006,008
97+000 to 102+000	1,176,398	1	1,176,398	50	58,819,896
102+000 to 108+000	770,974	1	770,974	50	38,548,693
108+000 to 118+581	902,138	2	1,804,275	25	45,106,879
Total Federal O&M (CY)					**282,110,088**

FWP changes to Advance Maintenance (AM) and dredging cycle are discussed in the Engineering Appendix. Nearly 282 MCY is expected to be dredged over 50 years.

7.4 Advance Maintenance

The FWP AM methodology and proposed plan are detailed in Appendix F. The summary of this plan is provided in Table 7-4. Changes are proposed for the AM depth for station 97+000 to 118+581 (FWP end stationing).

Table 7-4: FWP Advance Maintenance Summary

Stationing	FWP Dredge Cycle (yr)	FWP AM Depth (ft)
-26+000 to -14+000	4	3
-14+000 to 0+000	4	3
0+000 to 20+000	2	2
20+000 to 25+000	2	2
25+000 to 35+000	2	2
35+000 to 50+000	2	2
50+000 to 73+500	2	2
73+500 to 85+500	2	2
85+500 to 90+500	2	2
90+500 to 97+000	2	2
97+000 to 102+000	1	6
102+000 to 108+000	1	6
108+000 to 118+581	2	3

7.5 Placement Areas

The recommended NW placement plan includes the creation of a Sand Engine (SE), six open-water placement areas (NP 1 through NP 6), and a Bird Island. The addition of the Bird Island represents a significant difference from the 2019 IFR/EIS which did not propose any new island habitat creation.

For the six new open-water placement areas (NP 1 through NP 6), dredged material will be placed to a final settled elevation no higher than -3 ft Mean Lower Low Water (MLLW). This submerged placement approach is intended to maintain navigational safety and minimize the potential for placed material to migrate back into the navigation channel. This elevation restriction does not apply to the Bird Island, which is specifically designed to extend above the water surface to support beneficial-use habitat creation. All other NW sites are intended to be maintained at or below -3 ft MLLW following post-construction survey. Table 7-5 and Table 7-6 detail the management plan for both NW and O&M. O&M sites are listed as priority sites, intended solely to take materials up to their functional capacity (-3 ft MLLW). See Section 8.2 for a detailed list of O&M placement area priority.

Table 7-5: O&M Dredged Material Management Plan (Priority Sites)

Stationing	PA Site	Area (acres)	NW Site?
-26+000 to -14+000	ODMDS	2,768	Yes
-14+000 to 0+000	SE	165	Yes
0+000 to 20+000	Chester	202	No
20+000 to 25+000	OP1	238	Yes
25+000 to 35+000	OP2	410	No
35+000 to 50+000	OP3	495	No
50+000 to 73+500	OP4	714	No
73+500 to 85+500	OP5	454	No
85+500 to 90+500	OP6	215	No
90+500 to 97+000	PA15-A	102	No
97+000 to 102+000	OP8	459	Yes
102+000 to 108+000	OP9	708	No
108+000 to 118+581	PA 18/19 Exp.	606	No

Table 7-6: NW Dredged Material Management Plan

Stationing	PA Site	Area (acres)
-26+000 to -14+000	ODMDS	2,768
-14+000 to 0+000	SE	165
0+000 to 20+000	NP1	238
20+000 to 47+000	NP2	788
47+000 to 72+000	NP3	517
72+000 to 97+000	NP4/5	689
97+000 to 101+000	NP6	459
101+000 to 118+581	Bird Island	346

7.5.1 Sand Engine

The Sand Engine (SE) is a 165-acre open-water placement site located approximately 500 feet west of the west jetty at the MSC entrance channel. It is strategically designated to receive new work dredged material from both the offshore and jetty reaches. This placement ensures that sandy, beach-quality material from offshore and nearshore areas is used to construct a nearshore berm.

As a BU feature, the Sand Engine is specifically designed to mitigate shoreline erosion caused by the jetties. These structures disrupt the natural littoral drift of sand along the coast, effectively blocking sediment from reaching the downdrift western beach. This sediment deprivation has led to chronic erosion in that area.

By placing dredged sand in the nearshore berm, the SE enables the material to gradually migrate landward, helping to restore sediment supply to the beach and reduce the erosional effects of the jetties. Because the berm is engineered to naturally disperse over time, its capacity is finite and will diminish over the 50-year project lifespan. The estimated volumetric capacity of Sand Engine is 4.0 MCY; the average depth is nearly 18 ft MSL.

7.5.2 NP1

NP 1 is a 238-acre, rectangular open-water placement area situated in the lower portion of Matagorda Bay, where average water depths are approximately -12 ft MLLW. Although the pumping distance from the dredging channel to NP1 is relatively long, the site was selected due to its sufficient placement capacity, favorable environmental conditions, and offset from the GIWW intersection. The estimated volumetric capacity of NP1 is 3.5 MCY.

7.5.3 NP2

NP2 is a 788-acre, roughly square open-water placement site featuring a notched indentation at its northern corner. It is located in waters with depths ranging from -12 to -13 ft MLLW. The site's large surface area and relatively uniform bathymetry support the efficient and even distribution of dredged material. The estimated volumetric capacity of NP2 is 11.0 MCY.

7.5.4 NP3

NP 3 is a 517-acre, elongated, rhomboid-shaped open-water placement area located in the mid-bay region. It is situated in slightly shallower waters, with depths ranging from -8 to -10 ft MLLW. The estimated volumetric capacity of NP3 is 5.3 MCY.

7.5.5 NP4/5

NP4/5 is a 689-acre, rhomboid-shaped open-water placement area located in waters with depths ranging from -8 to -10 ft MLLW. Its elongated west-east orientation will result in relatively longer pumping distances from the dredging areas. The estimated volumetric capacity of NP4/5 is 5.2 MCY.

7.5.6 NP6

NP6 builds upon the existing PA16-A, expanding it into a 459-acre, rectangular open-water placement site. It is the only new work placement area located on the landward reach on the west side of the channel corridor. Situated in shallow waters with an average depth of roughly -6 ft MLLW, the expansion significantly enhances the site's placement capacity and utility. The estimated volumetric capacity of NP6 is 2.3 MCY.

7.5.7 Beneficial-Use Bird Island

A cornerstone of the project's beneficial use strategy is the creation of a new, engineered bird island in Lavaca Bay. This feature transforms dredged material into a valuable ecological asset that supports habitat restoration and long-term environmental resilience. The volumetric requirement of dredged material for the Bird Island is estimated as 9.7 MCY, assuming material is lost to retain nearly 6.8 MCY. The concept example for the preliminary design and planning of the bird island is pictured in Figure 7-3.

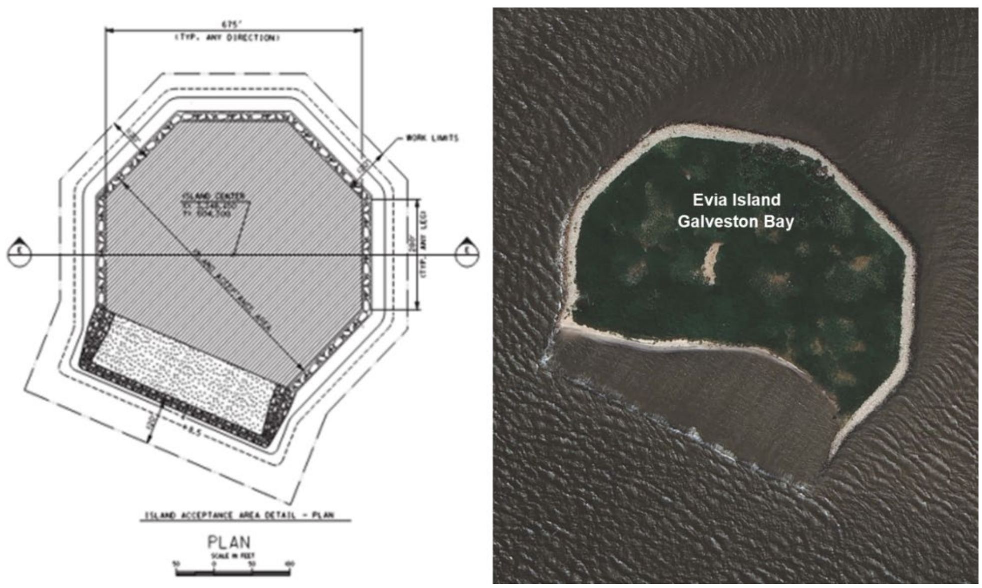


Figure 7-3: Bird Island Concept

- Location and Siting
    - The island will be strategically located approximately one mile west of the ship channel, in the upper part of Lavaca Bay, near the point where the channel takes a sharp northward turn. It will be constructed in a shallow open-water zone, with an average depth of roughly -7 ft MLLW.
- Physical Design
    - Footprint: Approximately 350 acres in size, with an octagonal shape to optimize stability and material containment.
    - Topography: The island will feature high points to invite bird nesting, sloping down to a perimeter crest at +6.2 ft MLLW.
    - Beach Areas: One side of the island will incorporate a 150-foot-wide raised beach to support nesting and biodiversity.

    - Side Slopes: The outer slopes will follow a stable 1 vertical to 5 horizontal (1V:5H) design for erosion resistance and structural integrity.
- Shoreline Protection
    - The wind-exposed perimeter of the bird island will be armored with riprap shoreline protection, providing durability against wave action and ensuring the long-term stability of the island.
- Placement Capacity
    - The island is designed to accommodate approximately 9.7 million cubic yards of new work dredged material, based on expected material retention within the engineered footprint; the design elevation accommodates
- Design Precedents and Development
    - Further refinement of the conceptual design during the resumed Preliminary Engineering and Design (PED) phase will draw from successful models such as:
    - Evia Island (Galveston Bay)
    - Three-Bird Island Marsh, part of the Houston Ship Channel Expansion – Channel Improvement Project
    - Long-Bird Island (Galveston Bay)

These proven precedents will guide design detailing, habitat structuring, and engineering best practices. Topographic adjustments for habitat diversity, as well as modification to the alignment, are expected in PED. The rough order of magnitude (ROM) for rock and fill quantities, however, should not change significantly. This BU Island represents a major enhancement to the overall project, transforming NW materials into viable habitat and capitalizing on the USACE BU initiative.

7.6 NW Placement Area Capacity

The project includes multiple placement areas designed to accommodate dredged material, with capacities varying by placement, designed to handle a range of dredged material volumes:

- The Sand Engine can hold almost 4 MCY, helping restore coastal beach area and mitigate erosion; the NW placement is planned for almost 2 MCY of material.
- Open-water sites NP1–NP6 offer different capacities:
    - NP1: 3.5 MCY.
    - NP2: 11.0 MCY.
    - NP3: 5.3 MCY.
    - NP4/5: 5.2 MCY.
    - NP6: 2.3 MCY.
- The Beneficial-Use Bird Island, a key habitat feature, is designed for approximately 9.7 million cubic yards of dredged material. Assuming acreage is unchanged, the true capacity is dependent on the prescribed design elevations.

Together, the placement areas provide flexible and environmentally responsive capacity to support the 50-year dredging and restoration plan. In total, nearly 41 MCY of capacity is provided in the plan, omitting ODMDS.

7.7 Environmental Mitigation Cost

High mitigation costs were a major concern between 2019 – 2024, leading to the development of the 2025 DMMP. The updated footprint avoids potential seagrass beds on the west of the MSC, live and historic oysters in Lavaca Bay, and VOH identified by the 2024 NFS survey. Figure 7-4 illustrates how the DMMP is an environmentally conscious plan that was coordinated between several disciplines of the USACE and NFS.

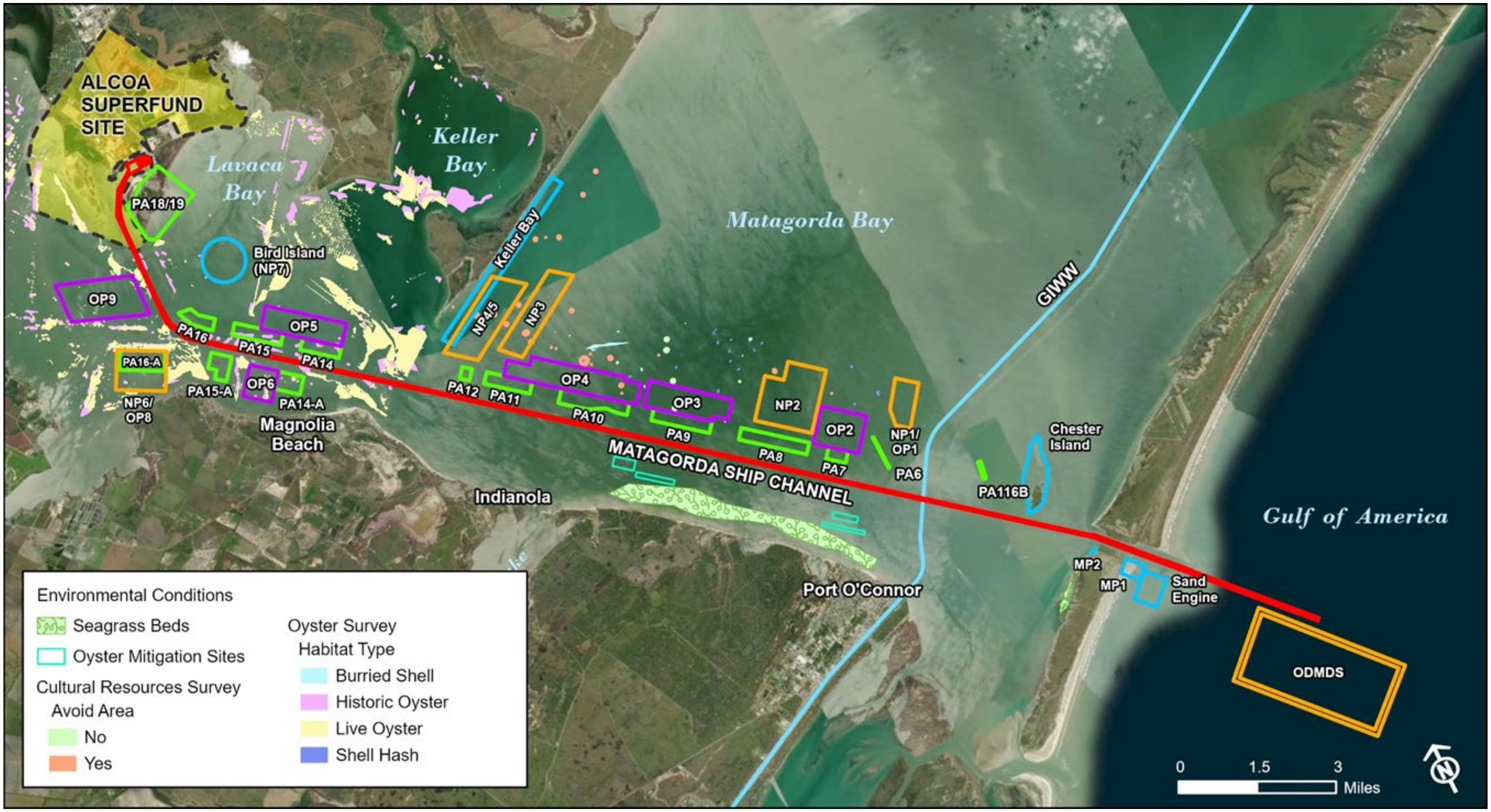
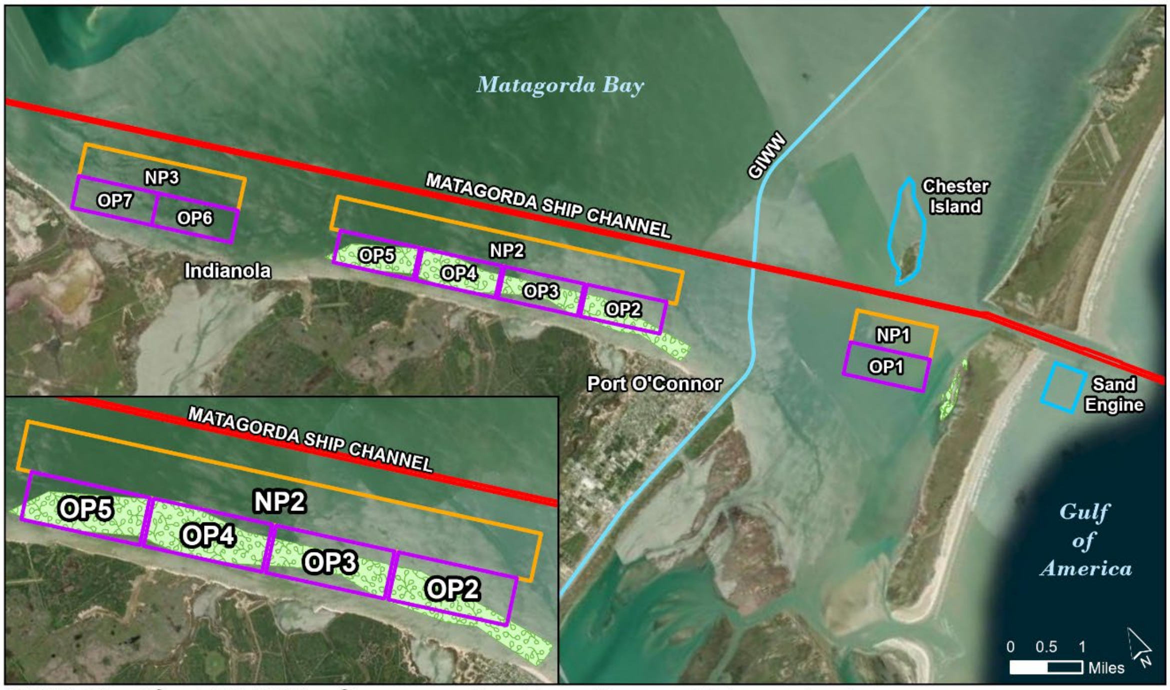
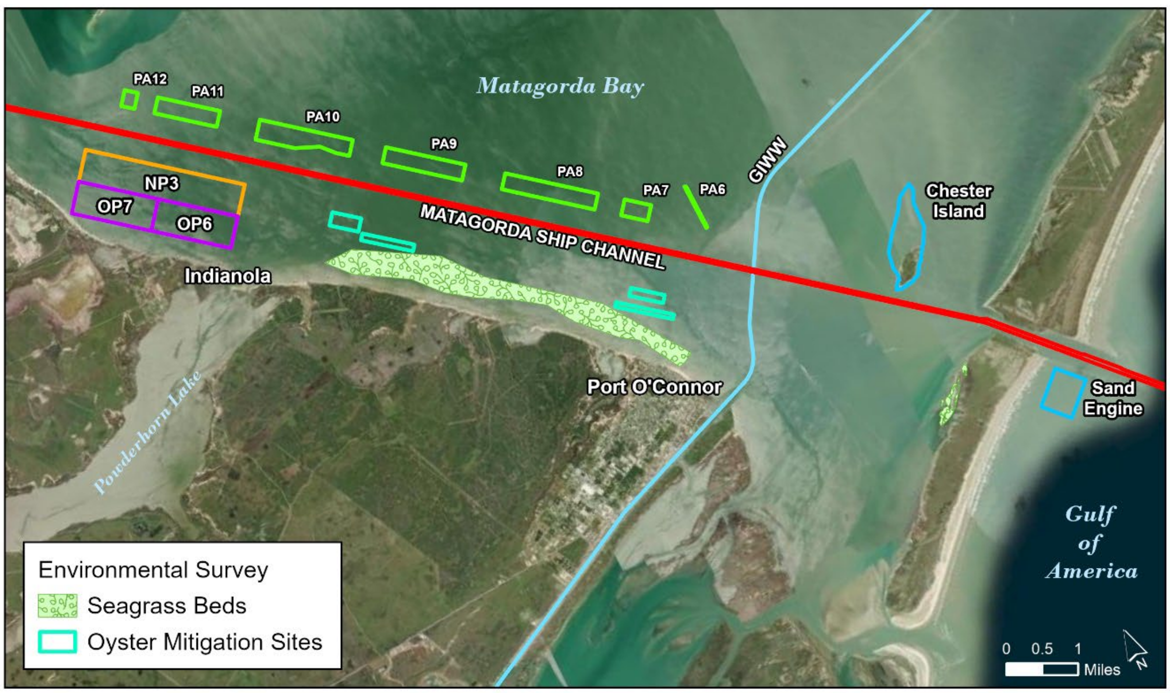


Figure 7-4: Proposed DMMP with Environmental and Cultural Resources Shown



2023 Modified DMMP - Seagrass bed locations within project area.



2024 Modified DMMP - NP2, OP2-OP5 removed due to environmental impacts to seagrass beds. Oyster mitigation sites proposed in this area.

Figure 7-5: Removal of NP2 & OP2-5 due to Seagrass Impacts

Figure 7-5 shows the shift from sites NP2 and OP2-5 in the 2023 version of the DMMP due to extensive seagrass impacts, resulting in high mitigation costs.

To offset the environmental impacts, mitigation sites are proposed for oyster recruitment and growth. These oyster beds are of equal area to that provided by the Environmental team lead, totaling 95 acres. The mitigation sites are located on hard, sandy bottom, west of the MSC.

7.8 Pumping Cost

In preparation for the Pre-TSP estimate, a comprehensive analysis was conducted during the May–June 2024 timeframe to evaluate alternative approaches for New Work Dredging. The objective was to identify a cost-effective DMMP that minimized environmental impact (see Attachment C-2 of Appendix F). Key factors considered included dredge type selection (hopper vs. pipeline), placement area (PA) locations to avoid ecological disruption, and pipeline alignment to reduce pumping distances. These considerations informed the development of the current New Work DMMP.

7.9 Cultural Resource Sites

In addition to the environmental resources provided to the Engineering team, cultural resource anomalies were also mapped in 2025. Potential cultural resources in the DMMP footprint are illustrated in more detail by Figure 7-6. Since the environmental resources took precedence, there may be impacts at NP3 and NP4/5 based on findings from cultural investigations. Likewise, OP4 could infringe upon cultural sites.

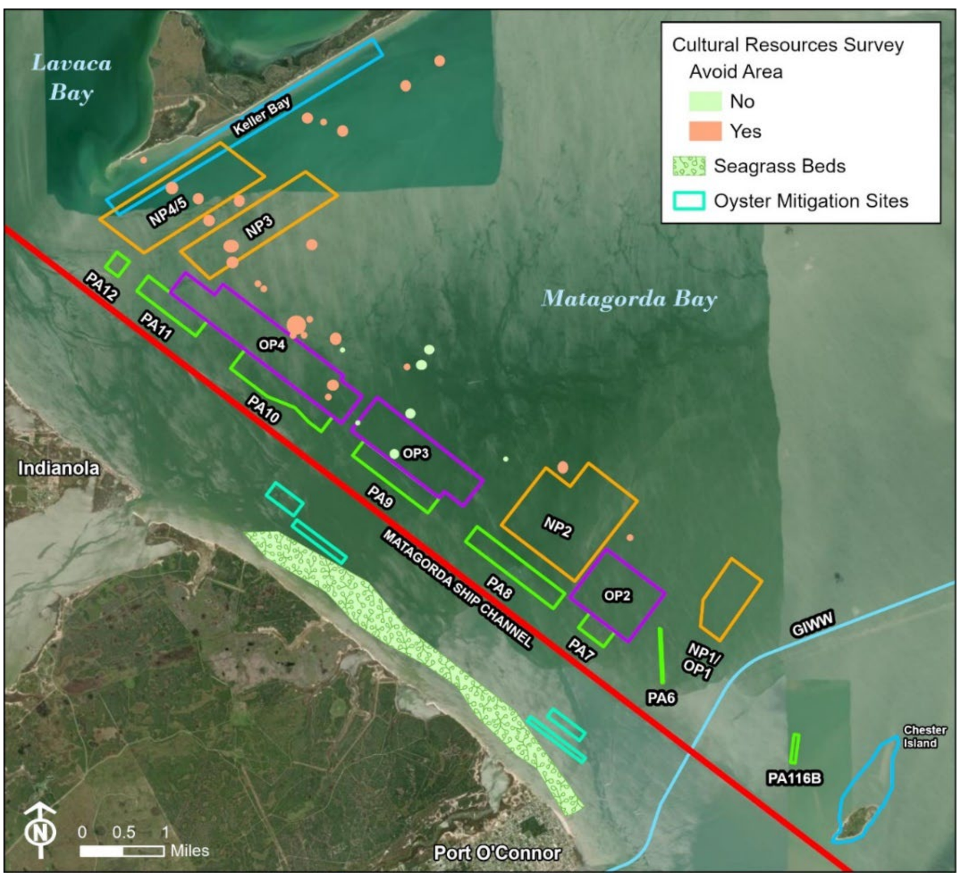


Figure 7-6: Cultural Resources in DMMP Footprint

7.10 PA Placement over Pipeline

Pipeline data was obtained by the Texas Railroad Commission database and confirmed with additional study conducted by the NFS. The DMMP does not place materials over pipeline unless the PA is actively being used by the USACE. Pipelines are avoided because of the unknown depth of cover and potential for collision with dredge pipeline (Figure 7-7). See Appendix F for more information on pipeline relocation and removal.

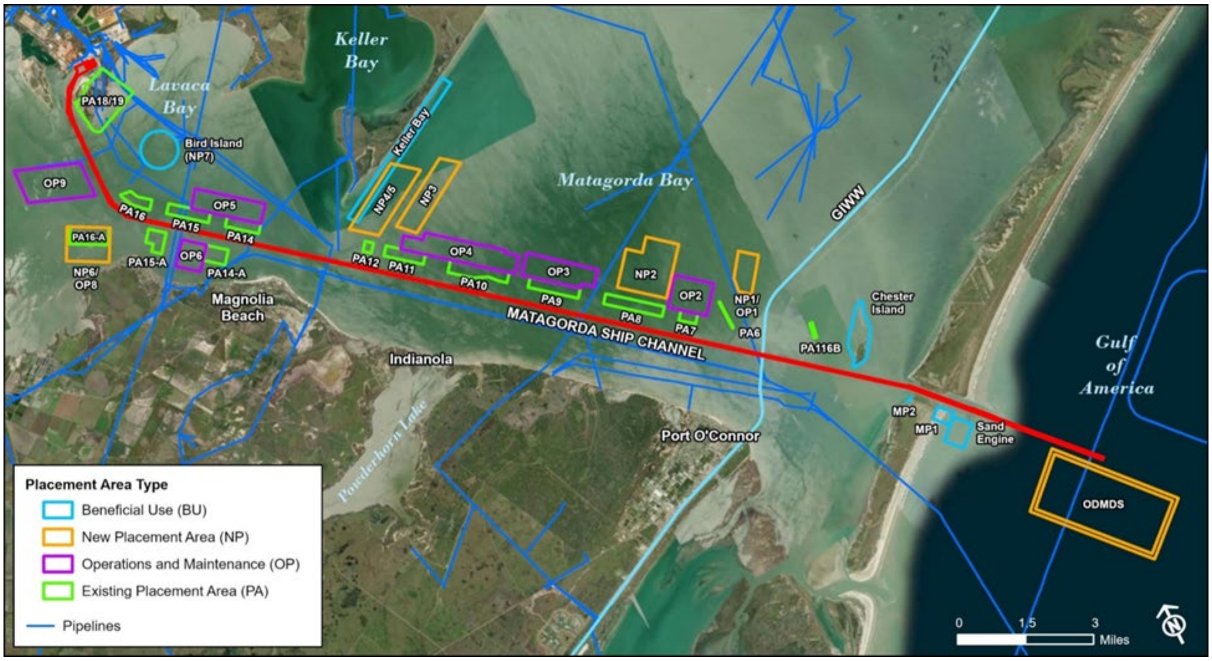


Figure 7-7: Proposed Placement Areas Avoidance of Known Pipelines

8 Plan Selection

The selected DMMP is that proposed in Section 6.5 and detailed by Table 7-5 and Table 7-6. Excluding ODMDS, the plan features 13 new PAs, several expansions (Chester Island, PA18/19, PA16-A to NP6/OP8), and existing O&M sites provided as contingency. The selected plan is also the base plan, as discussed in Section 6.1.

8.1 Costs

Costs as a consequence of the DMMP pertain primarily to the following:

- Altered pumping distance.
- Worsened shoaling conditions that change maintenance volumes.

NW materials are not an effect of the DMMP, but rather a natural feature of the design channel template. Because of the altered shoaling conditions, the DMMP is designed to accommodate a new maintenance dredging plan. The maintenance dredging plan is modified in the FWP condition by the following:

- Dredging cycle.
- Advance maintenance depth.
- Maintenance material volume.

Full details regarding the maintenance dredging changes are discussed in Appendix F. The consequence of increased maintenance volumes is higher operational costs in the MSC; these are fully captured in the cost analysis. The operational cost analysis is provided in Attachment C-3 of Appendix F.

8.2 Adaptive Management Plan

8.2.1 Core Philosophy and Objectives

The Adaptive Management Plan for the MSCIP is a structured, iterative approach for managing dredged material sustainably and adapting to changes over the project's 50-year life. Its central goal is to maintain a robust DMMP capable of adjusting to evolving site conditions, shoaling rates, and operational requirements in a dynamic coastal environment.

The plan is built on the premise that future conditions will change. Anticipated climate-related factors, such as sea level change, altered sediment transport patterns, and increased storm intensity, are expected to accelerate shoaling and place added demands on placement area infrastructure. Accordingly, the strategy is not a fixed schedule, but a responsive process that can adapt to long-term uncertainties. It covers both the initial placement of new work material and ongoing placement of maintenance material, emphasizing beneficial use opportunities and preserving long-term capacity.

8.2.2 Foundational Components of the Adaptive Management Strategy

The adaptability of the DMMP is grounded in a robust network of placement areas and a deliberately conservative design philosophy.

- Diverse Placement Area Network

  The plan encompasses 19 total placement areas, including the expanded ODMDS, newly constructed facilities, and existing maintenance sites. Four sites - the ODMDS, SE, NP1/OP1, and NP6/OP8 - are dual-use, designed to receive both new work and future maintenance material. Additional new sites, such as the Chester Island expansion and PA 18/19, are dedicated exclusively to maintenance needs. This diverse portfolio ensures ample volumetric capacity and maximizes operational flexibility.

- Conservative Site Design

  New placement sites were sized conservatively, assuming lower long-term material loss rates than detailed modeling might predict, creating an inherent capacity buffer. To reduce the likelihood of rapid sediment return to the channel, all placement areas on the east side maintain an additional 1,000-foot offset from the channel.

- Integrated Beneficial Use

  The plan incorporates approximately 1,385 acres to beneficial use projects, including the creation of a bird island, the SE for beach nourishment, Chester

Island expansion, and nourishment of the Keller Bay Peninsula, ensuring dredged material is managed as a resource of long-term value rather than waste.

8.2.3 The Adaptive Management Process: Cycle of Assessment and Action

Rather than relying on a fixed placement schedule, the plan uses a data-driven, iterative process to guide the management of maintenance material (Figure 8-1). This cyclical approach ensures that each dredging cycle responds to current conditions rather than outdated assumptions.

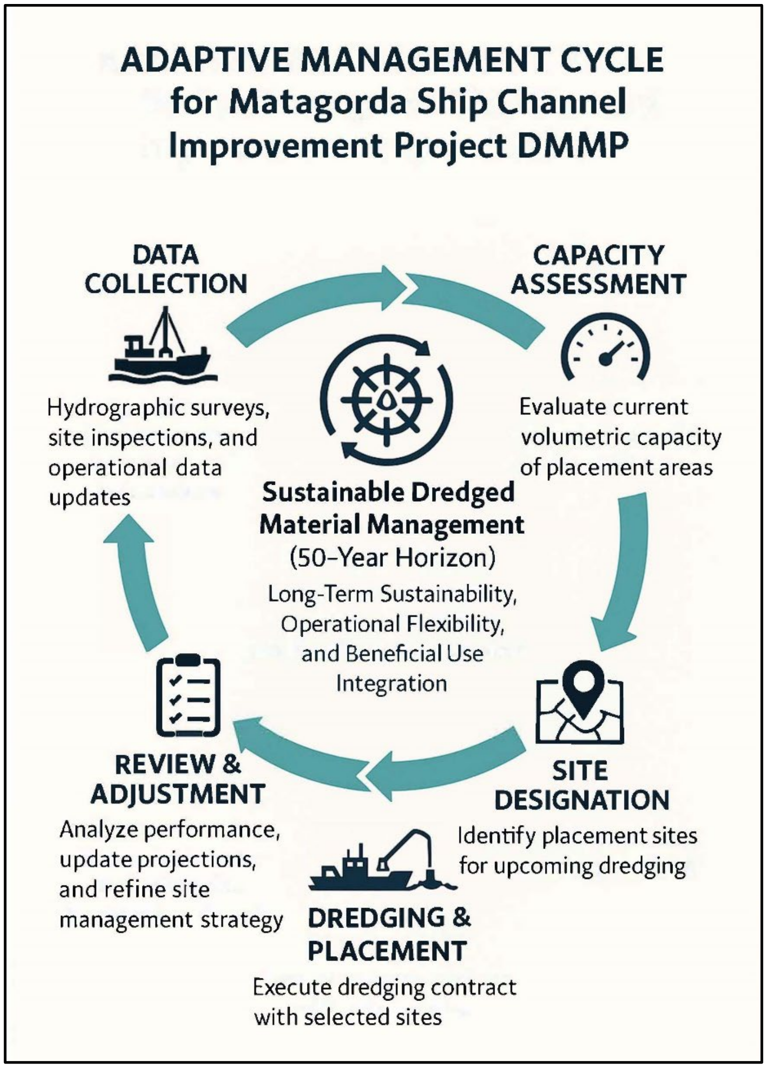


Figure 8-1: Adaptive Management Cycle

Before each future dredging contract is executed, the Operations Manager will evaluate the available capacities of all relevant placement areas using the most recent survey and operational data. Based on this real-time assessment, the Manager will designate both the primary and secondary sites for that cycle, favoring, when feasible, the use of newly constructed placement areas to maximize their long-term utility.

By continually reassessing placement site capacities and adjusting designations accordingly, this process helps maintain operational flexibility, extend the life of the placement network, and ensure that dredged material is managed in a sustainable and cost-effective manner.

As discussed in Section 2.3.1, most OWPA sites are conservatively designed for capacity needs. By use of annual loss estimates and FWP shoaling volumes (Section 2.3.1 and Section 7.3), PAs 15-A, OP6, OP5, OP8, and OP9 were modeled for adaptive placement over 50-yrs. The findings demonstrate that the additional space at OP5 and OP9 is desirable for FWP conditions.

At PA15-A, the condition to place at OP6 may occur in less than 10 years. Likewise, by redirecting PA15-A materials to OP6, OP6 may approach capacity by year 20. The planning strategy assumes a constant rate of loss occurs (10%) until capacity is almost met at each PA site. Then, materials are rerouted to the closest site while the retained volume continues to erode over time. By applying this rudimentary model, as can be seen in Figure 8-2, the full capacity at PA15-A and OP6 would recover by year 40.

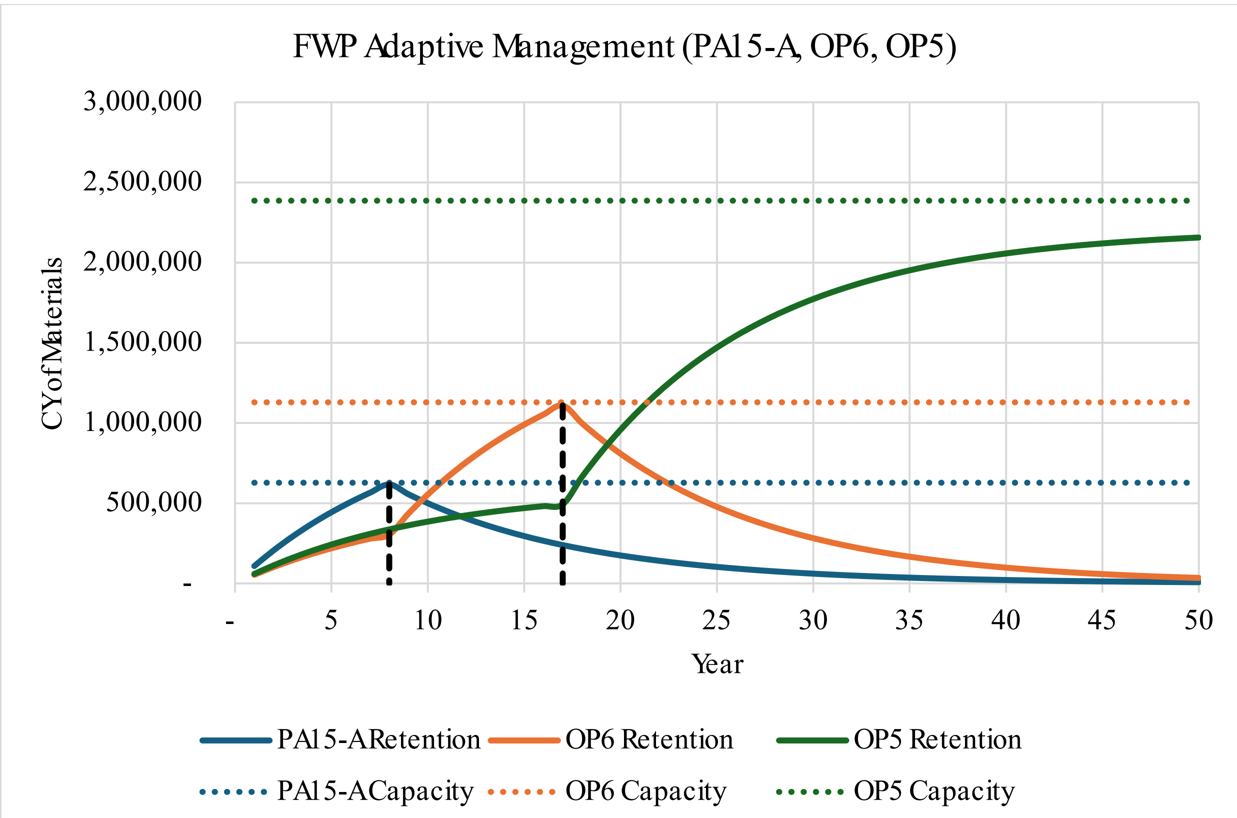


Figure 8-2: Adapting to Capacity Demands at PA15-A, OP6, OP5

This above placement model allows for OP5 to remain in use from years 18-50, as detailed in Table 8-1, without ever hitting capacity.

Table 8-1: Adapting to Capacity Demands at PA15-A, OP6, OP5

Previous PA	New PA	Year of New PA Use	Previous PA Capacity	Stationings
PA15-A	OP6	9	10,654	90+500 to 97+000, 85+500 to 90+500
OP6	OP5	18	19,873	90+500 to 97+000, 85+500 to 90+500, 73+500 to 85+500
OP5	NA	50	229,722	90+500 to 97+000, 85+500 to 90+500, 73+500 to 85+500

In the case of capacity concerns, PA15-A and OP6 materials are easily accommodated by OP5. However, OP8 is more complicated due to its dual-purpose function. OP8/NP6 is planned to receive nearly 1.7 MCY of material from construction of the new channel. In response, the site will immediately approach capacity after the first few years. To mitigate the risk of capacity being exceeded, OP8 materials may be placed at OP9.

Under the same assumptions highlighted previously, redistributing dredged materials between station 97+000 and 108+000 is feasible, demonstrated by Figure 8-3. The employed technique is a rough calculation that intends to provide USACE Operations with a plan to reroute maintenance materials. Ideally, the retention is represented by a constant rate of supply and loss. In reality, dredged material dispersion and the OWPA morpho-dynamics will vary considerably by site and over time.

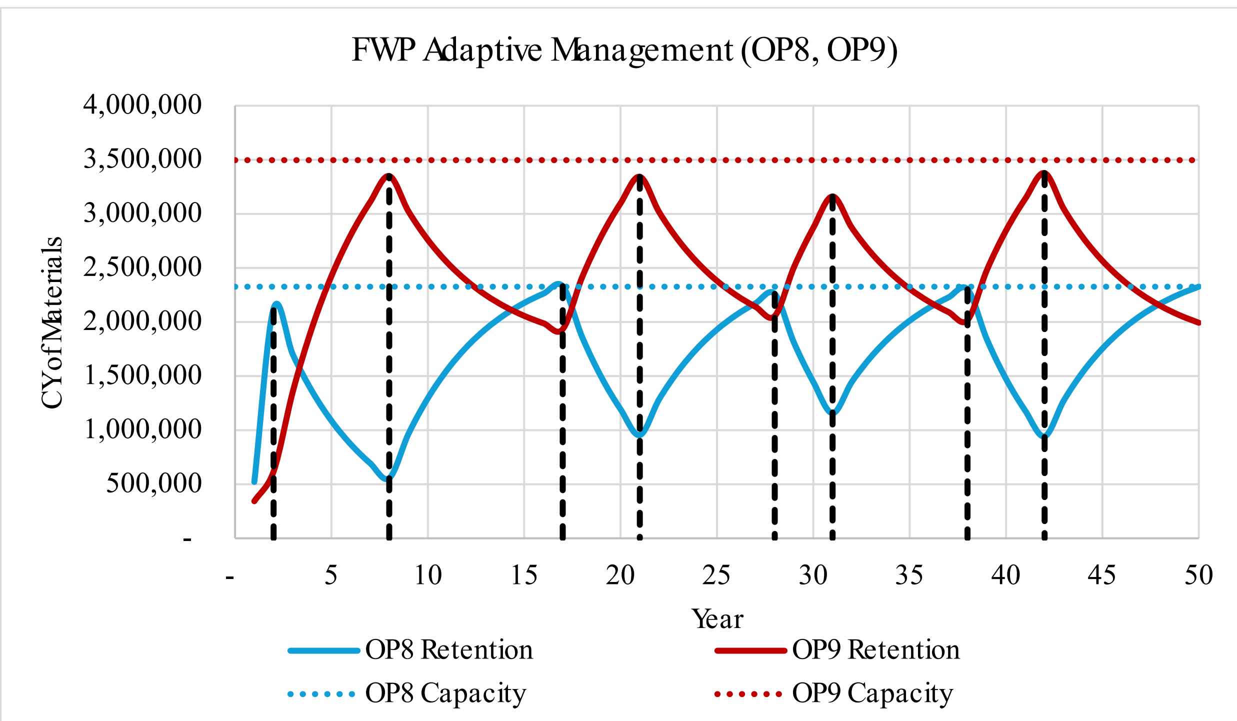


Figure 8-3: Adapting to Capacity Demands at OP8, OP9

As illustrated by Figure 8-3, the spike of NW materials at OP8/NP6 may render the PA unusable shortly after project construction. However, relocating maintenance materials to OP9 is expected to provide 6 years of maintenance relief between stations 97+000 and 108+000. The capacity model assumes that OP9 will receive prescribed volumes for both OP8/OP9 once OP8 nears capacity. Likewise, once OP9 hits capacity, it continues to receive its respective shoaling volume while OP8 retention grows. The only rule in this exercise is that OP8 does not receive shoaling volume designated for OP9 in the 50-yr timeframe (Table 8-2). To provide additional flexibility, contingency PAs are provided in the plan by availability of legacy sites (Table 8-3).

Table 8-2: Adapting to Capacity Demands at OP8, OP9

OP8 Status	OP9 Status	OP8 Stationing	OP9 Stationing	Years
Active	Active	97+000 to 102+000	102+000 to 108+000	1-2
Inactive	Active	N/A	97+000 to 108+000	3-8
Active	Active	97+000 to 102+000	102+000 to 108+000	9-17
Inactive	Active	N/A	97+000 to 108+000	18-21
Active	Active	97+000 to 102+000	102+000 to 108+000	22-28
Inactive	Active	N/A	97+000 to 108+000	29-31
Active	Active	97+000 to 102+000	102+000 to 108+000	32-38
Inactive	Active	N/A	97+000 to 108+000	39-42
Active	Active	97+000 to 102+000	102+000 to 108+000	43-50

Table 8-3: DMMP Placement Area Selection Process

Stationing	Priority Site	Secondary Site	Contingency Sites	Note
-26+000 to -14+000	ODMDS	ODMDS	N/A	No Capacity Concern
-14+000 to 0+000	SE	ODMDS	MP1	No Capacity Concern
0+000 to 20+000	Chester Island	OP1	PA116-B, PA6, MP2	–
20+000 to 25+000	OP1	OP2	PA6, PA7	–
25+000 to 35+000	OP2	OP3	PA7, PA8	–
35+000 to 50+000	OP3	OP2	OP4, PA9	–
50+000 to 73+500	OP4	OP3	PA10, PA11, PA12	Keller Bay open for BU
73+500 to 85+500	OP5	OP6	PA14	Keller Bay open for BU
85+500 to 90+500	OP6	OP5	PA14-A	–
90+500 to 97+000	PA15-A	OP6	OP5, PA15	–
97+000 to 102+000	OP8	OP9	PA16	–
102+000 to 108+000	OP9	PA18/19	N/A	–
108+000 to 118+581	PA 18/19	OP9	N/A	No Capacity Concern

8.2.4 Key Adaptive Management Strategies

When conditions change or a site approaches capacity, the Operations Manager may implement the following pre-approved strategies:

- Flexible Redirection of Material

  The plan allows zero-cost adjustments to the placement scheme. If a primary placement area nears capacity, material can be redirected to a designated alternative site. New sites such as OP9 and OP6 provide contingency capacity with comparable, or only slightly longer, pumping distances, avoiding significant cost increases.

- Management toward Dynamic Equilibrium

  Most open-water placement areas are expected, over time, to reach a dynamic equilibrium in which natural losses from waves and currents balance new deposition. These sites will be monitored and adaptively managed by continuing placement, recognizing that transported material contributes to nourishing the broader bay system.

- Targeted Mitigation for Environmental Resources

  The plan provides for mitigation of incidental impacts to sensitive ecological resources. For example, if monitoring shows impacts to oyster cultches, adaptive measures such as creating new habitat or modifying placement operations will be undertaken.

This adaptive management framework provides a robust, flexible, and data-driven approach to ensure the ship channel can be maintained in a cost-effective and environmentally responsible manner for its entire 50-year project life.

8.3 Future BU Opportunities

The FWP BU plan is conceptual in its current state. With uncertainty regarding the Bird Island design, expansion of Chester Island, and usage of Keller Bay, the DMMP allows for future refinement to accomplish BU goals. Construction materials and design efforts will require collaboration with partners; future improvements to the BU plan have not been fully examined in feasibility. Potential improvements are:

1. Utilize proposed OP9 to provide an ecological benefit for Lavaca Bay.
2. Expand Chester Island to create a comprehensive ecosystem in lower Matagorda Bay.
3. Consider the long-term option of onshore placement at Matagorda Peninsula, as opposed to the nearshore berm (SE).
4. Aid restoration projects, such as those west of the MSC, with outside partners.

The previous 4 concepts are illustrated in the following sections. The intention of feasibility graphics is to define the potential BU enhancements over the 50-yr project life, striving for the USACE 70% goal. Securing the resources for design, materials, and construction necessitates continued coordination between the USACE, NFS, and partners for the next 50-yrs.

8.3.1 OP9 for Shallow Water Habitat

OP9 is proposed in the FWP scenario to accommodate increased maintenance demand. The PA is projected to receive almost 39 MCY of O&M material. With high maintenance volumes, increased retention at OP9 could allow for habitat creation while also reducing channel shoaling.

The DMMP proposes OP9 as an open-water PA; however, future interest in OP9 may allow for BU. A hardened structure, such as a breakwater, and continual supply of dredged material would slowly create shallow-water habitat. In concept, a phased construction is most practical, building underwater berms behind a breakwater (or similar structure) to train materials. The concept is pictured in Figure 8-4.

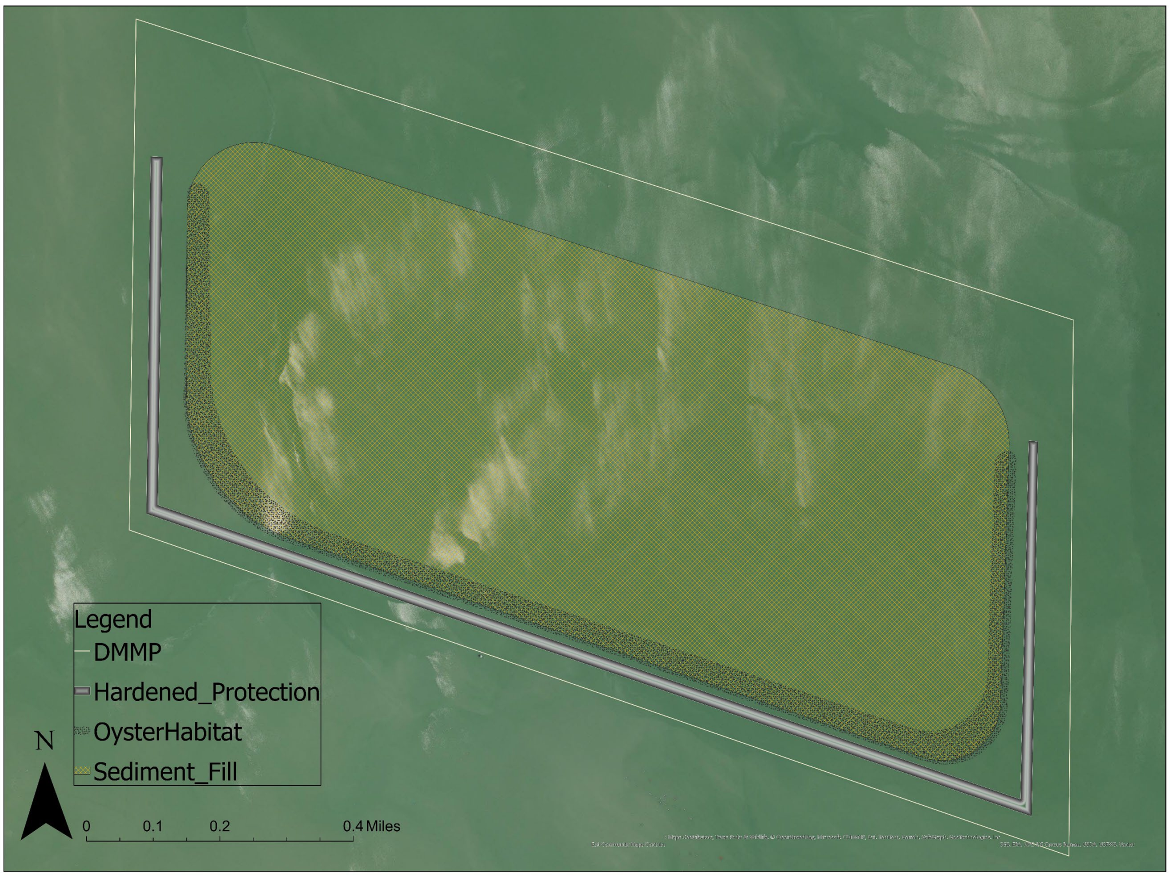


Figure 8-4: Concept use of OP9 as BU

Use of OP9 as BU would substantially increase the beneficial use provided by the project, potentially adding 400-700 acres of viable underwater habitat. Such habitat could be used to recruit oysters or create a series of fringe marshes. The immediate construction of OP9 as BU is rather unlikely. To achieve such a design, hardened structures would be installed in stages. Cultch or shell hash would be used to attract oysters and fish to the site.

Discussion with state and local partners is needed to refine concepts.

8.3.2 Tiered Habitat System at Chester Island

The expansion of Chester Island will likely occur in phases as maintenance materials are made available. Chester Island is set to receive roughly 12.7 MCY of FWP dredged material over 50-yrs. On average, each contract would place 500,000 CY at the BU site. By careful management of dredged material, a tiered habitat design can be constructed over several O&M contracts. A conceptual rendering of Chester Island expansion is shown in Figure 8-5.

Figure 8-5: Concept Expansion of Chester Island

The expansion may feature the following to create a healthy BU habitat with sandy maintenance material:

- Oyster shell or cultch beds to promote oyster recruitment.
- Hardened structures, such as breakwaters, rock sills and weirs, and proprietary concrete modules to provide protection, retain sediments, and control tidal exchange.
- Vegetation plantings in shallow-water habitat to encourage marsh growth.
- High-elevation topographic features to allow for bird nesting.
- Narrow channels to maintain hydraulic connectivity.

Concepts should be refined by partnering with state and local stakeholders.

8.3.3 Beachside and Bayside Erosion Mitigation for Matagorda Peninsula

The existing DA-2 PA site is located to the west of the MSC west jetty (see Figure 1-1). Historically, dredged materials have been placed near DA-2 (on nearby beach) to stabilize the jetty and provide recreational benefit. For the future management of O&M materials, Matagorda Peninsula beachside (MP1) and bayside (MP2) placement sites are recommended as shown in Figure 8-6.

Figure 8-6: Erosion Mitigation by use of MP1 and MP2

Environmental impacts and costs have not been developed for MP1 or MP2; however, the MP1 and MP2 sites are within existing USACE real estate easement. USACE-SWG Engineering and Construction (E&C) Division has expressed interest in the option due to uncertainty regarding the effectiveness of the SE in stabilizing the south jetty, as well as persistent shoreline erosion at proposed MP2. MP1 and MP2 may be utilized at the discretion of the USACE Galveston District OM.

8.3.4 Allow Partner Acceptance of Maintenance Materials for Restoration

Several outside interests have been expressed for restoration efforts west of the MSC. Should future interest continue, the option for dredged material placement in such locations may be desirable, allowing the USACE to achieve BU goals:

- Powderhorn Ranch
- Boggy Bayou Nature Park
- Indianola Shoreline
- Others

Maintenance between stationing 20+000 to 97+000 would likely accommodate the material demand. Such placement would require partner cost sharing.

9 2019 vs 2025

The 2019 DMMP available acreage is compared to the 2025 DMMP for both NW and O&M, not counting the expanded ODMDS, in Table 9-1. The 2025 plan features NW sites in deeper water and the construction of an emergent Bird Island; O&M sites are expanded from 2019.

Table 9-1: 2019 vs 2025 DMMP Acreage

Plan Year	New Work Placement Area (Acres)	O&M Placement Area (Acres)
2019	4,190	3,834
2025	3,202	4,840

The 2019 NW DMMP provided 4,190 acres of footprint. The current plan provides less at 3,202 acres. Though the current plan provides less acreage, PAs are proposed in deeper water, providing sufficient capacity. On the contrary, the updated O&M PA acreage is higher than 2019. This is primarily due to a lower projection of FWP maintenance demand in 2019.

10 Introduction to Dredge Plant

Selecting the appropriate dredging equipment, or “dredge plant,” is critical to both the successful construction and long-term maintenance of the improved navigation channel. The choice depends on factors such as the nature of the material to be removed (e.g., loose sands versus consolidated clays), whether work occurs offshore or within sheltered bay reaches, environmental constraints, and the distance and method of transporting material to placement sites.

For the MSCIP, multiple dredge types will be required to meet the variety of operational needs. The primary equipment will include hydraulic cutter suction dredges and hydraulic hopper dredges, with mechanical clamshell dredges used in limited, specialized situations.

10.1 Hydraulic Cutter Suction Dredge

The hydraulic cutter suction dredge, or cutterhead dredge, is a versatile machine well-suited for dredging in protected or semi-protected waters. It excavates material with a rotating cutterhead, similar to a drill, that breaks up consolidated clays and compacted sands. The loosened material is drawn in through a suction pipe and pumped via floating and submerged pipelines to the designated placement site. The dredge advances by pivoting on vertical spuds anchored to the bay bottom, enabling precise, controlled excavation.

- Typical Use: Cutterhead dredges excel in projects requiring accurate placement of large sediment volumes. They are commonly used to build bird nesting islands, marsh restoration features, and nearshore placement zones. Their ability to pump continuously over long distances makes them highly efficient for these applications.
- MSCIP Application:
  - Construction: Cutterhead dredges will be used throughout the in-bay channel reaches of Matagorda and Lavaca Bays. They will remove new work material from the channel and turning basin and pump it to create the Bird Island beneficial-use feature and fill the new work placement areas (NP 1 - NP 6).
  - Maintenance: For future maintenance cycles, cutterhead dredges will remain the primary equipment for the in-bay reaches, placing material into the designated areas identified in this DMMP.

10.2 Hydraulic Hopper Dredge

The hydraulic hopper dredge is a self-propelled, ocean-going vessel often compared to a hydraulic vacuum cleaner. It dredges while underway using trailing suction pipes, or drag arms, that are lowered to the seafloor. Dragheads at the end of the arms loosen unconsolidated materials such as sand and silt, which are then pumped into large onboard hoppers. Once filled, the vessel transits under its own power to a designated placement area, where the material is discharged through bottom doors or pumped out via pipeline.

- Typical Use: Hopper dredges are particularly effective in high-traffic navigation areas and exposed open-water environments, such as entrance channels, where dredging must be accomplished quickly with minimal disruption to shipping. They are best suited for free-flowing materials and for projects where placement sites are located at a considerable distance from the dredge cut.
- MSCIP Application:
  - Construction: A hopper dredge will be used to construct the Entrance Channel and Jetty Channel improvements. It will remove sandy new work material and transport it offshore for placement within the expanded Ocean Dredged Material Disposal Site (ODMDS) and the Sand Engine (SE) area.

- Maintenance: For future maintenance, the hopper dredge will be the primary equipment for the Entrance and Jetty Channels. These reaches are exposed to ocean wave energy and tidal currents, making the hopper dredge's mobility and high production capacity well suited to maintaining reliable channel depth in these dynamic conditions..

10.3 Mechanical (Clamshell) Dredge

Unlike hydraulic dredges that rely on pumps and pipelines, the mechanical dredge—most commonly the clamshell dredge—excavates material through direct mechanical action. A crane mounted on a barge operates a hinged bucket (the clamshell), which is lowered to the bottom to scoop sediment. The material is then placed into scows or barges for transport to the designated placement area. Although generally slower than hydraulic dredges for large-volume excavation, clamshell dredges provide precision and flexibility in confined or hard-to-reach locations.

- Typical Use: Clamshell dredges are well suited for constrained work zones such as berth pockets, slips, and areas around piers or bridge supports, where precise excavation is essential. They are advantageous for handling coarse, debris-laden, or contaminated material unsuitable for hydraulic systems. Because they generate less turbidity, they are often preferred in environmentally sensitive settings.
- MSCIP Application:
    - Construction: While not intended as a primary excavation tool, a clamshell dredge may be used for specialized work such as debris removal, obstruction clearance, or detailed excavation in restricted areas of the berthing basins where hydraulic dredges are less effective.
    - Maintenance: In future cycles, mechanical dredging may be employed for localized shoal removal near docks, terminals, or other facilities where full-scale hydraulic operations are unnecessary. Including mechanical dredging as an option in smaller maintenance contracts may also broaden competition by enabling participation from smaller firms that specialize in this equipment.

11 References

Brown, G.L. May 2011. Final Draft Report: Relative Sea Level Rise associated with Proposed Matagorda Entrance Channel Modifications: Addressing the Most Recent Corps Guidance, ERDC/CHL Engr. Technical Letter, 11 pp.

Coastal Engineering Manual (6 volumes). February 2002. US Army Corps of Engineers

Coastal Engineering Manual Interactive 2004. Veri-tech Consulting, Vicksburg, MS.

Dunkin, L. M., Coe, L. A., & Ratcliff, J. J. (2018). Corps Shoaling Analysis Tool: Predicting channel shoaling (ERDC/CHL TR-18-16). U.S. Army Engineer Research and Development Center.

Dunkin, L.M. and K.N. Mitchell, 2015, "Quantitative approach to navigation channel asset management," Dredging Summit and Expo 2015, Proc. Western Dredging Association and Texas A&M Dredging Center, 16pp.,https://www.researchgate.net/publication/289502865

EM 110-2-5027 "Confined Disposal of Dredged Material", September 1987, by U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

ER 1110-2-1150 Engineering and Design for Civil Works Project, August 1999

ER 1130-2-520 Navigation and Dredging Operations and Maintenance Policies, November 1996

ER (Engineering Regulation) 1100-2-8162, “Incorporating Sea Level Change in Civil Works Programs”, 31 Dec 2013, 3 pp + 2 Appendices.

ETL (Engineering Technical Letter) 1100-2-1, “Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation,” 30 Jun 2014, 5 Chapters + Appendices A-G.

“Final Geotechnical Data Report Matagorda Bay Ship Channel Improvement Project Matagorda Bay, Texas”, January 2022 by Tolunay-Wong Engineers, Inc (TWEI 2022), Houston, Texas.

Frey, A.E., J. Rosati III, K.J. Connell, H. Hanson, and M. Larson. 2012. “Modeling Alternatives for Erosion Control at Matagorda County, Texas, with GENCADE”, Proc. Intl. Conf. Coastal Engr., American Society of Civil Engineers, 14 pp.

GeoStudio 2021.3, developed by GEO-SLOPE International, Ltd.

GCCPRD Phase 2 Report, 02/23/2016, “Storm Surge Suppression Study”, Gulf Coast Community Protection and Recovery District, 69pp

G&W Surveyors. (2001). *Liquid Cargo Public Dock* (G1.8) [As-built drawing]

Hall, C., Jensen, R. E., Collins, C. O., Hesser, T. J., & Brown, M. E. (2024). US Army Corps of Engineers (USACE) Wave Information Study: 2021 Annual Update (ERDC/CHL CHETN-I-102). U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory. dx.doi.org

Intergovernmental Panel on Climate Change (2007) *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the*

Intergovernmental Panel on Climate Change (S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H. L. Miller, ed.). Cambridge, UK: Cambridge University Press. http://ipcc-wg1.ucar.edu/wg1/wg1-report.html

Kraus, N.C., L. Lin, B.K. Batten, and G.L. Brown, August 2006. Matagorda Ship Channel, Texas: Jetty Stability Study. ERDC/CHL TR-06-7, 165 pp.

Kraus, N.C. and B.K. Batten. May 2008. Morphological Examination of the Stability of Pass Cavallo, Texas. ERDC/CHL TR-08-6, 48 pp.

Lambert, S.S., S.S. Willey, T. Campbell, R.C. Thomas, H. Li, L. Lin, and T.L. Welp. August 2013. Regional Sediment Management Studies of Matagorda Ship Channel and Matagorda Bay System, Texas. ERDC/CHL TR-13-10, 76 pp.

Lin, L., Islam, M.S., White, T.E. 2018. Hydrodynamic and Salinity Modeling for Matagorda Ship Channel (MSC) Improvement Project. ERDC Letter Report, US Army Corps of Engineers, U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS.

Maynord, S.T., W.C. Seabergh, L. Lin, N.C. Kraus, and D.W. Webb. October 2007. “Evaluation of Risks to Navigation for the Matagorda Ship Channel Entrance,” ERDC/CHL-TR-?, ? pp.

Maynord, S.T., L. Lin, N.C Kraus, D.W. Webb, G. Lynch, R.E. Wahl, D.A. Leavell, D.E. Yule, and J.B. Dunbar. August 2011, Risks to Navigation at the Matagorda Ship Channel Entrance, Texas, Phase 2: Evaluation of Significant Risk Factors. ERDC/CHL TR-11-8, 257 pp.

Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., (2014): Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.

Mott MacDonald. (2019). Magnolia Beach erosion protection feasibility study: Phase 1 Calhoun County, TX.

Mott MacDonald. (2022). Matagorda Ship Channel Improvement Project - Due Diligence Report

Mustang Engineering. (1999). *Point Comfort to Green Lake* (9105-A) [As-built drawing]

National Oceanic and Atmospheric Administration. (2025). *Tides and Currents: Maps*. Tides and Currents. https://tidesandcurrents.noaa.gov/maps.html

Parris, A., P. Bromirski, V. Burkett, D. Cayan, M. Culver, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss (2012) *Global Sea Level Rise Scenarios for the U.S. National Climate Assessment*. NOAA Technical Report OAR CPO-1. Washington, DC: National Oceanic and Atmospheric Administration, Climate Program Office. http://cpo.noaa.gov/Home/AllNews/TabId/315/ArtMID/668/ArticleID/80/Global-Sea-Level-Rise-Scenarios-for-the-United-States-National-Climate-Assessment.aspx

Permanent International Association of Navigation Congress (PIANC), Supplement to Bulletin No.57, 1987. “Guidelines for the Design and Construction of Flexible Revetments Incorporating Geotextiles for Inland Waterways", Report of Working Group 4 of the Permanent Technical Committee I.

Peterson, T.C., R. Heim, R. Hirsch, D. Kaiser, H. Brooks, N. Diffenbaugh, R. Dole, J. Giovannettone, K. Guirguis, T. Karl, R. Katz, K. Kunkel, D. Lettenmaier, G. McCabe, C. Paciorek, K. Ryberg, S. Schubert, V. Silva, B. Stewart, A. Vecchia, G. Villarini, R. Vose, J. Walsh, M. Wehner, D. Wolock, K. Wolter, C. Woodhouse, D. Wuebbles (2013)

Monitoring and Understanding Changes in Heat Waves, Cold Waves, Floods, and Droughts in the United States: State of Knowledge. Bulletin of the American Meteorological Society, Volume 94, 821-834 pp. doi: 10.1175/BAMS-D-12-00066.1

PIANC Maritime Navigation Commission. 2014. Harbour Approach Channels Design Guidelines. PIANC Report No. 121, 320 pp.

PIANC, 2008, Report No. 102, “Minimising harbour siltation”, The World Association for Waterborne Transport Infrastructures, 76 pp.

Puckette, T. March 2006. Data Report – Matagorda Bay Field Data Collection. Evans-Hamilton, Inc., EHI Project No. 5503, 561 pp. + Data CD.

Puckette, T., October 2017. Data Report – Matagorda Bay Field Data Collection. Unpublished additional Data CD of ADCP Transects. Trap.Puckette@rpsgroup.com

Ratzlaff, K.W., 1982, “Land Surface Subsidence in the Texas Coastal Region”, Texas Department of Water Resources Report #272.

Rosati III, J., A.E. Frey, M.E. Brown, and L. Lin. April 2011. Analysis of Dredged Material Placement Alternatives for Bottleneck Removal, Matagorda Ship Channel, Texas. ERDC/CHL TR-11-2, 49 pp.

Schiereck, G.J., 2004, "Introduction to Bed, Bank and Shore Protection.”" Spon Press.

Shore Protection Manual (Volume 1). 1984. U.S. Army Corps of Engineers.

URS Corporation. 2014a (July revision). DRAFT Section 204(f) Feasibility Report – Matagorda Ship Channel Improvement Project, 219 pp.

Sorensen, R.M. and J.R. Weggel, “Development of Ship Wave Design Information”, Chapter 216, Proceedings, 27th International Conference on Coastal Engineering, 1984.

Sorensen, R.M., 1997, “Prediction of Vessel-Generated Waves with Reference to Vessels Common to the Upper Mississippi River System””. Prepared for US Army Corps of Engineers.

URS Corporation. 2014b (July revision). Engineering Appendix ‐ Matagorda Ship Channel Improvement Project, 1366 pp.

URS Corporation, Section 204(f) Feasibility Report for Matagorda Ship Channel Improvement Project, July 2014

U.S. Army Corps of Engineers. (n.d.). *Sea Level Analysis Tool*

USACE. 1983. EM 1110-2-5025. Dredging & Dredged Material Disposal. Washington, D.C.

USACE, 1990, EM 1110-1-1904. Settlement Analysis, Washington, D.C.

Washington, D.C. USACE EM 1110-2-1913 Design and Construction of Levees (30 April 2000)

U.S. Army Corps of Engineers. 1989. Matagorda Ship Channel, Texas ‐ Reconnaissance Report.

U.S. Army Corps of Engineers. May 2006. Hydraulic Design of Deep-Draft Navigation Projects. EM 1110-2-1613, Ch 1-13 & App A-E.

U.S. Army Corps of Engineers. 2011. Matagorda Ship Channel, Texas ‐ Compilation of Studies on the Entrance Channel through Matagorda Peninsula. Final Report, 182 pp.

U.S. Army Corps of Engineers (2013) *Coastal Risk Reduction and Resilience*. CWTS 2013-3. Washington, DC: Directorate of Civil Works, U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers. July 2015. Vertical Datum Conversion: MLT to MLLW ‐ Matagorda Ship Channel. Engineering Documentation Report, 16 pp.

U.S. Army Corps of Engineers. December 2016. Matagorda Ship Channel Feasibility Study Project Management Plan, 37 pp. US. Army Corps of Engineers, June 2016. Sabine to Galveston Feasibility Draft Report.

U.S. Army Corps of Engineers, Galveston District. (2019, August). Matagorda Ship Channel improvement project, Port Lavaca, Texas: Final integrated feasibility report and environmental impact statement

Washington, D.C. USACE EM 1110-2-1902 Slope Stability (31 Oct 2003)

Washington, D.C. USACE EM 1110-2-5025 Dredging and Dredged Material Management (31 July 2015)

Waterway Simulation Technology, Inc. April 2014. Proposed Deepening and Widening of the Matagorda Ship Channel, Texas ‐ A Ship Maneuvering Simulation Study, 87 pp.

Weiser, E.A., 1962, “Design of Matagorda deep draft channel”, Proc. 8th International

Conference on Coastal Engineering, ASCE, 17 pp.

Wise, Larry, 10/4/2006. Matagorda Navigation Channel - Shoreline Impact Analysis, reprinted as Appendix G in Moffatt & Nichol (2006a).

Wood, E., T. Campbell, M. Duke, L. Olson, L. Dunking, and L. Lin. June 2017. Identification of Alternatives to Reduce Shoaling in the Lower Matagorda Ship Channel, Texas. ERDC/T

WTS/MITAGS, April 2014, Waterway Simulation Technology, Inc., "Proposed Deepening and Widening of the Matagorda Ship Channel, Texas - A Ship Maneuvering Simulation Study", 87 pp.